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December 12, 2016

Mr. Jeff Walker
Executive Administrator
Texas Water Development Board
1700 North Congress Avenue
P.O. Box 13231
Austin, TX 78711-3231

Via Hand Delivery

RECEIVED
DEC 12 2016
TEXAS WATER DEVELOPMENT BOARD

Re: Petition Appealing Desired Future Conditions Adopted by Lone Star GCD

Dear Mr. Walker,

Please find attached a petition from the Cities of Conroe and Magnolia, Texas, which was received by the Lone Star Groundwater Conservation District ("District") on December 2, 2016, appealing the desired future conditions adopted by the District. As required by Section 36.1083, Water Code, the District hereby submits this copy of the petition not later than the 10th day after its receipt to the Texas Water Development Board to conduct its review and study as prescribed by the statute.

If you have any questions related to this submission, please do not hesitate to contact me at your convenience.

Sincerely,

Brian L. Sledge
Legal Counsel for the District

Attachment

CC: Ms. Kathy Turner Jones, General Manager
Mr. Richard Tramm, Board President

CITY OF CONROE, TEXAS; CITY OF MAGNOLIA, TEXAS; CITY OF MONTGOMERY, TEXAS,	§	COPY
	§	
	§	
	§	
***Plaintiffs*,**	§	**PURSUANT TO TEXAS WATER CODE SECTION 36.1083**
	§	
v.	§	
	§	
	§	
LONE STAR GROUNDWATER CONSERVATION DISTRICT,	§	
	§	
Defendant.	§	

PETITION OF THE CITIES OF CONROE AND MAGNOLIA, TEXAS APPEALING DESIRED FUTURE CONDITIONS OF GMA 14 ADOPTED BY LONE STAR GROUNDWATER CONSERVATION DISTRICT

To the Lone Star Groundwater Conservation District, by and through its Board of Directors, Richard J. Tramm, Sam W. Baker, M Scott Weisinger P.G., Jim Stinson, P.E., John D Bleyl, P.E., Jace Houston, Roy McCoy, Jr., Rick Moffatt, and W. B. Wood, and General Manager, Kathy Turner Jones, 655 Conroe Park North Drive, Conroe, Texas 77303:

1. The Cities of Conroe and Magnolia, Texas (collectively, the "Cities"), acting pursuant to Texas Water Code Section 36.1083, file the following Petition appealing the Desired Future Conditions ("DFCs") applicable to Groundwater Management Area 14 ("GMA 14") adopted by Lone Star Groundwater Conservation District (the "District") on August 9, 2016. The Cities hereby appeal the District's DFCs because they are unreasonable in all respects. The Cities seek all the rights available to them under Section 36.1083, as well as the Texas and United States Constitutions and other applicable rules of law.

2. Pursuant to Section 36.1083, the District is required to contract with the State Office of Administrative Hearings ("SOAH") to conduct a contested case hearing on the "reasonableness" of the DFCs for Montgomery County, Texas, adopted by the District.

3. The DFCs, proposed by water regulators and their consultants and attorneys who historically have strived to impose more complicated and restrictive regulation of groundwater, and then rubber-stamped by groundwater conservation districts such as the District, will have significant detrimental effects on the Cities, which operate municipal water systems, private property owners who own the groundwater, and all other water users in the area subject to the District's regulatory effects—in this case Montgomery County, Texas. As the Texas Legislature's Sunset Commission foresaw in its December 2010 *Decision on the Texas Water Development Board*, DFCs "can directly affect the amount of groundwater available for use" by landowners and water producers, who then will suffer "significant harm from the loss of available groundwater." That is what Montgomery County faces as a result of GMA 14's DFCs for Montgomery County, which the District adopted without change. If the District's DFCs are not invalidated as unreasonable—as they clearly should be—the District will rely on them to justify continued, and likely even greater, more severe, and unjustified

restrictions on use of the abundant groundwater that underlies Montgomery County for many years to come.

I. BACKGROUND

A. The Cities

4. The City of Conroe is a home-rule municipality located within Montgomery County, Texas. Unlike groundwater conservation districts, as a home-rule city, Conroe derives its powers from the Texas Constitution, not the Legislature. *See, e.g., City of Galveston v. State*, 217 S.W.3d 466, 469 (Tex. 2007); *State v. Portillo*, 314 S.W.3d 210, 214 (Tex. App.—El Paso 2010, no pet.) ("powers of home-rule city encompass all of the powers of the state not inconsistent with the Constitution, the general laws, or the city's charter"). Article XI, § 5 of the Texas Constitution was intended to give home-rule cities "full authority to do anything the legislature could theretofore have authorized them to do." *Forwood v. Taylor*, 214 S.W.2d 282, 286 (1948). Home-rule cities have "full power of self-government" and only look to the legislature for limitations on those powers. *Forwood*, 214 S.W.2d at 286. Since a home-rule city has such broad, constitutionally-granted power, it then follows that a state agency may not abrogate those rights without consequence.

5. Conroe is the largest city within Montgomery County and one of the fastest-growing cities of its size in the United States. There are reliable estimates

that by 2030, Montgomery County will have one million residents, many of whom will live in Conroe. The Conroe city government is responsible for providing ample supplies of water, at reasonable costs, to its current and future residents. Although the District's regulations now force Conroe to purchase more than half its water from the San Jacinto River Authority, Conroe is still the second largest producer of groundwater in Montgomery County. As a result of the District's restrictions of Conroe's groundwater production, the water bills of Conroe's residents have nearly doubled in the past year. Conroe owns water wells that are permitted by the District, as well as land and water rights within Montgomery County. Conroe is an "affected person" as defined in 31 T.A.C. § 356.10(1).

6. During the GMA 14 DFC process, Conroe sought to be heard. For examples, it sent the letter dated May 5, 2015, signed by its then-Mayor and approved by its City Council,[1] and the report, titled "Evaluation of Desired Future Conditions for the Gulf Coast Aquifer within GMA 14," dated September 2015,[2] to the representatives of all groundwater conservation districts comprising GMA 14. Nothing that Conroe (or any other participants in the GMA 14 process except the professional groundwater regulators and their pro-regulation consultants) said or did had any effect on GMA 14's DFCs.

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[1] *See* Exhibit B attached hereto and incorporated by reference.

[2] Exhibit K to this Petition is the Affidavit of Robert D. Harden ["Harden Affidavit"]. The Cities incorporate by reference, as if set forth verbatim herein, the Harden Affidavit, including all attachments thereto. The above-referenced September 2015 report was authored by Mr. Harden; a true and correct copy of that report is attached as Exhibit 4 to the Harden Affidavit.

7. The City of Magnolia is a smaller, but also fast-growing, city located within Montgomery County. Magnolia continues to supply its residents with water produced from water wells. Nevertheless, due to the District's regulations, which have caused Magnolia to have pay large (and increasing) "pumpage fees" to the San Jacinto River Authority, Magnolia's water bills to its citizens have also nearly doubled. Magnolia owns water wells that are permitted by the District, as well as land and water rights within Montgomery County. Magnolia is an "affected person" as defined in 31 T.A.C. § 356.10(1).

B. <u>The District and GMA 14</u>

9. The District is a groundwater conservation district that is subject to Chapter 36 of the Texas Water Code and that has jurisdiction over Montgomery County only. No major aquifer underlying Montgomery County is confined to Montgomery County only. Indeed, the three major aquifers—the Jasper, Chicot, and Evangeline—underlie all or parts of numerous counties in the Northern Texas Gulf Coast area. The aquifers know nothing about county lines on the surface. Groundwater freely flows across county boundaries, and pumping in one county affects the aquifers in other counties, some of which have their own groundwater conservation districts, but some do not.

10. Although the District has never grasped this fact, it is a governmental unit with limited powers. Unlike Conroe, a home rule city, the District's powers

are limited to those expressly enumerated in its governing statutes, and it may exercise only the authority the Legislature clearly granted to it. *See, e.g., Tri-City Fresh Water Supply Dist. No. 2 v. Mann*, 142 S.W.2d 945, 948 (Tex. 1941); *S. Plains Lamesa RR, Ltd. v. High Plains Underground Water Conservation Dist. No. 1*, 52 S.W.3d 770, 776 (Tex. App.—Amarillo 2001, no pet.).

11. Recognizing the folly of allowing individual, often-single county, groundwater conservation districts to attempt to develop DFCs for aquifers underlying much larger areas, the Legislature provided for joint planning in groundwater management areas ("GMAs") delineated by the Texas Water Development Board ("the Board" or "TWDB") as "areas suitable for management of groundwater resources." TEXAS WATER CODE § 35.004(a). Presently, the Board has designated sixteen GMAs, each covering a different aquifer, distinct part of an aquifer, or a group of aquifers serving a particular part of the State.

12. One of those GMAs is GMA 14, which covers the major aquifers in the large area of Texas known as the Northern Gulf Coast Aquifer System. The area covered by GMA 14 includes all of the following counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington. Groundwater conservation districts within a GMA are required to designate a representative of that district to the GMA. For example, the District

designated its executive director, Ms. Kathy Turner Jones, to represent it on GMA 14. During GMA 14's recent DFC process, Ms. Jones served as GMA 14's presiding officer, and GMA 14 held most, if not all, of its meetings at the large, new headquarters building the District built for itself in Conroe.

13. The Legislature assigned GMAs the task of proposing DFCs "for the relevant aquifers within the management area." TEXAS WATER CODE § 36.108(d). The DFCs proposed were supposed to "provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area." TEXAS WATER CODE § 36.108(d-2). As will be explained below and in the contested case hearing requested by this Petition, the District's adopted DFCs completely failed to carry out this joint planning task.

C. <u>The DFCs</u>

14. GMA 14 ultimately proposed,[3] and the District adopted, two sets of DFCs for each of the major aquifers serving Montgomery County. (*See* Resolution #16-006, attached hereto as Exhibit A). GMA 14's process did not start out to produce two sets of DFCs. Directly contrary to its mandate under the Water Code, GMA 14's consultants appear to have run a computer simulation named the "Houston Area Groundwater Model" to calculate DFCs for each aquifer on a

[3] GMA 14's Resolution 2016-01 is attached to this Petition as Exhibit G.

county-by-county basis, and then later in its process did something to consolidate or average the county-by-county DFCs to come up with DFCs for the aquifers underlying GMA 14 as a whole. The Cities will need to take discovery from GMA 14's consultants to understand what they did in greater detail. The Desired Future Conditions Explanatory Report ["Explanatory Report"] authored by GMA 14's consultants seems intentionally vague about the exact processes they followed.

15. To illustrate the impracticability of the DFCs GMA 14 proposed, and the District adopted, for Montgomery County, consider the following table which compares, for the Jasper Aquifer, the DFCs proposed for (a) GMA 14 as a whole, (2) Montgomery County, and (3) the counties contiguous to Montgomery County for which separate DFCs were established. Note that no limiting DFC was established for Harris County, the most populous county within GMA 14, and the contiguous county with the longest border with Montgomery County. All of these DFCs are stated as being from "estimated year 2009 conditions," and are expressed as "not-to-exceed average drawdowns in approximate feet after 61 years:"

Jasper Aquifer

All of GMA 14	66.2
Montgomery County	34
Liberty County	120
Harris County	No DFC
Walker County	42
Grimes County	52

Walker County	42
San Jacinto County	108

16. As is obvious, Montgomery County, the most populous and fastest-growing county for which GMA 14 proposed a single-county DFC for the Jasper Aquifer, has the most restrictive DFC of any of its contiguous counties. In neighboring Liberty County, for example, groundwater producers may produce sufficient groundwater to draw the Jasper aquifer down 120 feet over the 61-year period; but for producers in Montgomery County, the District will regulate to prevent average drawdown in the Jasper greater than 34 feet over the same period. There is no barrier in the Jasper along the border between Montgomery and Liberty Counties. Nothing prevents the Jasper underlying Montgomery County from being drained by pumping in Liberty County, and the same is doubly true of pumping in contiguous Harris County, for which GMA 14 did not establish single county DFCs.

17. To illustrate the absurdity of the DFC for all of GMA 14 as a whole, if one takes the simple arithmetic average of the Jasper DFCs for the six counties shown in the table above, the answer is 66.3, very close to the supposed GMA 14 DFC of 66.2. But that "average" is meaningless. The single-county DFCs for the Jasper Aquifer range from 34 to 120. If the 66.2 all-GMA DFC were meaningful, there would be no reason why it could not serve as the DFC for the Jasper for Montgomery County rather than the more restrictive single-county DFC of 34 feet.

If the Montgomery County DFC limiting drawdown to 34 feet in the Jasper is not invalidated, the District will continue to adopt rules written to achieve that restrictive DFC within Montgomery County, without regard to the DFC for GMA 14 as a whole, and without regard to the resulting drainage of Jasper Aquifer water, which is the private property of Montgomery County landowners, to other counties surrounding Montgomery County.

18. Similar analyses can be done for the other major aquifers underlying Montgomery County—the Chicot and Evangeline. For examples, the DFC for Montgomery County for the Chicot is an average 26 feet drawdown in 61 years, and for the Evangeline is actually an average 4 feet increase in levels over the next 61 years. But Waller County, contiguous to Montgomery, has DFCs allowing 39 feet of average drawdown over 61 years in both aquifers. The DFCs for neighboring Liberty County allow average drawdowns of 27 feet in the Chicot and 29 feet in the Evangeline. Again, the movement of groundwater through these aquifers is not influenced by county boundary lines.

19. Thus, the approach followed by GMA 14 in setting county-by-county DFCs, which the District adopted for Montgomery County, explicitly ignores the fact that groundwater is moving between groundwater conservation districts and the counties of GMA 14. This movement of groundwater between groundwater conservation districts means that no one district in GMA 14 can actually "manage"

the groundwater, including the protection of property rights of all owners overlying the common reservoir, without considering the geohydrologic conditions of the aquifers, the natural and lateral boundaries present, and the effects of production. The District has consciously ignored undisputed hydrological facts to reach the disparate DFCs it adopted.

20. GMA 14 did not propose a DFC for subsidence in Montgomery County, and the District did not adopt one, although such DFCs were established for some of the contiguous counties. With a few localized exceptions along the border between Harris and Montgomery Counties, subsidence is not an issue in Montgomery County, and it is no issue at all for the Jasper Aquifer.

II. SUMMARY OF WHY THE DFCS ARE UNREASONABLE

21. In this section of this Petition, the Cities will summarize, in general, the major reasons why the DFCs adopted by the District are unreasonable. In later sections of this Petition, the Cities will plead with greater particularly and identify evidence they now have that the DFCs are unlawful, confiscatory, and otherwise unreasonable. The Cities seek to take discovery prior to the contested case hearing on unreasonableness. In summary form, the DFCs are unreasonable for at least each of the following reasons. The Cities reserve the right to expand on these reasons and prove additional reasons after discovery, and in the contested case hearing.

A. **<u>The Water Code does not authorize DFCs based on county boundaries absent proof that county boundaries have a scientific relationship to the aquifers</u>.**

(1) The Texas Water Code does not authorize GMA 14 or the District to adopt or enforce DFCs on a county-by-county basis, based on county lines which have no scientific relationship to the underlying aquifers. It makes no logical—and certainly no scientific—sense to restrict Montgomery County to restrictive DFCs and resulting severe groundwater production limits, when its contiguous counties, served by the same aquifers, have far less restrictive DFCs. The inevitable result will be unlawful confiscation, *i.e.*, the government's taking of private property from Montgomery County groundwater owners and the giving of that property to owners in adjacent counties. This is prohibited by the Constitution, and thus unreasonable. *See, e.g., Marrs v. Railroad Commission*, 177 S.W.2d 941 (Tex. 1945) (government must treat owners of oil and gas in the same reservoir equally).

(2) Contrary to the exceedingly weak arguments in the Explanatory Report, there is no authority in the Water Code for DFCs on a county-by-county basis, with no showing of a scientific relationship between county boundaries and any characteristics or conditions of the underlying aquifers.

(3) The governing statute, Texas Water Code § 36.108(d-1), states that "the districts [in a GMA] may establish different desired future conditions for:

(1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or part within the boundaries of the management area; or

(2) each geographic area overlying an aquifer in whole or part or subdivision of an aquifer within the boundaries of the management area."

(4) Section 36.108(d-1) intends DFCs to be based on hydrological or geological conditions or characteristics of groundwater reservoirs so that reservoirs may be scientifically managed, not on political subdivision lines that have nothing to do with reservoir boundaries, conditions, or characteristics. The statute does not contain the phrase "political subdivision," even though the Legislature defined that phrase twice in Chapters 35 and 36 of the Texas Water Code, and knows how to use it when it means "political subdivision." *See* TEX. WATER CODE §§ 35.002(13), 36.001(15). Had the Legislature intended that DFCs could be established for "political subdivisions," it would have said so, but it did not because it makes no sense to establish DFCs on a "political subdivision" basis. *E.g., In re Ament*, 890 S.W.2d 39, 41 (Tex. 1994) ("In a 'statutory construction' sense, omissions [] are presumed to be intentional.").

(5) The Explanatory Report claims the phrase "each geographic area overlying an aquifer in whole or part" authorizes GMAs, and thus the District, to establish DFCs on a county-by-county basis. The argument is wrong for at least three reasons. *First*, this argument proves too much. If GMAs, composed of its district members, can arbitrarily select counties as a "geographic area," presumably they could select city boundaries, U. S. Postal Service ZIP Codes, or any other areas on the surface that have no scientific relationship to the subject matter of a DFC—aquifers. GMA 14's argument would render the rest of Texas Water Code § 36.108(d-1) meaningless. Under this supposed interpretation of "geographic areas," GMAs could base DFCs on any surface area.

(6) *Second*, the Board's staff has said, in a written directive, that DFCs may be established on the basis of the boundaries of political subdivisions only if those boundaries happen to coincide with "substantial and discernable differences in uses or conditions" within the GMA. (*See* Memorandum to Members of the Texas Water Development Board from the Board's Director of Groundwater Resources and General Counsel, March 10, 2010, submitted herewith as Exhibit H). The Board staff continued: "It should be emphasized that employing geographic areas that are not based on clear and substantial differences in uses or aquifer conditions is not supportable, regardless of how those geographic areas are drawn," and that GMAs cannot use "county or other political subdivision lines to gerrymander DFCs for purposes other than accommodating discernable, substantial differences in uses or aquifer conditions with the GMA." (*Id.* at 2-3). Of course, there is nothing in the Explanatory Report showing or even suggesting that GMA 14, or the District, attempted to identify "discernable, substantial differences in uses or aquifer conditions" at all, much less any effort to establish that those differences happen to coincide with the boundaries of the twenty counties within GMA 14.

(7) *Third*, Mr. William F. Mullican, III, a consultant who apparently was the principal author of the Explanatory Report, elsewhere has defined "geography" for the purpose of elucidating "geographic area" within Section 36.108(d-1)(2) as "the physical characteristics, especially the surface features, of an area."[4] In a widely-distributed paper, Mr. Mullican and his co-authors did not suggest that county or other political subdivision boundaries could be used as a "geographic area overlying an aquifer in whole or part" under the statute.

B. The DFCs fail to protect, and in fact will destroy, private property rights.

(1) In Texas, groundwater is a protected private property interest. Landowners, including the Cities, own absolute title to groundwater in place beneath the land they own. *Edwards Aquifer Authority v. Day*, 369 S.W.3d 814, 831-32 (Tex. 2012). Chapter 36 of the Texas Water Code, from which the District derives its existence and authority, expressly recognizes and adopts the common law rule vesting ownership of groundwater in landowners. TEX. WATER CODE § 36.002. Section 36.002 states in pertinent part that a landowner, including lessees

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[4]R. Mace, R. Petrossian, R. Bradley, W. Mullican & L. Christian, *A Streetcar Named Desired Future Conditions: The New Groundwater Availability for Texas (Revised)* at 4 n.24 (May 8-9, 2008).

and assigns, "owns the groundwater below the surface of the landowner's land as real property'' and that "[n]othing in this code shall be construed as granting the authority to deprive or divest a landowner, including a landowner's lessees, heirs, or assigns, of the groundwater ownership and rights described by this section." TEXAS WATER CODE § 36.002(a), (c).

(2) By statute, the districts in GMA 14, including the District, are required to consider the impact of proposed DFCs on private property, including ownership and the rights of management area landowners and their lessee and assigns in groundwater. TEXAS WATER CODE § 36.108(d)(7). As discussed more particularly in Section IV below, the District failed to consider the impact of proposed DFCs on private property, including ownership and the rights of management area landowners and their lessee and assigns in groundwater. The adopted DFCs will damage or destroy private property. The District may not regulate as if it owns the Gulf Coast Aquifer lying beneath Montgomery County or that its mandate is to apportion rights to withdraw water from that aquifers. The District should recognize, but clearly does not, that it may regulate, but does not own, and cannot by regulation destroy, private real property rights in groundwater.

(3) The District's DFCs for Montgomery County are based on the District's self-imposed, reverse-engineered 64,000 acre-feet per year production restriction (explained in greater detail below). This artificial restriction on groundwater production, lacking any legitimate technical or scientific basis, is not a reasonable method of groundwater management because it destroys the market for water rights in Montgomery County and thereby destroys the value of privately-owned groundwater rights through the District's borders. Landowners are entitled to sever water rights from their land and sell those rights to others; thus, water rights can have substantial value to private landowners. In the ordinary course, for example, if the Cities needed additional groundwater to serve their residents, they could negotiate a purchase of, or exercise eminent domain to acquire, additional water rights and then drill new, permitted wells to produce groundwater. The District's DFCs preclude the Cities from satisfying their residents' need for additional water by purchasing water rights. If prospective buyers of groundwater rights are prohibited, by government regulation, from purchasing groundwater rights, government has thereby destroyed the value of potential sellers' groundwater rights. Government may not destroy the market for groundwater rights without thereby destroying the value of the water rights.

C. GMA 14 did not consider, and affirmatively disregarded, the Board's Report on the Total Estimated Recoverable Storage of aquifers within GMA 14.

Section 36.108(d)(3) of the Texas Water Code expressly *requires* GMAs to consider "hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator" of the Board. Board regulations define "total estimated recoverable storage" ("TERS") as "the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25% and 75% of the porosity-adjusted aquifer volume." 31 T.A.C. §356.10(23). On June 9, 2014, the Board published its report titled "GAM Task 13-037: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 14." (*See* Exhibit I hereto). But despite the statutory requirement that GMA 14 "shall consider" the Board's TERS, GMA 14 declared TERS irrelevant to its contrived process for developing DFCs and in stark violation of Section 36.108(d)(3), paid TERS no attention. GMA 14's Explanatory Report states that "TERS has no practical application in the GMA 14 joint-planning process or in groundwater management of the Gulf Coast Aquifer System." (Explanatory Report at 81). The District's DFCs are unreasonable because the District declared irrelevant one of the nine mandatory statutory factors.

D. <u>GMA 14's backwards, reverse-engineered approach is not based on the best available science and fails to meet the statutory criteria.</u>

(1) The DFCs approved by GMA 14, and later adopted by the District, are not based on the best available since relating to the Gulf Coast Aquifer. The DFCs for Montgomery County are supposedly based on computer simulation models but, when examined in greater detail, were truly "reverse engineered" in order to contrive DFCs that justify the District's unscientific and terribly-misguided obsession to restrict groundwater production in Montgomery County to 64,000 acre-feet per year. Although the original basis for the District's 64,000 acre-feet limitation is uncertain and has been difficult to determine, the District has enshrined that number in each of its Groundwater Management Plans. The District's recharge estimate appears to be based on a simplistic calculation of rainfall that makes its way to each acre of surface over of the aquifers multiplied by the acres in the county, without regard for the size of the recharge zones of the separate aquifers or inflows from other counties.

(2) During GMA 14's DFC process, it appears that the District provided its 64,000 acre-feet limitation to GMA 14's consultants and instructed those consultants to propose DFCs for Montgomery County that justify the District's continued use of that number. For examples, the minutes of GMA 14's meeting for June 26, 2013, attached to GMA 14's Explanatory Report, state that a GMA 14 consultant "pointed out that to adjust the pumpage to match a particular DFC would be very work intensive," and "[t]he more direct method would be to review the pumpage figures and projected demands for each entity and once agreed upon, put those numbers into the model and determine the resulting DFCs." (*See* Harden Aff. at Ex. 9 thereto). That is apparently what the consultants did. The minutes of GMA 14's meeting for April 30, 2014, also attached to the Explanatory Report,

report that "Lone Star GCD wishes to pursue an additional model run to better align the pumpage package with the currently regulatory plan for the district." (*See* Harden Aff. at Ex. 10 thereto). The DFCs, born from the District's self-imposed and arbitrary restriction of groundwater production in Montgomery County to 64,000 acre-feet per year, lack any technical basis. (*See* Harden Aff. at ¶ 19).

(3) The Explanatory Report is a futile attempt to mask the true nature of the District's reverse-engineered DFCs. While the origin of the District's DFCs is well-documented as being the District's supposed annual recharge estimate (*i.e.*, 64,000 acre-fee per year), the Explanatory Report seeks to support the DFCs for Montgomery County based on different (albeit equally unsupported and conclusory) justifications. GMA 14's consultants claim in the Explanatory Report, without any supporting evidence or study, that "[w]ithout preservation of [] artesian pressure, the costs of drilling a well, equipping the well, lifting the water to the surface, the huge impacts to well yields, and in some cases water quality degradation would simply render the option of a water well economically infeasible to most landowners as a source of water supply." (Explanatory Report at 29). So GMA 14, which includes the District, is hanging its hat on "economics" with the claim that further reduction of artesian pressure would require "huge" costs, but GMA 14 offers no actual science. For instance, it makes no comparison of aquifers. The Jasper has much more artesian pressure than the Evangeline.

There is no legitimate hydrologic or engineering reason why the Jasper production should be reduced like the Evangeline. Based on "artesian pressure," these two aquifers should be regulated independently. The focus on maintaining artesian pressure for the benefit of some (principally existing) well owners results in confiscating the private property interest in groundwater from many in order to confer a speculative benefit on only some.

III.
THE DISTRICTS OF GMA 14, INCLUDING THE DISTRICT, IMPROPERLY ESTABLISHED MULTIPLE DFCs FOR THE SAME AQUIFERS

22. Under the Texas Constitution, the District has only those limited powers as were conferred to it by its enabling statute. TEX. CONST. Art. XVI, §59(b); *accord Tri-City*, 142 S.W.2d at 948; *S. Plains Lamesa*, 52 S.W.3d at 776.

23. Contrary Section 36.108(d) of the Texas Water Code, and contrary to GMA 14's own administrative rules, the groundwater conservation districts of GMA 14 (including the District) adopted multiple DFCs for the same aquifers within GMA 14, based on political subdivision lines rather than aquifer subdivisions or conditions. Such DFCs are unreasonable because (1) DFCs that vary from county to county over the same aquifer violate the statutory directives for establishing DFCs; (2) TWDB staff has previously issued a memorandum discouraging DFCs based solely on political subdivisions (*see* Ex. H); and (3) the DFCs violate GMA 14's own administrative rules (*see* Ex. F). Most importantly,

(4) DFCs based on county boundaries lack any scientific relationship to the aquifers.

24. As discussed in Section IV, below, multiple DFCs for a single aquifer will ultimately result in disparate and unequal rules and regulatory requirements that deprive groundwater rights owners of their right to a fair opportunity to produce a fair share of the groundwater in the relevant aquifers.

A. Aquifer Management Should Be Regional In Nature.[5]

25. GMA 14 includes several different aquifers of the Gulf Coast Aquifer System. These aquifers are not confined to the area encompassed by the boundaries of the District, and the boundaries of the District (the political lines outlining Montgomery County) are not coterminous with the boundaries of any of such aquifers. (*See* Ex. K, Harden Affidavit ¶¶ 8, 11-15, 17, 18 & Exs. 4 & 5 thereto.). None of the groundwater conservation districts of GMA 14 completely encompasses any of the aquifers in the management area of GMA 14, and no groundwater conservation district in GMA 14 has boundaries coterminous with the boundaries of any such aquifers. (*Id.*)

26. Withdrawals of groundwater from the aquifers of the Gulf Coast aquifer system outside the boundaries of the District can and will affect the groundwater resources inside the boundaries of the District. (*Id.*) Therefore,

[5] *See* Ex. K, Harden Aff. at ¶ 8.

production from any of the Gulf Coast aquifers under Montgomery County will affect groundwater in adjacent counties, and production from any of those aquifers under any adjacent counties will impact groundwater in Montgomery County. (*Id.*) The District cannot change that hydrological fact.

27. On April 29, 2016, the groundwater conservation districts of GMA 14 (including the District) adopted the DFCs reflected in Resolution 2016-01-01, a copy of which is attached as Exhibit G hereto. In Resolution 2016-01-01, the groundwater conservation districts of GMA 14 claimed to adopt a single DFC for each relevant aquifer across the entire breadth of GMA 14, but also adopted different and separate DFCs for each relevant aquifer in each separate county encompassed in GMA 14.[6] As an example, the Jasper Aquifer in Montgomery County and Liberty County has two DFCs, described in terms of "average draw down" from estimated 2009 conditions after 61 years:

County	County DFC	GMA-Wide DFC
Montgomery	34	66.2
Liberty	120	66.2

28. Montgomery and Liberty Counties are adjacent to one another. There is no aquifer subdivision or other hydrological barrier in the Jasper Aquifer as it exists between Montgomery and Liberty Counties. Production of groundwater on

[6] The GMA 14's documentation establishes that the improper "county-based DFCs were first determined and only in an attempt to refute criticism" did they add language to the resolution regarding GMA-wide DFCs. (Ex. K, Harden Aff. at ¶ 24).

one side of the county line will affect groundwater on the other side. There is no groundwater conservation district in Liberty County, and there are no production limits or spacing and density rules that apply to that county. And the future water demands are unquestionably much greater in Montgomery County than in Liberty County.

B. <u>The DFCs Are Contrary To The Intent Of § 36.108.</u>

29. The differing county-specific DFCs adopted by the District violate the statutory direction for DFCs. Section 36.108(d-1) of the Texas Water Code, provides:

> (d-1) The districts may establish different desired future conditions for:
>
> (1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or
>
> (2) each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area."

30. The groundwater conservation districts of GMA 14, including the District, have violated the provisions of Texas Water Code Section 36.108(d-1) by adopting different DFCs for each aquifer in each of the counties in GMA 14. There are no identified aquifer subdivisions in any of the aquifers of the Gulf Coast Aquifer System. Specifically, there are no identified subdivisions in the Jasper

Aquifer, no identified subdivisions in the Evangeline Aquifer, no identified subdivisions in the Chicot Aquifer, and no identified subdivisions in the Burkeville confining unit. (*See* Ex. K, Harden Aff. ¶¶ 13-15 & Ex. 5 thereto). There are no identified geographical areas overlying the aquifers as they relate to unique or specific natural conditions that would affect groundwater. The DFCs established for GMA 14 are tied strictly to political subdivision lines which do not delineate substantial and discernible differences in uses or conditions of these aquifers, either coincidentally or otherwise. (*Cf.* Ex. H, TWDB Memo). The DFCs adopted by the districts of GMA 14 are based entirely on political subdivision lines, and the aquifers do not "see" those political lines. The District is not authorized by the Texas Water Code to adopt DFCs based only on political subdivision lines.

31. The District's different DFC for the Jasper in Montgomery County is not based on substantial and discernible differences in uses or conditions as between Montgomery and Liberty Counties, but on the stated objective of the District to limit groundwater production to what it mistakenly claims to be a "sustainable" amount equal to the supposed recharge to the portions of aquifers within Montgomery County. *See, e.g.,* Lone Star Groundwater Conservation District Groundwater Management Plan adopted October 14, 2003 at p. 8 ("The estimated annual amount of recharge to the groundwater resources of the District is

64,000 acre-feet per year.");[7] Lone Star Groundwater Conservation District Groundwater Management Plan adopted October 14, 2008 at p. 7 ("However, in 2003, the District adopted in its Management Plan an available useable groundwater amount of 64,000 acre-feet per year.");[8] Lone Star Groundwater Conservation District Groundwater Management Plan adopted November 12, 2013 at p. 6 ("Pursuant to the District Rules and this management plan, the District shall seek to limit production of groundwater from the resources within its boundaries to a sustainable level, so that the groundwater resources of Montgomery County are not depleted for future generations. For purposes of this plan, the word 'sustainable' means limiting total groundwater production in the District or in a management zone designated by the District to an amount that does not exceed the amount of effective deep aquifer recharge available in the District or the management zone, as applicable when averaged over a term of years to be determined by the District.").[9]

32. This "sustainable amount" of 64,000 acre-feet per year has been in the District's management plan (and implementing rules) since well before any DFCs were ever mandated by the Legislature or adopted by the District. The 2016 DFC

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[7] Available at http://lonestargcd.org/wp-content/uploads/2014/09/031014-Final-Adopted-Management-Plan-BS.pdf (last visited September 22, 2016).

[8] Available at http://lonestargcd.org/wp-content/uploads/2014/09/031014-Final-Adopted-Management-Plan-BS.pdf (last visited September 22, 2016).

[9] Available at http://lonestargcd.org/wp-content/uploads/2014/09/Lone-Star-Mgmt-Plan-Update-2013-FINAL.pdf (last visited September 22, 2016).

for the Jasper Aquifer of no more than 34 feet of drawdown over the next 60 years is based solely on the District's desire to limit groundwater production in Montgomery County to an amount equal to the recharge, *i.e.,* 64,000 acre-feet per year. The Jasper DFC is therefore not based on the factors set forth in Section 36.108(d-1), but on a decision made long ago, before the Legislature created the requirement for DFCs. Basing DFCs on a political or non-scientific feelings rather than the factors set forth in Texas Water Code Section 36.108(d) is pure pretense, and unreasonable as a matter of law.

33. Not only is the District's recharge calculation arbitrary and wrong, it is not based on, or equate to, "substantial and discernible difference in uses or conditions" of the aquifers. (*See* Ex. K, Harden Aff. at ¶ 19) The resulting DFCs for each aquifer are simply "reverse-engineered" to meet the above-stated political objective of the District. (*Id.*) Basing DFCs on political subdivision lines is unreasonable where political subdivision lines do not reflect substantial and discernible differences in uses or conditions of an aquifer.

34. The DFC chosen for the Jasper aquifer within Montgomery County (*i.e.,* under the District) ignores the effects of recharge from the Jasper outcrop outside of Montgomery County. (*Id.* at ¶¶ 15, 18 & Exs. 5 & 7-8 thereto). It is scientifically undeniable that the Montgomery County Jasper is recharged from an

area of Jasper outcrop that far exceeds the 4,300 acres of outcrop that actually exists in Montgomery County.

C. <u>The DFCs Are Contrary To TWDB's Opinions.</u>

35. On March 10, 2010, the TWDB staff prepared a memorandum to its board discussing the use of "geographic areas" in establishing DFCs. (*See* Ex. H hereto). In that memorandum, TWDB Director of Groundwater Resources William R. "Bill" Hutchison and General Counsel Kenneth L. Petersen presented the issue whether districts in a GMA may delineate different "geographic areas" within the GMA by use of political subdivision boundaries. (*Id.*) Messrs. Hutchison and Petersen advised the TWDB that such practice was defensible only if the political subdivision boundaries happened to coincide with "substantial and discernible differences in uses or conditions" within the GMA. (*Id.*) TWDB's memorandum continues: "It should be emphasized that employing geographic areas that are not based on clear and substantial differences in uses or aquifer conditions is not supportable, regardless of how those geographic areas are drawn." (*Id.*)

36. Accordingly, the DFCs adopted by the District are unreasonable because they fail to adhere to TWDB's guidance; Texas Water Code Sections 36.102, 36.108(d-1); and *Marrs v. Railroad Commission*, 177 S.W.2d 941 (Tex. 1944).

37. Section 4.3 of the Explanatory Report relies on Texas Water Code Section 36.108(d-1) to justify GMA 14's disparate DFCs for the same aquifer, claiming the Legislature intended to allow groundwater conservation districts to establish different DFCs based on political subdivision boundaries. To the extent that Section 36.108(d-1) is construed to allow arbitrary lines to be drawn across an aquifer for regulatory purposes, that legislation would be unconstitutional. *See Marrs, supra.* Texas courts are instructed to avoid construction of a statute that would render the statute unconstitutional. *City of Houston v. Clark*, 197 S.W.3d 314, 320 (Tex. 2006); *Brady v. Fourteenth Court of Appeals*, 795 S.W.2d 712, 715 (Tex. 1990); TEXAS GOV'T CODE § 311.021.

D. The DFCs Are Contrary To GMA 14's Administrative Rules.

38. The groundwater conservation districts of GMA 14 adopted certain administrative procedures for the consideration, proposal, and adoption of DFCs for GMA 14 ["GMA 14 Administrative Procedures"]. (*See* Exhibit F hereto). Included in the GMA 14 Administrative Procedures are the following sections:

> Section 2.04 The GMA 14 Member Districts, as a group to engage in joint planning activities, shall have only the power granted by Chapter 36, Water Code, that relates to joint planning activities.
>
> ***
>
> Section 3.05 Only after consideration of the nine statutory factors as stated in Section 3.04 may a DFC option become eligible for approval as the proposed DFC. **For each relevant aquifer** in GMA 14, the Member District Representatives shall approve by two-thirds vote of the total Member District Representatives **one DFC option** to serve as the proposed DFC as required by Sections 36.108(d) and (d-2), Water Code. The proposed DFC

> must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in GMA 14. (Emphasis added).

(Ex. F) (emphasis added).

39. In undertaking to define different DFCs for each aquifer under certain county boundaries within GMA 14, the districts, including the District, have violated Section 2.04 of the GMA 14 Administrative Procedures specifying that the Districts have only the power granted by Chapter 36 of the Texas Water Code that relates to joint planning activities.

40. The groundwater conservation districts of GMA 14, including the District, have violated Section 3.04 of the GMA 14 Administrative Procedures by adopting more than one DFC for each relevant aquifer within GMA 14.

41. Adopting two DFCs for each relevant aquifer in each county prevents each groundwater conservation district from complying with the requirements of Texas Water Code Sections 36.1085 and 36.1132, which requires each district to achieve the DFC for each aquifer.

42. Adopting two DFCs for each relevant aquifer also prevents the TWDB from designating the "modeled available groundwater" for each relevant aquifer pursuant to Texas Water Code Section 36.1084.

43. Section 4.3 of the Explanatory Report attempts to disguise the reality that GMA 14 adopted different DFCs based on county lines. That section states

that only one DFC was adopted for each relevant aquifer in GMA 14, and the average drawdown for each county was then calculated. The Explanatory Report claims that the DFCs adopted for each aquifer in each district were not DFCs at all, but just a calculated average of GMA-wide DFCs. However, the Explanatory Report at Section 3.0 sets forth the adopted DFCs for both GMA 14 and for the individual counties in GMA 14, expressing all DFCs in identical language, and states that the county DFCs are "...to better facilitate the management and conservation of groundwater resources at the individual GCD level..." If only one DFC has been adopted by GMA 14 for the Jasper Aquifer, then the District must amend its rules to allow groundwater owners in Montgomery County to produce an amount of groundwater up to the point that the total volume of exempt and permitted groundwater production could cause 66.2 feet of drawdown in the Jasper Aquifer over the next 61 years. TEXAS WATER CODE § 36.1132. The District has not done so, but has persisted in imposing restrictions that would allow only 34 feet of drawdown in that aquifer over that period.[10]

44. Because all the districts of GMA 14 have different rules, and because the county-level DFCs were reverse-engineered to reflect local political decisions (*see, e.g.*, Ex. K, Harden Aff. at ¶ 19 & Exs. 9-10 thereto), the statement in the

[10] The "two sets of DFCs inspire confusion" (Ex. K, Harden Aff. at ¶ 24). "If all of the GMA 14 county-based DFCs are achieved, then the GMA-wide DFC must be achieved by simple application of mathematics. But, the reverse is not true. *** Achieving the GMA-wide DFC does not ensure achieving each county-based DFC. Therefore ... the GMA-wide DFC is meaningless for regulatory purposes." (*Id.*)

Explanatory Report is mere sophistry, designed to mask the fact that GMA 14 did its work by creating a different DFC for each aquifer in each county. The existence of the statement in Section 3.1 indicates that the districts were aware of the requirements of the statute, but have tried to gloss over their failure to follow the command of the Legislature.

IV.
THE ADOPTED DFCS FAIL TO PROTECT PRIVATE PROPERTY RIGHTS

45. In violation of Texas Water Code Section 36.018(d)(7), the districts of GMA 14, including the District, failed to consider properly the impact of the proposed DFCs on private property, including ownership and the rights of management area landowners and their lessee and assigns in groundwater. The Explanatory Report notes at page 27 that "the two overriding policy justifications for the DFCs adopted by GMA 14 are socioeconomic considerations and impacts on private property rights." At page 28 of the Explanatory Report, the districts admit that "[t]he primary economic and private property impact analyses that were considered by the GMA 14 District Representatives that justify the adoption of the DFCs were the impacts of those DFCs on **the economic costs to landowners of producing groundwater**. The evidence clearly indicates that economic considerations, and their inseparability from protection of private property rights, are the controlling factor behind the selection of the adopted DFCs." (Emphasis in

original). The Explanatory Report then attempts to tie this supposed economic harm incurred by the favored few to a secondary concern for "subsidence" that might be caused by increased production. The analysis is flawed and fails for several reasons.

46. *First*, in its Explanatory Report, GMA 14's consultants treat well operating costs as if those costs constitute a protected private property interest — which they are not. Unlike the private ownership of groundwater in place, well owners have no constitutionally protected right to operate their wells at a lower cost.

47. *Second*, and perhaps of the greatest constitutional concern, is the GMA 14's focus on maintaining artesian pressure for the benefit of some (principally existing) well owners results in confiscating the private property interest in groundwater from many in order to confer a cost-based benefit on some. GMA 14 acknowledges that it must "strike a balance between all of the[] property interests." (*See* Explanatory Report at 92). But the correlative rights of those who own the groundwater are disregarded by the districts. The GMA 14 approach adopted by the District, is, in effect, a *de facto* historic use program that disadvantages groundwater rights owners except those who currently produce groundwater. This approach to regulation was examined in *Bragg v. Edwards Aquifer Authority*, 421 S.W.3d 118 (Tex. App.—San Antonio, writ denied), and

found to result in a taking of private property without compensation, in derogation of the constitutional protections afforded to owners of constitutionally-protected private property. The District's approach is actually worse than *Bragg* because it amounts to a taking of private property for *private* purposes, which is not allowed in Texas. *See* TEXAS GOV'T CODE § 2206.001, *et seq*. DFCs that result in unconstitutional takings are unreasonable as a matter of law.

48. *Third*, the District's DFCs have and will result in rules that deprive groundwater rights owners in Montgomery County of their fair opportunity to produce a fair share of the groundwater beneath the county. "Conspicuously absent in [GMA 14's] balance, is the consideration of a groundwater owner's legal right to 'drill for and produce the groundwater below the surface of real property' as stated in Texas Water Code Section 36.002(b)(1), and the requirement that groundwater [conservation] districts pass rules that are 'fair and impartial' (Texas Water Code Section 36.101(a)(2))." (Ex. K, Harden Aff. at ¶ 23).

49. The Texas Supreme Court has held that groundwater rights owners are entitled to produce a fair share of the groundwater in an aquifer. *Day,* at 830. This is in accord with well-settled law in the oil and gas area. *See Railroad Commission v. Shell Oil,* 380 S.W.2d 556 (Tex. 1964); *Railroad Commission v. Williams,* 356 S.W.2d 131 (Tex. 1961). *See also, Elliff v. Texon Drilling Co.* 210 S.W.2d 558, 562 (1948) ("[O]ur courts, in decisions involving well-spacing regulations of our

Railroad Commission, have frequently announced the sound view that each landowner should be afforded the opportunity to produce his fair share of the recoverable oil and gas beneath his land....").

50. "The Explanatory Report authors' chief mistake is a failure to recognize [the] well established principle that groundwater is a private property and every owner of a common reservoir is to be provided a fair share opportunity to use their property." (Ex. K, Harden Aff. at ¶ 23). The statement in the Explanatory Report that "[t]he amount of groundwater located under the geographic area defined by GMA 14 is ultimately not a controlling consideration" (Explanatory Report at 28) is an example of the District's unconstitutional thinking about private property rights and failure to ensure landowners' have the opportunity to produce a fair share of groundwater in place. Every landowner has different economics; but each owner must be allowed to produce a fair share of the groundwater in place. Those groundwater rights are a controlling consideration under the statute. Each owner must comply with well spacing and production allocation rules that apply to their property. If every landowner in Montgomery County were allowed a fair opportunity to produce their groundwater, they will make the economic decision to produce or not.

51. *Fourth*, the Explanatory Report fails to make any study or analysis, much less quantify, the cost to the current producers to lower pumps or drill deeper

wells. For example, on page 90, the Explanatory Report authors state that "GMA 14 District Representatives had *discussions of qualitative* socioeconomic impacts that *may* result from the proposed DFCs." (emphasis added). Thus, the GMA 14 District Representatives, including the District's representative, Ms. Jones, conducted no scientific analysis of the actual costs of production of groundwater, and instead simply assumed greater amounts of groundwater production are not possible because costs and impacts will be "huge." (*See, e.g.*, Explanatory Report at 29).

52. "Loss of artesian pressure" relates only to the amount of lift work that must be performed to bring well water to the surface and related well engineering required to achieve and maintain it. Lift work is performed by a water pump located downhole in virtually all water wells of any significant production, artesian or otherwise. Lift is a minor and secondary component of total costs and a routine part of well engineering, maintenance and upgrading with time. The cost to lift 1 acre-foot of water 100 feet is about $15.00. (Ex. K, Harden Aff. at ¶ 21). The lift costs to supplement artesian pressure are *small* in comparison the value of private groundwater rights over which the District is riding roughshod.

53. Further, the Explanatory Report fails to analyze or quantify the market value of all the groundwater in storage put "off limits" by the District's DFCs. Every owner of groundwater rights is damaged by the District's actions because all

groundwater in storage—all 180 million acre feet—has been condemned by the District's actions and become valueless. If that groundwater is valued at the cost of surface water from San Jacinto River Authority, then the DFCs and resulting regulatory rules effectively condemn billions of dollars of groundwater. Given the magnitude of this harm, it is hard to imagine that the cost to current producers of lowering pumps or drilling new wells outweighs the economic loss to all other groundwater rights owners. But again, the Explanatory Report fails to quantify either cost.

54. In an attempt to achieve its DFCs, the District has adopted (and will be required to continue to enforce) rules regarding production of groundwater that are much more restrictive than those of neighboring districts. The DFCs and rules adopted by the District prevent any use of groundwater in storage under Montgomery County, a resource that belongs to the landowners and groundwater rights owners. As a result, groundwater in storage in Montgomery County will be captured by production from wells outside the County's boundaries. This drainage of privately-owned real property will be the result of the actions of the District, a governmental entity, without compensation to Plaintiffs. Moreover, the lack of ability to offset drainage and the lower production limits, together and separately, have caused and will cause a diminution in the fair market value of all groundwater

rights in Montgomery County. None of these factors are considered in the frighteningly shallow analysis presented in the Explanatory Report.

55. As a second justification for the District's DFCs, the Explanatory Report relies on supposed "economic costs" caused by subsidence in GMA 14. Nevertheless, the Report fails to recognize that the greatest volume of groundwater in storage in Montgomery County is found in the Jasper Aquifer, where most current pumping also takes place.[11] The Jasper Aquifer is not susceptible to subsidence. (Ex. K, Harden Aff. at ¶ 22 & Ex. 16 (pp. 2-3)). "The Explanatory Report authors [] do not consider the different geohydrologic characteristics, relating to subsidence, of the common reservoirs within GMA 14 and Montgomery County." (Ex. K, Harden Aff. at ¶ 22) Thus, from a factual standpoint, the rationale for LSGCD's DFCs is fundamentally wrong.

56. The Explanatory Report references several studies of historical costs of subsidence, but the areas of these past studies are located entirely in the Harris-Galveston and Fort Bend Subsidence Districts. "The areas of the greatest projected land-surface subsidence from 2010 through 2070 are located within Fort Bend

[11] As depicted on page 2 of Exhibit 16 to Mr. Harden's Affidavit, the total land-surface subsidence is dramatically less in Montgomery County than in Harris, Galveston and Fort Bend Counties. "It is also evident that much of Montgomery County is projected to never experience any land-surface subsidence. There are scientific reasons for this. ... This means that larger amounts of subsidence, such as historically occurred in Harris and Galveston counties and projected to occur in the future in Fort Bend County, will never occur in Montgomery County and will not occur in the future due to natural conditions present." (Ex. K, Harden Aff. at ¶ 22 & Ex. 16).

Subsidence District. These projected amounts of future land-surface subsidence were considered by Fort Bend Subsidence District in detailed regulatory planning activities." (*Id.*) The Fort Bend Subsidence District strikes a balance between the costs of subsidence and the benefits of greater groundwater supply. (*Id.*) In stark contrast, GMA 14 conducted no such cost-benefit study. (*Id.*) GMA 14 conducted the reverse-engineered modeling activity and then stated any greater amounts of reduction of artesian pressure are not allowed because any greater amounts of subsidence do not properly protect private property rights. (*Id.*)

57. The Explanatory Report's superficial justifications are demonstrably wrong. Because the District's DFCs result in a prohibited taking of private property, they are unreasonable as a matter of law.

V.
GMA 14 DID NOT CONSIDER THE BOARD'S TERS

58. In violation of Section 36.108(d)(3), GMA 14 disregarded the Board's TERS for Montgomery County in establishing the DFCs. (*See, e.g.*, Explanatory Report at 81) (claiming that "TERS has no practical application in the GMA 14 joint-planning process or in groundwater management of the Gulf Coast Aquifer System.").

59. The District commenced its attack on the Board's TERS Report within the same month the Board's Report was released. The problem with the TERS Report was that it proved that the District's repeated cries of a groundwater

shortage in Montgomery County were false. The TERS Report undercut the entire basis for the District's Regulatory Plan, the purposes of which apparently were to justify the District's existence and force the Cities and other large groundwater users in Montgomery County to pay for the San Jacinto River Authority's large, new, unnecessary surface water treatment plant at Lake Conroe, and the associated overbuilt pipeline infrastructure.

60. On June 27, 2014, the District issued a press release, which correctly stated that the Board's TERS Report estimated the recoverable groundwater in storage under Montgomery County as between 45 *million* acre feet if only 25% of the water is recovered, and 135 *million* acre feet if 75% is recovered. (*See* Ex. K, Harden Aff., Ex. 12 thereto). Contrast these Board estimates with the District's Management Plan, which caps groundwater production at a maximum of only 64 *thousand* acre-feet per year. Thumbing its nose at the Board, the District's press release announced to the Cities and Montgomery County's residents that "the very large water volumes provided in the TERS have limited to no applicability for the Lone Star GCD's setting of management goals for the aquifers underlying Montgomery County." (*See id.*). In violation of Section 36.108(d), the District clearly carried its arrogant, dismissive attitude toward the Board's TERS into GMA 14's planning process, and from there into the DFCs for Montgomery County proposed by GMA 14 and adopted by the District. The GMA 14 and the

District have utterly disregarded the statutory command of Section 36.108(d-2) that DFCs "*must* provide a balance between *the highest practicable level of groundwater production* and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area."

61. The District (and other districts of GMA 14) do not properly understand how aquifer storage works. (Ex. K, Harden Aff. at ¶ 20). "It is a well-known and established principle that groundwater in storage must first be reduced in the production of groundwater to move recharge to wells." (*Id.* & Ex. 6 thereto). GMA 14 did not consider the value of additional reduction of storage for sustaining groundwater supplies. (*Id.*) GMA 14 made no analysis of the change in aquifer storage in the common reservoirs either historically or that could be expected in the future. (*Id.*) "The lack of these studies and considerations is clear indication the DFCs were not developed using the most basic considerations of groundwater hydrology and do not comply with Section 36.0015 of the Texas Water Code which requires the use of the best available science." (*Id.*) [12]

62. A recent report by the Bush School of Government and Public Service to the Texas State Comptroller of Public Accounts (Exhibit J hereto, attaching Bush School, *Reorganizing Groundwater Regulation in Texas* at 2 (May 12, 2016))

[12] *See also* Ex. K, Harden Aff. at ¶ 20 & Exs. 13 & 14 thereto.

highlights the unreasonableness of the District's DFCs for Montgomery County. After analysis of the Board's TERS Reports, other information, and interviews with GCD staffs, the Bush School concludes that "there is a relative abundance of groundwater in all but two of the state's major aquifers, and that a review of the regulatory practices of the local GCDs supported the conclusion that Texas has a regulation-induced shortage of groundwater." (*Id.*) Neither of the two Texas aquifers in which there is limited groundwater are within GMA 14; one, the Ogallala, serves the Texas Panhandle, and the other, the Hueco-Mesilla, is in the El Paso area. For the Gulf Coast Aquifer, including the Jasper, Chicot, and Evangeline aquifers in GMA 14, the Bush School reports that assuming consumption levels at the current rate and that only 50% of the TERS is recoverable, the supply of groundwater is *unlimited*. The supply remains *unlimited* even if one assumes consumption continues to grow at its historical rate. If one continues to assume that only 50% of TERS is recoverable but assumes that consumption grows at an annual rate of 2 percent, the Gulf Coast Aquifer will supply groundwater for 200 years. (*See* Ex. J, Bush School Report at 3) The Gulf Cost aquifer has been, is and realistically will remain full for the foreseeable future without any restriction on use. These projections stand in stark contrast to the false claims by the District (and the San Jacinto River Authority), parroted by GMA 14's DFCs for Montgomery County, that the Gulf Coast Aquifer is rapidly depleting and groundwater production by the Cities and other large groundwater users in Montgomery County should be severely limited.

63. By statute, the districts in GMA 14 are required to consider the total estimated recoverable storage ("TERS") in an aquifer before voting on DFCs. The District failed to actually consider the total estimated recoverable storage of the aquifers in question. In fact, Section 5.3 of the Explanatory Report admits that the Districts ignored the TERS report because of "the negative socioeconomic impacts of subsidence." But subsidence is not relevant to the Jasper Aquifer, so ignoring the TERS is not reasonable as to that aquifer. Because of the geometry between the aquifer outcrop and southeasterly dip of the Evangeline and Chicot aquifers, subsidence in Montgomery County will forever be less of a concern than in neighboring Harris, Galveston, and Fort Bend Counties.

64. The adopted DFCs are artificially and adversely impacted by the failure to consider the Board's TERS. Because the DFCs do not address aquifer storage, the rights of groundwater owners in the District's boundaries are adversely impacted.

VI.
GMA 14'S REVERSE ENGINEERING OF DFCs FAILS TO MEET STATUTORY REQUIREMENTS

65. The Explanatory Report reveals that GMA 14 failed to meet several other statutory criteria that Texas law requires to be considered as part of the DFC

process. Further, the Explanatory Report is not based on the type of analytical process contemplated or required under Texas Water Code Section 36.108.

66. It appears that DFCs were not established by first considering and identifying critical levels of springflow protection, depletion of storage, subsidence, and other balancing factors such as protection of private property rights. Instead, the DFCs adopted by the District reflect only the District's self-imposed and arbitrary restriction of groundwater production in Montgomery County to 64,000 acre-feet per year, that lacks any technical basis.

67. It appears that the District's Board expressly determined its DFCs for the Gulf Coast aquifers on the assumption that the Modeled Available Groundwater ("MAG") would consist of only recharge which occurs within Montgomery County. The District's 64,000 acre-fee per year was assumed as MAG and distributed between the different strata of the Gulf Coast aquifer. These assumptions for determining DFCs ignores the best available science and ignores how recharge works in the individual strata of the Gulf Coast aquifer. Take for example the Jasper aquifer. If you consider only the outcrop of the Jasper that overlies Montgomery County (4,300 acres) and make the same assumptions that the District made about the amount of recharge (1.1 inch per acre per year), the resulting recharge (MAG) for the Jasper would be only 390 acre feet. Yet, the MAG for the Jasper aquifer in Montgomery County which results from the DFCs

adopted by GMA 14 is 24,000 acre-feet per year. Thus, the MAG for the Jasper under the District's DFCs is not based on even the simplistic "science" used by that the District to design its regulatory scheme or its DFCs.

68. The District's recharge rate is scientifically flawed also because it assumes recharge only occurs within the boundary of Montgomery County. However, it is commonly known that recharge enters the aquifers in the aquifer outcrops, and that the Gulf Coast aquifer outcrops extend across Montgomery County and numerous other counties. (Ex. K, Harden Aff. at ¶¶ 13-15 & Ex. 5 thereto; *also id.* at 18 & Exs. 7-8 thereto). For Montgomery County and surrounding areas, the publicly-available Houston Area Groundwater Model ("HAGM") is used by State and local agencies for regulatory and water planning purposes. Analysis using the HAGM indicates that groundwater production in Montgomery County receives recharge from an area much larger than Montgomery County. (*Id.* at ¶ 18 & Ex. 7 thereto) Similarly, the Board maintains a groundwater database that contains historical water levels in wells. Mapping of water levels from the Board's data indicates the pressure gradients of production in Montgomery County span an area much larger than Montgomery County. As discussed above, the Board estimates total storage in Montgomery County alone is about 180 million acre-feet and about 3 billion acre-feet in GMA 14.

69. The District provided the GMA 14's consultants with its policy-driven and unscientific production restriction as the "demand" those consultants input into their model. The administrative record clearly reveals the sequence of actions taken by the District and GMA 14. (*See* Harden Aff. at ¶ 19 & Exs. 9-10 thereto) (The activities conducted by GMA 14 are itemized by date in a timeline on pages 30-34 of Exhibit 10 to Mr. Harden's Affidavit). Using the District's 64,000 acre-feet/year demand figure — the DFCs for Montgomery County were predetermined approximately one year before their adoption, and long before GMA 14 had completed the majority of the statutory criteria set forth in Section 36.108. (*See id.*) The reverse-engineered approach employed by GMA 14, and the District's representatives, "does not follow a normal scientific approach of considering groundwater hydrology principles concerning aquifer management concerns, within a common basin, prior to establishing aquifer management criteria." (*Id.*)

70. Historical analysis using the HAGM indicates less than 1% of the pre-development storage has been reduced in the Gulf Coast aquifer system in southeast Texas. This is after 100 years of groundwater use. Therefore, the existing data indicates clearly that the aquifer is not being depleted nor are wells running dry.

71. Recharge is not a static number, but rather, is a dynamic rate that varies with changes in aquifer storage. (Harden Aff. at 20 & Exs. 6 & 13). And

the so-called "sustainable production" rate in the Gulf Coast aquifer system does not equal a recharge rate. In 1940, Dr. Charles V. Theis authored a well-respected groundwater paper titled "The Source of Water Derived from Wells." (*See* Ex. K, Harden Aff. at Ex. 6 thereto). Dr. Theis describes how prior to pumping, an aquifer is in a state of "dynamic equilibrium," which means that while groundwater continuously flows through the system, the aquifer is essentially full and there are no significant changes in aquifer storage over time. (*Id.*) Aquifer storage must be reduced to some extent before recharge is available for use by wells. (*Id.*)

72. It is a misconception that if production is limited to a supposed recharge rate, then water level declines (changes in artesian pressure or water table levels) will not occur. But the historical change in water levels in wells in Montgomery County reflect changes in artesian pressure in the aquifer sands and do not represent significant drainage or depletion of groundwater stored in water table areas. (Ex. K, Harden Aff. at ¶¶ 7-8).

73. GMA 14 failed to provide an explanatory report for each DFC for each aquifer in each groundwater conservation district of GMA 14 as required by statute. The alleged justifications for the adopted DFCs wholly fail to address each aquifer separately, and the justifications set forth in the Explanatory Report either do not apply to all aquifers, or do not apply in the same manner to all aquifers.

74. The Cities reserve the right to expand on these reasons and prove additional reasons after discovery, and in the contested case hearing.

VII.
REQUESTED RELIEF

75. The Cities request the District contract with SOAH to conduct a hearing with respect to the reasonableness of the DFCs adopted by the District, and to perform the other duties required of it pursuant to Texas Water Code Section 36.1083.

76. The Cities request the District forward a copy of this Petition to the TWDB, pursuant to Section 36.1083(e).

77. The Cities request the TWDB conduct an administrative review pursuant to Section 36.1083(e)(1) and a study containing scientific and technical analysis of the DFCs pursuant to Section 36.1083(e)(2), which shall be delivered to SOAH within the time period specified in Section 36.1083(f). The Cities request the TWDB to direct its members, employees, and staff to refrain from communicating with the parties, their agents, attorneys, witnesses, and representatives, including Mr. Mullican and the consultants involved in preparing the questioned DFCs or the Explanatory Report.

78. On information and belief, the District and its consultants are in possession, custody or control of documents and information that pertain to the production of the Explanatory Report, but which have been withheld. Since June

2016, Conroe has been seeking, through the Texas Public Information Act, data from the groundwater conservation districts in GMA 14, including Lone Star, related to the preparation of the Explanatory Report. Conroe has paid Lone Star's estimated fee for such data, but the District and GMA 14's consultant, William Mullican, have asserted exceptions to the general rules requiring public disclosure. The Cities request the District make all such records available to the Cities within a reasonable time after the filing of this Petition so that the Cities have a reasonable time to determine whether the District's production is complete, analyze it with expert assistance, and likely take depositions about it, before the Cities can be ready for trial in this matter. If the District and Mr. Mullican refuse to do so, the Cities request SOAH to order that production and require the District and Mullican to pay the Cities' costs.

79. On page 10 of the Explanatory Report it states that "groundwater data was obtained from the TWDB, which maintains records and reports of groundwater use, water wells and other relevant data." The Cities request the TWDB make all such records available to the Cities within a reasonable time after the filing of this Petition so that the Cities have a reasonable time to analyze it with expert assistance, and possibly take depositions about it, before the Cities can be ready for trial of this matter.

80. The Cities request SOAH to conduct all pre-hearing conferences, discovery matters, and contested case hearing pursuant to Texas Water Code Section 36.1083 and consistent with the procedural rules of the office and all other applicable laws.

81. The Cities pray that upon final hearing hereof, the duly appointed administrative law judge for SOAH find that Lone Star Groundwater Conservation District's Desired Future Conditions adopted on August 9, 2016 are unreasonable and grant all other relief to which the Cities are entitled under Texas Water Code Section 36.1083 and other applicable laws, together with their reasonable attorneys' fees and costs of Court.

Dated: December 1, 2016

Respectfully submitted,

Michael V. Powell
Texas Bar No. 16204400
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Direct Fax: (214) 756-8520

ATTORNEYS FOR THE
CITY OF CONROE AND MAGNOLIA, TEXAS

APPENDIX

Exhibit A: LSGCD Resolution No. 16-006

Exhibit B: Letter, May 5, 2015, from the City of Conroe, Texas to GMA 14 (5/5/2015), with attachments

Exhibit C: Letter, August 25, 2015, Marvin W. Jones to Ms. Kathy Jones, et al., Re: Groundwater Management Area 14

Exhibit D: Letter, September 14, 2015, Michael V. Powell to Mr. Richard J. Tramm, Re: Lone Star Groundwater Conservation District's Public Hearing on Desired Future Conditions, call for September 17, 2015

Exhibit E: Minutes of June 14, 2016 Meeting of Board of Directors of Lone Star Groundwater Conservation District

Exhibit F: GMA 14'S "Resolution Establishing Administrative Procedures for the Consideration, Proposal and Adoption of Desired Future Conditions for Groundwater Management Area 14," adopted November 18, 2014

Exhibit G: GMA 14's Resolution 2016-01-01, "Resolution for the Approval of Desired Future Conditions for All Aquifers in Groundwater Management 14," adopted April 29, 2016

Exhibit H: TWDB Memorandum dated March 10, 2010

Exhibit I: Certified copy of TWDB's report titled "GAM Task 13-037: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 14" published June 9, 2014

Exhibit J: Declaration of James Griffin, attaching The Bush School, *Reorganizing Groundwater Regulation in Texas* at 2 (May 12, 2016)

Exhibit K: Affidavit of Robert D. Harden, including Exhibits 1-17 attached thereto

RESOLUTION #16-006

RESOLUTION FOR THE ADOPTION OF THE DESIRED FUTURE CONDITIONS FOR THE GULF COAST AQUIFER THAT APPLY TO THE LONE STAR GROUDNWATER CONSERVATION DISTRICT

LONE STAR GROUNDWATER CONSERVATION DISTRICT

THE STATE OF TEXAS §

COUNTY OF MONTGOMERY §

WHEREAS, the Lone Star Groundwater Conservation District ("Lone Star") was created by the Legislature of the State of Texas by the Act of May 17, 2001, 77th Leg., R.S., ch. 1321, 2001 Tex. Gen. Laws 3246, as amended (the "Enabling Act"), as a groundwater conservation district operating under Chapter 36, Texas Water Code, and the Enabling Act; and

WHEREAS, pursuant to § 35.151 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas that, together, cover all major and minor aquifers in the state, and, through Title 31 Texas Administrative Code §356.21, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

WHEREAS, Lone Star and four other groundwater conservation districts, Bluebonnet Groundwater Conservation District, Brazoria Groundwater Conservation District, Lower Trinity Groundwater Conservation District, and Southeast Texas Groundwater Conservation District, (collectively referred to herein as the "Districts") are located wholly or partially within GMA 14; and

WHEREAS, the Districts are authorized by Chapter 36, Texas Water Code, to engage in joint planning activities for the coordinated management of the aquifers located in GMA 14, and in that regard, the Districts are required to establish desired future conditions ("DFCs") for the relevant aquifers within GMA 14; and

WHEREAS, Section 36.108 of the Texas Water Code requires representatives from the Districts to hold joint planning meetings for the consideration of DFC options, the proposal of DFCs for adoption, and after the contemplation of comments and suggested revisions provided by the public and Districts, the adoption of DFCs for each relevant aquifer in GMA 14 and the submission of an explanatory report to the TWDB for approval of the DFCs adopted; and

EXHIBIT A

WHEREAS, as set forth in the attached Resolution for the Approval of Desired Future Conditions for All Aquifers in Groundwater Management Area 14 (the "Resolution"), attached hereto as Attachment A and incorporated by reference for all intents and purposes, the District representatives for GMA 14 have complied with the requirements provided by statute in Section 36.108, Texas Water Code, and on April 29, 2016, the District representatives for GMA 14 took final action to adopt the DFCs for the relevant aquifers in GMA 14 by approving the attached Resolution and the submission of the Desired Future Conditions Explanatory Report to the TWDB and the Districts as required by Section 36.108(d-3) of the Texas Water Code; and

WHEREAS, the DFCs adopted by the District representatives of GMA 14 are described in terms of acceptable drawdown levels for each subdivision of the Gulf Coast Aquifer, including the Chicot, Evangeline, Burkeville, and Jasper, for each county located within GMA 14, or in land surface subsidence, as applicable, and the DFCs were also adopted on aquifer-wide scales within GMA 14 for each of those aquifer subdivisions, which do not differ substantively in their application from the county-scale numbers; and

WHEREAS, the acceptable levels of drawdown for each subdivision of the aquifer underlying Montgomery County are measured in terms of water level drawdowns over the proposed current planning cycle measured in feet from 2009 estimated water levels; and

WHEREAS, Section 36.108(d-4) of the Texas Water Code provides that as soon as possible after a district receives the DFCs resolution and explanatory report under Subsection (d-3), the district shall adopt the DFCs in the resolution and report that apply to the district; and

WHEREAS, TWDB rules at Title 31, Texas Administrative Code §356.34 provide that as soon as possible after a district receives notice from the Executive Administrator of the TWDB that the DFC Submission Package submitted to the TWDB has been determined to be administratively complete, the district shall adopt the DFCs that apply to the district; and

WHEREAS, at this time, Lone Star has received a copy of the Resolution, as provided herein as Attachment A, and the Desired Future Conditions Explanatory Report prepared by GMA 14, and the Lone Star Board seeks to adopt the DFCs in the Resolution and the Explanatory Report that apply to Lone Star; and

WHEREAS, Lone Star received a letter from the TWDB, dated July 12, 2016, notifying Lone Star that the DFC Submission Package provided to the TWDB by the GMA 14 Districts has been determined to be administratively complete by the Executive Administrator of the TWDB, and therefore it is now appropriate for Lone Star to proceed with the adoption of the DFCs that apply to Lone Star in compliance with TWDB rules as set forth in Title 31, Texas Administrative Code §356.34; and

WHEREAS, the Board finds that the DFCs provided herein for adoption are reasonable and necessary for the effective and prudent management of groundwater resources within Montgomery County, and have otherwise been developed in accordance with, and do satisfy the obligations imposed by Chapter 36 of the Texas Water Code and all other applicable laws of the State of Texas; and

WHEREAS, the Board also finds that all notice requirements for a meeting, held this day, to take up and consider the adoption of the DFCs described herein that apply to Lone Star have been, and are, satisfied;

NOW, THEREFORE, be it resolved by the Board of Directors of the Lone Star Groundwater Conservation District that the following DFCs are hereby established for the Gulf Coast Aquifer as the DFCs that apply to Lone Star:

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer in Montgomery County should not exceed approximately 26 feet after 61 years;
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer in Montgomery County should not exceed approximately -4 feet after 61 years;
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit in Montgomery County should not exceed approximately -4 feet after 61 years;
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer in Montgomery County should not exceed approximately 34 feet after 61 years; and
- The Board also adopts as applicable to Lone Star the aquifer-wide scale average draw down numbers within GMA 14 for the Chicot Aquifer, Evangeline Aquifer, Burkeville confining unit, and the Jasper Aquifer as specifically set forth in the attached Resolution for the Approval of Desired Future Conditions for All Aquifers in Groundwater Management Area 14 (Attachment A).

AND IT IS SO ORDERED.

PASSED AND ADOPTED on this 9th day of August, 2016.

LONE STAR GROUNDWATER CONSERVATION DISTRICT

By: ______________________
Richard J. Tramm, Board President

ATTEST:

____
Rick Moffatt, Secretary

Office of the Mayor

CITY OF CONROE

Est. 1904

May 5, 2015

To: District Representatives to
Texas Groundwater Management Area 14

Re: Your Task of Developing Desired Future Conditions for Aquifers

Dear District Representatives:

Conroe is the largest city in Montgomery County, and it is rapidly growing. In 2013, Conroe was the tenth fastest-growing city in the United States among all cities having a population greater than 50,000. There are reliable estimates that by 2030, Montgomery County's population will increase to one million residents, many of whom will live in Conroe. The Mayor and City Council of Conroe are responsible for providing ample supplies of water, at a reasonable cost, to all of Conroe's current and future residents and businesses. Carrying out that role, Conroe is presently the second largest producer of groundwater in Montgomery County.

I am writing to you, on behalf of Conroe's City Council, in your capacities as "District Representatives" to Groundwater Management Area 14 ("GMA 14") under Texas Water Code §36.108. To put our reason for writing bluntly, Conroe has lost confidence in the Lone Star Groundwater Conservation District's ("LSGCD's") regulation of groundwater within Montgomery County. As a result, the City Council and I concluded that Conroe should express its very serious concerns directly to GMA 14, as you, the District Representatives to GMA 14, undertake GMA 14's statutory obligation to adopt updated desired future conditions ("DFCs") for the four different aquifers that underlie not only Montgomery County, but also adjacent

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counties. I can confirm to you that Conroe is not alone in its exasperation with LSGCD's non-responsiveness to the concerns of Montgomery County citizens. Many private parties and other governmental units in Montgomery County have the same increasingly-urgent concerns about LSGCD that Conroe has.

Conroe's strong requests to you are (1) that GMA 14 not follow its incorrect past practice of attempting to establish balkanized, county-by-county, DFCs for the aquifers underlying GMA 14, rather than engaging in regional planning for the aquifers, as you should do, and (2) that GMA 14 not follow its very poor past practice of "backing into" DFCs for aquifers underlying Montgomery County by accepting, uncritically, LSGCD's scientifically-unsupported limitation of Montgomery County groundwater production to 64,000 acre-feet-per-year, and then merely "deriving" DFCs for Montgomery County based on that limitation.

The minutes of GMA 14's Joint Planning Group meeting of June 26, 2013, succinctly describe the backwards approach that GMA 14 has followed in the past:

> "[T]o adjust the pumpage to match a particular DFC would be very work intensive. The more direct method would be to review the pumpage figures and projected demands for each entity and once agreed upon, put those numbers into the model and determine the resulting DFCs."

Under that flawed approach, LSGCD's arbitrary 64,000 acre-feet-per-year limit becomes a self-fulfilling mandate. LSGCD adopted that limitation, based on virtually no science, and reported it to GMA 14; GMA 14 "put that number into the model" and calculated supposed DFCs for Montgomery County based on LSGCD's limit; and now LSGCD claims it must enforce regulations to achieve the 64,000 acre-feet-per-year limit because DFCs require it to do so. This process—clearly not the process contemplated by section 38.108 of the Water Code—is crippling Conroe and other owners and producers of groundwater in Montgomery County.

As you, the District Representatives to GMA 14, carry out your statutory obligations in the current DFC cycle, Conroe asks you not to accept what LSGCD says about Montgomery County, but rather to conduct your own work and comply with your own statutory obligations under section 36.108, which, as you know, has been substantially amended since GMA 14 last adopted DFCs.

We will not prolong this letter by attempting to describe all the problems Conroe has with LSGCD's flawed and unscientific approach, but here are examples that relate directly to the task the Legislature has assigned to GMA 14:

►Under section 36.108(d2), DFCs adopted by GMA 14 "must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging and prevention of waste of groundwater and control of subsidence in the management area." (Emphasis added). LSGCD's 64,000 acre-feet-per-year is based on only two of the factors listed in the statute—recharge and subsidence. LSGCD's 64,000 acre-feet-per-year gives no weight whatsoever to GMA 14's statutory mandate to achieve the highest practicable level of groundwater production. I am enclosing with this letter a Resolution of the Conroe City Council that calls upon GMA 14 to give equal attention to the other side of the "balance" required by section 36.108(d2), which is the "highest practicable level of groundwater production."

Last year, the Texas Water Development Board estimated there are 180 million acre-feet of water in storage in aquifers underlying Montgomery County, and for a conservative estimate, that 45 million acre-feet are recoverable. Total groundwater production over the past 75 years has depleted less than 1% of the water in storage under the County. None of the groundwater conservation districts adjacent to Montgomery County propose to limit production to achieve zero reduction in storage, but that is what LSGCD seems single-mindedly determined to do. Yet, it is well-established that the aquifers do not recognize the Montgomery County line, so LSGCD is manifestly disadvantaging Montgomery County residents vis-à-vis neighboring counties.

There is no evidence of subsidence with respect to the Jasper and Catahoula aquifers from which Conroe produces, and can produce, groundwater. Yet, LSGCD claims it must sharply limit groundwater production to prevent subsidence throughout Montgomery County. Subsidence is a concern only in the extreme southern portions of Montgomery County bordering Harris County. Even there, LSGCD's plan to prevent subsidence is far more restrictive of groundwater production than the plan of any subsidence district covering the southern areas within GMA 14 where subsidence is, without doubt, a substantial and continuing problem.

▶Under section 36.108(d)(3), GMA 14 <u>must</u> consider the "total estimated recoverable storage as provided by the Water Development Board." When the TWDB released its recent total estimated recoverable storage ("TERS") for Montgomery County (described above), LSGCD issued a press release declaring TWDB's TERS to be "somewhat irrelevant" to LSGCD. The same press release admits that LSGCD uses only "total effective recharge to the aquifer as the basis for how much groundwater it allows to be pumped annually." Consequently, if GMA 14 accepts LSGCD's 64,000 acre-feet limit as the basis for calculation of DFCs for the aquifers underlying Montgomery County, GMA 14 will be in direct violation of its statutory obligation to consider the TERS data.

▶Section 36.108(d)(7) requires GMA 14 to consider the impacts of its DFCs "on private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002." GMA 14 should not abdicate to LSGCD or the other groundwater conservation districts its obligation to consider this factor on a regional basis. If GMA 14 adopts DFCs that result in substantially varying levels of allowable groundwater production from county to county, or even among groundwater conservation districts, rather than developing DFCs for reservoirs on a regional basis, GMA 14 will be unlawfully discriminating among owners of groundwater rights within its region, with no scientific basis for doing so.

That is not what section 36.108(d)(7) requires, and GMA 14 should have no illusions about the destructive effects of imposing sharply different groundwater management standards on different areas of common reservoirs. The Texas Supreme Court ruled in *Edwards Aquifer Authority v. Day*, 369 S.W.3d 814 (Tex. 2012), that groundwater in place is a real property interest protected by the Takings Clause of the Constitution. The Court also clearly stated: "Like oil and gas, one purpose of groundwater regulation is to afford each owner of groundwater in a common, subsurface reservoir, a fair share." By gerrymandering different DFCs based solely on estimated demand reported to you by groundwater conservation districts (and in the case of Montgomery County, sharply curtailed demand because of LSGCD's 64,000 acre-feet per year limitation), GMA will not be carrying out its "fair share" responsibilities under section 36.108(d)(7).

It is easy to see that LSGCD's severe restrictions aimed at water producers will destroy the market for sales of groundwater rights in Montgomery County (and likely contiguous counties) by eliminating potential large buyers for groundwater rights. The value of groundwater rights in Montgomery County are being effectively "regulated away." Conroe has already brought this massive taking of private property to LSGCD's attention, but its warnings have landed on deaf ears. Conroe asks GMA 14 to conduct its own, in-depth analysis of the section 36.108(d)(7) factor, which is of Constitutional-level importance to groundwater owners throughout GMA 14. The Texas Supreme Court's denial on May 1, 2015, of the Edwards Aquifer Authority's petition for review in *Edwards Aquifer Authority v. Bragg*, 421 S.W.3d 118 (Tex. App.—San Antonio 2013, pet. denied), serves to highlight the importance of section 36.108(d)(7) in the DFC process.

Conroe recognizes that this letter is unusual and may come as a surprise to its recipients. Specifically, Conroe understands the significance of stating to GMA 14 that GMA 14 should not rely on LSGCD. Please be assured that Conroe has not come to the decision to send this letter lightly, but has studied the issue, consulted with experts, and tried to reason with LSGCD. Conroe has decided that it must seek every means of recourse available to it from the continued, inexplicable actions of LSGCD. Consequently, if GMA 14 adopts DFCs for Montgomery County that enable LSGCD to try to justify its very harmful per-producer limits purportedly designed to achieve LSGCD's 64,000 acre-feet-per-year production limit, Conroe most likely will appeal to TWDB and beyond TWDB to the courts, if necessary. In light of that, Conroe believes it best to make its position known to GMA 14, to seek your assistance, and to offer its assistance, at this stage of your DFC process.

Conroe would be pleased to make its hydrologists and attorneys available to speak with GMA 14 at any place or time.

Respectfully,

Webb Melder

Webb Melder,
Mayor of Conroe

cc: [list the Montgomery County Legislative Delegation]

The Hon. Carlos Rubenstein, Chairman, Texas Water Development Board
The Hon. Bech Bruun, Director, Texas Water Development Board
The Hon. Kathleeen Jackson, Director, Texas Water Development Board

Mr. Kevin Patteson, Executive Administrator, Texas Water Development Board

The Hon. Craig Doyal, County Judge, Montgomery County

Mr. Richard J. Tramm, President
Lone Star Groundwater Conservation District

State Senator Brandon Creighton, District 16
State Senator Robert Nichols, Dist. District 3
State Senator Larry Taylor, District 11
State Senator Joan Huffman, District 17
State Senator Lois Kolkhorst, District 18
State Senator Charles Schwertner, District 5
State Senator Mark Keough, District 15

State Representative Will Metcalf, District 16
State Representative Cecil Bell, District 3
State Representative James White, District 19
State Representative John Otto, District 18,
State Representative Joe Deshotel, District 22
State Representative Dade Phelan, District 21
State Representative Wayne Faircloth, District 23
State Representative Ed Thompson, District 29
State Representative Dennis Bonnen, District 25
State Representative Leighton Schubert, District 13

Mayor Pro Tem Kirk Jones, City of Montgomery
City Manager Hector Forestier, City of Willis
City Manager Vicky Rudy, City of Oak Ridge North
City Manager Greg Smith, City of Shenandoah
City Administrator Paul Mendes, City of Magnolia

Simon Sequeira, President Quadvest Water & Sewer Utility
Mike Stoecker, President, Stoecker Corp.
Jack Curtsinger, General Manager. River Plantation Municipal Utility District
Richard Ramirez, General Manager. East Plantation Utility District
J. Jared Patout, President Bluebonnet GCD
Zach Holland, General Manager Bluebonnet GCD
Alan Mueller, President Brazoria County GCD
Kent Burkett, General Manager Brazoria Co. GCD
Kathy Jones, General Manager Lone Star GCD
Clyde Jordan, President Lower Trinity GCD
Gary Ashmore, General Manager Lower Trinity GCD
Walter Glenn, President Southeast Texas GCD
John Martin, General Manager Southeast Texas GCD

CERTIFICATE FOR RESOLUTION

I.

On the 5th day of May, 2015, the City Council of the City of Conroe, Texas, consisting of the following qualified members, to-wit: **Webb K. Melder, Mayor; Guy Martin, Mayor Pro Tem; Council Members Seth Gibson, Marsha Porter, and Duke Coon** did convene in public session in the Council Chambers of the City Hall at 505 West Davis in Conroe, Texas. The roll being first called, a quorum was established, all members being present except **Gil Snider**. The Meeting was open to the public and public notice of the time, place and purpose of the Meeting was given, all as required by Chapter 551, Texas Government Code.

II.

WHEREUPON, AMONG OTHER BUSINESS transacted, the Council considered adoption of the following written Resolution, to-wit:

RESOLUTION NO. 4232-15

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF CONROE, TEXAS, SUPPORTING THE ADOPTION BY TEXAS GROUNDWATER MANAGEMENT AREA 14 OF DESIRED FUTURE CONDITIONS THAT ALLOW THE HIGHEST PRACTICABLE LEVEL OF GROUNDWATER PRODUCTION THAT IS CONSISTENT WITH CONSERVATION AND SCIENTIFIC AQUIFER MANAGEMENT AND CALLING UPON THE LONE STAR GROUNDWATER CONSERVATION DISTRICT TO IMPLEMENT REGULATIONS PERMITTING PRODUCTION CONSISTENT WITH SUCH DESIRED FUTURE CONDITIONS; PROVIDING FOR EFFECTIVE DATE AND OTHER RELATED MATTERS.

III.

Upon motion of Mayor Pro Tem Martin, seconded by Council Member Gibson, all members present voted for adoption of the Resolution, except the following: Council Member Coon abstained. A majority of those Council Members present having voted for adoption, the presiding officer declared the Resolution passed and adopted.

IV.

A true, full and correct copy of the Resolution adopted at the Meeting is attached to and follows this Certificate.

RESOLUTION NO. 4232-15

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF CONROE, TEXAS, SUPPORTING THE ADOPTION BY TEXAS GROUNDWATER MANAGEMENT AREA 14 OF DESIRED FUTURE CONDITIONS THAT ALLOW THE HIGHEST PRACTICABLE LEVEL OF GROUNDWATER PRODUCTION THAT IS CONSISTENT WITH CONSERVATION AND SCIENTIFIC AQUIFER MANAGEMENT AND CALLING UPON THE LONE STAR GROUNDWATER CONSERVATION DISTRICT TO IMPLEMENT REGULATIONS PERMITTING PRODUCTION CONSISTENT WITH SUCH DESIRED FUTURE CONDITIONS; PROVIDING FOR EFFECTIVE DATE AND OTHER RELATED MATTERS.

* * * * * * * * * *

WHEREAS, the City of Conroe is a rapidly growing community with a rising demand for water; and

WHEREAS, the use of groundwater obtained from the Jasper Aquifer is and will remain an important source of water for the City of Conroe; and

WHEREAS, the Lone Star Groundwater Conservation District (LSGCD) regulates and limits the production of water within Montgomery County based on desired future conditions (DFCs) adopted by Groundwater Management Area 14 (GMA 14); and

WHEREAS, pursuant to the Texas Water Code, the establishment of DFCs must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging and prevention of waste of groundwater and the control of subsidence in the management area; and

WHEREAS, LSGCD has advocated the adoption of a county-based DFC that justifies the district's regulatory limits on groundwater production within Montgomery County, rather than basing its regulations on a regional DFC established in accordance with the balancing of factors prescribed by the Texas Water Code; and

WHEREAS, the increased demand for water associated with a growing population coupled with stringent limitations upon groundwater production will of necessity force even greater reliance on the finite surface water resources of Lake Conroe or other alternatives including the Catahoula Aquifer; and

WHEREAS, excessive use of the surface waters of Lake Conroe will reduce lake levels and be potentially harmful to the recreational use of the Lake, damaging to Lake Conroe area businesses, and may cause depreciation in the value of properties in the Lake Conroe area; and

WHEREAS, a balanced approach to the establishment of DFCs should permit the highest practicable level of production of groundwater from regional aquifers and not support arbitrary limits on production:

NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF CONROE, TEXAS:

Section 1. That the City Council of Conroe supports the balanced use of groundwater, including Catahoula Aquifer water, surface water, and conservation and other alternative water supply strategies, and supports the continued right to produce from the Jasper Aquifer, from which Conroe presently supplies its water needs, at the highest practicable levels.

Section 2. That the City Council of Conroe supports the consideration of the best scientific data relevant to the establishment of the DFCs, including valid data related to the recharge rate; however, the recharge rate alone should not dictate the DFCs but should instead be given due consideration along with the other statutory criteria.

Section 3. That the City Council of Conroe supports the establishment of DFCs assuming reasonable reductions in groundwater storage levels in the regional aquifers, provided that such reductions do not substantially increase the danger of localized subsidence or other adverse environmental impacts. The City Council calls on LSGCD and GMA 14 to engage large volume groundwater users, municipalities, municipal utility districts and others in meaningful discussions to establish DFCs that reflect the consensus of the stakeholders.

Section 4. That the City Council of Conroe calls upon the board of the LSGCD to enact regulations establishing reasonable groundwater pumping limits that do not arbitrarily restrict pumping for the City of Conroe, but are instead consistent with the DFCs established by a process as provided by this resolution.

Section 5. The City Council of Conroe directs that a copy of this resolution and that a letter in substantially the form attached hereto be provided to the Texas Water Development Board, District Representatives to GMA 14, and the LSGCD.

Section 6. This resolution is effective upon adoption.

PASSED AND APPROVED this the 5th day of May, 2015.

WEBB K. MELDER, Mayor

APPROVED AS TO FORM:

MARCUS L. WINBERRY, City Attorney

ATTEST:

MARLA J. PORTER, City Secretary

CITY OF CONROE LETTERHEAD

[date]

To: District Representatives to
Texas Groundwater Management Area 14

Re: Your Task of Developing Desired Future Conditions for Aquifers

Dear District Representatives:

Conroe is the largest city in Montgomery County, and it is rapidly growing. In 2013, Conroe was the tenth fastest-growing city in the United States among all cities having a population greater than 50,000. There are reliable estimates that by 2030, Montgomery County's population will increase to one million residents, many of whom will live in Conroe. The Mayor and City Council of Conroe are responsible for providing ample supplies of water, at a reasonable cost, to all of Conroe's current and future residents and businesses. Carrying out that role, Conroe is presently the second largest producer of groundwater in Montgomery County.

I am writing to you, on behalf of Conroe's City Council, in your capacities as "District Representatives" to Groundwater Management Area 14 ("GMA 14") under Texas Water Code §36.108. To put our reason for writing bluntly, Conroe has lost confidence in the Lone Star Groundwater Conservation District's ("LSGCD's") regulation of groundwater within Montgomery County. As a result, the City Council and I concluded that Conroe should express its very serious concerns directly to GMA 14, as you, the District Representatives to GMA 14, undertake GMA 14's statutory obligation to adopt updated desired future conditions ("DFCs") for the four different aquifers that underlie not only Montgomery County, but also adjacent counties. I can confirm to you that Conroe is not alone in its exasperation with LSGCD's non-responsiveness to the concerns of Montgomery County citizens. Many private parties and other governmental units in Montgomery County have the same increasingly-urgent concerns about LSGCD that Conroe has.

Conroe's strong requests to you are (1) that GMA 14 not follow its incorrect past practice of attempting to establish balkanized, county-by-county, DFCs for the aquifers underlying GMA 14, rather than engaging in regional planning for the aquifers, as you should do, and (2) that GMA 14 not follow its very poor past practice of "backing into" DFCs for aquifers underlying Montgomery County by accepting, uncritically, LSGCD's scientifically-unsupported limitation of Montgomery County groundwater production to 64,000 acre-feet-per-year, and then merely "deriving" DFCs for Montgomery County based on that limitation.

The minutes of GMA 14's Joint Planning Group meeting of June 26, 2013, succinctly describe the backwards approach that GMA 14 has followed in the past:

> "[T]o adjust the pumpage to match a particular DFC would be very work intensive. The more direct method would be to review the pumpage figures and projected demands for each entity and once agreed upon, put those numbers into the model and determine the resulting DFCs."

Under that flawed approach, LSGCD's arbitrary 64,000 acre-feet-per-year limit becomes a self-fulfilling mandate. LSGCD adopted that limitation, based on virtually no science, and reported it to GMA 14; GMA 14 "put that number into the model" and calculated supposed DFCs for Montgomery County based on LSGCD's limit; and now LSGCD claims it must enforce regulations to achieve the 64,000 acre-feet-per-year limit because DFCs require it to do so. This process—clearly not the process contemplated by section 38.108 of the Water Code—is crippling Conroe and other owners and producers of groundwater in Montgomery County.

As you, the District Representatives to GMA 14, carry out your statutory obligations in the current DFC cycle, Conroe asks you not to accept what LSGCD says about Montgomery County, but rather to conduct your own work and comply with your own statutory obligations under section 36.108, which, as you know, has been substantially amended since GMA 14 last adopted DFCs.

We will not prolong this letter by attempting to describe all the problems Conroe has with LSGCD's flawed and unscientific approach, but here are examples that relate directly to the task the Legislature has assigned to GMA 14:

▶Under section 36.108(d-2), DFCs adopted by GMA 14 "must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging and prevention of waste of groundwater and control of subsidence in the management area." (Emphasis added). LSGCD's 64,000 acre-feet-per-year is based on only two of the factors listed in the statute—recharge and subsidence. LSGCD's 64,000 acre-feet-per-year gives no weight whatsoever to GMA 14's statutory mandate to achieve the highest practicable level of groundwater production. I am enclosing with this letter a Resolution of the Conroe City Council that calls upon GMA 14 to give equal attention to the other side of the "balance" required by section 36.108(d-2), which is the "highest practicable level of groundwater production."

Last year, the Texas Water Development Board estimated there are 180 million acre-feet of water in storage in aquifers underlying Montgomery County, and for a conservative estimate, that 45 million acre-feet are recoverable. Total groundwater production over the past 75 years has depleted less than 1% of the water in storage under the County. None of the groundwater conservation districts adjacent to Montgomery County propose to limit production to achieve zero reduction in storage, but that is what LSGCD seems single-mindedly determined to do. Yet, it is well-established that the aquifers do not recognize the Montgomery County line, so LSGCD is manifestly disadvantaging Montgomery County residents vis-à-vis neighboring counties.

There is no evidence of subsidence with respect to the Jasper and Catahoula aquifers from which Conroe produces, and can produce, groundwater. Yet, LSGCD claims it must sharply limit groundwater production to prevent subsidence throughout Montgomery County. Subsidence is a concern only in the extreme southern portions of Montgomery County bordering Harris County. Even there, LSGCD's plan to prevent subsidence is far more restrictive of groundwater production than the plan of any subsidence district covering the southern areas within GMA 14 where subsidence is, without doubt, a substantial and continuing problem.

►Under section 36.108(d)(3), GMA 14 must consider the "total estimated recoverable storage as provided by the Water Development Board." When the TWDB released its recent total estimated recoverable storage ("TERS") for Montgomery County (described above), LSGCD issued a press release declaring TWDB's TERS to be "somewhat irrelevant" to LSGCD. The same press release admits that LSGCD uses only "total effective recharge to the aquifer as the basis for how much groundwater it allows to be pumped annually." Consequently, if GMA 14 accepts LSGCD's 64,000 acre-feet limit as the basis for calculation of DFCs for the aquifers underlying Montgomery County, GMA 14 will be in direct violation of its statutory obligation to consider the TERS data.

►Section 36~~8~~.108(d)(7) requires GMA 14 to consider the impacts of its DFCs "on private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002." GMA 14 should not abdicate to LSGCD or the other groundwater conservation districts its obligation to consider this factor on a regional basis. If GMA 14 adopts DFCs that result in substantially varying levels of allowable groundwater production from county to county, or even among groundwater conservation districts, rather than developing DFCs for reservoirs on a regional basis, GMA 14 will be unlawfully discriminating among owners of groundwater rights within its region, with no scientific basis for doing so.

That is not what section 36.108(d)(7) requires, and GMA 14 should have no illusions about the destructive effects of imposing sharply different groundwater management standards on different areas of common reservoirs. The Texas Supreme Court ruled in *Edwards Aquifer Authority v. Day*, 369 S.W.3d 814 (Tex. 2012), that groundwater in place is a real property interest protected by the Takings Clause of the Constitution. The Court also clearly stated: "Like oil and gas, one purpose of groundwater regulation is to afford each owner of groundwater in a common, subsurface reservoir, a fair share." By gerrymandering different DFCs based solely on estimated demand reported to you by groundwater conservation districts (and in the case of Montgomery County, sharply curtailed demand because of LSGCD's 64,000 acre-feet per year limitation), GMA will not be carrying out its "fair share" responsibilities under section 36.108(d)(7).

It is easy to see that LSGCD's severe restrictions aimed at water producers will destroy the market for sales of groundwater rights in Montgomery County (and likely contiguous counties) by eliminating potential large buyers for groundwater rights. The value of groundwater rights in Montgomery County are being effectively "regulated away." Conroe has already brought this massive taking of private property to LSGCD's attention, but its warnings have landed on deaf ears. Conroe asks GMA 14 to conduct its own, in-depth analysis of the section 358.108(d)(7) factor, which is of Constitutional-level importance to groundwater owners throughout GMA 14. The Texas Supreme Court's denial on May 1, 2015, of the Edwards Aquifer Authority's petition for review in *Edwards Aquifer Authority v. Bragg*, 421 S.W.3d 118

(Tex. App.—San Antonio 2013, pet. denied), serves to highlight the importance of section 368.1089(d)(7) in the DFC process.

Conroe recognizes that this letter is unusual and may come as a surprise to its recipients. Specifically, Conroe understands the significance of stating to GMA 14 that GMA 14 should not rely on LSGCD. Please be assured that Conroe has not come to the decision to send this letter lightly, but has studied the issue, consulted with experts, and tried to reason with LSGCD. Conroe has decided that it must seek every means of recourse available to it from the continued, inexplicable actions of LSGCD. Consequently, if GMA 14 adopts DFCs for Montgomery County that enable LSGCD to try to justify its very harmful per-producer limits purportedly designed to achieve LSGCD's 64,000 acre-feet-per-year production limit, Conroe most likely will appeal to TWDB and beyond TWDB to the courts, if necessary. In light of that, Conroe believes it best to make its position known to GMA 14, to seek your assistance, and to offer its assistance, at this stage of your DFC process.

Conroe would be pleased to make its hydrologists and attorneys available to speak with GMA 14 at any place or time.

Respectfully,

Webb Melder,
Mayor of Conroe

cc: [list the Montgomery County Legislative Delegation]

The Hon. Carlos Rubenstein, Chairman, Texas Water Development Board
The Hon. Bech Bruun, Director, Texas Water Development Board
The Hon. Kathleeen Jackson, Director, Texas Water Development Board
Mr. Kevin Patteson, Executive Director, Texas Water Development Board

The Hon. Craig Doyal, County Judge, Montgomery County

Mr. Kevin Patteson, Executive Administrator, Texas Water Development Board

The Hon. Craig Doyal, County Judge, Montgomery County

Mr. Richard J. Tramm, President
Lone Star Groundwater Conservation District

State Senator Brandon Creighton, District 16
State Senator Robert Nichols, Dist. District 3
State Senator Larry Taylor, District 11
State Senator Joan Huffman, District 17
State Senator Lois Kolkhorst, District 18
State Senator Charles Schwertner, District 5
State Senator Mark Keough, District 15

State Representative Will Metcalf, District 16
State Representative Cecil Bell, District 3
State Representative James White, District 19
State Representative John Otto, District 18,
State Representative Joe Deshotel, District 22
State Representative Dade Phelan, District 21
State Representative Wayne Faircloth, District 23
State Representative Ed Thompson, District 29
State Representative Dennis Bonnen, District 25
State Representative Leighton Schubert, District 13

Mayor Pro Tem Kirk Jones, City of Montgomery
City Manager Hector Forestier, City of Willis
City Manager Vicky Rudy, City of Oak Ridge North
City Manager Greg Smith, City of Shenandoah
City Administrator Paul Mendes, City of Magnolia

Simon Sequeira, President Quadvest Water & Sewer Utility
Mike Stoecker, President, Stoecker Corp.
Jack Curtsinger, General Manager. River Plantation Municipal Utility District
Richard Ramirez, General Manager. East Plantation Utility District
J. Jared Patout, President Bluebonnet GCD
Zach Holland, General Manager Bluebonnet GCD
Alan Mueller, President Brazoria County GCD
Kent Burkett, General Manager Brazoria Co. GCD
Kathy Jones, General Manager Lone Star GCD
Clyde Jordan, President Lower Trinity GCD
Gary Ashmore, General Manager Lower Trinity GCD
Walter Glenn, President Southeast Texas GCD
John Martin, General Manager Southeast Texas GCD

SPROUSE SHRADER SMITH PLLC
ATTORNEYS AT LAW

MARVIN W. JONES
(806) 468-3344

August 25, 2015

VIA EMAIL kjones@lonestargcd.org
Kathy Jones
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655 Conroe Park North Drive
Conroe, Texas 77303

VIA EMAIL: Jmartin@setgcd.org
John Martin
SOUTHEAST TEXAS GROUNDWATER CONSERVATION DISTRICT
271 East Lamar
Jasper, Texas 75951

VIA EMAIL: ZHolland@bluebonnetgroundwater.org
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Kent Burkett
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VIA EMAIL: ltgcdristrict@livingston.net
Gary Ashmore
LOWER TRINITY GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1879
Livingston, Texas 77351

Re: Groundwater Management Area 14 ("GMA 14")

We are writing at the request of our clients Quadvest Water and Sewer Utility and Stoecker Corporation. We write to you in your capacity as the general manager of one of the groundwater conservation districts ("GCDs") that make up Groundwater Management Area 14 ("GMA 14") under Tex. Water Code Sec. 36.108.

On June 24, 2015, the district representatives of the GCDs of GMA 14 adopted Desired Future Conditions ("DFCs") for all aquifers in GMA 14. In reviewing the DFCs adopted by these representatives, we note that the DFCs for the various aquifers comprising the "Gulf Coast Aquifer" vary from county to county within GMA 14. In many instances, the variation is substantial. In our opinion, the groundwater conservation districts of GMA 14 cannot establish different DFCs for the various aquifers of the Gulf Coast aquifer system based on political subdivision lines. The DFCs adopted by GMA 14 are both legally and hydrologically wrong.

Background Information Regarding Groundwater District Boundaries

In 1949, the Legislature authorized the creation of Underground Water Conservation Districts.[1] This Act defined "reservoir" as follows:

> (4) "Underground Water Reservoir" is a specific subsurface water bearing reservoir having ascertainable boundaries and containing underground water capable of being produced from a well at the rate of not less than one hundred fifty thousand (150,000) gallons per day.

The term "subdivision of an underground water reservoir" was defined as:

> (5) "Subdivision of an underground water reservoir" is that definable part of an underground water reservoir from which withdrawal of waters <u>cannot measurably affect the underground water of any other part of such reservoir</u>, based upon existing conditions and reasonably foreseeable conditions, at the time of the designation or alteration of such subdivision.

Subsection C of Chapter 306 placed limitations on the creation of underground water conservation districts:

> C. No petition for the creation of a District to exercise the powers and functions set forth in Subsection B of this Section 3c shall be considered by a Commissioners Court or the Board, as the case

[1] Acts 1949, 51st Leg., ch. 306, s 1.

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> may be, unless the area to be included therein is coterminous with an underground water reservoir or subdivision thereof which theretofore has been defined and designated by the Board as an underground water reservoir or subdivision thereof. Such district, in conforming to a defined reservoir or subdivision, may include all or parts of a county or counties, municipal corporations or other political subdivisions, including but not limited to Water Control and Improvement Districts.

This early history of groundwater regulation is important today because the Legislature clearly recognized that regulation of groundwater must comport with sound principles of law and science. The early legislation recognized the imperative that regulation must be based on hydrological units. Central to the thesis was the idea that a proper management unit should be defined by the impact that withdrawal of water within the unit would produce elsewhere; if withdrawal of groundwater within a management area could impact groundwater outside the management area, the management area was too narrowly drawn. This makes sense because of the constitutionally protected rights of owners in the same aquifer—as noted below, any regulatory unit that encompasses less than the full aquifer under management will inherently tread on those rights.

The Current Legislation Regarding DFCs

Although the Legislature later allowed the creation of single county groundwater conservation districts, they did so with full knowledge that the boundaries of groundwater districts created after 1989 were to be coterminous with or inside the most suitable area for management of the underground water resources. Additionally, the Legislature has never materially changed the definitions of "groundwater reservoir" or "subdivision of a groundwater reservoir." Today, in the statutory environment in which your district must operate, Chapter 36 of the Water Code contains the following definitions:

> Sec. 36.001. DEFINITIONS. In this chapter:
>
> ...
>
> (6) "Groundwater reservoir" means a specific subsurface water-bearing reservoir having ascertainable boundaries containing groundwater.
>
> (7) "Subdivision of a groundwater reservoir" means 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.

The Legislature has never changed the definition of "subdivision of a groundwater reservoir" to allow groundwater supplies in one groundwater district to be appreciably affected by withdrawals from the same aquifer in a different groundwater district. Although the Legislature has allowed groundwater conservation districts boundaries to be based on political subdivisions like counties, the Legislature has never authorized the establishment of desired future conditions based on political subdivision lines. Establishing different desired future conditions based on political boundaries instead of aquifer boundaries is therefore not authorized, and the districts of GMA 14 have acted outside their authority in doing so.

As noted above, neither the original legislation nor the current legislation authorizes different DFCs for an underground reservoir based solely on political subdivision lines. Section 36.108, relating to joint planning in a management area, continues the concepts of the original legislation by repeatedly mentioning "subdivisions" of aquifers as a basis for different DFCs. Some districts have seized on the language of Sec. 36.108(d-1) to justify different DFCs in adjacent districts. That section does not authorize different DFCs based on political boundaries. It states:

> (d-1) The districts may establish different desired future conditions for:
>
> (1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or
>
> (2) each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area.

Section 36.108(d-1) does not give the districts any authority to establish different DFCs based on political subdivision lines. Section 36.108(d-1)(1) refers to hydrological units: aquifers, subdivisions of aquifers and geologic strata. None of these terms can be construed to include county lines.

The only other possible justification for the districts of GMA 14 to establish different DFCs for each political subdivision is the language of Sec. 36.108(d-1)(2), referring to "geographic areas." While the terms "reservoir" and "subdivision of a reservoir" are defined in Section 36.001, the term "geographic areas" is not. By elimination, geographic area is not an aquifer, subdivision of an aquifer or geologic strata. Can a geographic area be a political subdivision? 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 different desired future conditions.

Therefore, the current legislation does not give groundwater conservations districts in a joint planning area the authority to establish DFCs based on their political boundaries.

The Legal Problem with Different DFCs

Section 36.108 and the DFC process require each district to promulgate rules that are designed to achieve the adopted DFCs. Obviously, if five groundwater districts "share" a common aquifer but have different DFCs, those five districts will have five different sets of rules designed to achieve their individual DFC for that aquifer. If adjacent districts have different DFCs and therefore different production limits, groundwater rights owners on one side of a political line will be affected by withdrawals of groundwater on the opposite side of the line. These owners will be hampered in their ability to exercise their right of offset. That being true, their property will effectively be taken by virtue of governmental regulation.

Our opinion in this regard is based in part on the holding of the Texas Supreme Court in the 1945 case of *Marrs v. Railroad Commission*, 177 S.W.2d 941 (Tex. 1945), where the Court specifically held that owners within the same field must be treated equally. That case involved an arbitrary line drawn by the Railroad Commission through an oil field. The oil field itself was continuous at and under the line, just like the Gulf Coast aquifers are at and under the county lines that surround your GCD. The Texas Supreme Court held that the Railroad Commission's field rules resulted in a prohibited taking of private property because the owners on the south side of the line could not protect themselves from drainage by the owners to the north.

Like the oil formation in *Marrs*, the aquifers do not see arbitrary lines drawn on a map. Given the total lack of coordination between the GCD's of GMA 14 in terms of production rules and limits, the differing DFC's adopted by GMA 14 will result in prohibited takings.

The Hydrological Issues with Different DFCs

As you know, Sec. 36.108(d) states that before voting on proposed desired future conditions, the districts shall consider:

(1) aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another;

(2) the water supply needs and water management strategies included in the state water plan;
(3) hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge;
(4) other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water;
(5) the impact on subsidence;
(6) socioeconomic impacts reasonably expected to occur;
(7) the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002;
(8) the feasibility of achieving the desired future condition; and
(9) any other information relevant to the specific desired future conditions.

Although all of the listed factors are important to the DFC process, Items 1 and 7 are particularly implicated by the DFCs adopted by GMA 14. While Sec. 36.108(d-1) states that the districts in a GMA may establish different desired future conditions for each geographic area overlying an aquifer within the boundaries of the management area, designating different DFC's for different groundwater districts or different counties can only be justified where there are discernible and substantial differences in aquifer uses or conditions that happen to be delineated by groundwater district or county political lines.

Our opinion is based on the language and intent of the Water Code provisions cited above. It is further based on a Texas Water Development Board ("TWDB") Staff Memo from William R. Hutchison and Kenneth L. Petersen dated March 10, 2010, where the issue "geographical area" language of the Code was addressed as follow:

> The question has been presented whether groundwater conservation districts within a groundwater management area (GMA) may delineate different "geographic areas" within the GMA by use of county (or other political subdivision) boundaries. Staff believes this approach is legally defensible provided the districts are using the political subdivision boundaries to locate discernible and substantial differences in uses or conditions within the GMA and not for any other purposes. It should be emphasized that employing geographic areas that are not based on clear and substantial differences in uses or aquifer conditions is not supportable, regardless of how those geographic areas are drawn.

I understand that some of the GMA 14 consultants and even some employees of the TWDB were not aware of this memorandum, so I asked that it be included in the materials at the recent GMA 14 meeting. Given the language of Sec. 36.108 and the implications of the *Marrs* case, the memorandum from respected counsel Ken Petersen and respected scientist Bill Hutchison is correct in its conclusions.

The districts of GMA 14 have not even attempted to demonstrate discernible and substantial differences in uses or conditions with respect to the Gulf Coast aquifer subdivisions within GMA 14 that are delineated by any political subdivision lines. Moreover, any discernible and substantial differences in uses or conditions of the subdivisions of the Gulf Coast Aquifer do not just happen to all exist along the exact political boundaries of the counties within GMA 14. In fact, there is absolutely no hydrogeological evidence to support such a notion.

The Current DFCs Will Not Accomplish The Purpose of Groundwater Management

The small, politically defined DFC areas currently under consideration are ineffective in accomplishing the statutory mandates of Chapter 36. Section 36.0015 states the purpose of groundwater management in Texas is "to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of <u>groundwater reservoirs or their subdivisions</u>, and to control subsidence caused by withdrawal of water from those <u>groundwater reservoirs or their subdivisions</u>…". The DFC areas now under consideration are drawn solely on political boundaries. The DFC areas have no relationship to the geohydrology of the aquifers within GMA 14 and the current patterns of use and the potential for future use. Pumping from wells under artesian conditions creates a widespread cone of depression that can easily cross the county areas and appreciable effects on water supplies can be created by adjacent developments. Therefore the small, politically based DFC areas do not qualify as being "aquifer subdivisions."

The effects of production are readily known to span across the adopted DFC boundaries. Pumping outside of one DFC area could effectively make management within an adjoining DFC area impossible or to no avail. For instance, groundwater development in Liberty County could preclude achievement of a DFC inside of only Montgomery County. So, the small, politically based DFC areas are ineffective for providing the framework to properly regulate the production of wells in order to minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure as provided for by Chapter 36.116.

Only by having a defined DFC area that is consistent with the geohydrologic conditions of the aquifer, present groundwater development, and potential future developments, is it possible to reasonably ensure that the DFC area is the most suitable to administer the statutory purpose of groundwater districts. This includes the development of "fair and impartial" rules as required under Section 36.101(2), while also considering the groundwater ownership and private property rights described by Section 36.002. Section 36.002 recognizes groundwater is privately owned and the regulation of such, accordingly, is provided normal constitutional protections regarding regulation of private property. The Supreme Court has stated "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". *Edwards Aquifer Authority v. Day and McDaniel*, 369 S.W.3d 814 (Tex. 2012). The GMA 14 meeting minutes clearly state that the proposed DFCs were derived through a process of reviewing pumpage figures and projected demands by County and once agreed upon, "put those numbers into the model and determine the resulting DFCs". Therefore, GMA 14 has done nothing more than appropriate varying amounts of groundwater to owners through an assumption of demand for a groundwater owner dependent solely on the political location of one's land. Clearly, this does not conform to normally applied concepts of fairness but rather is arbitrary and discriminatory.

Accordingly, the districts of GMA 14 should reject any approach to the adoption of different DFC's for each groundwater district or county within GMA 14. The DFC's that are ultimately adopted for the individual geologic strata of the Gulf Coast aquifer within GMA 14 should not be based on political subdivision boundaries without any scientific justification.

Request for Detailed Explanatory Report

Sec. 36.108(d-3) requires the district representatives in GMA 14 to produce an explanatory report to be submitted to the TWDB. That report must:

(1) identify each desired future condition;
(2) provide the policy and technical justifications for each desired future condition;
(3) include documentation that the factors under Subsection (d) were considered by the districts and a discussion of how the adopted desired future conditions impact each factor;
(4) list other desired future condition options considered, if any, and the reasons why those options were not adopted; and
(5) discuss reasons why recommendations made by advisory committees and relevant public comments received by the districts were or were not incorporated into the desired future conditions.

We request that the above report provide the policy and technical justifications that were considered and documented prior to establishing each such desired future condition in each aquifer existing in each county of GMA 14. We request that the report specifically identify the discernible and substantial differences in uses or conditions that are delineated by each of the political subdivision boundaries within GMA 14, and how the adopted political boundaries are the most suitable areas for the protection of private property rights in a common aquifer.

Hydrologic Flaw in Lone Star's Underlying DFC Assumptions

The DFC's adopted by GMA 14, and which your district is now being asked to endorse, are not based on the best available science relating to the various aquifers. The board of the Lone Star GCD (LSGCD) expressly determined its DFC's for the Gulf Coast aquifers on the assumption that the Modeled Available Groundwater (MAG) would consist of only recharge which occurs within Montgomery County. The total recharge in Montgomery County is estimated by LSGCD as 64,000 ac-ft per year. This total recharge estimate was assumed as MAG and distributed between the different strata of the Gulf Coast aquifer. This assumption for determining DFCs ignores the best available science and ignores how recharge works in the individual strata of the Gulf Coast aquifer. This is evident, for example, with respect to the Jasper aquifer. If you consider only the outcrop for the Jasper that overlies Montgomery County (4,300 acres) and make the same assumptions that LSGCD made about the amount of recharge (1.1 inch per acre per year), the resulting recharge (MAG) for the Jasper would only be 390 acre feet. Yet, the MAG for the Jasper aquifer in Montgomery County which results from the DFC adopted by GMA 14 is 24,000 AFY. Thus, the DFC for the Jasper under LSGCD is not based on even the simplistic "science" used by that district to design its MAG or its DFCs.

More importantly, the DFC chosen for the Jasper aquifer under LSGCD ignores the effects of recharge from the Jasper outcrop outside of Montgomery County. It is scientifically undeniable that the Montgomery County Jasper is recharged from an area of Jasper outcrop that far exceeds the 4,300 acres of outcrop that actually exists in Montgomery County. Thus, the approach followed by GMA 14 in setting the adopted DFC's explicitly ignores the fact that groundwater is moving between the GCD's and the counties of GMA 14. This movement of groundwater between GCD's means that no one GCD in GMA 14 can actually "manage" the groundwater, including the protection of property rights of all owners overlying the common reservoir, without considering the geohydrologic conditions of the aquifers, the natural and lateral boundaries present, and the effects of production.

The representatives of GMA 14 have consciously ignored undisputed hydrological facts to reach the disparate DFC's that they adopted. Your district should reject this approach to "joint planning," and should insist that the DFC's be set based on the actual extent of the aquifers, the actual contributing areas to recharge, and the nature of effects of production, and not simply on political boundaries.

Thank you for your consideration of these comments. If you have any questions at all regarding these comments, please not hesitate to contact me directly.

Respectfully,

Marvin W. Jones

MWJ:sdf

Cc: Bob Harden
Mike Thornhill
Mike Stoecker
Simon Sequeira
Mike Powell

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September 14, 2015

VIA FEDEX OVERNIGHT DELIVERY

Mr. Richard J. Tramm, President
Board of Directors
Lone Star Groundwater Conservation District
655 Conroe Park North Drive
Conroe, Texas 77303

Re: Lone Star Groundwater Conservation District's Public Hearing on Desired Future Conditions, called for September 17, 2015

Dear Mr. Tramm:

On behalf of this firm's client, the City of Conroe (the "City"), I am submitting 12 copies of an "Evaluation of Desired Future Conditions for the Gulf Coast Aquifer within GMA 14," prepared for the City by R.W. Harden and Associates, Inc., of Austin. The City requests that the District include this Evaluation in the District's official record of the public hearing the District will hold on GMA 14's proposed Desired Future Conditions ("DFC's), and that the District give careful consideration to the matters addressed by this Evaluation before voting the proposed DFCs, as required by Section 36.108(d) of the Texas Water Code.

The City respectfully requests that you ask the District's staff to forward a copy of the enclosed Evaluation to each member of the District's Board of Directors prior to Thursday's public hearing. The City has asked Mr. Bob Harden to attend Thursday's public hearing to answer any questions Board members may have about the enclosed Evaluation.

We are also enclosing 12 copies of a letter previously forwarded to the District's General Manager, in her capacity as the District's Representative on GMA 14, by Mr. Marvin W. Jones on behalf of certain of his clients who are water owners and users within the District. We think Mr. Jones' letter provides very important information for the District's Directors to consider as they decide how to vote on GMA 14's DFC's. We also request that Mr. Jones' letter be included in the District's official record of its September 17th public hearing.

Respectfully,

Mike Powell

Michael V. Powell

EXHIBIT D

Enclosures:

(1) R. W. Harden and Associates, Inc., "Evaluation of Desired Future Conditions for the Gulf Coast Aquifer within GMA 14, September 2015 (12 bound copies)

(2) Letter, August 25, 2015, Marvin W. Jones to Ms. Kathy Jones, et al., Re: Groundwater Management Area 14 ("GMA 14) (12 copies)

LONE STAR
GROUNDWATER CONSERVATION DISTRICT

June 14, 2016

MINUTES OF SPECIAL MEETING

The Board of Directors of the Lone Star Groundwater Conservation District ("District") held a "Special Meeting," open to the public, in the Lone Star GCD – James B. "Jim" Wesley Board Room located at 655 Conroe Park North Drive, Conroe, Texas, within the boundaries of the District on June 14, 2016.

President Tramm called the meeting to order at 9:06 a.m., announcing that it was now open to the public.

The roll was called of the members of the Board of Directors, to wit:

John D. Bleyl, PE
Greg Hope
Jace Houston
Roy McCoy, Jr.
Rick J. Moffatt
Jim Stinson, PE
Richard J. Tramm
M. Scott Weisinger, PG
W. B. Wood

All members of the Board were present with the exception of Director(s) Hope, Houston, McCoy, and Weisinger thus constituting a quorum of the Board of Directors. Also, in attendance at said meeting were Kathy Turner Jones, District General Manager; Paul R. Nelson, Assistant General Manager; Brian L. Sledge, General Counsel; District staff; and members of the public. ***Copies of the public sign-in sheets are attached hereto as Exhibit "A"***.

After a proper and legally sufficient announcement to the public by President Tramm, the Board of Directors went into a Closed Executive Session at 9:08 AM pursuant to Texas Government Code, Sections 551.071, to consult with the District's attorney regarding pending or contemplated litigation, settlement offers, or on matters in which the duty of the attorney to the governmental body under the Texas Disciplinary Rules of Professional Conduct of the State Bar of Texas clearly conflicts with the Texas Open Meetings Act, Chapter 551, Government Code.

Following Executive Session, the Board reconvened in Open Session and President Tramm declared it open to the public at 10:08 AM.

EXHIBIT E

No additional action was taken on matters discussed in Executive Session and President Tramm adjourned the meeting at 10:09 AM.

PASSED, APPROVED, AND ADOPTED THIS 12th DAY OF JULY 2016.

Rick Moffatt, Board Secretary

EXHIBIT E

LONE STAR
GROUNDWATER CONSERVATION DISTRICT

June 14, 2016

MINUTES OF PUBLIC HEARING ON PERMIT APPLICATIONS

The Board of Directors of the Lone Star Groundwater Conservation District ("District") met in regular session, open to the public, in the Lone Star GCD – James B. "Jim" Wesley Board Room located at 655 Conroe Park North Drive, Conroe, Texas, within the boundaries of the District on June 14, 2016.

CALL TO ORDER:

President Tramm called to order the Public Hearing on Permit Applications at 10:10 AM., announcing the meeting open to the public.

ROLL CALL:

The roll was called of the members of the Board of Directors, to wit:

John D. Bleyl, PE
Gregg Hope
Jace Houston
Roy McCoy, Jr.
Rick J. Moffatt
Jim Stinson, PE
Richard J. Tramm
M. Scott Weisinger, PG
W. B. Wood

All members of the Board were present with the exception of Director(s) Hope, Houston, McCoy and Weisinger thus constituting a quorum of the Board of Directors. Also, in attendance at said meeting were Kathy Turner Jones, General Manager; Paul R. Nelson, Assistant General Manager; Brian L. Sledge, District Counsel; Mark Lowry, District Consultant; District staff; and members of the public. *Copies of the public sign-in sheets are attached hereto as Exhibit "A".*

Permitting Director, Samantha Reiter stated there were five applications received for the month and that the items listed would be taken in one group. She then noted for the board that item #1, item #3 and item #5 were new small volume permits requesting new wells and

EXHIBIT E

allocations. Item #2 is an application for an existing well while item #4 is requesting an amendment to add a well only.

Item #1, **Drymalla Construction,** – Applicant is requesting registration of a new well and production authorization in the amount of 4,300,000 gallons for 2016 and 9,600,000 gallons for 2017 and annually thereafter. Based on technical review of the information supplied, it is the General Manager's recommendation to approve that which is being requested.

Item #2, **Kingwood Mini Storage** – Applicant is requesting registration of an existing well and production authorization in the amount of 10,000 gallons for 2016 and annually thereafter. Based on technical review of the information supplied, it is the General Manager's recommendation to approve that which is being requested.

Item #3, **Premier Shell Investments** – Applicant is requesting registration of a new well and production authorization in the amount of 75,000 gallons for 2016 and 150,000 gallons for 2017 and annually thereafter. Based on technical review of the information supplied, it is the General Manager's recommendation to approve that which is being requested.

Item #4, **Quadvest, LP (Magnolia Reserve)** – Applicant is requesting an amendment to an Operating Permit for drilling authorization for a new well. No additional production authorization is being requested at this time. Based on technical review of the information supplied, it is the General Manager's recommendation to approve that which is being requested.

Item #5, **RBA Investments, LLC** - Applicant is requesting registration of a new well and production authorization in the amount of 100,000 gallons for 2016 and 125,000 gallons for 2017 and annually thereafter. Based on technical review of the information supplied, it is the General Manager's recommendation to approve that which is being requested.

Following Ms. Reiter's report, a motion was made by Director Stinson, seconded by Director Moffatt to approve items #1-5, in accordance with the General Manager's recommendations. The motion passed unanimously.

President Tramm adjourned the public hearing on permit applications at 10:10 AM.

PASSED, APPROVED, AND ADOPTED THIS 12th DAY OF JULY, 2016.

Rick Moffatt, Board Secretary

EXHIBIT E

LONE STAR
GROUNDWATER CONSERVATION DISTRICT

June 14, 2016

MINUTES OF PUBLIC MEETING TO ADOPT DESIRED FUTURE CONDITIONS ("DFCs") FOR THE GULF COAST AQUIFER THAT APPLY TO THE LONE STAR GROUNDWATER CONSERVATION DISTRICT

The Board of Directors of the Lone Star Groundwater Conservation District ("District") met in regular session, open to the public, in the Lone Star GCD - James B. "Jim" Wesley Board Room located at 655 Conroe Park North Drive, Conroe, Texas, within the boundaries of the District on June 14, 2016.

CALL TO ORDER:

President Tramm presided and called to order the special-called Board of Directors meeting at 10:11 AM, announcing that it was open to the public.

ROLL CALL:

The roll was called of the members of the Board of Directors, to wit:

John D. Bleyl, PE
Gregg Hope
Jace Houston
Roy McCoy, Jr.
Rick J. Moffatt
Jim Stinson, PE
Richard J. Tramm
M. Scott Weisinger, PG
W. B. Wood

All members of the Board were present, with the exception of Director(s) Hope, Houston, McCoy and Weisinger thus constituting a quorum of the Board of Directors. Also in attendance at said meeting were Kathy Turner Jones, General Manager; Paul R. Nelson, Assistant General Manager; Brian L. Sledge, General Counsel; Mark Lowry, P.E., District Engineer; District staff; and members of the public. ***Copies of the public sign-in sheets are attached hereto** as Exhibit "A".*

President Tramm announced prior to the presentation that no action would be taken on agenda item #5 to allow all board members an opportunity to be present for discussion and provide input if so desired.

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3. Presentation and discussion of DFCs adopted by the district representatives of Groundwater Management Area (GMA) 14 at the GMA 14 joint planning meeting held on April 29, 2016 - Bill Mullican, Mullican & Associates – Mr. Mullican opened by briefing members of the Board and the public on the legal requirements of why this public meeting is required to be held. Mr. Mullican followed with a short presentation on the progress made to date, detailing the remaining actions required to bring to completion the current round of joint planning referencing Chapter 36.108 (d-4) of the Texas Water Code which requires that, after all other processes and considerations have been completed, each individual District within the GMA adopt the DFCs that are applicable to that particular District. Mr. Mullican reviewed the DFCs approved by GMA 14 for the Chico, Evangeline and Jasper aquifers, and went over the actions that need to be taken in the future with regard to the District's management plan, regional planning, etc.

   Mr. Mullican advised the board that a transmittal letter, explanatory report, and signed resolution adopting the DFCs had been sent to TWDB by GMA 14, along with all the model files and associated documents. These items are also listed on the LSGCD website.

5. Public comment. There was no questions or comments from the Board or members of the public.

6. Discussion, consideration, and possible action regarding the adoption of Resolution #16-006 – Resolution for the Adoption of Desired Future Conditions for the Gulf Coast Aquifer that apply to the Lone Star Groundwater Conservation District, in accordance with Section 36.108(d-4) of the Texas Water Code. No action was taken.

President Tramm announced the special meeting of the District to adopt desired future conditions for the Gulf Coast Aquifer is hereby continued until 10:00 AM, July 12, 2016.

The Public Meeting was recessed at 10:19 AM, to be continued as stated above.

PASSED, APPROVED, AND ADOPTED THIS 12th DAY OF JULY 2016.

Rick Moffatt, Board Secretary

EXHIBIT E

LONE STAR
GROUNDWATER CONSERVATION DISTRICT

June 14, 2016

MINUTES OF REGULAR MEETING

The Board of Directors of the Lone Star Groundwater Conservation District ("District") met in regular session, open to the public, in the Lone Star GCD - James B. "Jim" Wesley Board Room located at 655 Conroe Park North Drive, Conroe, Texas, within the boundaries of the District on June 14, 2016.

CALL TO ORDER:

President Tramm presided and called to order the regular Board of Directors meeting at 10:20 AM, announcing that it was open to the public.

ROLL CALL:

The roll was called of the members of the Board of Directors, to wit:

John D. Bleyl, PE
Gregg Hope
Jace Houston
Roy McCoy, Jr.
Rick J. Moffatt
Jim Stinson, PE
Richard J. Tramm
M. Scott Weisinger, PG
W. B. Wood

All members of the Board were present, with the exception of Director(s) Hope, Houston, McCoy and Weisinger thus constituting a quorum of the Board of Directors. Also in attendance at said meeting were Kathy Turner Jones, General Manager; Paul R. Nelson, Assistant General Manager; Brian L. Sledge, General Counsel; Mark Lowry, P.E., District Engineer; District staff; and members of the public. ***Copies of the public sign-in sheets are attached hereto as Exhibit "A".***

APPROVAL OF THE MINUTES:

President Tramm stated the Board would consider all meeting minutes as amended and listed for approval on today's agenda as one item. Upon review of the following, a motion was made to approve the meeting minutes as amended by Director Moffatt, seconded by Director Bleyl, and unanimously carried, to approve the meeting minutes:

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a) May 10, 2016, Special Board Meeting
b) May 10, 2016, Public Hearing on Permit Applications
c) May 10, 2016, Show Cause Hearing
d) May 10, 2016, Regular Board of Directors Meeting
e) May 24, 2016, Public Stakeholder Meeting

COMMITTEE REPORTS:

A. Executive Committee – Richard Tramm, President

1) Brief the Board on the Committee's activities since the last regular Board meeting – President Tramm noted that there had been a meeting of the Executive Committee to discuss the current lawsuit.

2) Defense of the following lawsuit: City of Conroe et al. v. Lone Star Groundwater Conservation District (and the District's directors and general manager in their official capacities) – Mr. Sledge noted that the Board was briefed and updated on issues related to the lawsuit filed by the City of Conroe et al during the closed executive session portion of the June 14, 2016 special board meeting.

B. Water Awareness and Conservation Committee- Billy Wood, Chair

1) Brief the Board on the Committee's activities since the last regular Board meeting- Director Wood reported that the committee had met on Tuesday, June 7th to discuss and take action on the Work Proposal submitted by Asakura Robinson. Their proposal is for efforts required to pursue the Water Smart Master Plan, as initially outlined by the students from Texas A & M. This includes improvements to the District's grounds as well as reaching out to stakeholders throughout the county to prepare a Low Impact Development ("LID") Vision document that can be used by developers and regulators to assist in creating projects that create minimal impact on the environment as well as conserve water and enhance the quality of storm runoff. The effort includes the solicitation of funding and "in kind" contributions by the stakeholders. After discussion, the committee voted to authorize the General Manager to execute the agreement and begin discussions with Asakura Robinson.

2) Update on water efficiency, conservation efforts – Paul R. Nelson
Mr. Nelson updated the board on two recent presentations that the District had participated in since the last Board meeting. On May 11, 2016, Mr. Nelson gave an update on the District's current activities to the Environment Committee of the North Houston Association. Mr. Nelson briefed the Board on the Water Efficiency Network meeting held May 26, 2016, during which the latest developments in high tech irrigation controllers were presented. Mr. Nelson commented that on June 30, 2016, another Water Efficiency Network meeting is scheduled to be held in Houston at H-GAC for a presentation on water smart software which will assist customers to be better aware of their water use in real time.

EXHIBIT E

3) <u>Briefing on public outreach activities – James Ridgway</u>
Mr. Ridgway briefed the board on current activities. He advised that with school being out for the summer, there were not as many outreach events or activities compared to the fall or spring. Mr. Ridgeway expressed his excitement in being invited to the New Caney School District on August 17th to assist the ISD with their curriculum planning. Mr. Ridgeway added he hoped this would be a positive step forward in opening the door for other school districts to begin including LSGCD in their planning where possible. Mr. Ridgway also remarked on last month's Dock Line article, "virtual water" and encouraged everyone to please read if they haven't done so already.

C. **Rules and Regulatory Planning Committee – Jim Stinson, Chair**

1) <u>Brief the Board on the Committee's activities since the last regular Board meeting –</u> Director Stinson noted there had not been a meeting of the committee since the last board meeting nor had any meetings been scheduled.

D. **Policy and Personnel Development Committee – Richard J. Tramm, Chair**

1) <u>Brief the Board on the Committee's activities-</u> President Tramm noted there had not been a meeting of the committee since the last board meeting nor had any meetings been scheduled.

E. **Budget and Finance Development Committee – Billy Wood, Chair**

1) <u>Brief the Board on the Committee's Activities –</u> The Budget and Finance Development Committee met on May 26, 2016 to review staff's projected five-year budget forecast, options for changes in water use fee structure, and five-year historical income. A budget workshop to present to the full Board is scheduled for June 29, 2016.

2) <u>Review of monthly financial reports</u> – Director Wood reported an actual month net loss for May 2016 of $172,381 was over budgeted amount of $134,552 by $37,829. Year to date actual net income is $64,510, with year to date budgeted net loss at $303,590. Over budget by $363,689.

F. **Findings and Review Committee – Rick Moffatt, Chair**

1) <u>Brief the Board on the Committee's activities since the last regular Board meeting -</u> Director Moffatt reported that the Findings and Review Committee held a meeting with the Stakeholders Committee on May 24th to review findings and provide input on the status report for Task 2 of the District's ongoing Strategic Water Resources Planning Study. Director Moffatt updated the Board that comments had been received from the public and that the District's consultant team (Seifert and Mullican) was currently reviewing and addressing the comments submitted.

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2) Status Update: update regarding development of a strategic plan evaluating opportunities for additional development of water resources in the District while ensuring long-term viability of the aquifers within the District - Bill Mullican, Mullican and Associates, provided an overview of recent activities completed on the Lone Star GCD Strategic Planning Study noting the following five actions or events:

- Status report was presented to the advisory committee on May 4, 2016;
- On May 24, 2016, a report was presented to the Stakeholder Advisory Committee;
- Comments were received from the public through June 8, 2016;
- Currently in the process of reviewing and considering comments received; and
- A report is currently being drafted for Task 2

3) Groundwater Management Area 14 – Update the board on the status of the current desired future conditions development process in GMA 14 – Kathy Turner Jones – Ms. Jones stated that everything had been covered in Bill Mullican's presentation earlier.

SHOW CAUSE HEARING:

Discussion and possible action to issue a show cause order directing the following permittees, or their designated representative, to appear at a show cause hearing for that purpose and show cause why appropriate enforcement action should not be taken, including without limitation initiating a lawsuit against it for overproduction of 2015 permitted allocation and/or fines associated with timely submission:

1) City of Patton Village, HUP167C/OP-15111001

Kathy Jones noted that District rules prohibit the overproduction of a permit's annual permitted allocation. On March 1st, Notice of Violation and Consent Orders were mailed out with non-compliance penalties and overproduction usage fees, based on the District's rules. In addition, staff has made numerous phone calls to try and assist with compliance. Staff is asking that the Board consider action to direct City of Patton Village to appear at a show cause hearing at the July 12, 2016 board meeting and show cause why appropriate action should not be taken against them for overproducing their 2015 permitted allocation and/or failure to remit the signed Consent Order and/or associated overproduction fees and fines.

Director Wood moved that the Board take action consistent with the recommended enforcement actions in the agenda for the violations associated with noncompliance, including issuance of a cease and desist order, authorization of filing of a civil suit, and other actions against such person or entity as specifically set forth in the agenda. Director Bleyl seconded the motion, which passed unanimously.

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ENGINEERING REPORT:

Mark Lowry, District Consultant, reported that a copy of his report was included in the Board's packet.

GENERAL MANAGER'S REPORT:

Kathy Turner Jones stated that a copy of this month's general manager's report is included in everyone's board packet and that the majority of the items included had previously been discussed in earlier agenda items today. Ms. Jones noted in addition to presentations reported earlier by Mr. Nelson, the District provided a presentation on June 10th to the American Council of Engineering Companies on groundwater district regulations verses subsidence districts and the similarities and differences, and was scheduled to present at the Bentwater Civic Association town hall meeting on June 23rd.

GENERAL COUNSEL'S REPORT:

Mr. Sledge reported that there were a couple of items worth mentioning since the last board meeting. One being the Supreme Court of Texas ruled on May 27, 2016, issuing their opinion in the Coyote Lake Ranch v. City of Lubbock case, which extended the accommodation doctrine that applies historically when a person has severed their mineral estate from their surface estate to situations in which a person has severed their groundwater estate from the surface estate. The accommodation doctrine deals with the right of access and the duty of care that the severed estate has and owes to the surface estate owner. The second item Mr. Sledge addressed were interim legislative hearings. He mentioned recent committee hearings by the House Natural Resources Committee on June 1, and the Senate Agriculture, Water, and Rural Affairs (SAWRA) Committee on May 23, as well as the basic subject matter of each hearing. Mr. Sledge advised that there would be another hearing of the SAWRA Committee on June 20, and that his firm would be present to monitor.

PUBLIC COMMENTS:

There were no public comments.

NEW BUSINESS:

No new business was reported.

There being no further business, upon a motion made by Director Wood, and seconded by Director Stinson, the meeting was adjourned at 10:41 AM.

PASSED, APPROVED, AND ADOPTED THIS 12th DAY OF JULY 2016.

Rick Moffatt, Board Secretary

EXHIBIT E

RESOLUTION ESTABLISHING ADMINISTRATIVE PROCEDURES FOR THE CONSIDERATION, PROPOSAL, AND ADOPTION OF DESIRED FUTURE CONDITIONS FOR GROUNDWATER MANAGEMENT AREA 14

WHEREAS, pursuant to Section 35.004 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas, which together cover all major and minor aquifers in the state, for the objective of providing the most suitable area for the management of the groundwater resources; and

WHEREAS, through Title 31, Section 356.21 of the Texas Administrative Code, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

WHEREAS, the Bluebonnet Groundwater Conservation District, Brazoria County Groundwater Conservation District, Lone Star Groundwater Conservation District, Lower Trinity Groundwater Conservation District, and Southeast Texas Groundwater Conservation District (the "Member Districts") are located wholly or partially within GMA 14; and

WHEREAS, the Member Districts are authorized by Chapter 36, Texas Water Code, to engage in joint planning activities for the coordinated management of the aquifers located in GMA 14, and in that regard, shall establish desired future conditions ("DFCs") for the relevant aquifers within GMA 14; and

WHEREAS, Section 36.108 of the Texas Water Code requires the Member District Representatives to hold joint planning meetings for the consideration of DFC options, the proposal of DFCs for adoption, and, after the contemplation of comments and suggested revisions provided by the public and Member Districts, the adoption of DFCs for each relevant aquifer in GMA 14 and the submission of an explanatory report to the TWDB for approval of the DFCs adopted; and

WHEREAS, Section 36.108(d-3) of the Texas Water Code provides that the explanatory report must include the following: (1) identification of each DFC; (3) the policy and technical justification for each DFC; (3) documentation that the Member Districts considered the nine statutory factors listed in 36.108(d)(1)-(9), Water Code, and how the DFC adopted impacts each factor, (4) a list of the other DFC options considered, if any, and the reasons why those options were not adopted, and (5) the reasons why recommendations made by advisory committees and relevant public comments received by the districts were or were not incorporated into the DFCs; and

WHEREAS, the DFC explanatory report serves as the administrative record in the DFC adoption process, and for this reason, the Member Districts recognize the importance of establishing a procedural record from the beginning of the DFC consideration, proposal, and

EXHIBIT F

adoption process that contemplates each of the items to be addressed and included in the explanatory report under Section 36.108(d-3), Water Code; and

WHEREAS, Section 36.108 of the Texas Water Code provides a clear procedural process for DFCs that have been approved by a two-thirds vote by the Member District Representatives as the proposed DFCs for distribution to the Member Districts for public hearings and subject to a public comment period, but the statute is less clear as to the procedure applicable to the consideration of one or more DFC option(s), DFC options that may be discussed, evaluated, or considered but not adopted, the extent to which those DFC options must be addressed in the explanatory report, and the consideration of the nine statutory factors prior to the Member District Representatives' vote to approve a DFC option as the proposed DFC; and

WHEREAS, the Member Districts desire to adopt an administrative procedural process that is consistent with Chapter 36, including the procedural requirements currently in place under Texas Water Code Section 36.108, for the consideration, proposal, and adoption of DFCs to ensure the development of a clear administrative record that not only supports the DFCs ultimately adopted, but also addresses any DFCs considered but not adopted, in a manner that is sufficient for inclusion in the explanatory report as required by Texas Water Code Section 36.108(d-3); and

NOW, THEREFORE, it is agreed and understood among the Member Districts as follows:

SECTION ONE
INTENT AND PURPOSES

1.01 It is the intent and purpose of the Member Districts to carry out and fulfill the joint planning activities and requirements of Chapter 36, Texas Water Code, to establish DFCs by adopting administrative procedures for the consideration, proposal, and adoption of DFCs that promote the consideration of various DFC options, as necessary, to be included in the explanatory report, while preventing the lack of procedural guidance provided in Texas Water Code Chapter 36 from hindering the development of a defensible administrative record or explanatory report. The Member Districts intend for the administrative procedures herein to promote the ability of the Member Districts to openly identify, evaluate, and discuss multiple ideas, proposals, technical information, and policy options regarding the establishment of DFCs while simultaneously establishing some procedures to identify when a particular discussion or evaluation rises to the level of it being formally considered for inclusion in the DFC explanatory report.

SECTION TWO
PARTICIPATION IN JOINT PLANNING PROCESS TO ESTABLISH DFCs

2.01 Each Member District shall be subject to these administrative procedures.

2.02 Only a Member District Representative may vote or take action on GMA 14 activities. For any action, only one representative from each Member District may vote.

2.03 Each Member District of GMA 14 shall endeavor to participate and contribute in good faith in joint planning activities and to satisfy the joint planning requirements of Chapter 36, Water Code.

2.04 The GMA 14 Member Districts, as a group to engage in joint planning activities, shall have only the power granted by Chapter 36, Water Code, that relates to joint planning activities.

2.05 GMA 14 joint planning meetings must be held in accordance with the Texas Open Meetings Act, Chapter 551, Government Code. The Member Districts agree that notice of meetings shall be provided in accordance with the requirements of Chapter 36, Texas Water Code.

2.06 Each Member District shall comply with the Texas Public Information Act, Chapter 552, Government Code, with regard to joint planning activities.

SECTION THREE
PROCEDURE FOR THE CONSIDERATION, PROPOSAL, AND ADOPTTION OF DFCs

3.01 For a DFC option to be formally considered as a potential candidate for proposal and adoption by the Member Districts to be included in the explanatory report as a DFC that was adopted or a DFC that was considered but not adopted pursuant to Section 36.108(d-3), Water Code, the DFC option must be requested in writing and approved by the Member District Representatives for formal consideration at a GMA 14 joint planning meeting.

3.02 A Member District Representative shall request a DFC option to be approved for formal consideration by submitting, no less than 14 days before a GMA 14 joint planning meeting, a written request to each Member District and the Contracted Consultant, as defined in Section 4 below, describing with sufficient specificity the DFC option requested to be approved for formal consideration. The sufficiency of the written request shall be reviewed by the Contracted Consultant and, no later than 7 days after receiving the written request, the Contract Consultant shall notify the requesting party of any possible deficiencies in the written request in preparation for discussion of the request at the GMA 14 joint planning meeting.

3.03 Based on the information provided in the written request, including any supplemental information provided in writing and accepted by the Member District Representatives at or before the GMA 14 joint planning meeting, the Member District Representatives shall vote to determine whether the requested DFC option shall be formally considered. To be formally considered, the requested DFC option must be approved by a two-thirds vote of the total Member District Representatives. If through discussions at the GMA 14 joint planning meeting, the DFC option originally requested in writing is amended, the DFC option, as amended, may nonetheless be approved for formal consideration by a two-thirds vote of the total Member District Representatives without the submission of an additional, amended written request. A DFC option approved for formal consideration under this section shall be included in the explanatory report pursuant to Texas Water Code Section 36.108(d-3).

3.04 Of the DFC options formally considered, at least one of the DFC options shall be approved by two-thirds vote of the total Member District Representatives to be further reviewed in consideration of the nine statutory factors listed in Section 36.108(d)(1)-(9), Water Code. For a DFC option approved for further review, the Member District Representatives shall discuss and consider the nine statutory factors and how the DFC option impacts each of the nine factors at a joint planning meeting. A written report shall be prepared to document the consideration of the nine statutory factors and the discussions relevant to the DFC option's impact to each factor, to the extent necessary for purposes of the explanatory report as required by Section 36.108(d-3)(3), Water Code.

3.05 Only after consideration of the nine statutory factors as stated in Section 3.04 may a DFC option become eligible for approval as the proposed DFC. For each relevant aquifer in GMA 14, the Member District Representatives shall approve by two-thirds vote of the total Member District Representatives one DFC option to serve as the proposed DFC as required by Sections 36.108(d) and (d-2), Water Code. The proposed DFC must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in GMA 14.

3.06 The proposed DFC approved by two-thirds vote of the total Member District Representatives shall be distributed to the Member Districts. A period of not less than 90 days for public comment begins on the day the proposed DFC is mailed to the Member Districts.

3.07 During the public comment period and after posting proper notice as required by Section 36.063, Water Code, each Member District shall hold a public hearing on the proposed DFCs relevant to that Member District pursuant to the requirements set forth in Section 36.108(d-2), Water Code. After the public hearing, each Member District shall compile for consideration at the next joint planning meeting a summary report of relevant comments received and any suggested revisions to the proposed DFC and the basis for the revisions.

3.08 Pursuant to Texas Water Code Section 36.108(d-3), after the earlier of the date on which all the Member District have submitted their district summaries or the expiration of the public comment period, the Member District Representatives shall reconvene to review the reports, consider any Member District's suggested revisions to the proposed DFCs, and vote to adopt the proposed DFCs. The DFCs must be adopted as a resolution by a two-thirds vote of all the Member District Representatives.

3.09 A record shall be prepared to address each relevant comment received during the public comment period or at the public hearing and any suggested revisions included in the Member Districts' summary reports submitted to and considered by the Member District Representatives at the joint planning meeting, as well as any recommendations made by advisory committees. The record shall identify those comments and revisions incorporated into the DFC, as well as those comments and revisions not incorporated, and provide the reasoning behind the decision to incorporate or not to incorporate the comments or revisions, and the record shall be included in the explanatory report as required by Texas Water Code Section 36.108(d-3)(5).

3.10 Upon adoption of the DFCs, the Member District Representatives shall prepare an explanatory report as required by Texas Water Code Section 36.108(d-3). Consistent with the statutory requirements and the procedural requirements adopted by this resolution, the explanatory report shall:

a. identify each DFC adopted pursuant to Section 3.08;

b. provide the policy and technical justifications for each DFC adopted;

c. include the written reports required by Section 3.04, relevant to the DFCs adopted, that document the discussions of the Member District Representatives in consideration of the nine factors listed in Texas Water Code 36.108(d)(1)-(9) and how the adopted DFCs impact each factor, inclusive of any amendments or supplemental information deemed necessary and taken into consideration for the adopted DFCs after the vote to approve the proposed DFCs under Section 3.05;

d. list the other DFC options approved for formal consideration under Sections 3.03, but not adopted, and the reasons why those options were not adopted, based on the written reports prepared for each DFC option approved for formal consideration under Section 3.03 or further review under Section 3.04; and

e. discuss reasons why recommendations made by advisory committees, if any, and relevant public comments received by the Member Districts were or were not incorporated into the DFCs by inclusion of the record prepared pursuant to Section 3.09; and

f. describe how the DFCs provide a balance between the highest practicable level of groundwater production and the conservation, preservation, recharging, and prevention of waste of groundwater and control of subsidence in GMA 14.

3.11 The Member District Representatives shall submit to the TWDB and each Member District proof that notice was posted for the joint planning meeting to adopt the DFCs, a copy of the resolution adopting the DFCs, and a copy of the explanatory report.

3.12 As soon as possible after the Member Districts receives the DFCs resolution and explanatory report, the Member district shall adopt the DFCs in the resolution and explanatory report that applies to the Member District.

SECTION FOUR
DEFINITIONS

These terms shall have the following meaning when used herein:

Advisory Committee: A nonvoting advisory committee or subcommittee, appointed by the Member District Representatives during the joint planning process, who represent social, governmental, environmental, or economic interest to assist in the development of DFCs as provided by Texas Water Code Section 36.1081. The appointment of an advisory committee by the Member District Representatives during the joint planning process is permissible and not mandatory.

Contracted Consultant: The consultant retained by the Member Districts to assist in conducting joint planning activities, developing DFCs for the relevant aquifers in GMA 14, and preparing the explanatory report as required by Section 36.108(d-3) of the Texas Water Code.

Desired Future Condition or DFC: The desired future conditions for the relevant aquifers within GMA 14 established in accordance with Chapter 36, Texas Water Code.

Groundwater Management Area 14 or GMA 14: Groundwater Management Area 14 as designated by the Texas Water Development Board and as may be amended from time to time.

Member District: A groundwater conservation district subject to Texas Water Code Chapter 36 that is located in whole or in part inside GMA 14, including the Bluebonnet Groundwater Conservation District, Brazoria County Groundwater Conservation District, Lone Star Groundwater Conservation District, Lower Trinity Groundwater Conservation District, and Southeast Texas Groundwater Conservation District. If the creation of a particular district requires confirmation through an election, the district shall not be a Member District until it is confirmed.

Member District Representative: The presiding officer or the presiding officer's designee for any district located wholly or partly in GMA 14.

NOW, THEREFORE, BE IT RESOLVED BY THE MEMBER DISTRICTS OF GROUNDWATER MANAGEMENT AREA 14:

1) Each of the affirmations and recitals set forth herein are true and correct;

2) The authorized voting representatives of the GMA 14 Member Districts have approved by a two-thirds vote of the total number of Member Districts in GMA 14 the administrative procedures set forth herein; and

3) Any previous administrative procedure agreed to by the Member Districts that is in conflict with the administrative procedures set forth herein is superseded by the administrative procedures set forth in this resolution for future actions of the Member Districts.

AND IT IS SO ORDERED.

PASSED AND ADOPTED on this 3 day of November, 2014.

ATTEST:

Bluebonnet Groundwater Conservation District

Brazoria County Groundwater Conservation District

Lone Star Groundwater Conservation District

Lower Trinity Groundwater Conservation District

Southeast Texas Groundwater Conservation District

RESOLUTION FOR THE APPROVAL OF DESIRED FUTURE CONDITIONS FOR ALL AQUIFERS IN GROUNDWATER MANAGEMENT AREA 14

Whereas, pursuant to Section 35.004 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas that, together, cover all major and minor aquifers in the state; and

Whereas, each groundwater management area was designated with the objective of providing the most suitable area for the management of groundwater resources; and

Whereas, through Title 31, Section 356.21 of the Texas Administrative Code, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

Whereas, GMA 14 includes all or portions of areas subject to groundwater regulation by Bluebonnet Groundwater Conservation District (Austin, Grimes, Walker, and Waller counties), Brazoria County Groundwater Conservation District (Brazoria County), Lone Star Groundwater Conservation District (Montgomery County), Lower Trinity Groundwater Conservation District (Polk and San Jacinto counties), and Southeast Texas Groundwater Conservation District (Hardin, Jasper, Newton, and Tyler counties) (the "Member Districts"); and

Whereas, the Member Districts are authorized by Chapter 36, Texas Water Code, to engage in joint planning activities for the coordinated management of the aquifers located in GMA 14, and in that regard, shall establish desired future conditions ("DFCs") for the relevant aquifers within GMA 14; and

Whereas Fort Bend Subsidence District (Fort Bend County), Harris-Galveston Subsidence District (Galveston and Harris counties), and other stakeholders within GMA 14 from Chambers County, and Washington County also contributed to the development of DFCs for GMA 14; and

Whereas, Section 36.108 of the Texas Water Code requires the Member Districts in GMA 14 to consider groundwater availability models and other data or information for the management area and vote on a proposal for the adoption of DFCs for each relevant aquifer within GMA 14 by May 1, 2016; and

Whereas, the Member Districts within GMA 14 secured hydrogeologic and engineering consulting services to provide technical support in their efforts to establish requisite DFCs; and

Whereas, in developing the proposed DFCs for the relevant aquifers within GMA 14, the Member Districts in GMA 14 considered the nine statutory factors set forth in Section 36.108(d) of the Texas Water Code:

EXHIBIT G

- aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another,
- the water supply needs and water management strategies included in the state water plan,
- hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge,
- other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water,
- the impact on subsidence,
- socioeconomic impacts reasonably expected to occur,
- the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002,
- the feasibility of achieving the desired future condition, and
- any other information relevant to the specific desired future conditions; and

Whereas, pursuant to Section 36.108(d-2), the Member Districts also considered in their development of proposed DFCs the balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area; and

Whereas, the Member Districts used this information to developed proposed DFCs for the portions of the northern segment of the Gulf Coast Aquifer that occurs within the bounds of GMA 14; and

Whereas, TWDB conducted an evaluation of the Houston Area Groundwater Model ("HAGM") and adopted it as the updated Northern Gulf Coast Groundwater Availability Model ("GAM"); and

Whereas, the Members Districts conducted a model run of the updated Northern Gulf Coast GAM specifically identified as GAM Run 2 for the purpose of evaluating drawdown in the Northern Gulf Coast Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-052 MAG for the Carrizo-Wilcox Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-053 MAG for the Queen City Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-054 MAG for the Sparta Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-055 MAG for the Yegua-Jackson Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-30 MAG for the Brazos River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-31 MAG for the Navasota River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-32 MAG for the San Bernard River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-33 MAG for the San Jacinto River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-34 MAG for the Trinity River Alluvium Aquifer; and

Whereas, during joint meetings noticed and conducted pursuant to Section 36.108(e) of the Texas Water Code, the Member Districts considered GAMs and other data and information relevant to the development of DFCs for GMA 14, including input and comments from stakeholders within GMA 14; and

Whereas, the Member Districts find that all notice requirements for a meeting, held this day, to take up and consider the approval of the proposed DFCs as described herein for GMA 14 have been, and are, satisfied; and

Whereas, Texas Water Code Section 36.0015(b), as amended by House Bill 200 during the 84th Texas Legislature states that "(b) In order 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, Texas Constitution, groundwater conservation districts may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management in order to protect property rights, balance the conservation and development of groundwater to meet the needs of this state, and use the best available science in the conservation and development of groundwater through rules developed, adopted, and promulgated by a district in accordance with the provisions of this chapter"; and

Whereas, the Member Districts find that the proposed DFCs provided herein for establishment are each merited and necessary for the effective and prudent management of groundwater resources within GMA 14, and have otherwise been developed in accordance with, and do satisfy the obligations imposed by, Chapter 36 of the Texas Water Code and all other applicable laws of the State of Texas.

Now, therefore, be it resolved by the Member Districts of GMA 14 that the following DFCs are each hereby established:

Formations of the Gulf Coast Aquifer

DFCs for the Gulf Coast Aquifer are hereby adopted, as documented by and incorporating herein GAM Run 2, at two scales, which do not differ substantively in their application; the first being for GMA 14 in its entirety, and also, to better facilitate the management and conservation of groundwater resources at the individual groundwater conservation district level after considering the statutory criteria set forth under Section 36.108(d), Water Code, on a county-by-county basis. DFCs for GMA 14 for the Gulf Coast Aquifer are as follows:

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 28.3 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 23.6 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 18.5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 66.2 feet after 61 years.

Austin County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 76 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Austin County should not exceed approximately 2.83 feet by the year 2070.

Brazoria County (BCGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 27 feet after 61 years.

Chambers County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 32 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 30 feet after 61 years.

Grimes County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 6 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 52 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Grimes County should not exceed approximately 0.12 feet by the year 2070.

Hardin County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 21 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 89 feet after 61 years.

Jasper County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 41 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 46 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 40 feet after 61 years.

Jefferson County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 17 feet after 61 years.

Liberty County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 27 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 25 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 120 feet after 61 years.

Montgomery County (LSGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 34 feet after 61 years.

Newton County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 45 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 44 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 37 feet after 61 years.

Orange County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 14 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 16 feet after 61 years.

Polk County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 10 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 73 feet after 61 years.

San Jacinto County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 22 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 108 feet after 61 years.

Tyler County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 30 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 62 feet after 61 years.

Walker County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 9 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Walker County should not exceed approximately 0.04 feet by the year 2070.

Waller County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 101 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Waller County should not exceed approximately 4.73 feet by the year 2070.

Washington County

- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 1 foot after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 16 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 48 feet after 61 years.

Formations in Fort Bend, Galveston, and Harris counties

Groundwater Management Area 14 (GMA 14) efforts to determine DFCs is primarily an aquifer water-level based approach to describe the regional and local desires for the aquifer beneath them. The GMA process requires Groundwater Conservation Districts (GCDs) to determine the DFCs for the entire GMA, regardless of whether each county is included within a GCD. The Fort Bend Subsidence District (FBSD) and the Harris-Galveston Subsidence District (HGSD), operating in Fort Bend County and Harris and Galveston counties, respectively, regulate groundwater for the purpose of ending land surface subsidence within their jurisdiction. They are not GCDs and operate considerably different from the typical GCD. Therefore, in an official context these three counties are "unrepresented" but the GCDs within GMA-14 must still determine the DFC for these counties.

Both FBSD and HGSD have participated in an unofficial role to aid the GCDs within GMA-14 with their evaluation of Fort Bend, Galveston and Harris County information. The groundwater pumpage within these three counties even though regulated is still greater than the sum of all other counties within GMA-14. FBSD and HGSD recognize that the projected groundwater pumpage from these three counties will impact the decisions of GMA-14 throughout a large portion of the area. FBSD and HGSD have provided considerable historical and projected groundwater pumpage data and details of regulations to assist GMA-14 in incorporating these counties in the overall GMA-14 DFCs. FBSD and HGSD cannot however, present DFCs for these three counties in terms of aquifer water-level changes over time. The FBSD and HGSD regulations do not specifically address water-levels nor do they designate a specific pumping limit, rather the regulations are based on limitations of groundwater as a percentage of total water demand. The percentage of groundwater to total water demand is decreased over time, as total water demand increases.

The goal of both FBSD and HGSD is to end land surface subsidence that is caused by man's pumpage of groundwater. There is a clearly established link between the over-pumpage of groundwater and land surface subsidence. The DFCs within the aquifer beneath Fort Bend, Galveston, and Harris counties has no easily defined relationship to water-levels. The DFC for FBSD and HGSD is the reduction and halting of the compaction of clay layers within the aquifer caused by the over-pumpage of groundwater. Stated more simply, the DFC for these three counties is that future land surface subsidence be avoided. That stated, HGSD and FBSD have adopted regulations, most recently in 2013, that require the reduction of groundwater pumpage and the conversion to alternate water sources, while balancing with the realistic ability of the permittees to achieve compliance with these regulations. This effort was accomplished with the aid of computer models and information specific to the missions of FBSD and HGSD and outside of the revised Northern Gulf Coast GAM (NGCGAM) adopted by the TWDB.

Within HGSD, from central to southeastern Harris County and all of Galveston County (Regulatory Areas 1 and 2), virtually all permittees have achieved compliance with previous and current HGSD regulations. Subsidence has been halted and water-levels within the aquifer have risen dramatically in these areas. However, in northern and western areas of Harris County (Regulatory Area 3), the HGSD regulations have allowed groundwater pumpage to continue until the required reductions in 2010, 2025, and 2035. With these scheduled reductions in groundwater pumpage, subsidence will slow dramatically and even be halted with water-levels stabilizing and in later years rising.

Within FBSD, from central to northern and eastern Fort Bend County (Regulatory Area A), the regulations call for reductions of groundwater pumpage in 2014/2016, and 2025. Similar to HGSD's Regulatory Area 3, subsidence within FBSD Regulatory Area A will slow dramatically and even be halted with water-levels stabilizing and in later years rising.

In both HGSD and FBSD, because of the percentage based approach to regulations, groundwater pumpage will increase until scheduled reductions in milestone years (ex: 2010, 2014/2016, 2025, and 2035). In between milestone years, groundwater pumpage will increase with the assumed increase in total water demand from an assumed increase in population. In order to demonstrate the DFC of these three counties using water-level changes, the area of previous groundwater-to-alternative water conversions must be separated from future conversions AND each annual time step must be depicted.

The HGSD and FBSD have submitted to GMA-14 their current regulations and projected groundwater pumpage projections through the year 2070. This data has been divided into the grid cells/layers relative to the NGCGAM and utilized by the GCDs in development of their DFCs.

Groundwater pumpage within GMA-14 from Fort Bend, Galveston, and Harris counties is regulated by FBSD and HGSD, non GCD governmental agencies (the only GMA in Texas with this occurrence) and the missions of HGSD and FBSD are vastly different from GCDs and do not fit well with a water-level designed DFC process). The groundwater pumpage projections developed in recognition of the HGSD and FBSD regulatory plans have been utilized without adjustment by GMA14 in the DFC process. Therefore, the DFCs adopted by GMA-14 are consistent with the HGSD and FBSD regulatory plans.

Carrizo Sand Aquifer

Grimes County (BGCD)

- The portion of the Carrizo Sand Aquifer occurring in Grimes County is declared non-relevant.

Walker County (BGCD)

- The portion of the Carrizo Sand Aquifer occurring in Walker County is declared non-relevant.

Queen City Aquifer

Grimes County (BGCD)

- The portion of the Queen City Aquifer occurring in Grimes County is declared non-relevant..

Walker County (BGCD)

- The portion of the Queen City Aquifer occurring in Walker County is declared non-relevant..

Sparta Aquifer

Grimes County (BGCD)

- The portion of the Sparta Aquifer occurring in Grimes County is declared non-relevant..

Walker County (BGCD)

- The portion of the Sparta Aquifer occurring in Walker County is declared non-relevant.

Yegua-Jackson Aquifer

Grimes County (BGCD)

- The portion of the Yegua Jackson Aquifer occurring in Grimes County is declared non-relevant..
-

Jasper County (STGCD)

- The portion of the Yegua-Jackson occurring in Jasper County is declared non-relevant.

•

Newton County (STGCD)

- The portion of the Yegua-Jackson occurring in Newton County is declared non-relevant.

Polk County (LTGCD)

- The portion of the Yegua-Jackson occurring in Polk County is declared non-relevant.

Tyler County (STGCD)

- The portion of the Yegua-Jackson occurring in Tyler County is declared non-relevant.

Walker County (BGCD)

- The portion of the Yegua Jackson Aquifer occurring in Walker County is declared non-relevant..

Washington County

- The portion of the Yegua Jackson Aquifer occurring in Washington County is declared non-relevant..

River Alluvium Aquifers

Austin County (BGCD)

- The portion of the Brazos River Alluvium occurring in Austin County is declared non-relevant.
- The portion of the San Bernard River Alluvium occurring in Austin County is declared non-relevant.

Grimes County (BGCD)

- The portion of the Brazos River Alluvium occurring in Grimes County is declared non-relevant.
- The portion of the Navasota River Alluvium occurring in Grimes County is declared non-relevant.

Walker County (BGCD)

- The portion of the San Jacinto River Alluvium occurring in Walker County is declared non-relevant.
- The portion of the Trinity River Alluvium occurring in Walker County is declared non-relevant.

Waller County (BGCD)

- The portion of the Brazos River Alluvium occurring in Walker County is declared non-relevant.

Washington County

- The portion of the Brazos River Alluvium occurring in Washington County is declared non-relevant.

And it is so ordered and passed this 29th day of April, 2016.

Signed ______________________

Mr. Zach Holland Bluebonnet Groundwater Conservation District

Signed ______________________

Mr. Kent Burkett Brazoria County Groundwater Conservation District

Signed ______________________

Ms. Kathy Turner Jones Lone Star Groundwater Conservation District

Signed ______________________

Mr. Gary Ashmore Lower Trinity Groundwater Conservation District

Signed ______________________

Mr. John Martin Southeast Texas Groundwater Conservation District

TEXAS WATER DEVELOPMENT BOARD

TO: Board Members

THROUGH: Robert E. Mace, Deputy Executive Administrator, Water Science and Conservation

FROM: William R. Hutchison, Director, Groundwater Resources Division
Kenneth L. Petersen, General Counsel

DATE: March 10, 2010

SUBJECT: Briefing and discussion on: (a) status of joint planning in groundwater management areas; and (b) use of "geographic areas" in establishing desired future conditions.

ACTION REQUESTED

No action requested; this is a discussion item.

BACKGROUND

Key background points are:

- Groundwater management areas are required to submit desired future conditions to the Texas Water Development Board (TWDB) by September 1, 2010.
- Once desired future conditions are submitted, Groundwater Resources Division staff develops values of managed available groundwater based on the desired future condition.
- Groundwater conservation districts are required to include the desired future condition and managed available groundwater number in their groundwater management plans and permitting.
- Regional water planning groups are required to use the managed available groundwater values in their regional water plans if they are received in a timely manner.
- Once adopted, desired future conditions can be challenged by petitioning the TWDB.
- If the Board finds that the desired future condition is reasonable, the petition process ends.
- If the Board finds that the desired future condition is not reasonable, TWDB staff issues written findings to the petitioner and the groundwater conservation districts which include a list of findings and recommended changes to the desired future condition.
- The groundwater conservation districts are then required to prepare a revised desired future condition, to hold a public hearing, and to submit the revised future condition to the Board.
- TWDB will then provide public notice of the revised desired future condition and may provide a public response to the districts' revised conditions, at which point the petition process is concluded.

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A Member of the Texas Geographic Information Council (TGIC)

TNRIS

EXHIBIT H

KEY ISSUES

(a) Status of joint planning in groundwater management areas

The status of desired future conditions, managed available groundwater determinations, and active petitions is shown in the attachment. Progress during the first two months of 2010 includes:

- The groundwater conservation districts in Groundwater Management Area 11 adopted a set of preliminary desired future conditions that will generally result in managed available groundwater values that are about the same as the 2007 State Water Plan groundwater availability estimates. It is expected that formal adoption will occur at their April meeting after a series of public meetings being organized by individual groundwater conservation districts
- The groundwater conservation districts in Groundwater Management Area 12 adopted a set of preliminary desired future conditions. It is expected that formal adoption will occur at their April meeting.

(b) Use of "geographic areas" in establishing desired future conditions

Section 36.108(d) provides that groundwater conservation districts "shall consider uses or conditions of an aquifer within the management area that differ substantially from one geographic area to another" when establishing desired future conditions. However, the law does not define "geographic area" and there is no guidance to the districts either on how to delineate a geographic area or on how to measure "substantial" differences between geographic areas in either uses or conditions. Under Section 36.108(d)(2), districts may establish different desired future conditions within a management area for "each geographic area overlying an aquifer in whole or in part ... within the boundaries of the management area."

The question has been presented whether groundwater conservation districts within a groundwater management area (GMA) may delineate different "geographic areas" within the GMA by use of county (or other political subdivision) boundaries. Staff believes this approach is legally defensible provided the districts are using the political subdivision boundaries to locate discernible and substantial differences in uses or conditions within the GMA and not for any other purposes. It should be emphasized that employing geographic areas that are not based on clear and substantial differences in uses or aquifer conditions is not supportable, regardless of how those geographic areas are drawn.

As noted, there is no definition of "geographic" or "geographic area" in Chapter 36, Water Code, nor are there any such definitions in the Code Construction Act which is generally applicable to statutory schemes. Webster's Third New International Dictionary (Unabridged, 1993) recognizes "political geography" as one form of geography (in addition to "mathematical geography," "physical geography," "economic geography," "commercial geography" and "bio-geography"). The argument that the omission of "political subdivision boundaries" from Section 36.108(d) is not persuasive, as long as the groundwater conservation districts do not appear to be using county or other political subdivision lines to gerrymander DFCs for purposes other than accommodating discernible, substantial differences in uses or aquifer conditions within the GMA. (Known as the doctrine of expressio unius est exclusion alterius, the courts have stated that this approach to statutory construction is simply an aid to determine legislative intent and that it should not be mechanically applied. Mid-Century Insurance Co. of Texas v. Kidd, 1999 WL 450908 (Tex. 1999).

Attachment

Attachment

Status of Desired Future Conditions, Managed Available Groundwater Determinations, and Active Petitions

Status of Desired Future Condition Adoptions

Statute requires that groundwater conservation districts submit desired future conditions to the TWDB by September 1, 2010. To date, districts in four groundwater management areas have adopted desired future conditions. Districts in one area (Groundwater Management Area 8) have submitted conditions for all of its aquifers. Desired future conditions adopted thus far are:

Groundwater Management Area 1

- Ogallala Aquifer
- Rita Blanca Aquifer

Groundwater Management Area 8

- Blossom Aquifer
- Brazos River Alluvium Aquifer
- Edwards (Balcones Fault Zone) Aquifer
- Ellenberger-San Saba Aquifer
- Hickory Aquifer
- Marble Falls Aquifer
- Nacatoch Aquifer
- Trinity Aquifer
- Woodbine Aquifer

Groundwater Management Area 9

- Edwards Group of the Edwards-Trinity (Plateau) Aquifer
- Ellenberger Aquifer
- Hickory Aquifer
- Marble Falls Aquifer

Groundwater Management Area 10

- San Antonio Segment (excluding Kinney County) of the Edwards (Balcones Fault Zone) Aquifer

Status of Managed Available Groundwater Determinations

Statute requires that the TWDB provide managed available groundwater numbers based on the adopted desired future conditions to groundwater conservation districts and regional water planning groups. Final managed available groundwater numbers provided thus far are:

Groundwater Management Area 8

- Blossom Aquifer
- Brazos River Alluvium Aquifer
- Edwards (Balcones Fault Zone) Aquifer
- Ellenburger-San Saba Aquifer
- Hickory Aquifer
- Marble Falls Aquifer
- Trinity Aquifer
- Woodbine Aquifer

Groundwater Management Area 9

- Edwards Group of the Edwards-Trinity (Plateau) Aquifer

Groundwater Resources Division staff sends draft managed available groundwater numbers to the districts in the groundwater management area for review. Once comments are addressed and received from the districts, Groundwater Resources Division staff brings the numbers to the Board for review. As requested by the Board, this review will include a side-by-side comparison of managed available groundwater numbers with current state water plan and water use numbers as well as estimates of drainable water in place and a maximum sustained pumping level.

Status of Active Petitions

To date, TWDB has received two administratively complete petitions challenging the desired future conditions for the Ogallala Aquifer adopted by the districts in Groundwater Management Area 1. TWDB has also received three administratively complete petitions concerning desired future conditions in Groundwater Management Area 9. The process for Groundwater Management Area 1 is complete because the Board found the desired future conditions to be reasonable. The process for Groundwater Management Area 9 is ongoing after the Board's finding that the desired future conditions were not reasonable. The Board's recommended desired future condition has been discussed at a Groundwater Management Area 9 meeting, and a public hearing has been held. No action on the recommendation has been taken to date.

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

THE STATE OF TEXAS §
COUNTY OF TRAVIS §

As the Executive Administrator of the Texas Water Development Board, I hereby certify that attached is a copy of the following, as contained in the records of the Texas Water Development Board:

The document entitled "GAM Task 13-037: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 14", sealed and authored by Shirley Wade, Ph.D., P.G., David Thorkildsen, P.G., and Roberto Anaya, P.G., dated June 09, 2014. This document, can be found on the Texas Water Development Board website at http://www.twdb.texas.gov/groundwater/docs/GAMruns/Task13-037.pdf.

Under Texas Water Code §6.153(a), a certified copy with the seal of the Texas Water Development Board and the signature of the Executive Administrator is admissible as evidence in any court or administrative proceeding.

WITNESS MY HAND, and the Seal of the Texas Water Development Board, this the 27 day of October, 2016.

Texas Water Development Board

Jeff Walker
Executive Administrator

(Seal)

EXHIBIT I

GAM TASK 13-037: TOTAL ESTIMATED RECOVERABLE STORAGE FOR AQUIFERS IN GROUNDWATER MANAGEMENT AREA 14

by Shirley Wade, Ph.D., P.G., David Thorkildsen, P.G., and Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Resources Division
(512) 463-6115[1]
June 09, 2014

The seal appearing on this document were authorized by Shirley C. Wade, P.G. 525, and David Thorkildsen, P.G. 705, and Roberto Anaya, P.G. 480 on June 09, 2014.

The total estimated recoverable storage in this report was calculated as follows: the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson aquifers, the Gulf Coast Aquifer System and the Brazos River Alluvium Aquifer (Shirley Wade); and the San Bernard, Navasota, San Jacinto, and Trinity river alluviums determined as relevant (David Thorkildsen), quality assurance and report preparation (Roberto Anaya).

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[1] Contact information is for Roberto Anaya

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GAM TASK 13-037: TOTAL ESTIMATED RECOVERABLE STORAGE FOR AQUIFERS IN GROUNDWATER MANAGEMENT AREA 14

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EXECUTIVE SUMMARY:

Texas Water Code, §36.108 (d) (Texas Water Code, 2011) states that, before voting on the proposed desired future conditions for a relevant aquifer within a groundwater management area, the groundwater conservation districts shall consider the total estimated recoverable storage as provided by the executive administrator of the Texas Water Development Board (TWDB) along with other factors listed in §36.108 (d). Texas Administrative Code Rule §356.10 (Texas Administrative Code, 2011) defines the total estimated recoverable storage as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume.

This report discusses the methods, assumptions, and results of an analysis to estimate the total recoverable storage for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, Gulf Coast, and Brazos River Alluvium aquifers in addition to water-bearing alluvial sediments determined as relevant by Groundwater Management Area 14 groundwater conservation districts for the San Bernard, Navasota, San Jacinto, and Trinity rivers within Groundwater Management Area 14. Tables 1 through 20 summarize the total estimated recoverable storage required by the statute. The total estimated recoverable storage values are for areas within the official extent of the aquifers (and other portions deemed relevant by the groundwater conservation districts) in Groundwater Management Area 14. In addition, areas that currently have adopted desired future conditions but may be declared to be non-relevant are included

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as the total estimated recoverable storage values are needed for the associated explanatory report per Texas Administrative Code Rule §356.31 (b) (Texas Administrative Code, 2011).

DEFINITION OF TOTAL ESTIMATED RECOVERABLE STORAGE:

The total estimated recoverable storage is defined as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume. In other words, we assume that only 25 to 75 percent of groundwater held within an aquifer can be removed by pumping.

The total recoverable storage was estimated for the portion of the aquifers within Groundwater Management Area 14 that lie within the official lateral aquifer boundaries as delineated by George and others (2011). If portions of aquifers outside these boundaries were defined as relevant in the resolution dated August 25, 2010, that adopted the current desired future conditions, then estimates of total recoverable storage reported here include these specific areas. Total estimated recoverable storage values may include a mixture of water quality types, including fresh, brackish, and saline groundwater, because the available data and the existing groundwater availability models do not permit the differentiation between different water quality types. The total estimated recoverable storage values do not take into account the effects of land surface subsidence, degradation of water quality, or any changes to surface water-groundwater interaction that may occur as the result of extracting groundwater from the aquifer.

METHODS:

To estimate the total recoverable storage of an aquifer, we first calculated the total storage in an aquifer within the official and/or relevant aquifer boundary. The total storage is the volume of groundwater removed by pumping that completely drains the aquifer.

Aquifers can be either unconfined or confined (Figure 1). A well screened in an unconfined aquifer will have a water level equal to the water level outside the well or in the aquifer. Thus, unconfined aquifers have water levels within the aquifers. A confined aquifer is bounded by low permeable geologic units at the top and bottom, and the aquifer is under hydraulic pressure above the ambient atmospheric pressure. The water level at a well screened in a confined aquifer will be above the top of the aquifer. As a result, calculation of total storage is also different between unconfined and confined aquifers. For an unconfined aquifer, the total storage is equal to the volume of groundwater removed by pumping that makes the water level fall to the aquifer bottom. For a confined aquifer, the total storage contains two parts. The first part is the groundwater released from the aquifer when the water level falls from above the top of the aquifer to the top of the aquifer. The reduction of hydraulic pressure in the aquifer by pumping causes expansion of groundwater and deformation of aquifer solids. The aquifer is still fully saturated to this point. The second part, just like unconfined aquifer, is the groundwater released from the aquifer when the water level falls from the top to the bottom of the aquifer. Given the same aquifer area and water level drop, the amount of water released in the second part is much greater than the first part. The difference is quantified by two parameters: storativity related to confined aquifers and specific yield related to unconfined aquifers. For example, storativity values range from 10^{-5} to 10^{-3} for most confined aquifers, while the specific yield values can be 0.01 to 0.3 for most unconfined aquifers. The equations for calculating the total storage are presented below:

- for unconfined aquifers

$$Total\ Storage\ =\ V_{drained} = Area \times S_y \times (Water\ Level - Bottom)$$

- for confined aquifers

$$Total\ Storage\ =\ V_{confined} + V_{drained}$$

  - confined part

$$V_{confined} =\ Area \times [\,S \times (Water\ Level - Top)]$$

or

$$V_{confined} =\ Area \times [\,S_s\ \times (\mathrm{Top} - \mathrm{Bottom}) \times (Water\ Level - Top)]$$

  - unconfined part

$$V_{drained} =\ Area \times \left[S_y \times (Top - Bottom)\right]$$

where:

- $V_{drained}$ = storage volume due to water draining from the formation (acre-feet)
- $V_{confined}$ = storage volume due to elastic properties of the aquifer and water(acre-feet)
- *Area* = area of aquifer (acre)
- *Water Level* = groundwater elevation (feet above mean sea level)

- *Top* = elevation of aquifer top (feet above mean sea level)
- *Bottom* = elevation of aquifer bottom (feet above mean sea level)
- S_y = specific yield (no units)
- S_s = specific storage (1/feet)
- S = storativity or storage coefficient (no units)

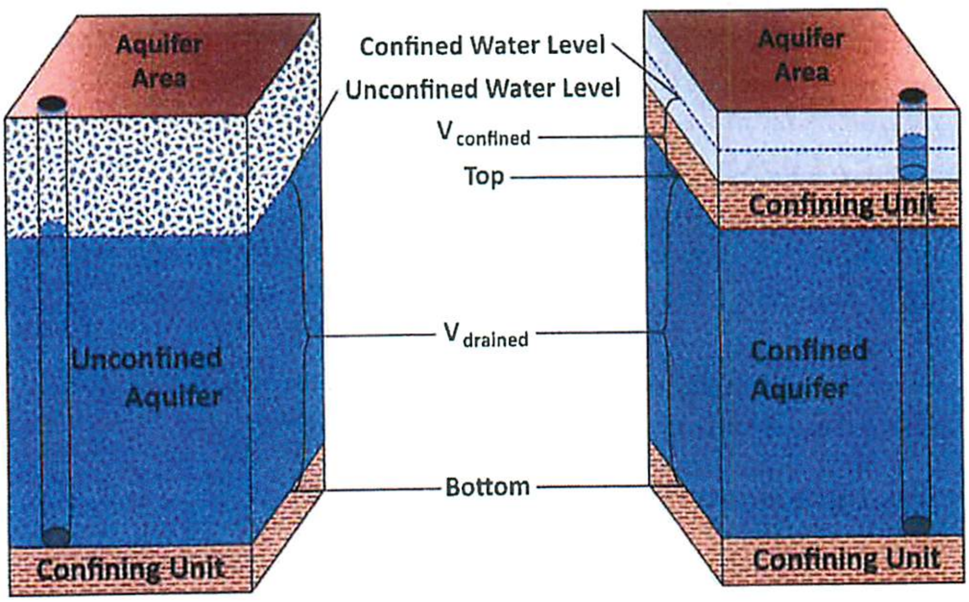

FIGURE 1. SCHEMATIC GRAPH SHOWING THE DIFFERENCE BETWEEN UNCONFINED AND CONFINED AQUIFERS.

As presented in the equations, calculation of the total storage requires data, such as aquifer top, aquifer bottom, aquifer storage properties, and water level. For the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Gulf Coast aquifers we extracted this information from existing groundwater availability model input and output files on a cell-by-cell basis.

For the Brazos River Alluvium Aquifer which does not have a groundwater availability model, we used an analytical approach. For each county, ArcMAP™ was used to estimate the Brazos River Alluvium Aquifer thickness (assuming base of the alluvium and land surface) and average water table depth (Shah and others, 2007; TWDB, 2013). Average Brazos River Alluvium Aquifer saturated thickness for each county was then calculated from average thickness minus average water table depth. Finally we estimated the total storage of the Brazos River

Alluvium Aquifer from average saturated thickness multiplied with area and an assumed specific yield value.

For the water bearing alluvial sediments determined as relevant for the San Bernard, Navasota, San Jacinto, and Trinity rivers, which do not have a groundwater availability model, we used an analytical approach. For each county, ArcMAP™ was used to calculate the acreage area for the delineated spatial extents of each of the river alluvia. The saturated thickness was then estimated based on water well and water-level data from the TWDB groundwater database for each of the acreage areas of the water bearing alluvial sediments determined as relevant (TWDB, 2011). Finally, we estimated the total storage for each of the river alluvia using average saturated thicknesses multiplied with associated areas and an assumed uniformly distributed specific yield values reported in the literature (Baker and others, 1974; Bradley, 2011; Cronin and Wilson, 1967; Johnson, 1967; Wilson, 1967).

The recoverable storage for each of the aquifers listed above was the product of its total storage and an estimated factor ranging from 25 percent to 75 percent.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used version 2.02 of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers to estimate the total recoverable storage for the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes eight layers which generally represent the Sparta Aquifer (Layer 1), the Weches Confining Unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Confining Unit (Layer 4), the Carrizo Formation (Layer 5), the Upper Wilcox Formation or Calvert Bluff Formation (Layer 6), the Middle Wilcox Formation or Simsboro Formation (Layer 7), and the Lower Wilcox Formation or Hooper Formation (Layer 8). To develop the estimates for the total estimated recoverable storage, we used Layer 1 (Sparta Aquifer), Layer 3 (Queen City Aquifer), and Layers 5 through 8 (Carrizo-Wilcox Aquifer system).

- The down-dip boundary of the model is based on the location of the Wilcox Growth Fault Zone, which is considered to be a barrier to flow (Kelley and others, 2004). This boundary is relatively deep and in the portion of the aquifer that is characterized as brackish to saline; consequently, the model includes parts of the formation beyond potable portions of the aquifer (Dutton and others, 2003). The groundwater in the official extent of the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004).
- The groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers was not considered for analysis because the active model area was more adequately covered by the overlap of the active model area for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

Yegua-Jackson Aquifer and the Catahoula Formation portion of the Gulf Coast Aquifer System

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer to estimate the total recoverable storages of the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes five layers which represent the outcrop section for the Yegua-Jackson Aquifer and the Catahoula Formation and other younger overlying units (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5). To develop the estimates for the total estimated recoverable storage in the Yegua-Jackson Aquifer, we used layers 1 through 5; however, we only used model cells in Layer 1 that represent the outcrop area of the Yegua-Jackson Aquifer.
- The down-dip boundary for the Yegua-Jackson Aquifer in this model was set to approximately coincide with the extent of the available geologic data, well beyond any active portion (groundwater use) of the aquifer (Deeds and others, 2010). Consequently, the model extends into zones of brackish and saline groundwater. The groundwater in the official extent of the Yegua-Jackson Aquifer ranges from fresh to brackish in composition (Deeds and others, 2010).

- For Jasper, Newton, Polk, Tyler, and Washington counties we used the official active areas of the groundwater availability model to estimate the total recoverable storage for the Yegua-Jackson Aquifer. However, for Grimes and Walker counties the desired future condition statement adopted on August 25, 2010,o included confined and brackish confined areas outside of the official aquifer area. Geographic information for those areas was submitted with the desired future condition statement. We used that information in this assessment to estimate the total recoverable storage for Grimes and Walker counties for layers 2 through 5 which represent the confined parts of the Yegua-Jackson units.

Gulf Coast Aquifer System

- We used version 3.01 of the groundwater availability model for the northern portion of the Gulf Coast Aquifer system for this analysis. See Kasmarek (2013) for assumptions and limitations of the model.
- The model has four layers which represent the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville confining unit (Layer 3), and the Jasper Aquifer and parts of the Catahoula Formation in direct hydrologic communication with the Jasper Aquifer (Layer 4).
- The southeastern boundary of flow in each hydrogeologic unit of the model was set at the down-dip limit of freshwater (defined in this case to be up to 10,000 milligrams per liter of total dissolved solids; Kasmarek, 2013).

Brazos River Alluvium Aquifer

- The Brazos River Alluvium Aquifer is under water table conditions in most places (George and others, 2011).
- The thickness of the Brazos River Alluvium Aquifer is based on a U.S. Geological Survey electromagnetic and resistivity imaging project (Shah and others, 2007).
- Water levels are from the TWDB groundwater database http://www.twdb.texas.gov/groundwater/data/gwdbrpt.asp accessed in July 2013. The three latest years of water level data were used to estimate the average water table depth for each county.
- We used a specific yield value of 0.15 from Cronin and others (1967).

San Bernard River Alluvium

- The areal extent of the San Bernard River Alluvium within Austin County was calculated to be 2,792 acres (USGS and TWDB, 2006).
- Average saturated thickness of the water bearing alluvium determined as relevant was calculated to be 20 feet (Thorkildsen and Backhouse, 2011).
- We used a specific yield value of 0.15 (Wilson, 1967).

Navasota River Alluvium

- The areal extent of the Navasota River Alluvium within Grimes County was calculated to be 12,004 acres (USGS and TWDB, 2006).
- Based on water well and water-level data from the TWDB groundwater database near the confluence of the Navasota and Brazos Rivers the water bearing alluvium determined as relevant has an average saturated thickness of 32 feet (TWDB, 2011).
- We used a specific yield value of 0.15 (Baker and others, 1974; Bradley, 2011; Johnson, 1967).

San Jacinto River Alluvium

- The areal extent of the San Jacinto River Alluvium within Walker County was calculated to be 7,399 acres (USGS and TWDB, 2006).
- Based on water well and water-level data from the TWDB groundwater database the water bearing alluvium determined as relevant has an average saturated thickness of 20 feet (TWDB, 2011).
- We used a specific yield value of 0.15 (Cronin and Wilson, 1967; Johnson, 1967).

Trinity River Alluvium

- The areal extent of the Trinity River Alluvium within Walker County was calculated to be 19,873 acres (USGS and TWDB, 2006).
- Based on water well and water-level data from the TWDB groundwater database the water bearing alluvium determined as relevant has an average saturated thickness of 23 feet (TWDB, 2011).

- We used a specific yield value of 0.15 (Cronin and Wilson, 1967; Johnson, 1967).

RESULTS:

Tables 1 through 20 summarize the total estimated recoverable storage required by statute. The county and groundwater conservation district total storage estimates are rounded to two or three significant digits. Figures 2 through 11 indicate the extent of the groundwater availability models or aquifer boundaries deemed relevant by the groundwater conservation districts in Groundwater Management Area 14 for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, Gulf Coast, and Brazos River Alluvium aquifers as well as the water bearing alluvial sediments determined as relevant by Groundwater Management Area 14 groundwater conservation districts for the San Bernard, Navasota, San Jacinto, and Trinity rivers.

TABLE 1. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE CARRIZO-WILCOX AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Grimes	14,500,000	3,625,000	10,875,000
Walker	5,040,000	1,260,000	3,780,000
Washington	264,000	66,000	198,000
Total	19,804,000	4,951,000	14,853,000

TABLE 2. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[2] FOR THE CARRIZO-WILCOX AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
No District	264,000	66,000	198,000
Bluebonnet GCD	19,500,000	4,875,000	14,625,000
Total	19,764,000	4,941,000	14,823,000

[2] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to three significant digits.

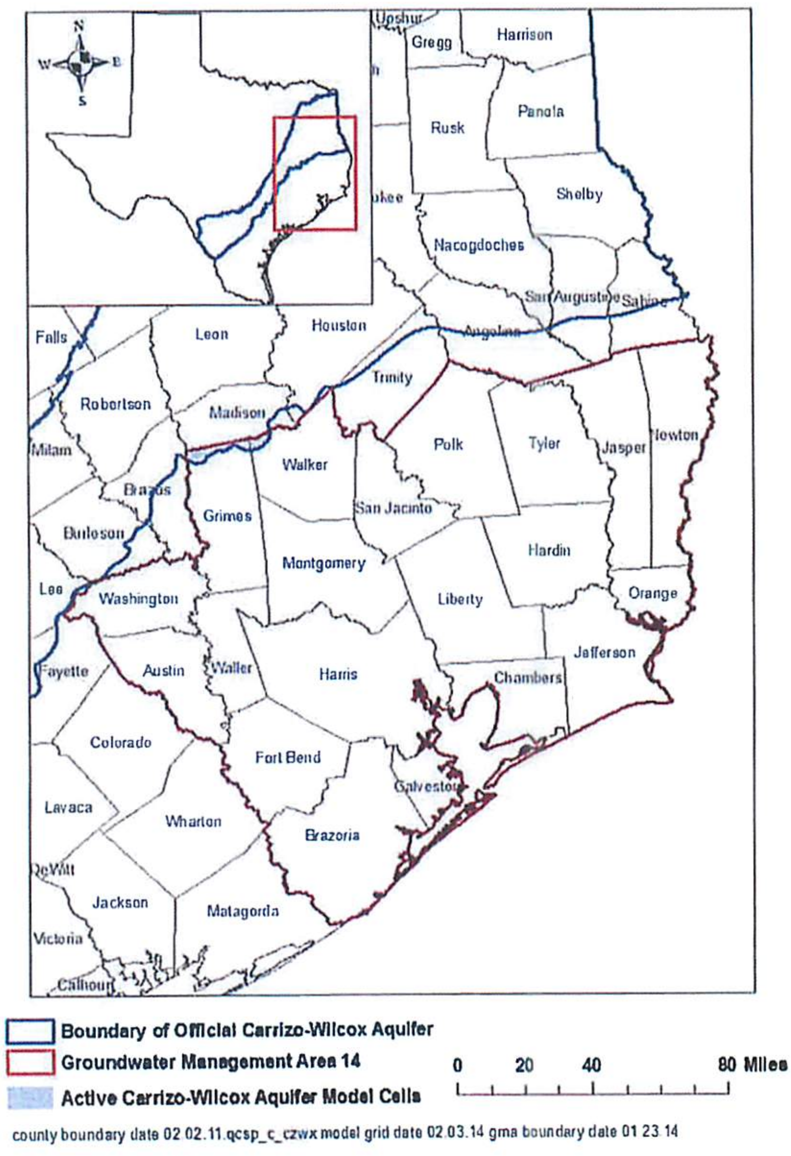

FIGURE 2. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PART OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS USED TO ESTIMATE TOTAL RECOVERABLE STORAGE FOR THE CARRIZO-WILCOX AQUIFER (TABLES 1 AND 2) WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 3. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE QUEEN CITY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Grimes	4,970,000	1,242,500	3,727,500
Walker	624,000	156,000	468,000
Washington	4,330,000	1,082,500	3,247,500
Total	9,924,000	2,481,000	7,443,000

TABLE 4. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[3] FOR THE QUEEN CITY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
No District	4,330,000	1,082,500	3,247,500
Bluebonnet GCD	5,590,000	1,397,500	4,192,500
Total	9,920,000	2,480,000	7,440,000

[3] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to three significant digits.

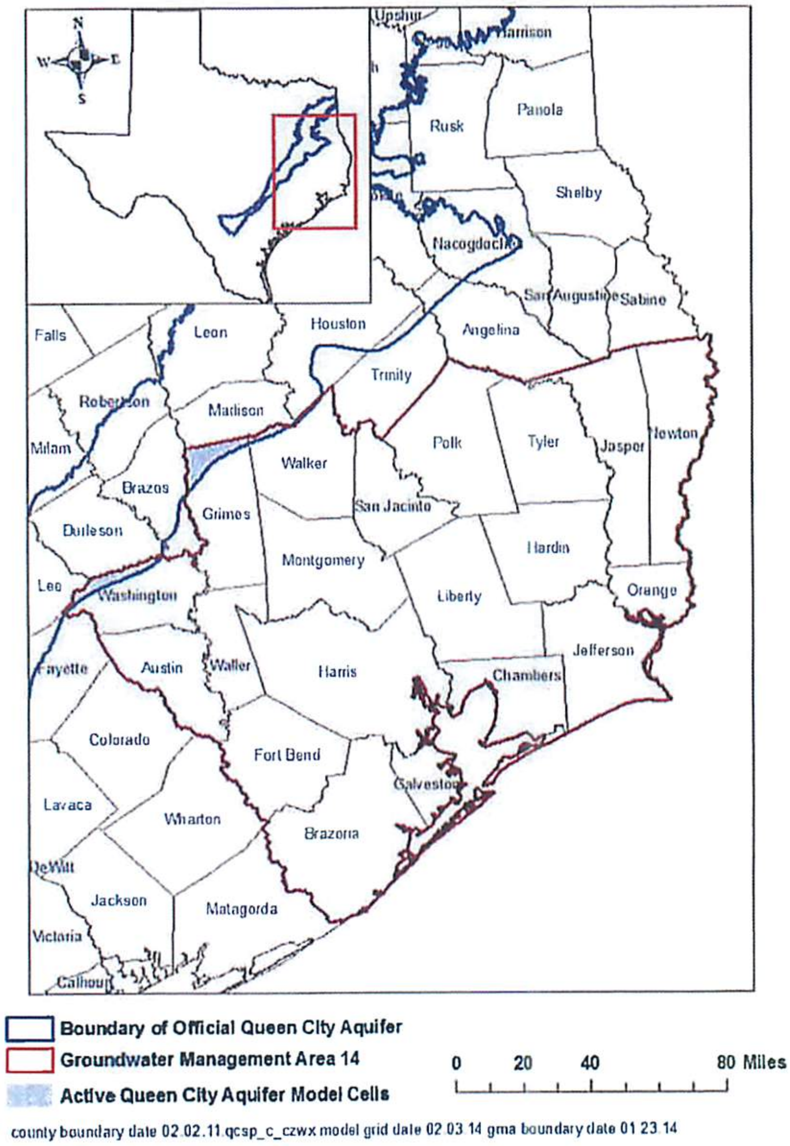

FIGURE 3. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PART OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS USED TO ESTIMATE TOTAL RECOVERABLE STORAGE FOR THE QUEEN CITY AQUIFER (TABLES 3 AND 4) WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 5. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE SPARTA AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Grimes	11,600,000	2,900,000	8,700,000
Walker	8,550,000	2,137,500	6,412,500
Washington	1,860,000	465,000	1,395,000
Total	22,010,000	5,502,500	16,507,500

TABLE 6. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[4] FOR THE SPARTA AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
No District	1,860,000	465,000	1,395,000
Bluebonnet GCD	20,100,000	5,025,000	15,075,000
Total	21,960,000	5,490,000	16,470,000

[4] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to three significant digits.

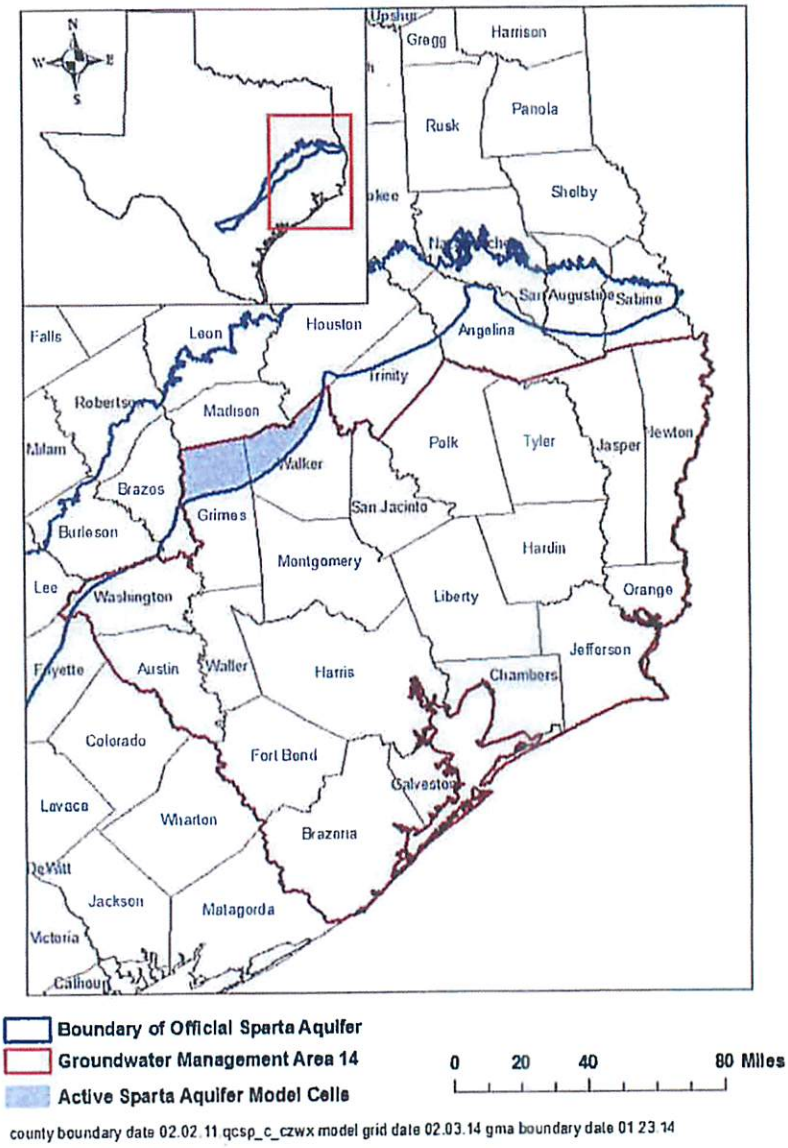

FIGURE 4. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PART OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS USED TO ESTIMATE TOTAL RECOVERABLE STORAGE FOR THE SPARTA AQUIFER (TABLES 5 AND 6) WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 7. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE YEGUA-JACKSON AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Grimes	94,900,000	23,725,000	71,175,000
Jasper	6,930,000	1,732,500	5,197,500
Newton	1,270,000	317,500	952,500
Polk	27,900,000	6,975,000	20,925,000
Tyler	8,650,000	2,162,500	6,487,500
Walker	103,000,000	25,750,000	77,250,000
Washington	12,400,000	3,100,000	9,300,000
Total	255,050,000	63,762,500	191,287,500

TABLE 8. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[5] FOR THE YEGUA-JACKSON AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
No District	12,400,000	3,100,000	9,300,000
Bluebonnet GCD	198,000,000	49,500,000	148,500,000
Lower Trinity GCD	28,000,000	7,000,000	21,000,000
Southeast Texas GCD	16,900,000	4,225,000	12,675,000
Total	255,300,000	63,825,000	191,475,000

[5] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to three significant digits.

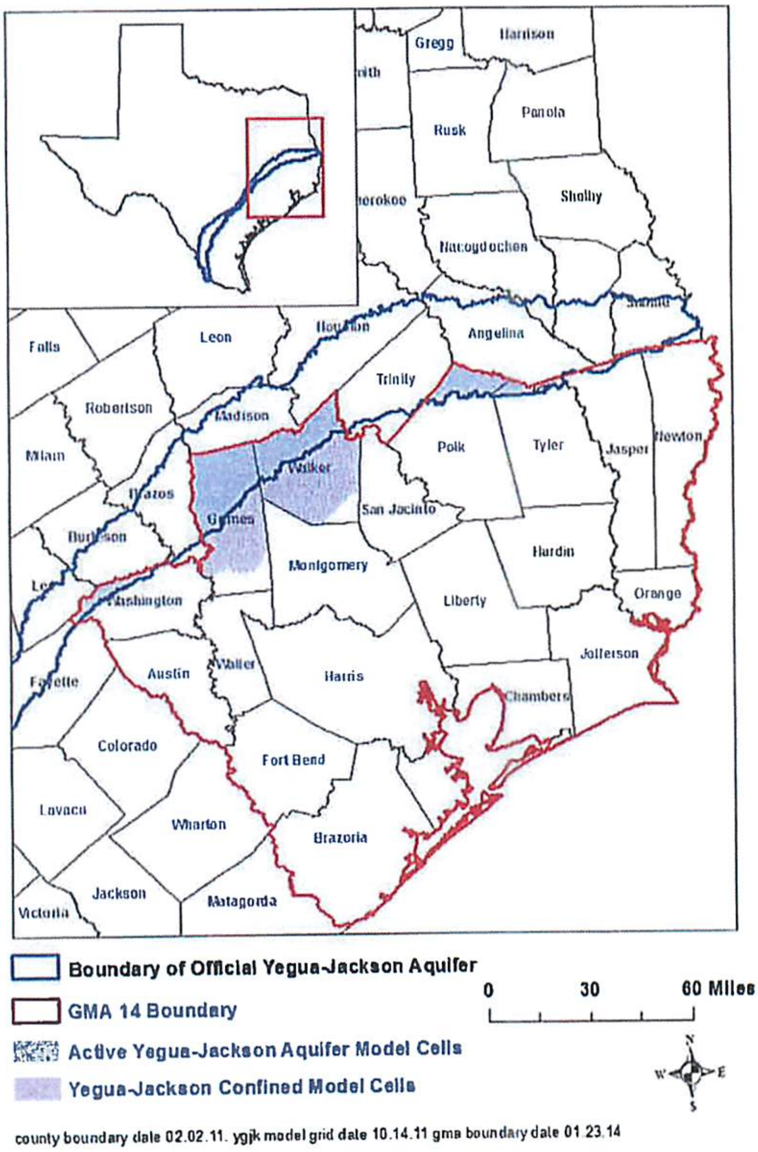

FIGURE 5. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 7 AND 8) FOR THE YEGUA-JACKSON AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 9. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE GULF COAST AQUIFER SYSTEM WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Austin	80,000,000	20,000,000	60,000,000
Brazoria	330,000,000	82,500,000	247,500,000
Chambers	130,000,000	32,500,000	97,500,000
Fort Bend	170,000,000	42,500,000	127,500,000
Galveston	81,000,000	20,250,000	60,750,000
Grimes	35,000,000	8,750,000	26,250,000
Hardin	190,000,000	47,500,000	142,500,000
Harris	380,000,000	95,000,000	285,000,000
Jasper	140,000,000	35,000,000	105,000,000
Jefferson	170,000,000	42,500,000	127,500,000
Liberty	250,000,000	62,500,000	187,500,000
Montgomery	180,000,000	45,000,000	135,000,000
Newton	120,000,000	30,000,000	90,000,000
Orange	61,000,000	15,250,000	45,750,000
Polk	110,000,000	27,500,000	82,500,000
San Jacinto	95,000,000	23,750,000	71,250,000
Tyler	120,000,000	30,000,000	90,000,000
Walker	32,000,000	8,000,000	24,000,000
Waller	80,000,000	20,000,000	60,000,000
Washington	22,000,000	5,500,000	16,500,000
Total	2,776,000,000	694,000,000	2,082,000,000

TABLE 10. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[6] FOR THE GULF COAST AQUIFER SYSTEM WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
No District	640,000,000	160,000,000	480,000,000
Bluebonnet GCD	230,000,000	57,500,000	172,500,000
Brazoria County GCD	330,000,000	82,500,000	247,500,000
Fort Bend Subsidence District	170,000,000	42,500,000	127,500,000
Harris-Galveston Coastal Subsidence District	460,000,000	115,000,000	345,000,000
Lone Star GCD	180,000,000	45,000,000	135,000,000
Lower Trinity GCD	200,000,000	50,000,000	150,000,000
Southeast Texas GCD	570,000,000	142,500,000	427,500,000
Total	2,780,000,000	695,000,000	2,085,000,000

[6] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant digits.

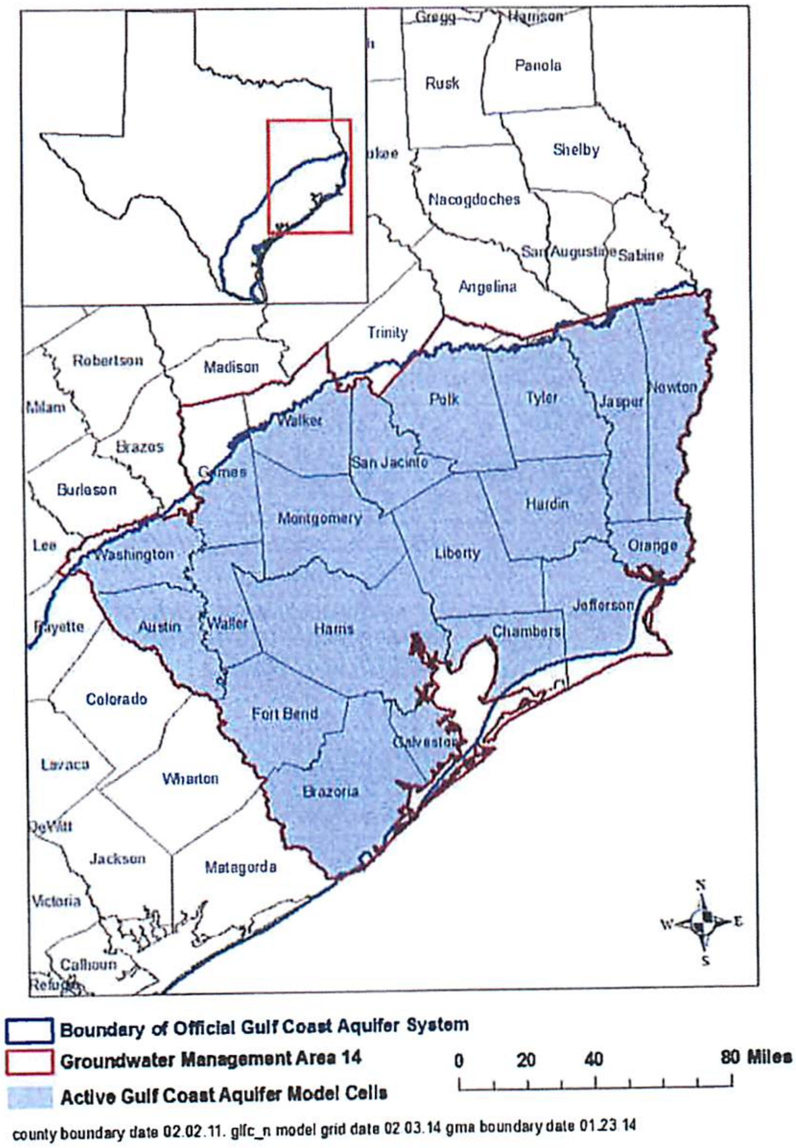

FIGURE 6. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PART OF THE GULF COAST AQUIFER SYSTEM USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 9 AND 10) FOR THE GULF COAST AQUIFER SYSTEM WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 11. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE BRAZOS RIVER ALLUVIUM AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Austin	220,000	55,000	165,000
Fort Bend	1,010,000	252,500	757,500
Grimes	74,700	18,675	56,025
Waller	412,000	103,000	309,000
Washington	179,000	44,750	134,250
Total	1,895,700	473,925	1,421,775

TABLE 12. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT[7] FOR THE BRAZOS RIVER ALLUVIUM AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO THREE SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
No District	179,140	179,000	44,750
Bluebonnet GCD	707,000	176,750	530,250
Fort Bend Subsidence District	1,010,000	252,500	757,500
Total	1,896,000	474,000	1,422,000

[7] The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to three significant digits.

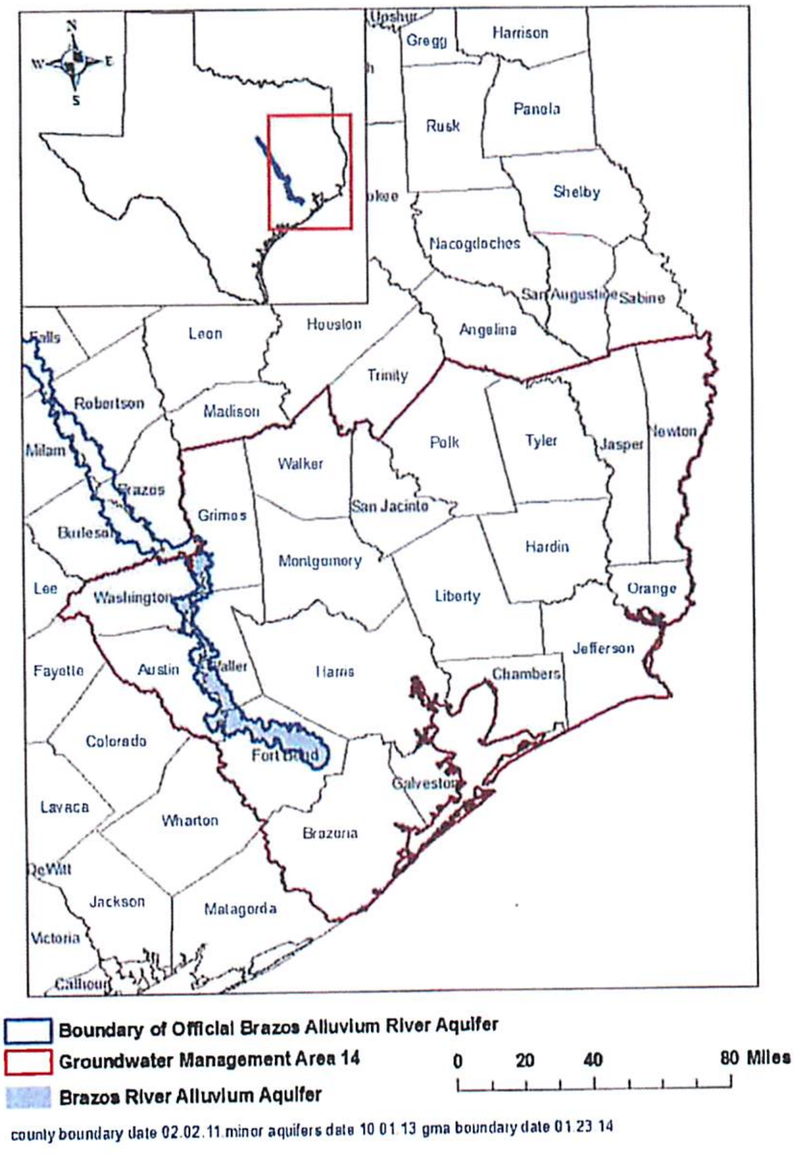

FIGURE 7. EXTENT OF THE BRAZOS RIVER ALLUVIUM AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 11 AND 12) FOR THE BRAZOS RIVER ALLUVIUM AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 13. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE SAN BERNARD RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Austin	8,400	2,100	6,300
Total	8,400	2,100	6,300

TABLE 14. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT FOR THE SAN BERNARD RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bluebonnet GCD	8,400	2,100	6,300
Total	8,400	2,100	6,300

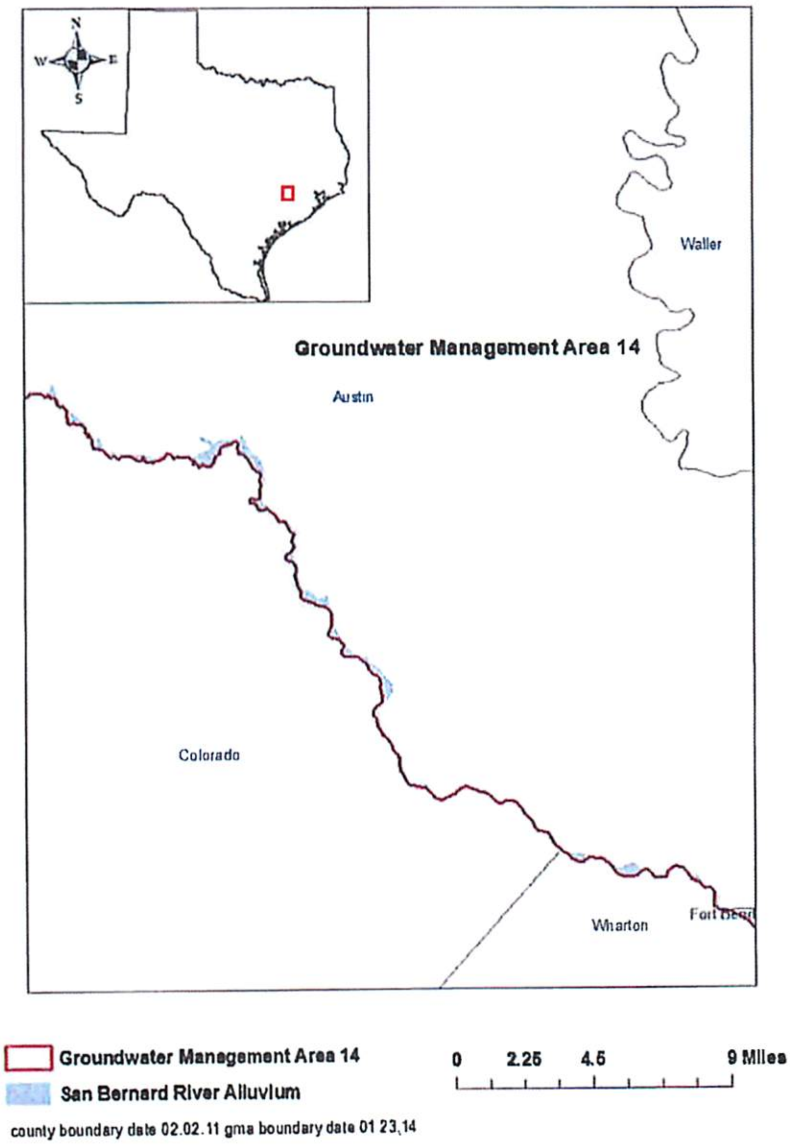

FIGURE 8. EXTENT OF THE SAN BERNARD RIVER ALLUVIUM DETERMINED AS RELEVANT IN AUSTIN COUNTY USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 13 AND 14) FOR THE SAN BERNARD RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 15. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE NAVASOTA RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Grimes	58,000	14,500	43,500
Total	58,000	14,500	43,500

TABLE 16. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT FOR THE NAVASOTA RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bluebonnet GCD	58,000	14,500	43,500
Total	58,000	14,500	43,500

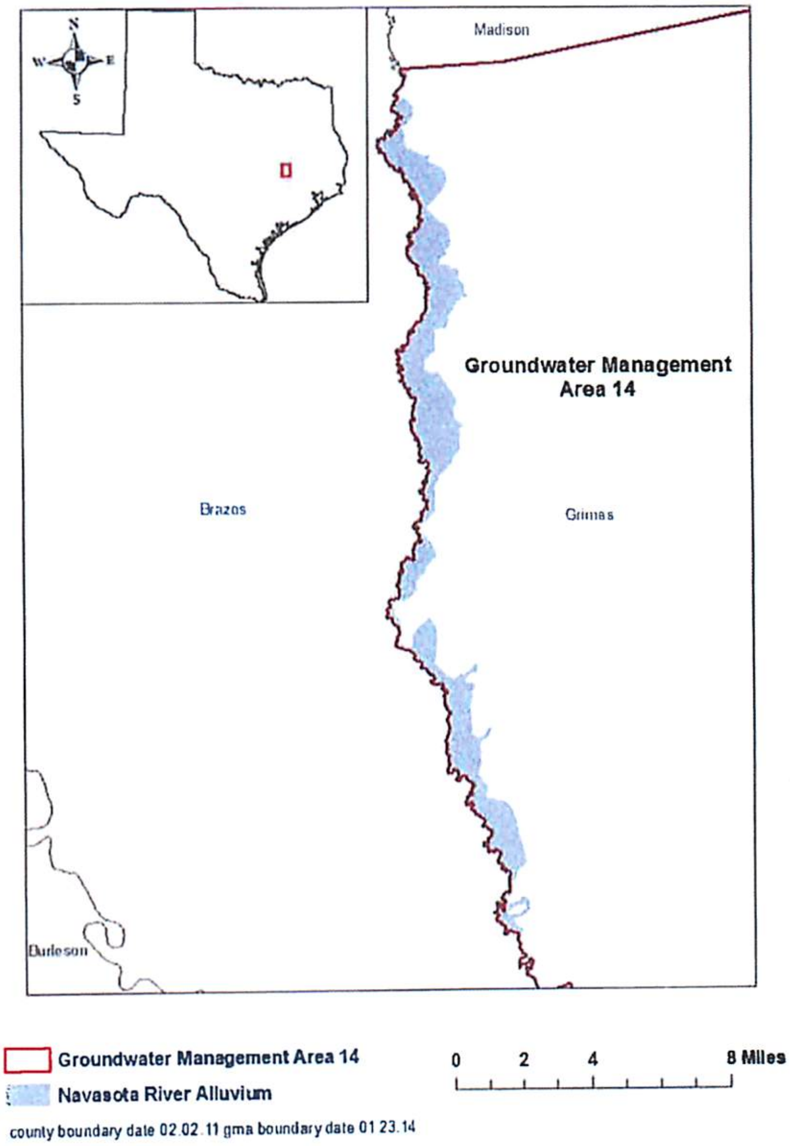

FIGURE 9. EXTENT OF THE NAVASOTA RIVER ALLUVIUM DETERMINED AS RELEVANT IN GRIMES COUNTY USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 15 AND 16) FOR NAVASOTA RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 17. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE SAN JACINTO RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Walker	22,000	5,500	16,500
Total	22,000	5,500	16,500

TABLE 18. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT FOR THE SAN JACINTO RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bluebonnet GCD	22,000	5,500	16,500
Total	22,000	5,500	16,500

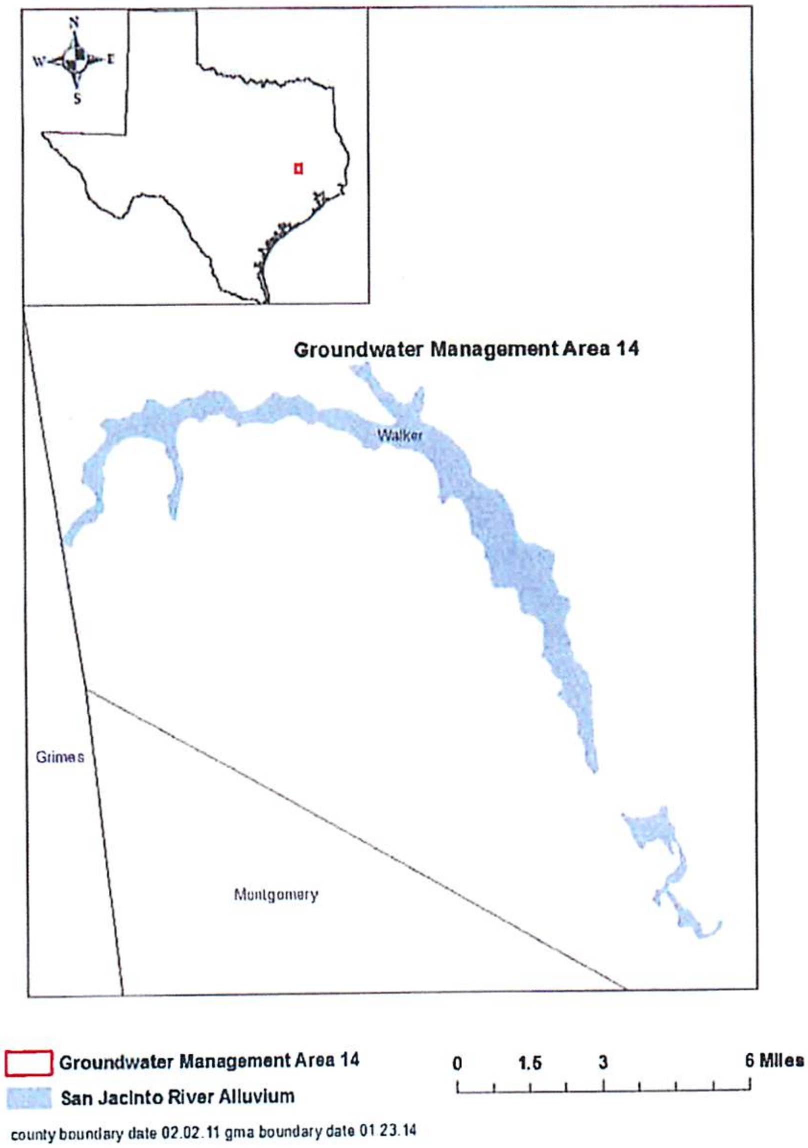

FIGURE 10. EXTENT OF THE SAN JACINTO RIVER ALLUVIUM DETERMINED AS RELEVANT IN WALKER COUNTY USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 17 AND 18) FOR THE SAN JACINTO RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14.

TABLE 19. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE TRINITY RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Walker	69,000	17,250	51,750
Total	69,000	17,250	51,750

TABLE 20. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT FOR THE TRINTY RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT DIGITS.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Bluebonnet GCD	69,000	17,250	51,750
Total	69,000	17,250	51,750

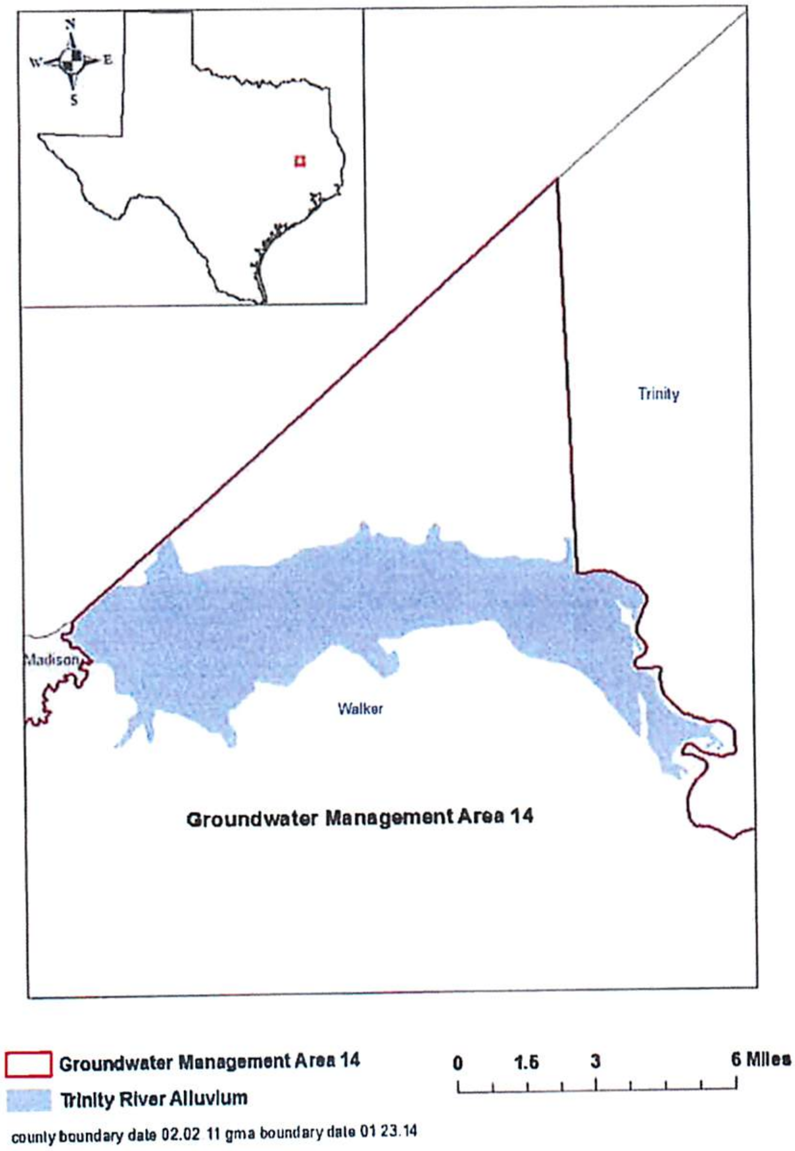

FIGURE 11. EXTENT OF THE TRINITY RIVER ALLUVIUM DETERMINED AS RELEVANT IN WALKER COUNTY USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 19 AND 20) FOR THE TRINITY RIVER ALLUVIUM DETERMINED AS RELEVANT WITHIN GROUNDWATER MANAGEMENT AREA 14.

LIMITATIONS

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objective(s). To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

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DECLARATION OF JAMES M. GRIFFIN

1. My name is James M. Griffin and my date of birth is November 13, 1944. My business address is Texas A&M University, 4220 TAMU College Station, Texas 77842.

2. I am a professor of economics and public policy at The Bush School of Government & Public Service. I also hold the Bob Bullock Chair in Public Policy and Finance.

3. A true and correct copy of the Bush School Capstone Report made to the Honorable Glenn Hegar, Texas State Comptroller of Public Accounts, in May 2016, and titled "Reorganizing Groundwater Regulation in Texas," is attached hereto as Exhibit A and incorporated herein by reference. A copy of that paper is also available on The Bush School's website at: http://bush.tamu.edu/psaa/capstones/Final%20Report%20Reorganizing%20Groundwater%20Regulation%20in%20Texas%20(3).pdf.

I declare under penalty of perjury that the foregoing is true and correct. Executed in Brazos County, State of Texas, on the 31st day of October, 2016.

James M. Griffin

EXHIBIT J

The Bush School
OF GOVERNMENT & PUBLIC SERVICE
TEXAS A&M UNIVERSITY

Reorganizing Groundwater Regulation in Texas

Ross Brady
Wayne Beckermann
Amber Capps
Braden Kennedy
Peyton McGee
Kayla Northcut
Mason Parish
Abdullilah Qadeer
Shuting Shan
Faculty Advisor: James Griffin

A Bush School Capstone Report to
Hon. Glenn Hegar,
Texas State Comptroller of Public Accounts

Executive Summary

The Texas Water Development Board's (TWDB) 2012 State Water Plan paints a pessimistic picture of future availability of groundwater. Is this due to the physical limitations of the resource or a regulation-induced shortage? To answer this question, it was first necessary to determine how much groundwater the state currently has and how long that quantity is expected to last. These primary assessments were reached using data from the TWDB for each of the nine major aquifers including total estimated recoverable storage (TERS), annual recharge, and historical pumping rates. Additionally, interviews were conducted with the staff of each of the state's 97 groundwater conservation districts (GCDs). At current consumption rates, five of the nine major aquifers have unlimited years of supplies of groundwater. Even using historical growth rates in consumption, we obtained much the same result. The two exceptions are the Ogallala and Hueco-Mesilla Aquifers which have less than one hundred years supply. For the others, only if consumption is projected to grow at a rate of 2% annually (a highly unrealistic estimate), do the numbers decline dramatically. Yet even so, five of the nine aquifers would still have over a two-hundred year supply. These calculations reveal a misconception about the state's availability of groundwater. Most citizens believe groundwater is rapidly being depleted and want to protect it for local use. Our findings show there is a relative abundance of groundwater in all but two of the state's major aquifers. Furthermore, a review of the regulatory practices of the local GCDs supported the conclusion that Texas has a regulation-induced shortage of groundwater.

In attempting to examine alternative regulatory options, it is necessary to have basic criteria for evaluation of these options. We adopted the following criteria based on existing legal precedent, economics, basic equity considerations, and hydrology as follows:

- The protection of property rights,
- Using water at its highest and best use,
- Mitigating against landowner losses, and
- Managing aquifers in a prudent manner.

Using these criteria, we have evaluated the following four policy options:

Policy Option One maintains the existing GCD structure while reinstating the landowner's ability to treat groundwater as a property right. This option builds on best practices utilizing many of the features adopted by the Post Oak Savannah GCD. Under the current system, the power of GCDs to treat specific uses of groundwater differently has effectively usurped this property right. Therefore this policy would require GCDs to accept pumping permit applications regardless of use and implement a uniform, nondiscriminatory fee structure. Additionally, this policy would ensure each landowner receives an equal and fair share of groundwater by replacing the existing convoluted regulatory process with a simple formula-based system using a percentage of TERS, annual recharge, and correlative rights.

Policy Option Two proposes the replacement of the existing GCDs based on political boundaries with hydrological boundaries. Like Option One, it would use a simple formula for determining available groundwater and use correlative rights to assign pumping rates. This approach would allow for more effective regulation by treating groundwater consistently within each aquifer and reconciling the differences between adjacent GCDs.

Policy Option Three would create a statewide agency to protect, conserve, and regulate groundwater, using ideas similar to the Texas Railroad Commission's regulation of oil and natural gas. This statewide agency would retain elements of local input by dividing the state into 16 district offices, similar to the existing Groundwater Management Areas (GMAs). However, the state office would assume the responsibility for accepting permits, setting fees, and monitoring wells. This system would allow for economic certainty by creating consistent policy and should more easily facilitate the movement of groundwater from water abundant regions to water scarce regions.

Policy Option Four is based on a novel idea by Nobel Laureate economist, Vernon Smith who advocated the creation of groundwater bank accounts where each property owner owns the water under his/her land and has considerable flexibility to use it as he/she see fit. Groundwater bank accounts would encourage the development of a water market by using clearly defined property rights. The market established by this system promotes conservation by providing an incentive to keep the groundwater in the ground – as scarcity in the market increases, the price of groundwater will rise. Interestingly, this system would utilize the individual GCDs as their "local banks", while aquifer-wide authorities would measure recharge and administer mitigation.

Finally, to assist policy makers, these policy options were compared with each other as well as with the existing system of groundwater regulation. Grades were assigned to each depending on how effectively each policy (1) protects all property rights (2) allows water to be used towards its highest and best use (3) mitigates against rising costs; and (4) provides prudent aquifer management. Since the purpose of this report is to create a dialogue, we encourage each reader to assign their own grades. While this study does not examine the political feasibility of each option, we encourage policy makers to provide their own assessment.

Introduction

Groundwater—Part of the Problem or Part of the Solution?

The Texas Water Development Board's (TWDB) 2012 State Water Plan paints a dire picture of water availability out to 2060. Even though this plan calls for only modest growth in consumption (from 18 million acre-feet (AF) to 22 million AF by 2060), existing supplies decline significantly. The TWDB concludes the state faces a shortage of 8.3 million AF by 2060.[1] Increased reliance on new lakes and increased diversions from rivers seems problematic for several reasons. First, reliance on surface water makes us increasingly vulnerable to droughts such as in 2012. Second, evaporation of surface water is substantial, making it an inefficient source.

In the TWDB State Water Plan, groundwater is viewed as contributing to the problem rather than offering a solution. The TWDB projects groundwater pumping will actually decline from 8 million AF to 5.7 million AF, citing decreased pumping from the Ogallala and the Gulf Coast Aquifers as the causes for this decline. These forecasts served as the motivation for this capstone project asking the question whether the diminished role for groundwater is justified. Are the causes the hydrological limitations of the state's nine major aquifers or could this be a regulation-induced shortage?

Regulation by GCDs

1. Texas Water Development Board, 2012 Water for Texas (Texas Water Development Board, Austin, January 2012).

The State of Texas has established Groundwater Conservation Districts (GCDs) as the de facto institution for groundwater management under first the Texas Groundwater Act of 1949, and then later expanded GCD power under Senate Bill 1 in 1997. Today 97 GCDs, shown in Figure 1, determine groundwater pumping in their own districts. The Texas Water Development Board provides hydrologic assistance to the GCDs, but pumping rates are set locally. Interestingly, most GCDs project either modest increases or declining pumping rates. Is this due to the physical limitations of the underlying aquifers or is this a local political choice?

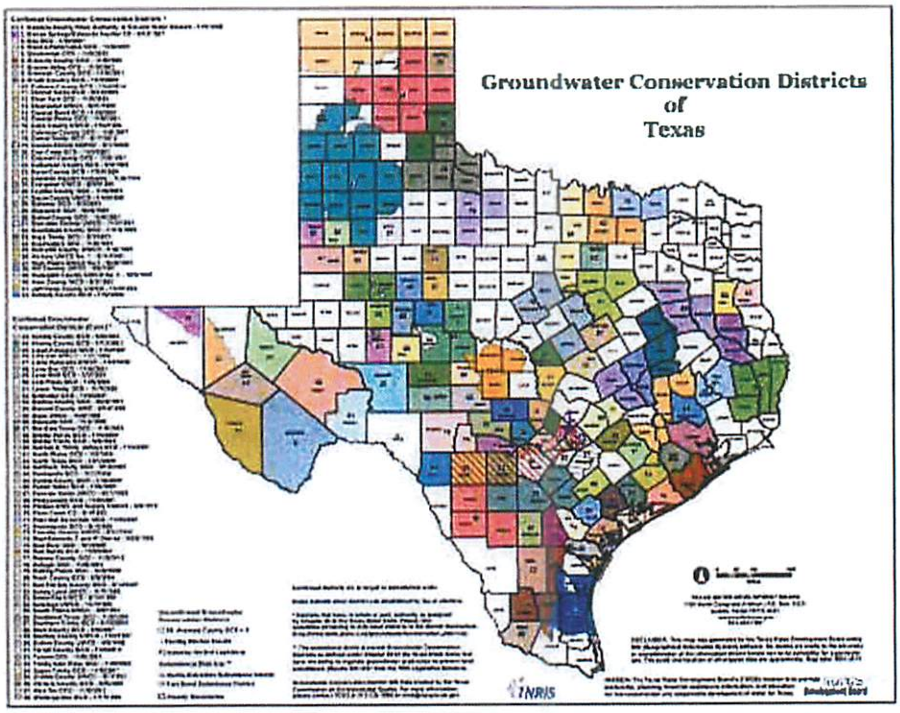

Figure 1-Groundwater Conservation Districts in Texas[2]

Assessing the Year's Supply of the 9 Major Aquifers

As shown in Figure 2, Texas has 9 major aquifers. In measuring the size of the underlying resource base of these aquifers, the TWDB uses a concept called TERS —total estimated recoverable storage. In effect TERS represents the technical maximum amount of groundwater that is retrievable from the aquifer. Because what is economically recoverable is generally less

2. "Groundwater Conservation Districts of Texas." Digital Image. Texas Water Development Board. Accessed March 31, 2016. https://www.twdb.texas.gov/mapping/doc/maps/GCDs_8x11.pdf.

than what is technically recoverable, the TWDB calculates 25% of TERS and 75% of TERS to provide a bracket of what might be practically recoverable for each aquifer. For simplicity, we have adopted the midpoint of this bracket —50% TERS as an approximate measure of the economically recoverable portion of the groundwater in an aquifer.[3]

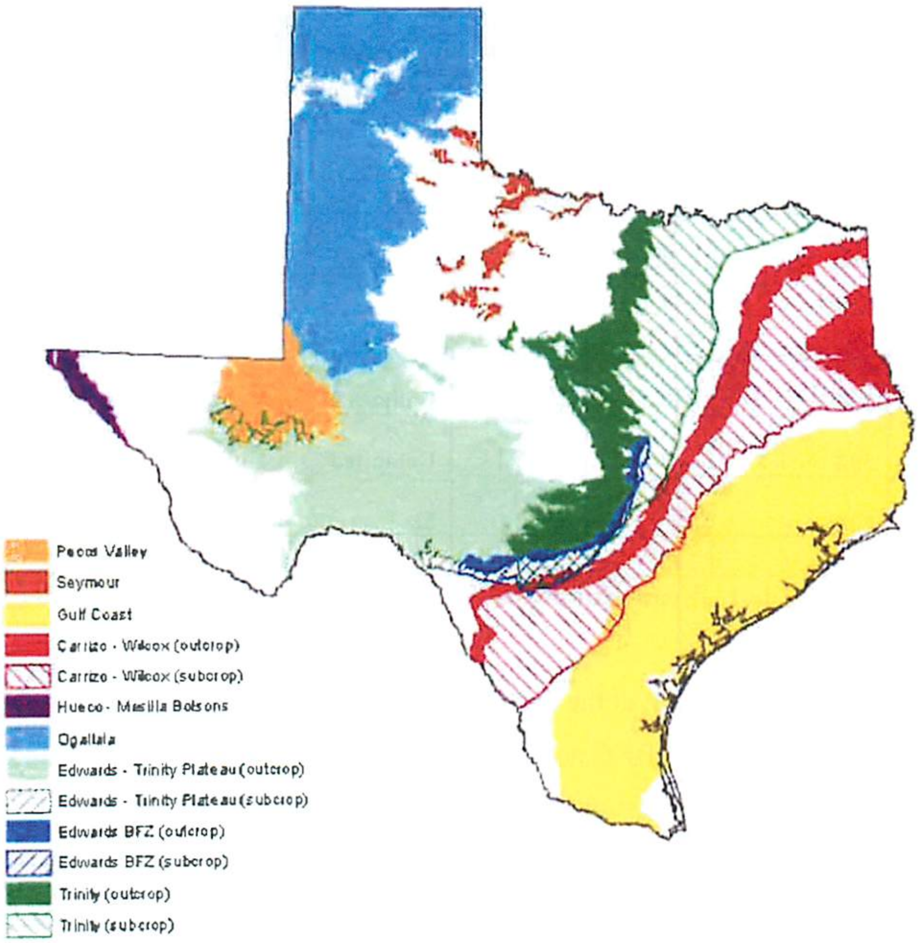

Figure 2: "Major Aquifers Map." Texas Water Development Board[4]

Table 1 shows current consumption, estimated annual recharge, and 50% of TERS based on data gathered by the TWDB for each of the nine major aquifers. The aquifers are ranked in terms of

3. We use 50%TERS as a mid-point in the TWDBs classification, acknowledging that for specific aquifers the economically recoverable portion can vary above or below 50% depending on the type of aquifer, the depth, water quality, etc.

4. "Major Aquifers Map." Digital image. Texas Water Development Board. Accessed November 19, 2015. http://www.twdb.texas.gov/groundwater/aquifer/.

their storage capacity. Interestingly, as shown in Figure 2, the three largest—the Gulf Coast, the Trinity, and the Carrizo-Wilcox are located in the most populous parts of the state. The key objective of Table 1 is to calculate how many years each of these nine major aquifers could produce at various consumption rates before reaching 50% of TERS.

Aquifer	Consumption (KAF)	Recharge (KAF)	50% TERS (KAF)	Years Supply at Constant Consumption	Years Supply at Historical Consumption Growth Rate	Years Supply at 2% Consumption Rate
Gulf Coast	851	1,300	2,587,224	Unlimited	Unlimited	200
Trinity	178	95	702,618	8,459	2,071	218
Carrizo-Wilcox	415	1,002	261,354	Unlimited	Unlimited	243
Ogallala	5,568	440	203,472	35	36	17
Pecos Valley	78	71	151,171	219	Unlimited	195
Edwards Trinity	250	780	36,420	Unlimited	Unlimited	120
Edwards BFZ	392	440	11,706	Unlimited	Unlimited	49
Hueco-Mesilla	132	5.6	6,927	51	49	26
Seymour	129	215	2,545	Unlimited	Unlimited	59

Table 1 –Years Supply of the Nine Major Aquifers

As shown in column five of Table 1, at the *current rate* of consumption, the Gulf Coast, Carrizo-Wilcox, Edwards Trinity, Edwards BFZ, and the Seymour Aquifers have an unlimited years of supply because recharge exceeds consumption. The vitally important Trinity Aquifer in central Texas has 8,479 year's supply before reaching 50% of TERS. In contrast, the Ogallala Aquifer, located in the Texas Panhandle, and the Hueco-Mesilla, in the El Paso area, are heavily pumped unconfined aquifers, which at current consumption rates face depletion.

Criticism of assuming constant consumption is that it does not allow for economic and population growth. Column six of Table 1 projects future consumption based on the historical growth rate in consumption for each major aquifer. Even based on the *historical growth rate of consumption*, six of the nine major aquifers still have an unlimited supply of water, and the Trinity Aquifer has 2,071 years of supply. Finally, since the historical growth rates in consumption tended to be less than 1% annually, we thought it wise to present a worst case scenario in column seven—based on a *2% annual consumption growth rate.* In this worst case scenario, the seven most abundant aquifers drop sharply ranging between 49 and 243 years. Given historical growth trends going back to the 1970's, these outcomes appear unlikely.

Fortunately, the largest three aquifers, the Gulf Coast, Carrizo-Wilcox, and the Trinity, lay adjacent to large population centers such as Harris County, Bexar County, and Dallas County, respectively; yet they have almost unlimited supplies of groundwater under both the constant and historical consumption growth rate scenarios.[5]

A Regulation-Induced Shortage?

Juxtaposed against the above findings is the troubling statistic that most GCDs' management plans call for either constant or declining pumping out to 2060. Only 3 project increased pumping.[6] On an individual GCD basis, there appears to be a strong disconnect between projected pumping rates and the results based on TERS in Table 1. Could it be that political balkanization of local GCDs is preventing expanded use of the state's groundwater resources? Three pieces of evidence point in this direction. First, is the fact that only a few GCDs project future increases in pumping.[7] Second, as shown below, detailed evidence for three very important GCDs show a big disparity between potential consumption and actual consumption. Third, there is considerable evidence that GCDs oppose groundwater leaving the confines of their district.

Evidence from Three GCDs

Table 2 contrasts potential consumption versus actual consumption for three geographically distinct GCDs --the Evergreen, the Bluebonnet, and the Neches-Trinity Valley. The Evergreen GCD contains the Carrizo-Wilcox Aquifer and lies just south of San Antonio. The Bluebonnet GCD is primarily served by the Gulf Coast Aquifer and lies just to the north of Houston. The Neches-Trinity Valley GCD also contains the Carrizo-Wilcox Aquifer and lies approximately

5. Additionally, the Edwards Balcones Fault Zone (BFZ) adjacent to San Antonio has large supplies; however, pumping is restricted by the Edwards Aquifer Authority (EAA) in response to Federal Court Rulings.

6. See Beckermann, Wayne, Ross Brady, Amber Capps, Braden Kennedy, Peyton McGee, Kayla Northcut, Mason Parish, Abdullilah Qadeer, Shuting Shan, "An Assessment of Groundwater Regulation in Texas" Unpublished Paper, January 2016, Appendix B.

7. Ibid. , Appendix B.

100 miles southeast of Dallas. In order to compute potential consumption, two components must be added. First, it was assumed that prudent aquifer management would allow the TERS in each GCD to be drawn down by 5% over a 50 year period—or .1% of TERS annually. [8] In addition, precipitation recharge should be added to compute potential consumption.

As shown in column five of Table 2, the Bluebonnet GCD has a potential modelled available groundwater (MAG) of 284,201 AF from the Gulf Coast Aquifer. In contrast, the current MAG was determined to be 95, 803 AF with actual consumption was only 15,070 AF. The potential MAG is 18.8 times current production. For the Neches-Trinity Valley GCD, one sees much the same picture with the potential MAG far exceeding actual consumption by 21 times. For the Evergreen GCD, the potential MAG is about 3 times actual consumption. This statistic is particularly troublesome as the City of San Antonio is embarking on a very expensive pipeline project, Vista Ridge, to move groundwater 140 miles from Burleson County. Yet abundant supplies in the Evergreen GCD appear at its doorstep.

A criticism of the existing regulatory approach is that the MAG is determined by a reverse-engineered approach that places an arbitrary, excessively restrictive ceiling on future pumping. In turn, the GCDs permitting process is designed to keep pumping under the MAG. Table 2 also reveals just how overly restrictive the MAGs are compared to a potential MAG, which involves using a small fraction of TERS plus annual recharge. For the Bluebonnet GCD, the potential MAG is almost three times the current MAG. For the Evergreen GCD it is one and a half times, and for the Neches-Trinity GCD it is 15 times. These ratios support the preposition that the existing process of determining the MAGs results in overly restrictive permitting.

8. Later, we propose that this measure of potential consumption should be used to replace the MAGs currently calculated. See section under Option One.

GCD	Aquifer	0.1% TERS (in AF)	Recharge (in AF)	Potential MAG	Current MAG	MAG Difference	2010 Consumption	Potential Growth
Bluebonnet	Gulf Coast	210,000	54,201	284,201	95,803	3X	15,070	18.8X
Evergreen	Carrizo-Wilcox	540,000	20,850	560,850	375,654	1.5X	186,119	3X
Neches-Trinity Valley	Carrizo-Wilcox	436,000	18,758	454,758	30,141	15X	21,644	21X

Table 2 – Comparison of Potential MAGs, current MAGs, and Consumption

Discouraging Water Exportation

Additional evidence on the lack of water exportation leaving a GCD suggests that GCDs tend to be insular, protecting local historical agricultural irrigators and local municipalities.[9] While state law requires every GCD to allow groundwater exportation, only six have a significant percentage of groundwater being exported exceeding about 1% of supply.[10]

Even though by law, a GCD cannot prohibit the export of water outside a GCD, a GCD has considerable power to thwart the process. Examples include (1) reducing the permitted amount thereby vitiating the economies of scale of the project,[11] (2) taxing exports at a higher rate, and/or (3) increasing legal costs through the costly appeals process. All of these actions can raise the cost of water exports. An example of higher taxes being charged to exporters occurred in the Bluebonnet GCD where exporters were charged a fee of $55.38/AF as contrasted with $14.60/AF for local municipalities and zero for local agricultural pumpers.[12] A lengthy, litigious permitting process makes it very expensive to the party trying to get a project approved. Consequently, any

[9] Mason Parish points out that lower rates for agricultural users may be justified. However, there is no justification for treating export fees different from local municipal and industrial users.

10. Beckermann et al, op. cit., Appendix B

11. Edmond R. McCarthy. 2013. Motion for Rehearing. http://indytexans.org/wp-content/uploads /Forestar_s-Motion-for-Rehearing-8-6-13-1.pdf.

12. See Beckermann et al, op. cit., Appendix B

entity attempting to complete an export project must have a great deal of funding.[13] Lawyers and expert witnesses on both sides are incentivized to prolong litigation and subsequently bill more hours.[14] Water marketers are at a distinct disadvantage because they must pay the GCDs legal bill if they do not win appeals, and even if they do win, they may or may not be able to recover their own legal costs.[15]

Limits to GCD Authority

While some might characterize the 97 GCDs as Balkanized fiefdoms whose "jurisdictional entitlements" create an imbalance between our state's "municipal, agricultural, [and] industrial...water demands," their power is not absolute.[16] Recent legal proceedings indicate court intervention limits such powers. Ownership of groundwater throughout Texas must now be understood by the Texas Supreme Court's ruling in *Edwards Aquifer Authority v. Day* that, "...each owner of land owns separately, distinctly and exclusively all the oil and gas under his land and... we now hold that this correctly states the common law regarding the ownership of groundwater in place...."[17] As a private property right, groundwater is subject to equal protection and takings statutes, which place significant burdens on GCDs seeking to restrict pumping. The court also ruled landowners are, "...accorded the usual remedies against trespassers who appropriate the minerals or destroy their market value...for groundwater just like oil and gas...."[18]

It is important to define takings at this juncture. Under the United States Constitution, the Fifth Amendment states, "...nor shall private property be taken for public use without just

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13. Stuart R. White, "Guitar Holding: A Judicial Re-write of chapter 36 of the Texas Water Code?," The Baylor Law Review 62 (2010):324.

14 For a discussion of Clayton Williams' legal disputes with the Middle Pecos GCD, see Beckermann et al, op. cit., pp. 51-52.

15. Edmond McCarthy, Interview, November 24, 2015.

16. Larson, Lyle. "Balkanization of Texas Water Must End." San Antonio Express-News. March 28, 2014. Accessed April 07, 2016. http://www.mys anantonio.com/opinion/commentary/article/ Balkanization-of-Texas- water -must-end-5354966.php.

17. The Supreme Court of Texas. February 24, 2012. The Edwards Aquifer Authority and the State of Texas, Petitioners, v. Day and McDaniel, Respondents. No. 08–0964. http://caselaw.findlaw.com/tx-supreme-court/1595644.html#footnote_ref_141.

18. Ibid.

compensation…" and this just compensation requirement extends to easements, personal property, contract rights, and trade secrets. Takings, however, must not only be understood in terms of seizures, but also recognized as regulations that prevent an owner of private property from fully accessing and capitalizing upon their property. The government is absolutely financially liable if it physically invades or seizes private property, and remains potentially financially liable if regulatory effects burden property owners.

With respect to the groundwater governance situation in Texas, GCDs do not physically seize private groundwater; rather, they regulate its withdrawal. When GCDs across Texas approve or deny pumping permits they are effectively regulating groundwater from one perspective, and engaging in compensable regulatory takings from another. Texas Property Code Sections 21.012 and 21.0121 reveal the State of Texas created a relatively high standard for GCDs to meet before they may restrict the use of, or take, groundwater. Therefore GCDs who are actively engaged in regulation without meeting these thresholds expose themselves to financial liability.

Another landmark case, the case of *Edwards Aquifer Authority (EAA) v Bragg* involved owners of two pecan orchards seeking damages from the EAA because the authority denied their permit for the Home Place Orchard and only granted half of the requested amount for the D'Hanis Orchard.[19] Ultimately, the Courts ruled that a takings had occurred and awarded damages to the Braggs. Furthermore, the Edwards Aquifer Authority and not the state of Texas was ruled liable. Thus GCDs are financially responsible when the courts rule that their actions have resulted in a takings.

Common Elements of Regulatory Reform

If the existing regulation-induced shortage of groundwater is addressed by regulatory reform to allow greater pumping, there are two features that must accompany that any reform. First, increased pumping will raise lifting costs which can have both positive and negative effects as

19. Justice Sandee Bryan Marion. The Fourth Court of Appeals. The Edwards Aquifer Authority V. Bragg No. 04-11-00018-CV. August 28, 2013. http://www.search.txcourts.gov/SearchMedia.aspx? MediaVersionID= 88cef3c2-8ca6-41f2-9637-eb471dc21b13&coa=coa04&DT=Opinion&MediaID=d5ce49aa-44b2-4042-98fb-faac1ea3cd53.

discussed below. Second, currently groundwater is not metered in Texas; compulsory metering must be a part of responsible regulation.

Rising Pumping Costs – Both Positive and Negative Effects

In the event that regulatory restraints on pumping are relaxed to allow groundwater to help alleviate the impending future water shortage, the costs of extracting groundwater will rise. As pumps are lowered in wells to allow for greater use of groundwater, water will be pumped from greater depths and lifting costs will no doubt rise. Rising pumping costs can have both positive as well as negative effects, and the winners and the losers are likely to be different.

Negative Effects of Increased Pumping and need for Mitigation

Whereas rising costs slow growth in consumption and promote conservation, there are losers as well. As time progresses and more pumpers enter the market, and TERS is drawn further down, pumpers will find it necessary to lower their pumps. This will increase their pumping costs. Rising costs in most cases will be reasonable and manageable.[20] However, in other cases it may not be simply a case of pumpers needing to lower the pumps in their well.[21] Figure 3 describes a steeply down-dipping aquifer experiencing a 5% reduction in TERS over a 50 year period. This causes the water level to drop from the blue line to the red line. Farmer Smith must simply lower the pump in his well and pay the higher electricity cost of pumping from the red line.

But Farmer Jones' well is in the confined portion of the aquifer and his well becomes dry as the water level drops to the red line. Lowering the pump is not an option. Rather he could face significant mitigation costs by drilling a new well to a deeper aquifer, connecting to rural water supply, or finding some other water source.

20. At $.10/kwh electricity cost, every 100 feet of increased lift due to aquifer drawdown is estimated to cost $17.05/AF or $.06 per thousand gallons. Michael Thornhill, Feb. 16, 2016 email.

21. Some pumpers wells may go dry and lowering the pump is not an option, Figure 3 shows that shallow wells located in the up-dip confined portions of a strongly down-dipping aquifer may find their wells going dry entirely.

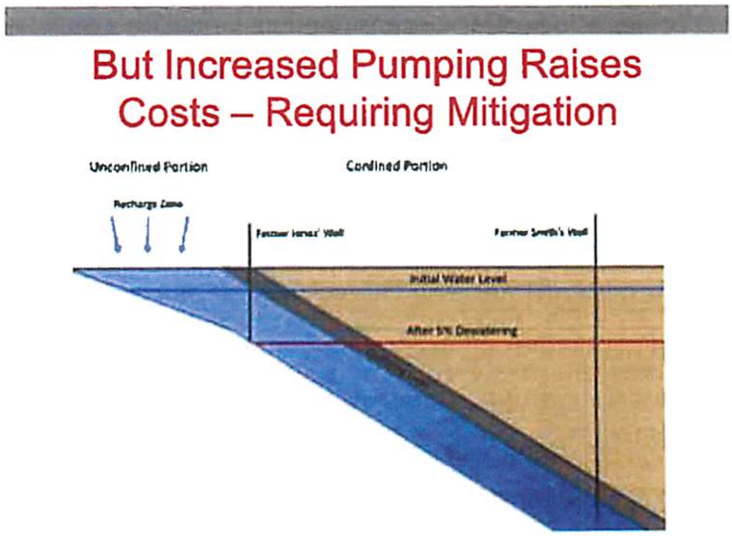

Figure 3 – Steeply Down Dip Aquifer

With this in mind, each of the proposed solutions incorporates a form of mitigation to alleviate injury to those like Farmer Jones who are severely impacted. Mitigation would involve some form of cost sharing for landowners severely impacted. These mitigation policies will be discussed in more depth in the policy proposals.

Positive Effects resulting in Increased Conservation

Now let us consider the positive effects of rising costs on the incentive to conserve. The price elasticity of demand for water can be used to estimate how much water could be conserved as a result of increasing water prices. The connection between the price of water and conservation can be illustrated by constructing a simple example. For this scenario, let us assume that initial consumption in year 0 is 100 AF and the price elasticity of demand for water is -0.5[22] Let us also assume that the initial water price is $100/AF. After adjusting for inflation, assume that its price increases by 3.5% per year over 20 years rising to $200/AF after 20 years. To put $100/AF into perspective for an average residential or agricultural user, this translates to 3/10 of a penny per gallon.

22. For an analysis of various elasticities that would justify the choice of - .5 price elasticity estimate, see Griffin, Ronald C. "Water Resource Economics." *The Analysis of Scarcity, Policies, and Projects* (2006).

Figure 4 shows the effect of the rising prices on consumption. Gradually rising prices in excess of inflation causes consumption to gradually decrease reaching 50 AF in year 20. The shaded area in Figure 4 shows the amount of water that would be saved due to the increasing price of water from $100/AF to $200/AF over the 20-year period. The shaded area in Figure 4 shows water savings of 500 AF of water. If instead the water price had not increased, consumption would have been 2,000 AF instead of 1500 AF. This calculation shows that price-induced conservation accounted for a 25% reduction in consumption. Keep in mind; this level of savings came from raising the price of water from 3/10 of a penny per gallon to just 6/10 of a penny per gallon over a 20-year period. This simple calculation shows that properly functioning water markets can be the friend of conservationists and help to provide a sustainable future. Therefore, rising costs can slow the future growth rate in consumption, thereby extending the life of the aquifer. An additional benefit is to landowners that benefit from selling water that would otherwise be prevented from selling water by existing GCD regulation.

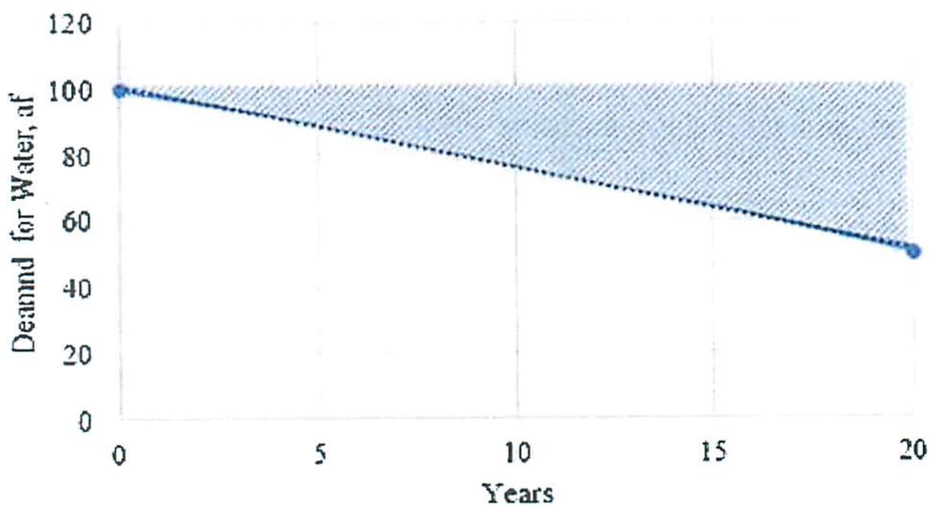

Figure 4 – Effect of Rising Prices on Water Consumption

Mandatory Metering - A Prerequisite to Prudent Aquifer Management

Another common feature of all proposals to improve regulation will be the need for mandatory metering for wells pumping from the major aquifers. This is a necessary measure if water is to be used efficiently in the future. Under the current system it is impossible for GCDs or the TWDB to obtain accurate numbers about water usage, particularly for agricultural users and exempt wells. Municipalities are the only users who report the quantity pumped. Beyond that, all the GCD has to go off of is an estimate based on the quantity of permitted pumping and maps showing irrigated areas. By adding mandatory metering the GCDs will be able to know the amount of water being pumped in their district and they will be able to enforce the permits of individual users, ensuring no individual is using more than their permitted amount.

Compared to the well cost and maintenance, the cost of these meters does not appear to be high;[23] they will be borne exclusively by the pumper. After installation water usage would be reported on an annual basis. The most effective way of doing this will be an electronic reporting system where pumpers submit their annual usage online. The relevant regulatory agency would have the authority to perform random spot checks to ensure pumpers are accurately reporting their usage. If a pumper is found to be making fraudulent reports they will be subject to severe enough fines to discourage under-reporting.

Four Policy Options to be Considered

The remainder of this report explores four quite different regulatory options without any **consideration of the political feasibility of these options. Too often, political feasibility or one's** perception of political feasibility completely dominates the policy choices. Policy makers then mistakenly choose among a restrictive set without ever asking the more fundamental questions. Instead we will explore a diverse set of options and propose criteria for their evaluation.

Policy Option One maintains the existing GCD structure but modifies the existing allocation system designed (1) to return water as a property right, (2) to end the threat of protracted takings lawsuit and (3) to replace the existing reverse-engineered determination of pumping rights with a simple formulaic approach.[24]

23. The costs of meters range from $600 to $2500 depending on diameter of discharge pipe and yearly maintenance is estimated at $200 per year. http://texas living waters.org/wpcontent/uploads/2013/04/water metering in texas.pdf.

24. Option One was written by Ross Brady, Wayne Beckermann, and Amber Capps.

Policy Option Two considers regionalization of aquifer authority. This option incorporates many of the key features of option one, but shifts regulatory authority away from the GCDs and places it at the aquifer level.[25] Therefore, these "aquifer authorities", would become the primary regulatory mechanism for the groundwater found within its confines.[26]

Policy Option Three explores the efficacy of a statewide regulatory agency as the central agency required to protect, conserve, and regulate groundwater use across the State of Texas. In this option, either a newly created agency or the TWDB could assume the role of preventing groundwater waste, protecting the correlative rights of landowners, and dealing with aquifer management issues.[27]

Policy Option Four proposes the creation of a groundwater bank account. The idea is that each landowner would have a bank account based on the water storage under his/her property and would have maximum flexibility to utilize it as he/she wishes.[28]

Four General Criteria for Evaluating these Policy Options

In order to guide policy makers, we developed four criteria for evaluating each of the above four policy options. In effect, a framework of analysis is needed and the four criteria we propose are as follows:

1. *Respect all landowners' property rights subject only to correlative rights.*
2. *Utilize water in its highest and best use.*
3. *Mitigation available for pumpers severely impacted by changes to the system.*
4. *Prudent aquifer management. Prudent aquifer management will seek a reasonable balance between current pumping and the needs of future generations.*

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25. Option Two was written by Peyton McGee and Kayla Northcut

26. This option was added to the original scope of the project in response to the suggestions of several persons experienced in this area.

27. Option three was written by Braden Kennedy and Shuting Shan

28. Option four was written by Mason Parish and Abdullilah Qadeer.

Note that criteria 1 is a legal criteria based upon existing groundwater law that clearly establishes groundwater as a private property right.[29] Criteria 2 is based on the economic principles of using the low cost resources first and allocating a resource to its highest and best use.[30] Criteria 3 is based on the value judgment that those substantially injured from increased pumping should receive partial mitigation. Criteria 4 is a subjective management criteria based in part on hydrology and economics to arrive at prudent aquifer management.[31]

[29] See Beckermann, op. cit., pp. 45-54.
[30] J. M. Griffin and H. B. Steele, *Energy Economics and Policy, 2nd Edition* (Orlando: Academic Press, 1986), Ch. 2.3.
[31] The term "safe yield" is also commonly used by water experts to mean that pumping rates fall within this threshold. This concept is akin to prudent aquifer management and can be interpreted interchangeably.

Policy Option One: Working Within the Existing GCD Structure

Basic Proposal

Local GCDs are primarily motivated by maintaining local control. The following proposal aims to work within the existing regulatory framework to continue this system of local governance. The following section will offer four foundational alterations, which will improve groundwater governance statewide, while still maintaining the same structure of local control through GCDs.

- The most necessary change within the current GCD system is for groundwater to be governed and managed unequivocally as a property right, respecting *all* property through a correlative rights system.
- As noted in the introduction, mandatory metering will be a necessity.
- Permits shall be issued irrespective of use.
- GCDs should implement a uniform and nondiscriminatory fee structure, which will support mitigation funds to protect affected pumpers.
- By returning groundwater to its appropriate property right status, a market will emerge allowing water to go to its highest and best use.

How it Would Work

The proposed system presents several advantages compared to the current system. Fundamentally, the benefit of these alterations is a re-emphasis of groundwater as a property right, using many of the features of the Post Oak Savannah GCD (POSGCD). Restoring groundwater to its property right status, to be determined by the pumper rather than the GCD, is essential to allow every pumper an "equal chance for a fair share". The property right management strategy will increase the entrepreneurial nature of water, as pumpers will be free to use their water for whatever purpose they deem best.

These changes can be achieved through a simple modification of the existing use of MAGs. As shown subsequently, the best method of regulating pumping is on an acre-foot per surface-acre basis with proportional cutbacks when necessary. Having a common system in which all pumpers understand the rules will greatly increase both the fairness and certainty of the system. In the six confined aquifers the process of arriving at each pumper's groundwater allocation can be demonstrated by the following two formulas which take into account the aquifer's recharge, recoverable storage, and the number of surface acres overlying the aquifer. Due to hydrological and regulatory differences, the unconfined Ogallala and Hueco-Mesilla Aquifers will require a different formula and the Edwards Balcones Fault Zone is regulated separately by the Edwards Aquifer Authority. Thus, what follows is primarily directed towards the six major confined aquifers.

First, in Step 1, the local GCD would calculate its MAG as follows:

MAG= 0.1% TERS + Annual Precipitation Recharge[32]

In step 2, the GCD computes the number of permitted acres.

In step 3, the correlative factor (c) is calculated by computing the lesser of two numbers: 2 AF/SA or MAG/ Permitted Acres as follows:

C = Lesser of (2 AF/SA or MAG/Permitted Acres)

In step 4, individual landowners who have applied for pumping permits for their permitted acres would receive an allocation for the following year by simply multiplying the correlative factor C by their surface acres as follows:

Individual Pumping Limit = C x Individual's permitted surface acres

To illustrate graphically how this would work, Figure 5 shows a hypothetical case of a GCD with a MAG equal to 600,000 AF, with .1% TERS of 550,000 AF and 50,000 AF of precipitation recharge. The blue line shows that in year zero, only 100,000 acres were permitted. Even though the ratio of MAG to surface acres is 6 AF/SA, by step 3 the correlative factor would be the lesser of 2 AF/SA and 6 AF/SA. Thus pumpers would be restricted to 2 AF/SA. Thus 200,000 AF would

32. Note that recharge would only include the precipitation recharge entering the aquifer within that particular GCD.

be pumped along the red line in Figure 5. The graph assumes that with landowners being free to apply for additional permitted acres, the number of permitted acres increases every 10 years by 100,000 acres reaching 600,000 after 50 years. Note that the correlative factor is two for the first 20 years. After that, as new permits continue to grow, the correlative factor declines to 1.5 AF/SA in year 30 and ultimately to 1.0 AF/SA after 50 years. All pumpers are forced to cut back proportionally. With all pumpers sharing proportionally, GCDs avoid the political pressures of choosing among alternative user categories.

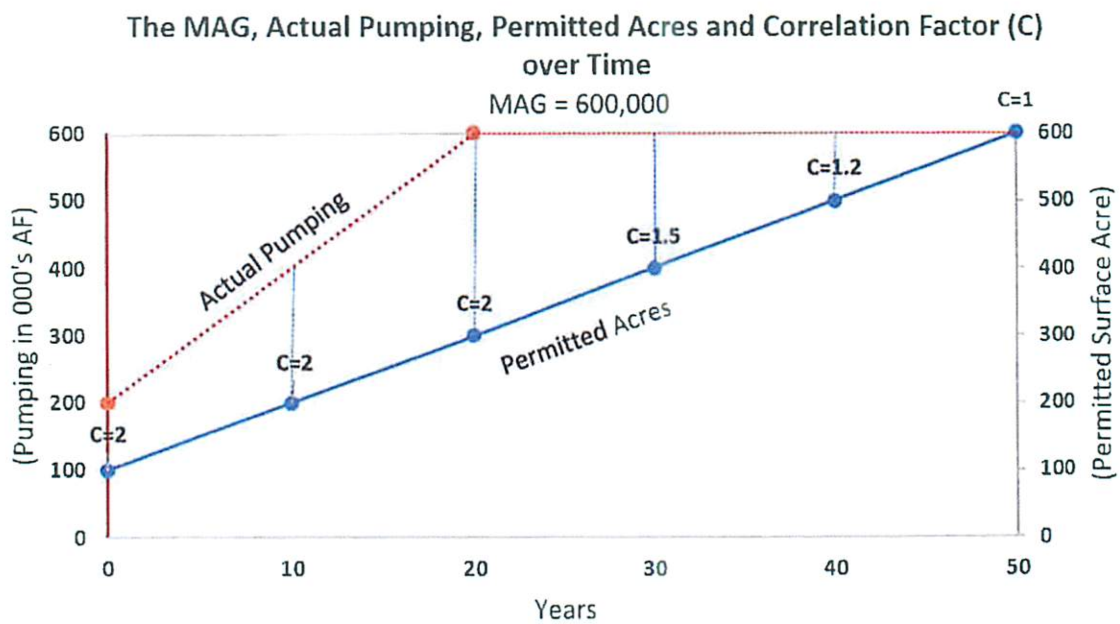

Figure 5: An illustration of How the Process would Work

MAG Calculation

The simple elegance of basing the MAG on the sum of .1% of TERS plus estimated annual precipitation recharge deserves considerable discussion because it represents a radical departure from existing methods. Few could argue with the importance of including precipitation recharge into the MAG calculations, the question is why use TERS and why .1% of TERS? The alternative of never drawing down any of TERS violates the economic principle of utilizing the low cost water resources first and giving time for technology to bring down the cost of brackish and other water sources. As shown in Table 1, Texas is blessed with six major confined aquifers which can provide water for many years. So the question is not whether to dip into TERS but rather how much and how fast.

We have conservatively used .1% of TERS in determining the MAG formula because .1% per year results in a *5% drawdown in TERS over 50 years*. As noted in the introduction, TERS is normally reported by the TWDB at 25% and 75% of TERS to reflect the practicality of recovery. As an aquifer is de-watered, pumping costs will increase more or less linearly as the water must be pumped from greater depths. However, at some threshold costs rise exponentially as more infill wells must be drilled to recover equivalent amounts of water. While this point of exponentially rising costs will vary between aquifers, this point is likely to be far in excess of 5% TERS.[33] Thus taking 5% of TERS over 50 years or equivalently, .1% TERS, is both prudent and conservative. Yet another factor to suggest that this approach is conservative is that by capping the correlative factor at 2 AF/SA, the permitted average is not likely to lead to actual pumping at the MAG rate. In Figure 5, pumping did not reach the MAG until year 20.

Correlative Factor

Our initial calculations for various GCDs show that the MAG divided by existing permitted acres substantially exceeds 2 AF/SA as in Figure 3. Therefore, initially in these GCDs, the correlative factor would be set at 2 AF/SA. An important feature of this system is that new permits based on surface acres would be issued without discrimination and irrespective of use. Thus, in the future, it is possible that when permitted acres exceed half of the MAG, the correlative factor would fall below 2. In this case, all landowners would cut back proportionally below 2 AF/SA as shown in Figure 5.

In most GCDs, east of I-35 the current number of acre feet being pumped is substantially less than the proposed MAG shown in Step 1. For example, Table 2 shows the Neches Trinity GCD, which covers the northern end of the Carrizo-Wilcox Aquifer, would have a MAG of 454,758 acre feet. With approximately 10,822 permitted acres the Neches Trinity GCD would then have an allowable

33. Informal conversations with hydrologists lead us to believe 5% TERS is well within the safety margin.

pumpage allocation of 42 acre-feet per surface acre. Even towards the southern end of the Carrizo-Wilcox Aquifer, the same holds true. By our formula, the Evergreen GCD has a potential pumpage of 560,850 acre feet with only about 93,060 permitted acres.[34] While, this would result in an allocation of six AF/SA, such an allowance would be far in excess of what is used for irrigation. Prudent aquifer management suggests a maximum allocation of 2 AF/SA. This cap, which is currently used in the POSGCD, will be useful by creating an element of certainty in the market. It ensures that new pumpers will be able to enter the market without lowering the allocations of existing pumpers for a considerable number of years. When so many new pumpers have entered the market that the allocation is driven below two acre feet per surface acre, the new allocation would be determined by the aforementioned formula with all pumpers sharing alike.

Furthermore, this system will include the ability to hold pumpers accountable through compulsory metering. Any allocation system without this feature is a paper tiger at best. Once a pumper has been given an allocation based strictly on the size of their property, then the GCD can begin to monitor actual pumping compared to allowed pumping. Fines for the first infractions and pumping limitations for further infractions represent possible tools for GCDs to use in response to pumpers who exceed their allocation. Compulsory metering, while somewhat costly and complex, will ensure every pumper operates honestly and fairly.

Fee Structure & Mitigation Fund

Table 4 illustrates a fee structures based on permit applications and permit use, each applicant would pay a one-time fee of $10 per surface acre associated with filing a permit, and then once approved, there would be a $3 annual fee associated with each acre-foot of groundwater pumped. Of the $3 usage fee, $2/AF would go to administration and $1/AF would go to mitigation. These fees are based on two key ideas. First, the initial application fee will be a one-time payment going towards a mitigation fund because it is new users entering the market who contribute to the need for mitigation through the further depletion of the aquifer. Secondly, the usage fee provides an inherent incentive to conserve groundwater because those who pump less water will be charged less in GCD fees. Note that as the amount of permitted acres increases each year in Table 4 by

34. Note that permitted acres are not normally reported to the GCDs. Based on rates for irrigation of 2 AF/SA, we estimated permitted acres. In reality, actual permitted acres if known would be even less.

100 acres, the mitigation fund rises over time to cover potential future issues. Fee structures based solely on permit applications and utilization are concepts inspired by current governance of the POSGCD. The same GCD also manages groundwater somewhat as a property right, although the GCD currently continues to treat agricultural and exempt well users uniquely. The premise is to clarify and expand POSGCD's practices by treating all pumpers equally and requiring GCDs statewide to adopt such practices.

Time Period	Permitted Acres	Application fee = $10/SA	Usage Fee = $3/AF	Allocation To Administrative Fund = $2/AF	Allocation to Mitigation Fund = $1/AF	Cumulative Mitigation Fund
Year 1	100	$1,000	$300	$200	$100	$1,100
Year 2	200	$1,000	$600	$400	$200	$2,300
Year 3	300	$1,000	$900	$600	$300	$3,600
Year 4	400	$1,000	$1,200	$800	$400	$5,000
Year 5	500	$1,000	$1,500	$1,000	$500	$6,500
Year 6	600	$1,000	$1,800	$1,200	$600	$8,100
Year 7	700	$1,000	$2,100	$1,400	$700	$9,800
Year 8	800	$1,000	$2,400	$1,600	$800	$11,600
Year 9	900	$1,000	$2,700	$1,800	$900	$13,500
Year 10	1000	$1,000	$3,000	$2,000	$1000	$15,500

Table 4 - Fee Structure Example

Creation of water markets

Finally, by granting water permits in a nondiscriminatory fashion, a vibrant water market should emerge. By returning groundwater to its appropriate property right status, trade will occur naturally. Given the drastic differences in groundwater availability between the Panhandle, East

Texas, and South Texas, a market for trading and transporting groundwater seems likely. To this end, GCDs will be forbidden from prohibiting the exportation of water from a GCD.

Water markets could potentially flourish *within* GCDs. The GCD boards could in principle establish zones of transferability based on the transmissivity of the aquifer; thus, pumpers could trade their water rights *within* a GCD. This creates even more opportunities for trade. Interestingly, within the Edwards BFZ Aquifer where permits are predetermined, an active market for trading water permits exists. While the transmissivity of this aquifer lends itself to such trading, it would seem possible on a smaller scale within zones in other aquifers regulated by GCDs.

Positive Attributes

Fairness, Certainty, and Transparency

The process of arriving at a MAG under this policy proposal is different from the current system, which often relies on the reverse engineered DFC and MAG process designed to limit pumping and protect incumbent stakeholders. The revised system will allow GCDs to determine their MAG, in a transparent manner, based on readily available data from the TWDB. Furthermore, with a uniform fee structure, GCDs will no longer be able to discriminate based on groundwater use and to protect historical pumpers. Once each pumper's allocation has been set, the GCDs will act as an enforcer of the policy, ensuring no pumper exceeds their allocation. Fines and other deterrents can be issued in order to maintain the new system's integrity. Pumpers must know GCDs are vigilant and empowered.

The formula-based allocation system will also ensure each landowner has an equal chance at a fair share. This has not occurred under the current system which has resulted in preferential treatment given to historic users, irrigators, and municipalities. These disparities would not exist under the proposed allocation system.

Mitigation Funds

While the existing system will have many winners there will also be losers. As shown in Table 4, funds will accumulate in a mitigation fund which while not needed today would become important with long-term increased pumping. This fund will assist pumpers who are no longer able to pump a previously possible quantity as a result of decreased artesian head or a lowered water table. In such a case, the injured pumper could apply to their GCD for assistance. Our thought would be that it would work like an insurance policy with for example a $1500 deductible and a 25% co-pay. Maintaining a socially equitable system is of the utmost importance, especially because of the amount pumpers vary in their habits and uses. As discussed in Figure 4, shallow wells in the confined portion of a steeply down-dipping aquifer could find their well running dry. While this option creates large gains to landowners generally by making their water more valuable, it is important to provide mitigation funds for individuals like Farmer Jones in Figure 4.

Dealing with the Issues:

No solution is without problems; yet, with proper planning many problems may be minimized or prevented altogether. The following section attempts to anticipate problems the previously mentioned policy may create, and offer solutions to the issues.

If the suggested system alterations were to be implemented in the early years there may be some confusion and unwillingness to change. Additionally, GCDs may continue experiencing pressure to allow exemptions for certain users by ignoring meter readings for said users or even misreporting readings. In order to avoid both of these problems, it will be important for the TWDB to closely monitor actions of GCDs during the first five to ten years of the new system's implementation. For minor violations of the policy or for first offences, the GCD should be warned of their infraction and given time to make corrections. If a GCD continues to resist the new policy, or they engage in severe mismanagement, the Board of the GCD should be removed and a special election held to replace them.

Even though as a property right it is each pumper's prerogative to decide if they wish to trade or not, most resistance seems to come from the inaccurate belief there is a shortage of water in the state. As the data in Table 1 of this report reveals, Texas has relatively abundant groundwater resources, particularly in the most populous parts of the state. Therefore, to combat this misconception, this policy should involve a program of adult and youth education. Adult education could be primarily handled through agencies such as the Agricultural Extension Service and the

Natural Resource Conservation Service. Youth education could be conducted through local 4-H and FFA programs.

A third possible difficulty with this policy is the inability of GCDs to address mitigation and discrimination through equitable application of uniform usage fees. To prevent this problem, these fees might be legislatively set within brackets stating the upper and lower bound a GCD could charge.

The final problem we have identified is the areas of the state which are currently ungoverned by a GCD, known as "white areas." In these regions, the rule of capture continues to prevail. These areas do not account for a large portion of water use, yet nevertheless to ensure each landowner truly has an equal and fair share of groundwater they must be brought under some form of governance. Therefore, as the state transitions to this revised GCD system these areas would need to be either absorbed into existing nearby GCDs or would need to form their own. Once this policy is adopted these areas could be allowed one year to form their own GCD. If they have not done so by the conclusion of that period they would be absorbed by the surrounding GCDs.

Unintended Consequences

By its nature, unintended consequences often turn out to be unpredictable and have dire effects. A potential circumstance could arise in the proposed system if after 30, 40, or 50 years of pumping based on the calculated MAG, some unanticipated negative aquifer impacts occur. In this situation, mitigation costs will rise sharply as the winners would no longer be able to compensate the losers. In such an event, the GCD would have two options. First, it could raise the mitigation fees which would discourage pumping for the aquifer. Another option, when the impacts were localized as with subsidence areas, the GCDs could prescribe for those areas a lower percent of TERS, thereby reducing the MAG, forcing users in that particular area to be subject to a lower correlative factor and lower pumping rates. Even though these situations are difficult to predict, the formula approach laid out above retains enough flexibility to deal with a variety of unforeseen events.

Policy Option Two: Aquifer Wide Management

Basic Proposal

The policy alternative discussed in the following section focuses on a regionalized approach to regulation based on the actual aquifer configurations of the nine major aquifers.[35] This proposal is designed to move regulatory authority away from the GCD level and place it at the aquifer level. These aquifer authorities, therefore, would become the primary regulatory apparatus for the groundwater within its confines. Several key features comprise this proposal. Under this option:

- Eight aquifer authorities would exist: one for each major aquifer in Texas.[36]
- Within each aquifer authority would exist sub-aquifer regions established to reconcile the hydrological variation that may exist within an aquifer.[37]
- Each aquifer authority will also maintain either a supervisory or administrative (or both) relationship with those minor aquifers that interact closely with each respective major aquifer.

Each authority will establish one central board that would act as the aquifer's seat of power. The board would retain seven members —three members appointed by the governor and the remaining four elected by the County Commissioners affected by each respective aquifer. To allow for regional representation, each aquifer would be divided into four districts with the County Commissioners from those four regions electing their own directors. Like Option 1, the aquifer authority would regulate on the basis of acre foot/surface acre (AF/SA) to assure all property rights are protected. This system of regionalization would offer open access to permits

35 This option was added to the original work plan based on the suggestion of several knowledgeable individuals who thought this option should at least be considered.

36. Nine major aquifers exist in Texas; however, the Edwards Aquifer Authority (EAA), which manages the Edwards Balcones Fault Zone Aquifer, is federally established and will remain unchanged under this policy proposal.

37. The Carrizo-Wilcox is a major aquifer that geologically varies greatly within itself, and therefore, has four different sub-aquifer regions to deal with this variance. Accounting for variance, like that found in the Carrizo-Wilcox, should lead to efficient and effective management of each major aquifer.

and proportional sharing on an AF/SA basis, while also encouraging the development of water markets to ensure water is used at its highest and best use.

- Aquifer authorities would have the authority to utilize hydrological science to assure prudent aquifer management, and be able to set fee structures in a nondiscriminatory fashion.

How it Would Work

Operational Responsibilities

Because primary authority of groundwater management rests with the central board of the aquifer authority, there would be minimal oversight from the TWDB in this system. In concordance with this facet of the policy, MAGs would no longer involve TWDB approval. Even within the aquifer authority, there would be one MAG for each sub-aquifer region. Again, sub-aquifer regions are created to account for the geological differences within an aquifer. So, mandating a MAG for each sub-aquifer region, based on the MAG formula discussed in Policy Option One, would provide the board with a more realistic understanding of what is going on within the aquifer at each area of geological uniqueness.[38] Each MAG would be based on the following formula:

$$\text{MAG} = .1\%\ of\ TERS\ of\ aquifer\ subregions + aquifer\ subregion\ annual\ recharge.$$

Likewise as in Option 1, individual pumping rights would be determined on an AF/SA basis using the correlative factor (C). Individual pumping rates would be determined by multiplying

38. Note that this MAG formula differs slightly from the MAG prescribed in Policy Option One in that .1% of TERS would cover the whole aquifer sub-region, and not just that of the GCD. Particularly important is that this formula would use aquifer sub-region recharge, which from a hydrological perspective is preferred for its precision over just the precipitation recharge captured by a particular GCD.

the correlative factor times the individual's permitted acres., where C, the correlative factor, would be calculated as follows: C= minimum of [2 AF/SA or $\frac{MAG}{Permitted\ Acres}$]

Just as the MAG would be managed at the aquifer authority level, minor aquifers could be managed at this level as well. Minor aquifers may not require regulation due to their small size, but for minor aquifers located primarily within the major aquifer, the aquifer authority could exercise regulatory power at its discretion. Nonetheless, whether the aquifer authority board votes to manage a minor aquifer or not, for the sake of transparency of resources there would need to be some form of representation from the minor aquifer within the aquifer authority.[39]

In addition to MAG creation, each aquifer authority would be responsible to ensure some local monitoring of metering, well conditions, and test-well conditions. Monitoring of test-well conditions are especially important in the unconfined regions of aquifers because these unconfined areas most accurately depict how fast the aquifer is depleting.

Offices located within each district of the aquifer would monitor local metering for compliance and also observe test-well conditions. In this way, these management groups are the enforcement mechanism at the local level for the aquifer authority.

Fee Structure and Groundwater Export

Under this policy alternative, the board of each aquifer authority can establish its own fee structure —with one major stipulation. The fee must be uniform across the jurisdiction. In addition to keeping the fee structure consistent across each aquifer authority, water utilized by municipalities and agriculture should be equally charged. One type of fee that is common under

39. For example, the Blaine (minor) Aquifer is in close proximity to the Seymour (major) Aquifer. Yet, the Blaine Aquifer does not yield much water. In this case, the Seymour Aquifer Authority may choose not to regulate the Blaine's groundwater resources due to the low yield; however, the Seymour Aquifer Authority could hire an employee that specifically works to understand how much groundwater is in the Blaine and where it goes to maintain total transparency of Texas' groundwater resources.

the current GCD system that would not be allowed under this policy alternative is any fee that discriminates against water export outside of jurisdictional boundaries. As previously discussed,[40] any limits on trade diminish economic efficiency and total societal benefits.

It is also important to note that like in Option One, each aquifer authority would have a mitigation fund. The mitigation fund of an aquifer authority is used to cover costs of some pumpers potentially losing access to water due to aquifer depletion.[41] The fee structure of the mitigation fund would include principles of cost sharing – similar to those in Policy Option One. The mitigation fund, as outlined in Policy Option One, would compensate those severely impacted with the affected party paying the first $1500 deductible and a 25% co-pay on additional expenses.

Water Allocation

As noted above, under this alternative, water would be allocated on an AF/SA per year basis with proportional sharing. The key to water use in this alternative is that producers will be able to consolidate pumping for all allocated water use on contiguous acres onto a single well as long as two conditions are met that will prevent impact on neighboring producers' wells or land:

1. Wells must be spaced so that the cone of depression will have minimal impact on neighboring wells
2. Wells must not cause substantial land subsidence

Each sub-aquifer region's management group would be responsible for making sure the above conditions are met and determining spacing requirements and pumping rates to prevent negative impacts on neighboring wells.

Differential Correlative Factors

40. Beckermann et al, op.cit., pp. 55-61.

41. This may include aquifer activities such as water export (internal or external the aquifer), which could result in a well going dry. The authority's mitigation fund would help cover expenses like this on the behalf of the individual landowner.

Keeping in mind that groundwater production will impact sub-aquifer regions in different ways, there will be separate per acre water allocations for each sub-aquifer region. The following scenario will be used to provide clarity. Producer A has 450 contiguous acres of land with 300 acres over sub-aquifer region A, 50 acres over sub-aquifer region B, and 100 acres over sub-aquifer region C. Assume that the aquifer authority, in collaboration with the sub-aquifer region management groups, determines that sub-aquifer region A producers may produce 1 AF/acre, sub-aquifer region B producers may produce 2 AF/acre, and sub-aquifer region C producers may produce .5 AF/acre. Assuming Producer A can meet the two conditions listed above, she can consolidate pumping into a minimum of three wells, one for each sub-aquifer region. The well tapping into sub-aquifer region A will produce a maximum of 300 AF/year (300 acres x 1 AF/acre), the well over sub-aquifer region B will produce a maximum of 100 AF/year (50 acres of land x 2 AF/acre), and the well over sub-aquifer region C will produce a maximum of 50 AF/year (100 acres x .5 AF/acre) for a total of 450 AF per year. Under this option, municipalities may be presented with an extra challenge. Because some cities have wells outside of the city limits on small plots of land, municipalities may be required to lease the acreage surrounding their wells to receive the amount of water necessary to sustain itself.

Positive Attributes

In comparison with the current system, there are several positive attributes regionalized aquifer authorities offer to existing groundwater management practices in Texas. This method of groundwater management, using AF/SA and uniform fees, offers both benefits of certainty and elements of fairness. Regionalization will provide a reasonable amount of certainty that would allow long-term development of the aquifer based on the formula of water allocation discussed above. This formula will allow people to know how much water they actually have to utilize on a long-term basis.

Additionally, this system would reconcile the differences amongst adjacent GCDs and reduce the balkanization that often occurs amongst the GCDs. With authority concentrated at the aquifer level, aquifer authorities would be forced to make decisions for the good of every citizen that comes into contact with the aquifer, not just for those who reside in a certain jurisdiction within the aquifer, and only care to protect certain stakeholders in that jurisdiction. Instances such as this are often the source of management gridlock under the current system. Basing rules on hydrology, as opposed to political pressure, would also alleviate many of the previous differences amongst neighboring GCDs.

Dealing with the Issues

Under this alternative, there will be less local bureaucratic control than exists under the GCD system. However, because county commissioners will be in charge of electing district representatives in the aquifer, there will still be a mechanism for local constituents. Additionally, there may be cities that will not have access to the same amount of water under the new system that will need to acquire water rights in order to meet their needs. This will not be such a strenuous process, as it is today, because attempts to limit water export will no longer be allowed. Exporting decisions will be made by individual landowners, and no longer for the good of one GCD and its primary stakeholders. Through this acquisition process, nearby cities adjacent to GCDs can end up with access to more water than is possible to acquire under the existing system. Furthermore, landowners can benefit by selling their water subject to the limitations of correlative rights.

Unintended Consequences

Possible unintended consequences of this alternative are similar to Policy Option One. For example, the potential for falsifying metering reports will always be present. Still, enforcing strict fines and penalties and spot-checking has the potential to keep this type of mis-behavior under control. However, with authority further removed from the local level, monitoring may be less effective. It is also possible in the process of allowing increased pumping may cause any number of landowners' artesian head to drop on their well. However, the mitigation fund should be able to shoulder these costs, making it the responsibility of the aquifer to determine how to reconcile this type of consequence. With any system, there may arise unintended impacts on the aquifer and subsidence. Having authority rest at the aquifer level seems likely to offer more flexibility in responding to such conditions. Since hydrology models are adopted to each sub-aquifer region, this structure seems likely to provide more science-based decisions and be better able to deal with such unforeseen conditions.

Policy Option Three: Statewide Regulation

Basic Proposal

In an attempt to solve many of the inefficiencies found in the current GCD system, a Statewide Groundwater Agency (SGA) would be created to regulate Texas groundwater. This idea has been proposed by a number of persons knowledgeable about groundwater and is motivated by the success the Texas Railroad Commission has had in regulating oil and natural gas production. Note that the SGA could be a newly created agency, or, the TWDB could simply be granted additional responsibilities.

- The SGA would have authorization to protect, conserve, and regulate groundwater use across the state of Texas.
- The SGA would perform a statutory role of preventing the waste of groundwater, protecting correlative rights of property owners, prudent management of Texas aquifers, and ensuring the safety of pumping.
- The SGA would create sixteen district offices across the state to handle the metering of well production, overseeing monitoring wells, and enhancing the communication between individual pumpers and the SGA.

How It Would Work

The Texas Legislature would delegate groundwater regulation authority to the SGA. The SGA would:

- Be managed by three board members serving six year terms and elected in alternating, two-year statewide elections;
- Create sixteen district offices along current Groundwater Management Areas (GMA), which would:
    - Collect mandatory metering reports from users within the district
    - Oversee monitoring wells
    - Serve as the first point of contact by local pumpers and citizens

- Provide in-house hydrological experts who monitor and study aquifers and create sound, scientifically-based regulations;
- Issue well permits based on:
    - Well spacing
    - Amount of land owned
    - Aquifer conditions
    - Hydrological makeup
    - Safety of pumping
- Set a uniform, non-discriminatory fee structure
- Encourage the development of a water market

Positive Attributes

There are several positive attributes that come from having the groundwater regulatory apparatus centralized at the state level in comparison to the existing system, which focuses on local authority.

Encouraging the creation of water markets

This system would allow for the creation of a statewide water market, which, in turn, would ensure water is put to its highest and best use. Because groundwater would be viewed from the state level instead of from the lens of rigid district lines, the SGA would be able to identify both areas of abundance and areas of scarcity in order to encourage trade between the regions. Additionally the state would have the ability to regulate areas of need and areas of abundance, differently. For example, in areas of abundance, the state could encourage groundwater use and exportation. In areas of scarcity, the state could impose more stringent regulations to prolong the life of the aquifer and encourage water imports.

Making statewide regulations

Under the current system, some areas of the state remain unregulated because GCDs have not yet been established. These "white spaces" operate under the rules of capture. GCDs have not been established in many of these areas due to the hindrance of local politics designed to protect small groups of stakeholders. Even in GCDs, local politics have played a role in setting rules, regulations, and fee structures. Having a statewide agency would take local politics out of the decision-making process and allow for a more fair, uniform, and transparent system.

Creating 16 local district offices

The SGA would be able to create district offices across the state. These districts offices would align with the TWDB's GMA breakdown, which is based on sub-aquifer regions. These 16 offices would be the first point of contact at the SGA and would handle local issues. Also, these offices would collect self-metering reports from all of the groundwater users in the district while occasionally spot checking wells for compliance. Each respective district office would also oversee monitoring wells installed within the district. Monitoring wells would allow hydrologists to study what is occurring underground in areas where more information is needed; the district offices would simply check on the wells four times a year and report back to Austin.

Financial strength of the SGA

The SGA would not be as financially limited as many GCDs are today. Along with the allocation of funds from the State, fees collected from permit sales would allow the SGA to mitigate landowner losses and finance the new administrative costs. In the current system, landowners have experienced harm from excessive pumping by their neighbors and they are not being compensated. It is important that the SGA is capable of mitigating landowners substantially harmed by the pumpage of others.

One way to address this issue is creating a policy where the state pays for 75% of any cost over $1,500 incurred due to the decrease in water levels. The biggest threat to landowners is the cost of lowering the pumps to the dropped water table. Often, landowners can do this for under $1,500. However, when there are large decreases in the water levels due to a massive cone of depression or if wells go completely dry, landowners would be facing large damage costs. At this point, the state can step in, using the fees it collects, to subsidize 75% of these costs in excess of the initial $1,500 deductible.

Additionally, many GCDs struggle to pay the bill for lawsuits that occasionally arise. A state agency, which operates on a much larger scale, will be more capable to fight litigation because of its greater resources. When the Texas Railroad Commission moved to state regulation of oil and natural gas in the 1930's, litigation initially increased in an attempt to avoid any limits on pumping. It is likely that litigation would actually decrease because the SGA could use correlative rights and scientifically-based regulations in determining pumping rates. When lawsuits do arise, a statewide agency would be better equipped to finance these cases.

In-house hydrological expertise

A great advantage of this system is the capability the SGA would have to house a large group of water professionals and hydrologists. These specialists would be able to work together to provide better management based on the collected data from metering reports and monitoring wells. This provides substantial opportunities to conduct comprehensive studies on all aquifers to maintain viable aquifer conditions. Hence, the new data would provide a strong basis for setting scientifically based regulation. Additionally, having these hydrologic models available at one location and being subject to periodic refinement would in principle be a substantial improvement over the existing system.

Statewide regulation of brackish groundwater

The SGA would be able to create a different regulation system for the state's abundant supplies of brackish groundwater. Under present circumstances, desalinating brackish water is not economically efficient in areas with abundant fresh groundwater. While very small today, desalination is occurring in certain municipalities.[42] Furthermore, in the future it may well be necessary to use the state's large reserves of brackish groundwater. The SGA would seem particularly adapted to setting a reasonable timeline and regulation plan for the use of brackish groundwater.

Dealing with the Issues

Accurate metering reports are a key aspect to the SGA management system. Instances may arise where the landowners understate their pumping rates. This will lead to a series of problems for

42. Beckermann, op. cit., Appendix A.

groundwater management; for instance, the hydrologists could update their models using false data. This may be even a larger problem in this policy option than in policy options one and two because the SGA is even further removed from the individual pumpers.

Next, GCDs were established to maintain local control over groundwater. Creating a statewide system to manage groundwater is in direct conflict with the rationale for local control and GCDs. It should be pointed out that there was initially great opposition to the Texas Railroad Commission regulation of oil and gas; today it works reasonably well. Local producers may complain about the price of oil and natural gas, but statewide regulation is not an issue.

Unintended consequences

Like local control by GCDs, statewide regulation will not be immune to "regulatory capture" by special interest groups.[43] The SGA would face strong presences from a variety of interest groups such as water marketers seeking a return to rule of capture, environmental groups seeking minimal pumping, and local NIMBY (Not In My Back Yard) groups that are not opposed to pumping and economic development as long as it is not in their area. The possibility of regulatory capture by any one of these groups cannot be discounted nor predicted.

43. George Stigler, "The Theory of Economic Regulation", *Bell Journal of Economics*, 2, 1971, pp.3-21.

Policy Option Four: A Groundwater Bank Account System

Basic Proposal

Texas has had a rich history of well-defined property rights, which has benefited the state's economic growth. Nonetheless, current policies regarding groundwater have left ownership of the resource largely undefined. Therefore, to define ownership and to ensure groundwater is utilized at its highest and most efficient use, a groundwater bank account framework is proposed. The idea of a groundwater bank account is not new. Variants thereof can be traced back to Nobel Laureate economist, Vernon Smith,[44] and have been recently applied in Australia by Michael Young.[45]

The fundamental characteristics of this policy option are as follows:

A groundwater account would be created for each landowner within a major aquifer. This account would allow the owner to buy, sell, or save his/her groundwater.

- Initially, each landowner's account would be allocated based on the water located directly beneath their property. Like a conventional bank account, water use would be debited and recharge would be credited with a running balance over time. However, a landowner can never pump more than their bank balance.
- In doing so, a water market would be created allowing users to pump water from their account, transfer it to a neighbor, save it for their grandchildren, or sell it to a nature conservancy.
- In transitioning from the existing system to this policy option, scarcity would develop as supply is limited and ownership is defined, fostering the right conditions for a water market to be born.

44. Vernon L. Smith, "Water Deeds: A Proposed Solution to the Water Valuation Problem," Arizona Review, Vol. 26, No. 1, 1977.

45. Young, M.D. 2015. "Unbundling Water Rights as a Means to Improve Water Markets in Australia's Southern Connected Murray Darling Basin." In *Use of Economic Instruments in Water Policy: Insights from International Experience,* edited by Manuel Lago, Jaroslav Mysiak, Carlos M. Gómez, Gonzalo Delacámara, and Alexandros Maziotis. London: Springer.

- Groundwater bank accounts create an incentive to keep water in the ground, since if you don't use it today, it is available for you in the future.

How it Would Work

Groundwater Bank Account Authority (GWBAA)

The GWBAA would serve as the regional authority responsible for the management of the aquifer through the groundwater bank account system. There will be a GWBAA for each of the eight major aquifers (excluding the Edwards Aquifer for legislative reasons) within the state. The GWBAA will be responsible for the creation and maintenance of an electronic banking system and for governing all GCDs located within the aquifer's geographic boundary. In addition, the GWBAA will be responsible for registering the initial allocation of water for a particular property, providing support to local GCDs, and ensuring the overall integrity of the aquifer.

Although the GWBAA will not directly perform functions like adding recharge credits, monitoring and recording water pumping activity, and recording the sales and purchase of water rights, it will provide direct governance over the GCDs who will be responsible for these tasks. Additionally, the GWBAA will be responsible for setting transaction fees collected by the local GCDs.

The Role of Groundwater Conservation Districts (GCDs)

The local GCDs seem ideally suited for the role of the local banker. Much like a regional bank with branch offices, the GWBAA will work with each GCD within their respective aquifer. The GWBAA will assist GCDs with overarching task like the creation of water registers and the initial water allocation. Tasks such as maintaining water accounts and transaction, applying recharge credits, and determining withdrawal impact radius will be enforced and managed through the local GCDs. Additionally, GCDs will be responsible for collecting the transaction fees and penalties for misreporting on water pumping. Currently, some areas within the state are not under the governance of a GCD. To ensure the proper management of the aquifer, these areas must either create a new GCD or be annexed into a pre-existing GCD.

Groundwater Bank Account Statement

The GWBAA will issue annual water statements, like the one below, to property owners in each aquifer showing balances at the end of the year. The statement will reflect groundwater activity recorded (deposits and withdrawals) for a particular property during the year.

Evergreen GCD

Groundwater Bank Account

EUWCD

Date:	January 1, 2029
Statement #	[100]
Customer ID:	[ABC12345]
Page 1 of	1

Bill To:

Property Name: Smith Farm
Individual Owner: Mr. Todd Smith
21779 Farm to Market 1774
Todd Mission, TX 77363
(979) 000 0001

Account Summary	
Previous Balance	3,000.00
Debit (AF)	3,200.00
Credit (AF)	200.00
Total Balance (AF)	**0**
As of Date	30-Dec-2028

Date	Description	Debit (AF)	Credit (AF)	Line Total (AF)
1-Jan-20	Opening Balance			3000
1-Jan-21	Yearly Pumpage (2020)	100	0	2900
1-Jan-22	Yearly Pumpage (2021)	150	0	2750
1-Jan-23	Yearly Pumpage (2022)	75	0	2675
1-Jan-24	Yearly Pumpage (2023)	80	0	2595
1-Jan-25	Yearly Pumpage (2024)	80	0	2515
1-Jan-25	Recharge Credits (2025 - 2030)		100	2615
1-Jan-26	Yearly Pumpage (2025)	75		2540
1-Jan-27	Water Rights Sold to Brown Farm (ID#123)	100		2440
1-May-27	Water Rights Procured from Jones Farm (ID#456)		100	2540
7-Jul-28	Water Rights Sold to Nature Conservancy	2540		0
			Account Current Balance	0

Figure 6- Groundwater Bank Account Statement Example

The above groundwater bank account statement provides a hypothetical example of water activity within a particular property in the Evergreen GCD. The statement lists all the completed water transactions by the "Smith Farm" account. The statement includes the initial opening balance (3,000 AF), yearly pumping, recharge credits, sales of ownership rights, purchases of ownership rights, and the current balance as of the issued date. The initial opening balance is the amount of water available in the account of the property owner as of January 1st, 2020 based on 5% of TERS for the square mile underlying his/her property. Yearly pumping is captured by adding the amount of pumped water in the debit section of the statement. The periodic recharge credits and procurement of water rights from Jones Farm is captured by crediting the account.

It is important to note that the transaction with Jones Farm is a unique situation only made possible by the parties' geographical proximity. In this case, Jones Farm happened to be within the transfer zone set by the GCD, allowing the transaction to take place. Selling of water rights to another owner, such as a nature conservancy, is captured by debiting the account on the 7th of July in 2022. This transaction represents Smith Farm's decision to sell his entire water balance to the nature conservancy, leaving the account balance at zero. The nature conservancy would then become the owner of Smith's water rights.

As illustrated above, an important characteristic of this system is its natural tendency to encourage conservation. Account owners who elect to deplete the water in their account will be forced to stop pumping, while account owners who save the resource will have water for the future. By clearly defining and enforcing groundwater ownership, conservation is incentivized as the consequences of pumping vary between each individual pumper.

Determining Initial Bank Balances

Currently, the TWDB maintains hydrological models that provide estimates of TERS on a one-square mile basis. Landowners located in that square mile would be allocated initial bank balances proportional to TERS. In this case, the thicker and more prolific the zone, the greater the quantity of water that will be allocated to the property. This approach differs from Option One which assumes the same AF allocation per SA and in effect assumes that all landowners have equal water saturation.

Transaction Fees

A transaction fee will be charged every time water is withdrawn from the aquifer. The magnitude of this fee will be directly tied to the amount of water pumped. No fees will be levied for transfers of ownership in order to incentivize trade. The revenue generated from these fees will be used to fund administrative needs, maintain hydrology models, and expenses for mitigation. To prevent fraud, spot checks will be conducted by the local GCDs on a regular basis. Misreporting of water pumping would result in hefty penalties and, if persistent, legal proceedings would be pursued against the property owner.

Aquifer Management Considerations

In order to assure prudent aquifer management, limiting aggregate pumping to 5% of TERS over a 50 year period is recommended. Thus the initial balance for a landowner would be equal to 5% of TERS underlying his/her property. Within that 50 year time period, the landowner would have freedom to allocate pumping at his/her discretion. At the conclusion of the 50-year period, the overall condition of the aquifer will be evaluated and an additional allocation based on some percentage of TERS would be credited to each bank account, based on aquifer conditions at that time. The water remaining from the initial allocation at the end of the 50-year period would remain in the bank account, creating an incentive for conservation.

Defining Water Transfer Zones

Another desired feature of the groundwater bank account system is the flexibility to transfer pumping rights between the bank accounts of nearby neighbors. The idea is that pumping could be maintained on Farmer Smith's property if he borrowed water from his neighbor, Farmer Jones. Smith's account would be credited and Jones' account would be debited. These types of transactions are desirable in aquifers with high transmissivity. The local GCD will be responsible for defining and enforcing water transfer zones. Basically, within a transfer zone, Farmer Jones could pump from his well using water that would have alternatively been pumped from Farmer Smith's well. Thus water would not require transportation from one pumper to another providing the two are located in the same transfer zone. To mitigate negative impacts to neighboring properties, GCDs would determine minimum well spacing and maximum pumping rates as well as transfer zones. In many cases, transfer zones will be extremely important as water users work to secure additional water permits to fill shortages in their consumption needs.

Recharge Credits

Periodically, bank accounts would receive credits for recharge. Based on data from the TWDB's hydrologic models, the GWBAA will determine aquifer wide recharge credits and allocate them in proportion to the original allocation of water placed in the account at the start of the 50 year period. On average, recharge credits would be issued every five years because the administrative costs of more frequent allocations would likely be prohibitive.

Strategy for Execution

To ensure the successful implementation of this policy, a pilot program will be conducted to better understand the potential impacts of the change. Best practices will be identified from this pilot program allowing for modification before releasing a statewide program in 2020.

Positive Attributes

Correlative Rights

The current system utilizes a blended approach to correlative rights — incorporating both high pumping rates historically obtained under the rule of capture and restraints on new pumpers through GCD regulations. Unfortunately, this system has resulted in unclear property rights, taking lawsuits, and a network of balkanized governing agencies. Under the groundwater bank account idea, the ownership of groundwater is clearly defined, resulting in greater incentives to conserve the resource. Furthermore, groundwater bank accounts would end the existing costly and wasteful takings lawsuits.

Highest and Best Use

By removing differentiated user fees, all uses of water are treated equally under the new system. The implementation of a water market allows for groundwater to be used for its highest and best use. In this system those willing to pay the highest price for water will be the recipient of the resource. This is in contrast to the previous system where certain water uses benefited from reduced fees, while others were eventually foreclosed from pumping. Under the groundwater bank account option, water is encouraged to follow the market, resulting in a more efficient use of the resource both today and in the future.

Mitigation

This policy solution ensures each user has fair access to their property right by determining the amount of water that may be pumped without causing neighboring wells to run dry due to cones of depression or subsidence. However, as aquifers are drawn down over time, there will be cases where wells do run dry. To provide assistance in these situations, the mitigation plan discussed in Option One would be applied; yet, in this policy option the GWBAA will provide oversight for all applications and the GCDs will ensure the execution of projects.

Prudent Management of the Aquifer

Implementation of this policy option provides for the overall prudent management of the aquifer due to the system's natural propensity to promote conservation. As discussed earlier, as the finite quantity of water owned by each property holder becomes clear, and as trade becomes more prevalent, conservation will naturally emerge as account holders manage the resource for future use. Additionally, conservationists interested in protecting the resource for the future will have the right to procure water rights and restrict them from being placed into production.

Dealing with the Issues

Those benefiting most from this policy option will be the property owners located in prolific water-bearing zones, conservationists, and existing producers with currently low pumping rates. First, the property owners located in a water-bearing zone, an area that is capable of transmitting water in ample quantity, will benefit from this system because ample supply will be reflected in their issued water balance. Second, conservationists will benefit because they can leave their water in the ground by not producing and can also procure rights from neighboring properties. Conservationists can continue adding water to their balance without worrying about it being withdrawn by other property owners. Lastly, existing property owners who are not maximizing their total water allocation will have that reflected in their water statement, which will allow them to trade their water rights with neighbors, sell it, or leave it in the ground for use at a later date.

Those who will suffer the greatest negative impacts from this policy include the property owners who are currently exceeding their water pumping limits, municipalities with service area comprising small groundwater allocations, and properties located in a non-prolific water-bearing zones. The properties currently exceeding their water allocation will have to procure additional water rights from property owners within the defined zone established by the local GCD. Without procuring additional water rights, the properties will not be able to produce water at their current rate. Furthermore, municipalities with a service area comprised of limited groundwater allocations will need to lease additional water rights from nearby landowners. Currently, these municipalities typically pump large quantities of water from small plots of land. Under this system, municipalities would incur additional costs as they work to secure enough groundwater to provide services to their residents. Similarly, properties located in non-prolific water-bearing zones will have a lower initial balance and will have to procure water rights within a defined zone to increase their water balance.

Unintended Consequences

In implementing a new policy, it is crucial to consider potential unintended consequences. An evaluation of this policy reveals three unintended consequences. The first unintended consequence arises when removing the differentiated user fee structures. By removing this structure, some parties will no longer benefit from discounted water prices. An increase in water cost for historically protected users, such as large irrigators, could decrease some operations' profitability and divert land to other uses. On the other hand, they could at least be able to sell their water for other uses. Additionally, the approach envisioned here houses all water, both fresh and brackish, in the same bank account. We believe that buyers and sellers of groundwater would take account of water quality differences. A possible complicating factor, however, would be whether pumping rates would affect the landowners on the margin between the fresh and brackish water zones. Finally, by setting bank accounts of 5% of TERS over 50 years provides both certainty and some important flexibility as one nears the end of 50 years and bank accounts would be re-adjusted. At this point, it will be important to be able to respond to unforeseen impacts.

Facilitating the Dialogue

In an effort to assist policy makers, each of the proposed policy options is graded against the four criteria deemed necessary to make meaningful improvements to the current system of groundwater regulation. These factors are: respecting the status of groundwater as a private property right, allowing water to serve its highest and best use, mitigating damages from rising costs of groundwater, and prudently managing each aquifer to ensure its continued existence. However, due to their structure, each policy option addresses the above criteria in a varying manner. Table 5 below provides a side-by-side comparison of each policy option with grades of equal weight given by the authors for all four policy options.

Protect all Property Rights

Each of the four policy options provides greater protection for property rights in comparison with the existing system. Under the current system, the ownership of groundwater is a subject of conflict as GCDs and individual property owners attempt to make decisions regarding the best use of the resource. Options One, Two, and Three clarify the ownership of groundwater by establishing a standard process that treats all applicants equally. Additionally, Option Four goes further in protecting property rights by allocating all groundwater proportionally to the amount of water located directly below their parcel of land. Due to these factors, Options One, Two, and Three all received a B+, while Option Four was awarded an A. The major differentiating factor between the first three options and Option Four is that this option assumes every person's groundwater is homogeneous. Overall, implementation of one of the four policy options would result in more clearly defined property rights, and in turn, increased economic development as owners of groundwater benefit from greater certainty.

Highest and Best Use

The authors concluded that utilization of water for its highest and best use is best facilitated under Policy Options Three and Four. The state-wide approach taken in Option Three allows for comprehensive management of the resource, while the market features of Option Four allow for economics to reallocate water to its most efficient use. Therefore, under both of these options, the transfer of the resource from water abundant areas to water scarce areas is made easier.

		Policy Options			
Evaluation Criteria	Existing Regulatory System with Local Control	Option One Modifying the Existing GCD Regulatory Process	Option Two Regional Aquifer-Specific Regulatory Agencies	Option Three Statewide Regulatory Agency	Option Four Groundwater Bank Accounts
Protect All Property Rights	D	B+	B+	B+	A
Allocate Water to Highest & Best Uses	D+	B	B+	A-	A-
Mitigation of Rising Costs	C-	B+	B	B-	B+
Prudent Aquifer Management	D	B	B+	A	B
Political Feasibility					

Table 5 - Grading the Existing System and the Four Policy Options

Options One and Two are graded marginally lower than Options Three and Four because as management of the resource is divided among multiple authorities in the state, the ability to utilize the resource for its highest and best use decreases with increased balkanization. However, in comparison to the existing system, each of these systems results in a much more effective framework to allow groundwater to be used for its highest and best use.

Mitigation

Under the current system there is no established policy to mitigate the loss if an individual pumper loses access to their groundwater due to increased pumping in the aquifer. However, this section was given a grade of C- rather than D because the discriminatory policies and arbitrarily set MAGs serve to preserve the quantity of water existing in the GCD, preventing the pumping of water which would necessitate mitigation. These discriminatory policies are however an inefficient system of resource preservation and can only loosely be considered mitigation.

All of the proposed policy options increase the availability of resources for mitigation. There is a clear downward slope from Policy Option One to Policy Option Three. This corresponds with the growing distance between the governing body of the groundwater and the governing body's constituents. With the continuation of the current GCD structure featured in Policy Option One the individuals would be fairly close to their government making it easy for them to communicate their needs should a loss of access to groundwater occur. These channels of communication narrow as the level of government controlling groundwater rises. Policy Option Four, which governs water through a bank account system uses the same mitigation structure as Policy Option One. Thus, Policy Options One and Policy Option Four received the same grade.

Prudent Management

Of the four policy options, the authors concluded that the statewide regulatory agency described in Policy Option Three, would most prudently manage the major aquifers of Texas. This is the result of the state's ability to take a big picture approach to aquifer management with the entire state hydrology and economy in mind. While Option Two has the advantage of managing aquifers as a whole, it did not score as high as Option Four because there may be some inter-aquifer relationships that are overlooked. Options One and Four fall around the same grade because aquifer-wide planning in these options seems likely to be more difficult. Finally, the current system received the lowest score because management decisions are primarily politically driven.

Key Takeaways

After evaluating the overall impact of each policy option, our group recognizes none of these policy options are perfect in every dimension. We realize that it is easy to point to the unintended consequences of the existing system, yet it is extremely difficult to anticipate those for the four alternatives. Nevertheless, we believe considerable improvements are possible with the four proposed policy options.

Political Feasibility

Although this analysis evaluated these policy options based on our four key criteria, we note that Table 5 leaves ungraded a fifth criteria—*political feasibility*. We are aware that evaluation of a change to regulatory policy is not complete without considering political feasibility. Our team elected to intentionally leave this section blank for several reasons. First, it is beyond the scope of our assignment. Second, we recognize that the feasibility of any option varies greatly with the ever changing political climate of the state and changing priorities of its citizenry.

By presenting the four policy options, our team hopes to simply initiate a dialogue among the key decision makers in the state regarding groundwater policy. In facilitating this dialogue, we would urge decision makers to first assign their own grades to the four criteria and four policy options in Table 5. After completing those steps, then proceed to fill in their assessment of political feasibility. Too often, we consider the latter before the former.

AFFIDAVIT OF ROBERT D. HARDEN, P.E.

STATE OF TEXAS)
)
COUNTY OF TRAVIS)

BEFORE ME, the undersigned authority, on this day personally appeared Robert D. Harden, who, being duly sworn by me, deposed and stated as follows:

1. My name is Robert D. Harden. I am over the age of 18 years, of sound mind, and capable of making this affidavit. The facts stated in this affidavit are within my personal knowledge and are true and correct.

2. I am Vice-President of R. W. Harden and Associates, Inc. (RWH&A). Our firm has been involved with groundwater planning, groundwater development, groundwater rights valuations, and regulatory development of Texas' groundwater resources for over 40 years. I received a Bachelor's of Science degree and a Master's of Science degree both from the University of Texas. My studies focused on water resources while earning each of these degrees. My work experience includes planning and designing groundwater supplies for municipalities, industry, private landowners, rural water supply corporations, and State governments. My experience also includes providing professional service to groundwater conservation districts regarding aquifer management criteria and development of rules and regulations. I have also provided assistance in the determination of groundwater availability for the State water planning process and developing regional groundwater models for the State of Texas. I am registered as a Professional Engineer in the State of Texas. **Exhibit 1 attached to my Affidavit** is my curriculum vitae.

3. I have 27 years of experience relating to Texas' groundwater resources including the Gulf Coast aquifer and other aquifers that possess similar hydrologic characteristics.

EXHIBIT K

Over the course of my career, I have participated in well design, construction administration, and groundwater supply development in the Gulf Coast aquifer and other aquifers with similar artesian pressure conditions. Since the 1970's, my firm has been involved in the planning, design, construction and performance monitoring of groundwater control systems for the surface mining industry. These groundwater control systems are designed for the purposeful reduction of artesian pressure to increase industrial safety. I have participated in the design and development of numerous groundwater models that simulate groundwater flow in aquifers that exhibit water table and artesian pressure conditions that are present in the Gulf Coast aquifer. I have identified the extents of common reservoirs to determine potential cumulative effects of production, which is a necessary consideration for proper design of groundwater supply systems, and I have identified the extents of effects of production within common reservoirs to delineate appropriate regulatory areas to manage and regulate such production. My firm has conducted extensive analyses of effects of the effects of production, impact investigation, and mitigation services on over 1,000 small, private water wells.

4. In my career, I have authored numerous papers and provided professional talks on a variety of topics relating to groundwater planning and regulatory policy. Some of the specific topics of my essays and talks include large groundwater rights transactions, how the progression of aquifer development towards sustainability works, how to restructure the groundwater management process in Texas, principles to observe for managing risk in life and water supplies, and scientific principles for regulation of brackish groundwater. Many of my papers have emphasized the importance of comprehensive aquifer-based management. Historically, one of the central premises of groundwater resource management is the common reservoir, or alternatively the aquifer subdivision, which has been defined in Texas since 1949.

5. I have provided professional services to clients regarding aquifer regulation, rules development, and groundwater management standards. My clients have included both private and public entities interested in producing groundwater or protecting private property interests. I have also provided professional services to regulatory agencies concerning development and implementation of groundwater regulatory programs.

6. **Exhibit 2 of this Affidavit** is a paper that Ridge Kaiser, P.E., former President of RWH&A presented to an American Institute of Hydrology Conference in 1995. Mr. Kaiser's paper describes the details of RWH&A's work on groundwater control systems in the surface mining industry. RWH&A is an industry leader in the planning, design, and monitoring of depressurization systems for the surface mining industry. For over 30 years, RWH&A has guided mining companies in the purposeful reduction of artesian pressure. This experience includes the near-complete reduction of artesian pressure in the area of a surface mining pit to increase industrial safety. RWH&A well monitoring measurements identified possible depletion of aquifer storage in water table zones due to production in the deeper artesian portion of the aquifer. RWH&A has guided mine operators to implement mitigation programs, required by State regulations, to replace any affected water supplies due to the lowering of artesian pressure or reduction of water table storage. Our experience indicates the costs to implement these mitigation programs is very practicable and feasible, and several groundwater districts have considered similar approaches in Texas. This experience is useful for understanding similar issues in Groundwater Management Area 14 (GMA 14).

7. Since August 2014, I have personally provided professional services relating to

groundwater availability planning and groundwater regulations to the City of Conroe. As part of these services, I have been invited to appear, and I have appeared before the Lone Star Groundwater District (LSGCD) to provide presentations to its Board of Directors. I also have provided public comment on many occasions and participated in workshops held by the LSGCD Board. All of my presentations were provided in public meetings and LSGCD has records of my presentations. I believe LSGCD is well aware of my professional opinions on the nature of the aquifers in Montgomery County as I have provided my comments to them on multiple occasions. One of my first activities was to inform the LSGCD Board about the cause of the historic change of water levels in larger production wells in Montgomery County. My comments were that these water level changes were not a function of the amount of recharge in the Gulf Coast aquifer system, but rather the water level changes represented a hydraulic response in the aquifer in accordance with increasing rates of production. I advised the LSGCD Board that this hydraulic response is equivalent to head loss or drag through the formation and is not representative of aquifer mining or "deficit pumping." I have also advised the LSGCD Board that the LSGCD's recharge calculation of 64,000 acre-feet/year does not conform to known principles of groundwater hydrology. I understand the LSGCD recharge estimate is partly based on an average flux of all aquifers, and spatial extent of those aquifers, contained in the original Northern Gulf Coast Groundwater Availability Model (GAM). This average flux is mostly a meaningless number scientifically, because the individual aquifers of the Gulf Coast system, specifically being the Chicot, Evangeline, and the Jasper do not behave as a single, average aquifer. Generally, each zone acts independently, and this is why the GMA 14 GAM discretizes the different aquifers into separate model layers. Accordingly, I have also recommended to the LSGCD Board that their regulations should not lump all aquifers into a single regulatory program, but rather their regulations should be specific to each individual aquifer. I have also advised the LSGCD Board that recharge to wells is not a static number, but rather is a dynamic rate that varies with changes in aquifer storage, and that aquifer storage must be reduced to some extent before any recharge is available for use by wells.

8. I, or Kevin Spencer, P.G. of RWH&A, have attended many meetings of GMA 14. GMA 14 is an area designated by the Texas Water Development Board with the objective of providing the most suitable area for the management of the groundwater resources of southeast Texas. GMA 14 includes all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties. Kevin Spencer or I attended GMA 14 meetings on September 23, 2014, November 18, 2014, May 28, 2015, June 24, 2015, October 28, 2015, and April 29, 2016. I have witnessed presentations by GMA 14 consultants, Mr. Bill Mullican and Mr. Jason Affinowicz, and have observed the nature and discourse of subsequent questions and answers between the consultants and GMA 14 representatives. Kevin Spencer, or I, have appeared before GMA 14 and provided public comment on the nature of the aquifers in GMA 14. We have consistently stated that the water level changes in wells are primarily changes in artesian pressure commensurate with increases in production; the effects on pressure, induced by a well's production, are regional in nature and do not obey or abide by any county or groundwater district boundaries within GMA 14; the changes in artesian pressure occur relatively quickly; any reductions of storage are small in comparison to total aquifer storage and occur slowly; any effects on aquifer storage are the result of production of all users due to the regional nature of the aquifers in GMA 14; and changes in storage are a necessary response for wells to capture recharge and increase sustainability of groundwater supplies. Accordingly, we have advised GMA 14

representatives that aquifer management criteria should be regional in nature. We also have indicated that changes in artesian pressure are a poor choice for aquifer management criteria, while aquifer storage is easier to measure and more important. **Exhibit 3 of my Affidavit** is a copy of RWH&A's first presentation provided to GMA 14 on May 28, 2015. I have also reviewed GMA 14 meeting minutes, presentation materials, draft DFC resolutions, the final DFC resolution, and other correspondence including email correspondence regarding modeling assumptions and the timing of groundwater model simulations.

9. RWH&A personnel have reviewed of the Houston Area Groundwater Model (HAGM) developed by the United States Geological Survey (USGS). Our firm has provided comments concerning the design and performance of the model to the Texas Water Development Board (TWDB) in conjunction with the adoption of the HAGM as the State's official GAM. I have met personally with USGS personnel to discuss changes made to the HAGM in relation to other historical groundwater models. Members of our firm have conducted numerous model simulations with the HAGM and tabulated and quantified various model results.

10. I am familiar with and have studied GMA 14's Resolution 2016-01-01 that adopts the Desired Future Conditions ("DFCs") proposed by the GMA 14 groundwater districts, and also LSGCD Resolution 16-006 which includes the specific DFCs adopted by LSGCD. I have reviewed GMA 14's Explanatory Report and associated Appendixes of the report. I have spent in excess of two hundred (200) hours reviewing geohydrologic data including historical water levels in wells, pumping history of entities in GMA 14, depths of pump setting for wells, water quality information, and other geohydrologic data. Furthermore, I, and in collaboration with RWH&A staff, have reviewed the GAM runs performed by GMA 14's consultants, including the

model simulation referenced by GMA 14 as Model Run Number 2.

11. Section 36.001(7) of the Texas Water Code defines a "subdivision of a groundwater reservoir" 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. Since 1949, Texas groundwater regulatory policy has recognized the scientific importance of designating a subdivision of a groundwater reservoir to formally identify the most proper area for a comprehensive groundwater management program. For instance, in 1986 our firm testified before the Texas Water Commission that the area of Bastrop County or a portion of Lee County were not an appropriate area for proper management of the Carrizo-Wilcox aquifer in Central Texas, because the aquifer management boundary was too small to encompass the extent of effects of known and future production likely to occur. During this hearing, Dr. Tommy Knowles of the TWDB also testified that the boundaries of a single county (Bastrop County) would not be an appropriate area for management of the resource considering the spatial extents of impacts from large capacity wells constructed in the aquifer. The hearings examiner agreed with our professional testimony and aquifer management areas of a single county were not approved, and instead an aquifer subdivision that encompassed many counties was approved.

12. In conjunction with a public comment period regarding the proposed DFCs adopted by GMA 14, I provided a written report to LSGCD expressing concerns over the nature of the DFCs adopted. My report is attached as **Exhibit 4 of this Affidavit.** One of the primary concerns I expressed is that small, county-based DFCs

significantly handicap a comprehensive management approach based on known scientific information. In addition, the report discusses important aspects of hydrologic systems such as artesian pressure and water table storage, recharge, and land-surface subsidence in relation to groundwater regulatory policy.

13. **Exhibit 5 attached to this Affidavit** are maps of the geologic extents of three of the aquifers deemed relevant by GMA 14. The three most important aquifers that comprise the Gulf Coast aquifer system are, from shallowest to deepest, the Chicot, the Evangeline and the Jasper aquifers. Page 1 of Exhibit 5 is a map showing the extent of the Chicot aquifer as it exists in GMA 14. The Chicot aquifer is shallowest aquifer of the Gulf Coast system and is exposed at land surface throughout GMA 14. The northwestern extents of the aquifer generally parallel the coastline with the highest elevations near 445 feet above sea level and sloping seaward to sea level at the coast. The elevation of the base of the aquifer ranges from about 420 feet above sea level to more than 1,500 feet below sea level near the coastline. The Chicot has a high sand-clay ratio throughout GMA 14 and the sands of the Chicot typically contain fresh water throughout GMA 14 and even extending below the Gulf of Mexico. Regionally, groundwater movement is towards the southeast moving from higher piezometric head in outcrop areas to lower piezometric head at sea level near the coastline. I am unaware of the State of Texas ever designating any geographic sub-area of the Chicot as an aquifer subdivision. GMA 14 has not identified any geographic sub-area of the Chicot aquifer as an aquifer subdivision.

14. Page 2 of Exhibit 5 is a map showing the extent of the Evangeline aquifer as it exists in GMA 14. The northwestern extents of the aquifer are present in the outcrop of the aquifer where the formation sands are exposed at the surface. The outcrop is a band that generally parallels the coastline and ranges from a few miles

to more than 20 miles in width. The elevation of the top of the aquifer is near 470 feet above sea level in the outcrop area and slopes to a depth of approximately 1,500 feet below sea level near the coastline. The elevation of the base of the aquifer ranges from about 430 feet above sea level in the outcrop to more than 5,300 feet below sea level near the coastline. The Evangeline has a high sand-clay ratio throughout GMA 14 and is a prolific producing zone. The extents of fresh water in the Evangeline approximately coincide with the coastline. Regionally, groundwater movement is towards the southeast moving from higher piezometric head in outcrop areas to lower piezometric head at sea level near the coastline. I am unaware of the State of Texas ever designating any geographic sub-area of the Evangeline aquifer an aquifer subdivision. GMA 14 has not designated any geographic sub-area of the Evangeline as an aquifer subdivision.

15. Page 3 of Exhibit 5 is a map showing the extent of the Jasper aquifer as it exists in GMA 14 where the total dissolved solids is less than 3,000 mg/L. The outcrop is located in the northwestern most extents of the aquifer and ranges from about 7 to 20 miles in thickness. The elevation of the top of the Jasper ranges from about 1,000 feet above mean sea level in the outcrop to more than 2,800 feet below sea level in the deep artesian section. The elevation of the base of the aquifer ranges from about 500 feet above sea level at the most updip extents to more than 3,800 feet below near the extent of the freshwater limit. The Jasper sands do continue further into the subsurface towards the coastline but the water becomes more saline to the southeast. The Jasper is most productive in the central and eastern portions of GMA 14 with less productive sands along the western boundary of GMA 14. Regionally, groundwater movement is towards the southeast moving from higher piezometric head in outcrop areas and to lower piezometric head towards pumping centers and towards the coastline. I am unaware of the State of Texas ever designating any

geographic sub-area of the Jasper aquifer as an aquifer subdivision. GMA 14 has not designated any geographic sub-area of the Jasper as an aquifer subdivision.

16. Over the course of my career, I have participated in several groundwater conservation district permitting processes. In my professional experience, the most effective permitting practices are those that are reasonable, fair, and treat all applications for production on an equal basis. My experience includes both representing clients who submit permit applications seeking to produce groundwater, and in providing professional services to groundwater districts in the regulation of groundwater.

It is my professional opinion that each groundwater owner is entitled to a fair share for the right of production of groundwater. Section 36.101 of the Texas Water Code states that a groundwater district is required to develop rules that are "fair and impartial". In my opinion, it is incumbent on a groundwater professional to be fully aware of the applicable laws and regulatory statutes governing regulations of groundwater. In Texas groundwater, it is my professional experience that regulatory programs which honor fair and impartial principles advance the ability of entities to secure long-term water supplies; best protect private property rights; and provide a clear basis for regulatory permitting procedures. My professional experience includes the sale and transfer of over 500,000 acres of groundwater rights. My firm, RWH&A, has provided professional services including aquifer testing and technical analysis that has led to sale and transfer of groundwater rights valued over $200 million; the leasing of over the 200,000 acres of groundwater rights; and the planning, permitting, and/or construction of groundwater supplies in excess of 500,000 acre-feet per year. The pertinent GCDs should provide fair and equitable regulation for the respective owners of groundwater, both those that wish to produce and those that wish to conserve. And, it is also my professional opinion that these regulatory programs should provide a roadmap for the respective GCD Boards to operate within to provide non-discriminatory permitting activities.

17. In consideration of the above, my professional opinion is the DFCs adopted by LSGCD are unreasonable on several grounds. The most important are: 1) in establishing the DFCs, GMA 14 failed to identify each relevant common reservoir including the reservoir's ascertainable boundaries, and failed to apply a uniform groundwater availability criteria to each reservoir, 2) GMA 14 conducted only a backwards "reverse engineering" approach by simulating the effects of assumed and variable demand by county to establish the DFCs, 3) the Explanatory Report authors falsely present, or are completely mistaken on, the relevance of aquifer storage in providing groundwater availability for the common reservoirs of GMA 14, 4) the Explanatory Report authors distort and mask groundwater supply economics and present no supporting cost analysis of groundwater supply engineering to support their claims, 5) the Explanatory Report authors fail to apply equal limits of allowable land-surface subsidence for the common reservoirs in GMA 14, and also fail to recognize the different land-surface subsidence characteristics of the various common reservoirs within GMA 14, 6) the adopted DFCs fail to provide for the interests and rights of private property, and 7) LSGCD has adopted multiple DFCs for each aquifer in Montgomery County. Each of these is further explained herein in my Affidavit.

LSGCD's DFCs Subdivide the Common Reservoirs of GMA 14

18. The DFCs adopted by LSGCD are unreasonable because the DFCs were not determined by using basic principles of groundwater hydrology that are commonly first applied to identify the ascertainable boundaries and important characteristics

of a common groundwater reservoir. Typically, geohydrologic studies is conducted to determine appropriate physically based boundaries by evaluating factors important for determining groundwater availability. Some of the factors useful for identifying the extents of the reservoir include the extents of deposition of important water bearing zones, spatial variations in hydraulic conductivity and water quality, the hydrostatic conditions of the reservoir including the extent and degree of artesian pressure and the thickness and location of water table zones, characteristic patterns of recharge, current patterns of development and the potential for future development of other areas of the resource, and the spatial effects of production on groundwater supplies.

Dr. Charles V. Theis wrote perhaps the first and most influential paper regarding groundwater hydrology that is very useful for understanding the importance of the concept of a common reservoir. Dr. Theis' paper is titled "The Source of Water Derived from Wells" and is included as **Exhibit 6 to this Affidavit.** In Theis' paper, he discusses how a groundwater reservoir responds to production and important considerations for the comprehensive management of the reservoir. Most applicable to the common reservoirs in GMA 14, are how 1) the rate of the "cone of depression" of a pumping well expands rapidly in an artesian aquifer because of the very small amount of artesian storage present, and 2) how all parts of the reservoir contained within the cone of depression can be considered a single hydrologic unit. These concepts are very useful for the identification of the boundaries of a common hydrologic basin Dr. Theis succinctly describes his most famous insight, which simply is all groundwater produced from a well must come from an increase in recharge, a decrease in discharge, and/or a reduction in storage. As Dr. Theis describes, before development of the groundwater resource with wells, the groundwater basin is said to be in a state of dynamic equilibrium. No material change in storage occurs over the long term. The aquifer is said to be "full" of storage and most potential recharge is said to be "rejected". This is similar to a full bucket of water. As more water is poured into the bucket it just overflows and no new storage is created in the bucket. This dynamic equilibrium changes when the first well is drilled and starts pumping, thereby establishing a new avenue of discharge within the aquifer system. An important and necessary effect, not acknowledged by the Explanatory Report authors, is that aquifer storage must be reduced, because only the reduction of storage allows previously rejected water to be accepted as recharge to the groundwater system. Dr. Theis also describes another very important issue, which is that the effects of production, including the spatial extent and magnitude of changes in artesian pressure, are dependent on the location of the well relative to the source of recharge.

A historical principle for defining a common reservoir includes analysis of the spatial distribution and extents of production. To demonstrate the potential for far-reaching extents of effects from production in artesian aquifers, **Exhibit 7 of this Affidavit** is a contour plot of the predicted change in piezometric head (artesian pressure decline and/or water table depletion) resulting from hypothetical groundwater production in the Jasper aquifer. This prediction is using the same groundwater model used by GMA 14 – the Houston Area Groundwater Model (HAGM) developed by the United States Geological Survey. After ten years of producing 20,000 acre-feet/year in one county, the effects extend into adjoining counties, more distant counties, and multiple groundwater districts throughout GMA 14. Exhibit 7 demonstrates that the main water sources that sustain this production, those being the reduction of storage and subsequent capture of recharge, are located over a large portion of the Jasper outcrop. Referring back to Exhibit 6, on the last page of the technical paper, paragraph number 5, Dr. Theis states important words relating to the management of artesian aquifers like the Jasper aquifer in GMA 14: "*In these aquifers, because the cones of depression spread with great rapidity, each well in a short time has its maximum effect on the whole aquifer and obtains most of its water by increase of recharge or decrease of natural discharge. Such an artesian basin can be treated as a unit...*". Exhibit 7 is a demonstration of Dr. Theis' words as applied to the Jasper aquifer in GMA 14.

For comparison, **Exhibit 8 of this Affidavit** presents the LSGCD adopted DFC for the Jasper and the other county-by-county DFCs (allowed changes in piezometric head from 2010 to 2070) adopted by GMA 14 for the same Jasper aquifer. The DFC established by LSGCD does not recognize or conform with the spatial extents of the effects of production in the Jasper and instead inappropriately subdivides the common reservoir. Looking at the Explanatory Report, the authors never describe what a common hydrologic basin is. The county boundaries adopted by LSGCD do not delineate a geographic area that is a common reservoir confined to Montgomery County whereby groundwater production located in Montgomery County will not affect the water supply of groundwater owners outside of Montgomery County, nor in a manner that groundwater owners outside of Montgomery County utilizing their groundwater will not affect the groundwater supplies inside Montgomery County. There is continuous groundwater flow between Montgomery County and adjacent counties, and it is well established that the performance and response of the aquifers in the Gulf Coast system do not obey political county boundaries. But, the economics of groundwater production and the rights of private property owners do not obey, follow, or conform in any manner to the geographic shape of Montgomery County. Beginning on page 120 of the Explanatory Report, the authors try to rationalize that Texas Water Code Section 36.108(d-1) provides the authority to delineate a DFC on a geographic boundary of a county. It is my professional opinion this is scientifically inappropriate, and the only geographic area boundaries that would make sense from a groundwater management standpoint would be boundaries of a common reservoir, or aquifer subdivision, that are not coterminous with the extents of a GMA boundary. As Dr. Theis describes in Exhibit 6, the common hydrologic basin can only be delineated through the analysis and mapping the extent of the cone of depression of production. Only by looking at the recharge, storage, springflow, pumpage, and other characteristics of the whole common reservoir can a comprehensive approach be conducted to manage the aquifer resource and the common rights of all owners of the reservoir. Therefore, it is my professional opinion that LSGCD's decision to employ a regulatory management program rooted in a political basis, that being the boundary of Montgomery County, compromises the integrity of a comprehensive aquifer management program based in science. As presented later herein, this has grave consequences for applying an equitable balance between the highest practicable level of groundwater production and conservation of the common reservoirs in GMA 14, and for the fair and impartial regulation of the common reservoir.

GMA 14's Reverse Engineering of DFCs

19. The DFCs adopted by LSGCD are not reasonable aquifer management standards because the DFCs were developed by simply calculating them by initially assuming a rate of production in each county. The DFCs were not established by first considering and identifying critical levels of springflow protection, depletion of storage, subsidence, and other balancing factors such as protection of private property rights. Instead, the DFCs are simply reflective of a specified amount of production by county that was provided to GMA 14 consultants and

representatives. With the demands in hand, GMA 14 put the demands into a groundwater flow model, executed the model, and then adopted the model results summarized by county as the aquifer management criteria.

GMA 14's administrative records reveal the sequence of actions taken by GMA 14. **Exhibit 9 attached to my Affidavit** are the GMA 14 meeting minutes dated June 26, 2013. On page 3 of Exhibit 9, both Bill Mullican and Jason Affinowicz, who both signed and sealed the Explanatory Report, discuss and recommend the reverse engineering approach. One sentence is particularly telling: "*The more direct method would be to review the pumpage figures and projected demands for each entity and once agreed upon, put those numbers into the model and determine the DFCs.*"

Exhibit 10 of this Affidavit includes a series of email correspondence and subsequent draft DFC Resolutions. First, is an email dated July 7, 2013 where Mr. Mullican sends an initial request to GMA 14 representatives for approving modeling input of pumpage for calculating DFCs. This is followed by a second email from Kathy Turner Jones again requesting GMA 14 Representative approve the model inputs for pumpage. As stated in these two emails, the basis for the pumpage input is TWDB report GAM 10-023 and the 2011 Region H Water Plan. After GMA 14 approved these model inputs for pumpage, the modeling effort resulted in the first draft DFC Resolution (Page 3 through 14 of Exhibit 10). Then, another model modification was requested by LSGCD via email dated June 3, 2014 where Mr. Mullican is specifying model pumpage input for Montgomery County (Page 15 of Exhibit 10). Mr. Mullican provides a directive to input 91,140 acre-feet per year of pumpage from 2010 to 2015 and then follow this with a reduction to 64,000 acre-feet per year from 2016 to 2070. Next on pages 16 through 29 of

Exhibit 10, is a draft DFC Resolution that reflects the model results from this change in assumed pumpage in Montgomery County. This resolution was discussed by GMA 14 on June 24, 2014, and lists the same DFCs, summarized by county, that GMA 14 later adopted on June 24, 2105. Therefore, the administrative record indicates the DFCs were predetermined approximately one year prior to their subsequent adoption.

Chapter 36.108 explicitly states nine important factors to be considered before developing DFCs. Also included in Exhibit 10 is a timeline of GMA 14 activities as represented by GMA 14. This timeline indicates GMA 14 had not completed the majority of the nine Chapter 36 considerations when the DFCs were already established. Specifically, seven of the nine required considerations that were not completed before the DFCs were pre-calculated include: 1) hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge; 2) other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water; 3) the impact on subsidence; 4) socioeconomic impacts reasonably expected to occur; 5) the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002; 6) the feasibility of achieving the desired future condition; and 7) any other information relevant to the specific desired future conditions.

The GMA 14's "reverse engineered" approach does not follow a normal scientific approach of considering groundwater hydrology principles concerning aquifer management concerns, within a common basin, prior to establishing aquifer management criteria. In addition, GMA 14's approach does not follow Chapter 36. Texas Water Code Section 36.108(d-1) states "After considering and documenting the factors described by Subsection (d) and other relevant scientific and hydrogeological data, the districts may establish different desired future conditions...".

Accordingly, the DFCs adopted by LSGCD are unreasonable because GMA 14's consultants did not perform initial studies to determine the ascendible boundaries of the common reservoirs within GMA 14 nor important hydrogeological considerations regarding the nature of the common reservoirs, and the GMA 14 consultants' approach does not follow Chapter 36 requirements for conducting scientific analysis prior to establishing DFCs. Instead, GMA 14's work protocol, recommended by GMA 14 consultants, was to approve the pumpage (MAG) desired, calculate DFCs to reflect the model pumpage input, and then conduct administrative meetings. The activities conducted by GMA 14 are itemized by date in a timeline on pages 30 to 34 of Exhibit 10.

Incorrect Understanding or Misrepresentation of Aquifer Storage

20. The DFCs adopted by LSGCD are also unreasonable because they do not properly recognize how aquifer storage works as a source of water produced by wells. One of the nine factors for consideration is Total Estimated Recoverable Storage (TERS). It is a well-known and established principle that groundwater in storage must be first reduced in the production of groundwater to move recharge to wells (Theis, Exhibit 6). The Explanatory Report authors do not provide an analysis of change in aquifer storage that has historically occurred in the common reservoirs of GMA 14, nor the change in storage that could be expected to occur in the future. The Explanatory Report authors do not identify the increase of recharge to wells

that occurs over time as the result of depletion of storage, and they fail to consider how much additional recharge could be beneficially captured to increase valuable water supplies and reduce waste. The Explanatory Report authors also do not consider the value of additional reduction of storage for sustaining groundwater supplies. The lack of these studies and considerations is clear indication the DFCs were not developed using the most basic considerations of groundwater hydrology and do not comply with Section 36.0015 of the Texas Water Code which requires the use of the best available science.

On page 32 of the Explanatory Report, the authors state "*artesian conditions are largely eliminated long before a question of how much total recoverable storage is actually in the aquifer if economic costs were of no consideration, the adopted DFCs are technically justified*." Additionally, on page 36, the Explanatory Report authors state that "*the elimination of artesian pressures in systems like the Gulf Coast Aquifer, a dynamic projected to occur with less than 1% of the TERS volume being produced, will clearly result in the elimination of the Gulf Coast Aquifer System as a viable water resource for almost all water use sectors*." These are remarkable statements and it is my professional opinion that the Explanatory Report authors are wrong.

It is unclear to me if the authors undertook any of their own scientific investigations or studies to assure themselves whether their claim, that production of less than 1% of TERS would cause the elimination of artesian pressures in the Gulf Coast Aquifer system, is scientifically truthful. Perhaps, the authors rely solely on a presentation provided by Van Kelley to the LSGCD on September 17, 2015 at the LSGCD public hearing conducted to review the DFCs. **Exhibit 11, attached to this Affidavit**, is a presentation slide that Mr. Kelley presented. Exhibit 11 is a hydrograph of water level in a City of Conroe water well relative to the depth of the top of the Jasper aquifer and shows specifically the height of artesian pressure above the screened interval. Mr. Kelley indicates on the slide that 2% reduction of aquifer storage would result in 728 feet of average drawdown and implies this would lower the water level in the Conroe well to below the top of the Jasper aquifer, i.e., "eliminate artesian pressure". It is my professional opinion that Mr. Kelley's representation is misleading and false. While Mr. Kelley is not specific on what his assertion is based on, I believe his demonstration of 728 feet is the results of a static calculation that Mr. Kelley performed regarding the relative percentages of total aquifer storage contained in artesian storage and in water table storage in Montgomery County. Based on work conducted by the TWDB, the amount of water in artesian storage in Montgomery County is less than 0.5% of total storage in the Gulf Coast aquifers, while the majority of aquifer storage, more than 99.5%, is present in the pore space of the aquifer sands (water table storage). Mr. Kelley's representation reflects these proportions of total storage, but appears to be nothing but a static calculation that does not conform to Darcy's Law, a fact Mr. Kelley acknowledged in his presentation. As presented by Dr. Theis in Exhibit 6, reduction of storage is a dynamic process not a static condition.

Mr. Mullican also appeared before the Montgomery County Commissioner's Court, on March 22, 2016, and stated his opinion concerning depletion of storage to the members of the Commissioner's Court. Quoting Mr. Mullican in his presentation to the Commissioner's Court: *"Only about 0.46 million acre feet of the water that's in Montgomery County is in this confined storage. You take away that .46 million acre feet of water out of the Gulf Coast aquifer system and you've totally eliminated all your artesian pressures in the system."* Mr. Mullican also stated that *"if you took 2% of the storage... out of the Jasper... then you would have a resulting decline* *of 728 feet of artesian head in Montgomery County in the Jasper. Well what would that do to you? That would totally remove all of the artesian head in Montgomery County from the Jasper. You have now taken away all of your driving force, all of the natural pressure that has been put on the system you have now eliminated that if you were to take 2% of the water out of storage out of the Gulf Coast aquifer system and out of the Jasper.*" Mr. Mullican and Mr. Kelley are representing that the depletion of storage will follow the sequential order of first eliminating all of the artesian pressure storage and subsequently, and only then, will water be removed from water table storage. This is scientifically wrong.

Even the LSGCD has perpetuated this erroneous perception regarding aquifer storage. **Exhibit 12 of this Affidavit** is a copy of a June 2014 press release issued by LSGCD in response to the reporting of Total Estimated Recoverable Storage (TERS) by the TWDB. In this press release, LSGCD claims: "*Pumping even one-half of 1 percent of the average TERS numbers released for Montgomery County would cause further water level declines to the point of complete elimination of all artesian pressure in the aquifers in Montgomery County.*" LSGCD also claims: "*As noted above, very large declines in water levels and well yields will occur with only a small fraction of one percent of the TERS removed. Using TWDB's information for Montgomery County, removing just 0.26% of the total storage in the aquifer, or 460,000 acre-feet, would result in additional average water level declines of 387 feet. The Evangeline and Jasper Aquifers, which supply over 95% of the groundwater pumped in the county, would experience average drawdowns of 78 and 710 feet, respectively.*" LSGCD does not provide any scientific analysis or analysis to support their claims.

Exhibit 13 attached to my Affidavit is a response to the LSGCD TERS Press release authored by Mr. John Seifert of LBG-Guyton & Associates. Mr. Seifert states "*The comment regarding 'complete elimination of all artesian pressure' is applicable only if one half of 1 percent of storage is removed at one time*." To clarify the words "one time", Mr. Seifert means instantaneously, a physical impossibility. Further, Mr. Seifert states "*It is my understanding that the statement regarding 460,000 acre-feet of water withdrawn from storage is that it would result in an additional acreage water level (artesian head) decline of 387 feet. It is my understanding that this is based on a one-time withdrawal of the 460,000 acre-feet occurring over a short period. This would be a static calculation. As stated previously, the system is dynamic and the system would have recharge entering it and lateral flow to the county and away from the county, which would produce different effects from a one-time withdrawal of 460,000 ac-ft*." It is my professional opinion that these statements by Mr. Seifert regarding the dynamics of groundwater are accurate and apply directly to the groundwater conditions in the LSGCD and GMA 14. The words stated by Dr. Theis, William F. Guyton & Associates, and Mr. Seifert are correct and contradictory to the statements made by LSGCD, Mr. Mullican, and the Explanatory Report.

Exhibit 14 attached to my Affidavit, is the title page and an additional excerpted page of a report prepared in 1975 for The City of Conroe and The Woodlands Development Corporation by William F. Guyton & Associates. The highlighted excerpt states that "*In addition, there is a tremendous volume of water in storage in sands in their outcrop areas, and even if there were no additional recharge available, this storage would be sufficient to supply the water pumped for many years with only a small lowering of the water tables in the outcrop areas.*" It is my professional opinion that this is a correct statement about how artesian aquifers respond to production, and the description of groundwater conditions in

Montgomery County are congruent with Dr. Theis' descriptions contained in Exhibit 6. In addition, William F. Guyton & Associates emphasizes that the important storage is in the aquifer outcrop, not storage contained in artesian pressure, and certainly not the storage contained in a political area called Montgomery County. The truth of how storage is reduced in a dipping outcrop-artesian aquifer is further evidence that basing DFCs on political areas is not conducive to a comprehensive aquifer management approach.

To illustrate further the dynamic process referenced by Mr. Seifert, **Exhibit 15 of this Affidavit** is a series of pages that provide a schematic representation of how artesian pressure and water table storage relate to each other in a dipping, artesian aquifer like the Jasper aquifer in GMA 14. The first page on Exhibit 15 shows a sloping column of water, like a cross-section of the aquifer, and how water will rise in a small tube to the highest elevation of the water in the slopping column. Page 2 represents removal of this water inside the tube, and page 3 indicates how the water moves to refill the tube. Page 4 shows where the source of the water comes from that refills the tube and the resulting pressure level after the system has re-equalized. It is this shallow area of the sloping water column that is the equivalent of the outcrop area of the artesian aquifer. Page 5 is a cross section of an idealized artesian aquifer to clarify the terms outcrop, artesian pressure, and where recharge enters the aquifer – the aquifer outcrop. The figure on Page 5 shows that artesian pressure is sustained while storage and recharge is recovered from the aquifer outcrop because the slope of the dip of the top of the aquifer sands is steeper than the slope of the hydraulic gradient when the well is pumping.

As Charles V. Theis expresses in Exhibit 6, the amount of pressure reduction and subsequent depletion of storage and capture of recharge is highly depending upon the distance of the location of production relative to the source of recharge. If wells are placed in the deepest portion of an artesian aquifer like the Jasper, the greatest decline in pressure will occur because the production is located most distant from sources of recharge. Conversely, if the production is located near the source of recharge, very little reduction in artesian pressure would transpire. But in each case, Dr. Theis indicates the loss of storage, in an artesian aquifer, will be depletion of storage in the shallow areas of the aquifer outcrop (water table), and not the complete elimination of artesian pressure before depletion of the water table occurs. This geohydrologic condition of the Jasper aquifer and other aquifers throughout Texas in the Trinity, Carrizo-Wilcox and Gulf Coast aquifers has been known for decades and decades.

In summary, the Explanatory Report authors are ignoring or do not understand that depletion of storage is a necessary response to groundwater production, that reduction of storage is a necessary to create sustainability, and the authors and LSGCD are misrepresenting that small changes in storage will eliminate the artesian pressure in the Gulf Coast aquifer system. These assertions are not consistent with best available science.

Inapplicability of Economic Argument

21. The DFCs adopted by LSGCD are unreasonable because the socio-economic determinations are presented without any technical or quantitative analysis. On page 28 of the Explanatory Report, the authors state that the primary economic and private property impact analyses that were considered were "***the impacts of those DFCs on the economic costs to landowners of producing groundwater.***" The Explanatory Report authors indicate the economic costs fall into two primary areas: (1) the cost to drill and operate a well for beneficial use, and (2) the economic cost

to a landowner for preserving the value of a surface estate, especially in terms of land-surface subsidence. On page 28, the Explanatory Report authors list many of the factors that contribute to the cost of production of groundwater such as well drilling and pumping costs. The authors claim that the only way to economically produce groundwater in the future is "*the preservation of artesian pressure*", but the DFCs are almost exclusively reductions in pressure in a variable manner, defined by political areas. No cost analysis of the changes of artesian pressure are provided by the Explanatory Report authors. Yet, on page 29 of the Explanatory Report, the authors state "*huge impacts to well yields*" will occur unless artesian pressure is preserved, and "*huge negative economic losses*" result from reduction of artesian pressure.

On page 90, the Explanatory Report authors state that "*GMA 14 District Representatives had discussions of qualitative socioeconomic impacts that may result from the proposed DFCs.*" Thus, the Explanatory Report authors clearly state that GMA 14 District Representatives and their expert consultants conducted no scientific analysis of the actual costs of production of groundwater, and instead simply assume greater amounts of groundwater production are not possible because costs and impacts will be "huge". This is yet another example of how the Explanatory Report authors and GMA 14 Representatives have not utilized the best available science in the development of the DFCs adopted by LSGCD as required by Texas Water Code Section 36.0015(a).

Over the course of my career with RWH&A, our firm has designed countless wells completed in a variety of groundwater aquifer conditions including artesian aquifers like the aquifers that are part of the Gulf Coast aquifer system. It is always a prudent design consideration to account for the interference decline in pressure that could occur as the result of the development of the common aquifer by others. In many cases, this interference decline does little to actual well rates and only represents very small increases in lift cost. Assuming a power cost of $0.10 per kWh and typical motor and pump efficiency, the cost to lift 1 acre-foot of water 100 feet is about $15.00 (roughly $0.05 per 1,000 gallons). In other instances, especially where initial well yields are originally designed without consideration or foresight to the likely future use of the reservoir by others, the instantaneous peak well rate can decline. One remedy is to run the well longer each day in combination with distribution system storage to meet peak demands, or alternatively new pumping equipment is set lower in the well. In other cases, additional in-fill well(s) are drilled to maintain peak pumping rate. These remedies to sustain production are common activities in maintaining groundwater supplies and are practiced throughout Texas and the world. But, the Explanatory Report authors do not identify any instance in GMA 14 where the economics of these type of remedies are prohibitive. Rather, the Explanatory Report authors provide only a listing of cost related issues without any supporting analysis or underlying data.

On page 98 of the Explanatory Report, the authors state that "*it was determined that adequate applied scientific research regarding the impact for producing groundwater from storage in an artesian aquifer such as the Gulf Coast Aquifer System does not exist, and thus a conservative approach with respect to consideration of the TERS volumes is warranted*." But, in Exhibit 13, Mr. Seifert indicates that modeling simulations could be performed to evaluate the suitability of producing different amounts of TERS in GMA 14. Mr. Seifert also implies that some amount of TERS could be recovered by small or large capacity wells. If such an analysis were to be conducted in the Jasper aquifer, then the results of the work would quickly resolve to the words of Dr. Theis in Exhibit 6. This work would show that deeper, high capacity wells will cause greater reductions on artesian pressure and the cones of depression of the wells will attempt to deplete storage over large extents of the aquifer outcrop, while shallower wells nearer the aquifer outcrop could reduce storage with less change in artesian pressure. I agree with Mr. Seifert, that this type of analysis is easily facilitated with the HAGM or even simpler analytical techniques. The failure of GMA 14 consultants to perform similar studies is but another example of how the DFCs adopted by LSGCD are not based on the best available science as required by Texas Water Code Section 36.0015(a).

In addition, the Explanatory Report authors claim that preservation of the saturated thickness in an aquifer outcrop is vital to maintain an expectation for landowners to drill economic wells. But, the Explanatory Report authors do not identify any historical or future volumes of depletion of the water table storage that occur, nor the locations of depletion of storage in water table areas. The Explanatory Report authors provide no analysis of whether any outcrop wells will be impacted and not be able to continue to sustain supplies through 2070, nor provide any estimates of costs to replace the water supply of any identified wells impacted by depletion of storage in the aquifer outcrop. As presented earlier in my Affidavit, it is common scientific knowledge that depletion of storage in a water table zone is a necessary response to production of groundwater by a well. It is also my experience, that any depletion of storage in the aquifer outcrop will likely be imperceptible over timeframes of a few decades, or through 2070, or perhaps even longer. The reason is simply the TERS volumes in GMA 14 are so large compared to any difference between groundwater production and captured recharge rates.

Finally, the economic concerns provided by the authors in the Explanatory Report do not support the current LSGCD regulatory provisions that groundwater use in Montgomery County must conform to a 30% reduction of 2009 groundwater use amounts. Each water supplier who produced a certain amount of water in 2009 has already spent the necessary capital to drill wells, set pumps and motors, and build infrastructure and then successfully produced their 2009 demands. The Explanatory Report authors have not tendered any arguments consistent with a necessity to not use 30% of the financial capital already expended to actually produce groundwater in Montgomery County. This makes little economic common sense. It would make more sense to allow users to continue to produce 2009 amounts. But, even the basis of LSGCD's directive of reduction of 30% of use is not actually an economic argument. It is the assertion that groundwater production must not exceed a recharge rate of 64,000 acre-feet/year in Montgomery County. But as shown in Exhibit 7 and as described by Dr. Theis in Exhibit 6, the area of recharge contributing to production in an artesian aquifer can span areas much greater than that area of Montgomery County. LSGCD's assertion that groundwater produced in Montgomery County is sustained by recharge that occurs only in Montgomery County does not conform to readily known science.

Misrepresentation of Subsidence in Common Reservoirs of GMA 14

22. The DFCs adopted by LSGCD are unreasonable because the acceptable levels of land-surface subsidence are not equally applied throughout GMA 14, and the expressed concerns of land-surface subsidence do not apply to all of the aquifers in Montgomery County. **Exhibit 16 attached to my Affidavit** are maps of subsidence. Page 1 of Exhibit 16 is a map showing the projected land surface subsidence predicted to occur from 2010 to 2070 due to compaction of the Chicot and Evangeline aquifers. The largest amounts of subsidence projected to occur

range from about 3 to 6 feet, while large areas of GMA 14 also have less than 1 to 2 feet of projected land surface subsidence. Page 2 of Exhibit 16 is the total historical and projected land-surface subsidence from 1890 to 2070 due to compaction of the Chicot and Evangeline aquifers.

The Explanatory Report authors state that to protect private property rights (surface estate values), changes in artesian pressure must be limited. They also reference several studies of historical costs of subsidence. But, the areas of these past studies lie mostly within the Harris-Galveston Subsidence District where up to 11 feet or more of historical land surface subsidence has occurred. Additionally, the areas of the greatest projected land-surface subsidence from 2010 through 2070 are located within Fort Bend Subsidence District. These projected amounts of future land-surface subsidence were considered by Fort Bend Subsidence District in detailed regulatory planning activities. The amounts of acceptable land-surface subsidence in the Fort Bend Subsidence District strike a balance between the costs of subsidence and the benefits of greater groundwater supply. GMA 14 has conducted no such cost-benefit study, but rather just conducted the reverse engineered modeling activity and then stated any greater amounts of reduction of artesian pressure are not allowed because any greater amounts of subsidence do not properly protect private property rights. But why is 3 to 6 feet of future land-surface subsidence in Fort Bend County a proper balance, but much less subsidence is required in Montgomery County and throughout GMA 14?

Referring to Page 2 of Exhibit 16, it is evident that total land-surface subsidence is dramatically less in Montgomery County than in Harris, Galveston, and Fort Bend counties. It is also evident that much of Montgomery County is projected to never experience any land-surface subsidence. There are scientific reasons for this as the nature and conditions of the Chicot and Evangeline aquifers in Montgomery County are different than in Harris, Galveston, and Fort Bend counties. These conditions include shallower total depths of the aquifers and shorter distance from groundwater production areas to the respective aquifer outcrop areas. Both of these conditions provide natural protection against larger reductions in artesian pressure which are the primary cause of subsidence. This means that larger amounts of subsidence, such as historically occurred in Harris and Galveston counties and projected to occur in the future in Fort Bend County, will never occur in Montgomery County and will not occur in the future due to natural conditions present. The Explanatory Report authors present no studies to justify their comments concerning the prevention of subsidence and the dramatically different amounts of "allowable" subsidence.

The Explanatory Report authors also do not consider the different geohydrologic characteristics, relating to subsidence, of the common reservoirs within GMA 14 and Montgomery County. Page 3 of Exhibit 16 is a map showing the amount of land-surface subsidence attributable to groundwater production of the Jasper aquifer. Comparing pages 2 and 3 of Exhibit 16, it is obvious that the Chicot, Evangeline, and Jasper aquifers differ greatly in regarding the concern for land-surface subsidence. Based on the HAGM, the Jasper aquifer is not susceptible to subsidence. But on Page 10, the Explanatory Report authors state: "***The only means of preventing subsidence is stabilizing groundwater levels throughout the Gulf Coast Aquifer System.***" Such gross, lumping of geohydrologic characteristics of the different aquifers is indicative of the lack of scientific study conducted by GMA 14. The lack of study is not in accordance with application of the best available science as stated in Texas Water Code Section 36.0015.

Flawed and Inconsistent Considerations of Private Property Rights

23. The DFCs adopted by LSGCD are unreasonable because the DFCs do not properly consider and address the impact of the adopted DFCs on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Texas Water Code Section 36.002. On page 92, the Explanatory Report authors state "GCDs must balance the interests of historic groundwater users, landowners who desire to preserve the aquifer levels beneath their property, and property owners who may be damaged by ether groundwater-level declines or subsidence. The DFCs attempt to strike a balance between all of these property interests". Conspicuously absent in this balance, is the consideration of a groundwater owner's legal right to "drill for and produce the groundwater below the surface of real property" as stated in Texas Water Code Section 36.002(b)(1), and the requirement that groundwater districts pass rules that are "fair and impartial" (Texas Water Code Section 36.101(a)(2)). The Explanatory Report authors' chief mistake is a failure to recognize well established principle that groundwater is private property and every owner of a common reservoir is to be provided a fair share opportunity to use their property.

The Texas Water Code clearly indicates that DFCs are to have regulatory consequence. Section 36.1071(f) indicates that districts "shall adopt rules to implement the management plan", and Section 36.1085 states that "Each district in the management area shall ensure that its management plan contain goals and objectives consistent with achieving the desired future conditions of the relevant aquifers adopted during the joint planning process." Section 36.1132 specifically requires groundwater districts to manage production to achieve desired future conditions. Section 36.101(2) states that groundwater districts are to adopt rules that are "fair and impartial". Thus, the DFCs adopted within a GMA are to be achieved by enforcement of fair and impartial rules of all of the applicable groundwater conservation districts.

LSGCD's subdividing a common reservoir gives rise to severe conflict for fair and impartial regulations. As with an oil and gas well, when groundwater is produced from a well it forms a cone of depression (the lowering of piezometric head) that radiates out from the well. The cone of depression is what causes groundwater to move towards the producing well to support the continued withdrawal of water from the well. Over time, as the cone of depression expands outward, fluids (oil, gas or groundwater) located under an adjoining property and hence owned by a different owner can be induced to migrate to move to the property owner with the producing well. When this occurs, the producing well owner has appropriated the ownership of the fluids from the adjoining property owner. I understand that in Texas, this appropriation of private property of others in the operation of a well is conducted without liability under the "Rule of Capture" provided the fluids are produced under certain operating conditions (for example, without malice, without causing negligent subsidence, non-wasteful, and the well operator is complying with production rules and regulations). Therefore, by subdividing the common reservoir with political based, county-by-county DFCs, the subsequent enforcement of the DFCs ensures that owners in counties with more lenient DFCs and hence more prolific production rules will appropriate private property from owners with more constraining production rules, and this appropriation is to be enforced by disparate groundwater regulations. It is my professional opinion that this runs afoul of each owner of a common reservoir being provided a fair share under fair and impartial regulations.

The oversight of GMA 14 regarding the consideration of fair and impartial regulations of private property rights can be further demonstrated by word searching the GMA 14 Explanatory Report. Searching for the words "fair share" or "fair and impartial" for instance, reveals these words are never mentioned. The words "common reservoir" exist once (page 28) regarding impacts to surface estate values, but are never used regarding the rights associated with vested ownership in place of a groundwater estate. No reference to the words common reservoir are contained in the presentation materials related to consideration of private property rights (Appendix S of the Explanatory Report) nor in the presentation materials related to consideration of aquifer uses or conditions (Appendix H of the Explanatory Report).

On Page 30 of the Explanatory report, the authors state: "*The DFCs adopted by GMA 14 strikes the appropriate balance of preservation of those artesian conditions, and of the preservation of the saturated thickness of the water levels in the outcrop areas of the aquifer layers.*" This statement is not supported by any scientific or quantitative analysis. One could take this statement and copy it to any Explanatory Report developed by any GMA. When one does, conflict quickly arises concerning the equitable application of the balance process used in different GMAs. For instance, GMA 8 allows reduction of artesian pressure to approach 1,000 feet historically. This level of pressure reduction is clearly supported by water supply economics or else the reduction of pressure would never occur or continue to be sustained. In GMA 1 and GMA 2, the balancing test equates to 50% or more of the depletion of the water table storage. This degree of storage depletion affects groundwater supply economics and rights of owners to access groundwater under their property much more significantly than any occurrence of depletion of storage in GMA 14. These dramatically different levels of reduction of artesian pressure or storage depletion in GMA 1, GMA 2, GMA 8, and GMA 14 do not represent the same applied balance between conservation and highest practical use. Instead, the Explanatory Report authors are indicating the rights of groundwater owners to reduce artesian pressure or reduce water table storage are established only by the model simulation results of future groundwater demand identified in the TWDB Report GAM Run 10-023 and the 2011 Region H State Water Plan. But the right to use one's private property is not earned by the assumption of demand in a State Water Plan, and the absence of a demand does not translate to the absence of a right to produce groundwater. The Explanatory Report authors simply do not consider the right of every owner to produce groundwater must comply with constitutional principles on the regulation of private property. It is my professional opinion that these principles require scientific analysis, and such analysis must also be non-arbitrary when applied across common reservoirs within the State of Texas.

As stated earlier, depletion of groundwater in storage is also necessary for creating aquifer sustainability. Reductions of storage will increase sustainability through increased recharge, and as in GMA 1 and 2, depletion of storage itself can sustain larger amounts of groundwater use for centuries. On Page 81 of the Explanatory Report, the authors indicate that there are no culturally important springs in GMA 14 and the authors advance no arguments that groundwater and surface water interactions would preclude any further reductions of storage. The TWDB estimates there is over 3 billion acre feet of groundwater in storage in the Gulf Coast aquifer system in GMA 14. This is more groundwater in storage than in the major aquifers of GMA 1, GMA 2, and GMA 12 combined. By reducing small amounts of storage in GMA 14, groundwater availability will increase and support water demand in one of the most populous and growing area of Texas. With such a growing demand for water in the region, it is not rational to claim that artesian pressure cannot be reduced economically and the depletion of the water table storage cannot occur in GMA 14. The balancing test that the Explanatory Report authors advance is not technically supported by scientific evidence and it is in stark contrast to the balancing tests employed in other parts of Texas, and already deemed reasonable by the TWDB.

LSGCD Adopts Conflicting DFCs for Same Aquifers

24. The DFCs adopted by LSGCD are unreasonable because LSGCD has adopted two separate DFCs for the Chicot, Evangeline, and Jasper aquifers in Montgomery County. **Exhibit 17 of my Affidavit** is LSGCD Resolution 16-006 which contains the descriptions of the DFCs that LSGCD has adopted. One set of DFCs are based on the average change in piezometric head from 2010 to 2070 in Montgomery County. The other DFCs are the average change in piezometric head from 2010 to 2070 across the entirety of GMA 14.

The GMA 14 Resolution 2016-01-01 and LSGCD Resolution 16-006 both claim the DFCs are adopted at two scales, "which do not differ substantively in their application;". But the two sets of DFCs inspire confusion.

Further misrepresentation exists in the Explanatory Report regarding the "two-scale" DFCs. Referencing the explanatory report, the first complete paragraph on page 33 indicates "First, the selected DFCs cover the entirety of each aquifer subdivision through GMA 14. Once the aquifer-wide DFC is selected, the average drawdown for each county and each GCD is then calculated." The statement does not represent the steps GMA 14 took to arrive at the DFCs adopted. The actual steps taken are reflected in the history of draft and initially signed DFC Resolutions prepared by GMA 14. These resolutions are included in Exhibit 10. The first DFC

Resolution is dated April 4, 2014 and includes no language concerning "selecting aquifer wide DFCs". Only county-based DFCs are described. The same is true concerning DFC Resolutions dated June 18, 2014 and a signed Resolution dated June 24, 2105. Additionally, the GMA 14 analysis of different uses and conditions do not consider the water budget of the common reservoir, but only water budgets of each county in GMA 14. This documented history clearly indicates the GMA-wide DFCs were not "first selected" and then county-based DFCs calculated, but rather county-based DFCs were first determined and only in an attempt to refute criticism of the non-reservoir based DFCs was language added to the DFC Resolution concerning GMA-wide DFCs. This is one of several examples of where, based on my experience attending GMA 14 meetings, the Explanatory Report does not reflect what considerations GMA 14 representatives truly performed, but rather is an after-the-fact rationalization of the actual GMA 14 considerations and actions taken.

The two scales of DFCs can be understood as "the parts and the whole". If all of the GMA 14 county-based DFCs are achieved, then the GMA-wide DFC must be achieved by simple application of mathematics. But, the reverse is not true. The GMA-wide DFC could be achieved by a variety of pumping patterns within the GMA depending on how each groundwater owner might chose to exercise his right to produce his groundwater. Achieving the GMA-wide DFC does not ensure achieving each county-based DFC. Therefore, the county-based DFCs are the unique groundwater management standards which are to be achieved by regulations, and the GMA-wide DFC is meaningless for regulatory purposes.

FURTHER AFFIANT SAYETH NOT.

STATE OF TEXAS
ROBERT HARDEN
79290
LICENSED
PROFESSIONAL ENGINEER

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Texas Registered Engineering Firm
F-1524

Robert Harden

ROBERT D. HARDEN, P.E.

SUBSCRIBED AND SWORN TO BEFORE ME this 28 day of November, 2016.

Sarah S Morrow
Notary Public, State of Texas

My Commission Expires: 10/30/2017

SARAH S. MORROW
Notary Public, State of Texas
My Commission Expires
October 30, 2017

Exhibit 1

Curriculum Vitae of Robert Harden, P.E.

BOB HARDEN, P.E.

Mr. Harden has over 25 years of specialized groundwater development, groundwater control for mining and construction, aquifer management, water planning, water rights acquisition, groundwater valuation, expert witness and regulatory experience in Texas, throughout the United States, and overseas. His experience includes work for municipalities, industry, landowners, river authorities, water supply corporations, and local and state governments. Specific work experience involves regional groundwater studies, availability analysis, water supply evaluation and development, dewatering and depressurization, water rights, and expert witness testimony covering groundwater use, contamination, water rights, and condemnation cases.

Within Texas, Mr. Harden has worked with issues in all of the major aquifers and many of the minor aquifers. This experience coves the unique differences between sand- and clay-based aquifers such as the Ogallala, the Carrizo-Wilcox, the Trinity, and the Gulf Coast, karst aquifers such as the Edwards, and alluvial aquifers such as the Brazos River Alluvium. Mr. Harden has been involved with exploration, discovery, and development of the deepest groundwater supply in the State of Mississippi, and subsequently Mississippi Department of Environmental Quality requested his assistance in long-term groundwater planning for the state. He has provided due diligence investigation, aquifer testing, and contracting assistance for numerous groundwater rights acquisitions including several of the largest in Texas' history.

Mr. Harden is currently active throughout Texas in providing guidelines for the successful, long-term, regional management of Texas' aquifers. As a technical professional, Mr. Harden has presented results of analysis to public stakeholders including groundwater conservation districts, state agencies, groundwater management areas, regional water planning groups, and the Texas Legislature.

Education

- B.S., Civil Engineering, 1988, The University of Texas at Austin
- M.S., Civil Engineering/Water Resources, 1992, The University of Texas at Austin

Registration/Certification

- Licensed Professional Engineer, State of Texas
- Registered Professional Engineer, State of Mississippi
- Registered Professional Engineer, State of Indiana

Professional Affiliations

- National Society of Professional Engineers
- Texas Society of Professional Engineers
- National Groundwater Association
- Texas Groundwater Association
- Association of Groundwater Scientists and Engineers

Professional Experience Summary

2000 - Present
Hydrologist / Engineer
Vice President
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Austin, Texas

1992 - 2000
Hydrologist / Engineer
R.W. Harden and Associates, Inc.
Austin, Texas

1989 - 1992
Assistant Engineer
Surface Mining Division
Railroad Commission of Texas
Austin, Texas

Exhibit 2

Depressurization Systems: Design, Construction, and Cost Consideration to Prevent Floor Heave

Ridge Kaiser, P.E.

AMERICAN INSTITUTE OF HYDROLOGY

Reprinted from

Water Resources At Risk

Editors:

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E.D. Gutentag
J.E. Moore

American Institute of Hydrology
3416 University Ave. S.E., Minneapolis, MN 55414-3328

WATER RESOURCES AT RISK
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American Institute of Hydrology

Depressurization Systems: Design, Construction, and Cost Considerations to Prevent Floor Heave

Ridge M. Kaiser, P.E.

R.W. Harden & Associates, Inc.
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ABSTRACT

Depressurization of underburden water-bearing zones to prevent floor heave is an integral part of many mining operations. A successful depressurization program is based on an understanding of the geohydrology of underburden materials. However as a practical matter, determination of depressurization amounts and design of depressurization systems starts not with geohydrologic considerations but with an evaluation of power reliability and mine operational goals. Only after these two factors have been thoroughly evaluated are depressurization amounts and detailed system design including well sizing and layout, technical and cost factors associated with electrical and discharge considerations, regulatory and mitigation issues, and pumping costs versus safety-factor evaluated.

Key Words: Depressurization, floor heave, lignite, pumpage, artesian pressure

PURPOSE OF DEPRESSURIZATION

Depressurization is the lowering of artesian pressure in important water-bearing strata beneath maximum mining depths. The purpose of depressurization is to prevent heaving of the mine pit floor and attendant upward ground-water flow. Such flows can be large and can contaminate mine product, affect mine floor trafficability, decrease highwall and spoil stability, and be unsafe.

In Texas there are about 15 operating surface lignite mines. Many of these mines produce lignite from the Wilcox Group. The Wilcox is composed of sands and clays deposited by ancient river systems in East and Northeast Texas, and in ancient barrier-bar and lagoon-bar systems in Central and South Texas. Historically, only the shallowest lignite seams were mined. However, over the years deeper lignite seams were mined. With the advent of deeper mining, depressurization activities were needed where lignite seams overlaid significant water-bearing sands. In Northeast Texas, depressurization activities are generally minor due to the lack of sands beneath and in close proximity to targeted lignite seams. However, in Central Texas, between the Colorado and Trinity Rivers, the Wilcox contains a significant water-bearing unit. The Wilcox has been subdivided into three formations: the Hooper Formation, composed of clay and minor amounts of sand; the

Simsboro Aquifer, composed predominantly of sand which forms a major water-bearing unit in Texas; and the Calvert Bluff Formation, composed predominantly of clay with some sand. The Calvert Bluff Formation is the principal lignite-bearing formation and much of the mining in Central Texas is conducted in the lower Calvert Bluff Formation, which directly overlies the Simsboro. Figure 1 presents a generalized cross section of the Wilcox Group.

The Simsboro is a major aquifer in Texas with sands commonly more than 200 feet in thickness, and well yields up to 3,000 gallons per minute (gpm). Transmissivities range from 20,000 to over 100,000 gallons per day per foot (gpd/ft). In areas where the Simsboro directly underlies targeted lignite seams, depressurization activities become a major operational activity for the mine. Without depressurization activities, floor heave would occur, and water inflows of over 4,000 gallons per minute to the pit could occur with associated stability, operational, and trafficability concerns. Current systems in individual mines are pumping up to about 30 million gallons of ground water per day to obtain artesian pressure declines of up to about 160 feet. Much larger depressurization pumpage amounts creating over 250 feet of artesian pressure decline are projected as mines recover even deeper lignite seams, in the future.

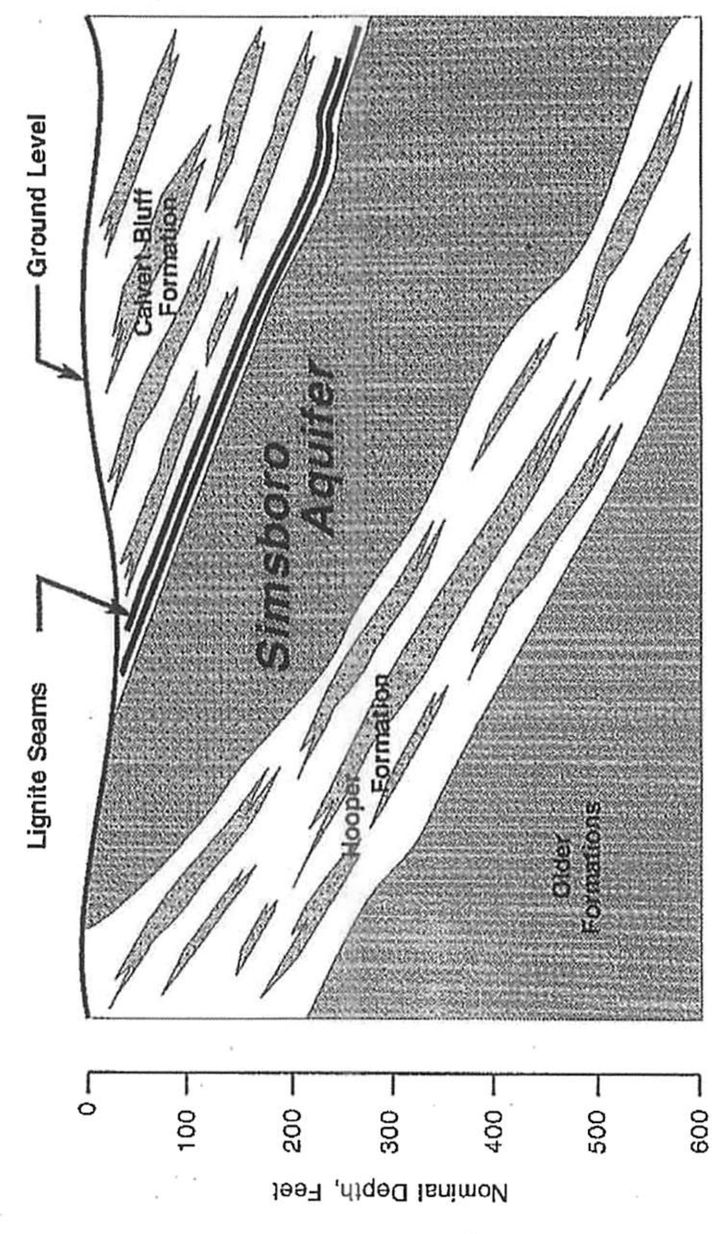
To prohibit floor heave, depressurization systems must be pumped 24 hours a day, 365 days per year, without interruption. Because of the possible severe impacts of floor heave, there is redundancy in system design including standby wells and pumping equipment, spare pumps, generators, alarms, contractors on-call for immediate repairs, and emergency action plans if well field failure occurs. Such activities are required due to the significant operational, safety, and cost issues associated with floor heave.

DEPRESSURIZATION AMOUNT

The most important, and sometimes difficult, decision when evaluating depressurization is determining the amount of depressurization (pressure relief) required to safely and cost-effectively conduct mining operations. At a minimum to prevent floor heave, the upward artesian pressure force of the underlying water-bearing zone(s) must not exceed the downward force exerted by the weight of materials between (separating) the pit floor and the top of the water-bearing zone (referred to herein as the separation), plus the strength of the separation materials. The minimum artesian pressure reduction required to prevent floor heave is site-specific and depends on the separation thickness, the amount of artesian pressure, details of the mine plan including pit width and length, the shear and tensile strength of separation materials, and the restraining effects of the spoil and highwall slopes. If the artesian pressure exerted at the top of the underlying water-bearing zone exceeds the weight and strength of separation materials and the restraining effects of the spoil and highwall, the mine pit floor will heave. For convenience and planning purposes, three depressurization levels are commonly used. Figure 2 schematically shows important depressurization terms and demonstrates the three depressurization levels.

1. Minimum Depressurization - The amount of artesian pressure reduction which results in the upward artesian pressure force at the top of the underlying water-bearing zone(s) being equal to the weight and shear and tensile strength of separation materials and the restraining effects of the spoil and highwall slopes.

FIGURE 1. Generalized cross section showing geologic units



2. Safe depressurization - The amount of artesian pressure reduction which results in the upward artesian pressure force at the top of the underlying water-bearing zone(s) being equal to the weight of separation materials. Shear and tensile strength of separation materials, and the restraining effects of the spoil and highwall slopes are not considered.

3. Dry Depressurization - The artesian pressure reduction required to lower the artesian pressure in the underlying water-bearing zone(s) to just below the mine pit floor (deepest lignite to be mined).

The selection of the appropriate depressurization amount for a mine or part thereof should be based on numerous factors. The following provides some guidance which should be used when evaluating the amount of depressurization (pressure relief) required:

- Application of Minimum Depressurization Requirement
  - When separation thickness is uniform.
  - When the materials composing the separation are homogenous.
  - When artesian pressures are consistent and predictable.
  - When cost and/or pumpage minimization is critical.
  - When sufficient standby equipment is available and power reliability is good.
  - When data concentration and reliability are high.
  - When floor heave would not result in significant operational problems or concerns.
  - When the material strength of separation materials is well understood and quantifiable.
  - When pit dimensions are reasonably constant.

- Application of Safe Depressurization Requirement
  - When separation thickness is variable.
  - When lithology of the separation thickness is variable.
  - When standby equipment is somewhat limited.
  - When significant operational concerns are associated with floor heave.
  - When equipment on the pit floor will require time to evacuate.
  - When power reliability is poor.
  - When spoil side mining is taking place.

- Application of Dry Depressurization Requirement
  - When floor heave has occurred in previous adjoining pit(s).
  - When unplugged bore holes and/or wells into the underburden sands exist.
  - When there is minimal standby equipment.
  - When power reliability is poor and power outages are common and reasonably lengthy.
  - When the separation is thin.

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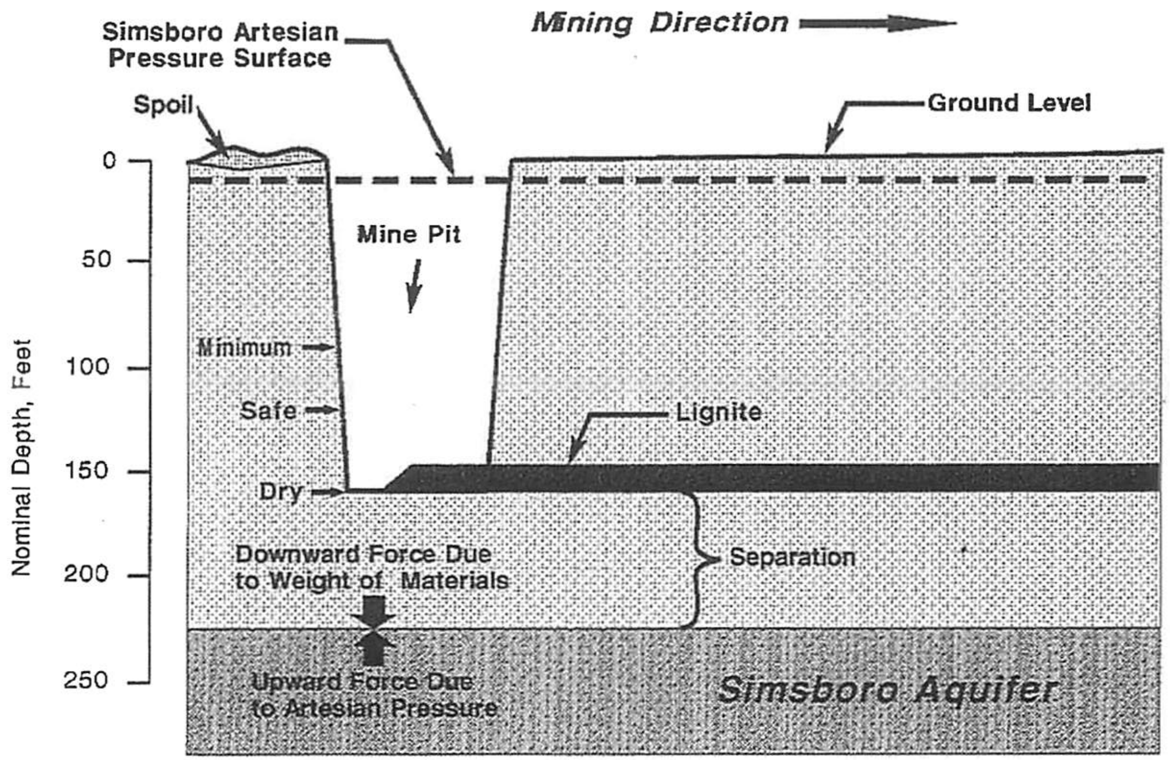
FIGURE 2. Schematic diagram showing depressurization terms



Most depressurization operations in Central Texas are generally depressurizing to between the safe and dry conditions. This is primarily due to the operational concerns if heave were to occur, power reliability, the variability in thickness and lithology of the separation zone and the cost-benefit of increased safety factor. At present, no large-scale depressurization activities in Texas are occurring with the minimum depressurization amount as the goal. This is primarily due to the difficulty, likely variability and confidence level of trying to determine tensile and shear strength of underburden materials, the varying effects of the spoil and highwall slopes in each pit and the costs associated with required increased standby equipment and power. The closer depressurization goals are set to the minimum depressurization amount the quicker floor heave will occur upon well or well field failure and therefore the more standby equipment required.

Generally, with a separation thickness of about 60 feet, average pit dimensions and typical Calvert Bluff separation lithology, depressurization from minimum to safe amounts results in about 20 to 25 per-cent more pressure reduction. However, the amount of this additional pressure reduction declines as the separation thickness thins, pit dimensions expand and underburden materials weaken. As the separation thickness becomes thinner the minimum and safe depressurization requirements approach dry depressurization requirements. When the separation thickness is zero, the minimum, safe and dry depressurization requirements are the same.

In practice, selection of a depressurization amount is not specific to one of these three depressurization goals and usually varies per mine and even per areas within a mine. In addition, in any given mine area depressurization goals change as mining progresses due to 1) depressurization requirements increasing in the downdip direction, and 2) the fact that most depressurization systems by necessity are located on the downdip edges of mine blocks and most pits are oriented along strike. Therefore as pits move downdip, depressurization requirements increase, pumpage requirements increase, and the time between well field failure and floor heave decreases as the mine pits are moving closer to the depressurization wells. These factors result in the necessity to periodically re-evaluate the system and adjust pumpage and equipment needs to meet operational and safety goals.

The starting point for the design of a depressurization systems is an evaluation of how much time after total well field failure and/or single well failure is required to get a well or entire well field system back on line and at what level of confidence or reliability should the depressurization system be designed. With that critical information the actual depressurization amount(s) can be determined, based on geologic, hydrologic, mechanical, and cost considerations involved in the design of such systems. In such evaluations statistics can be an important tool in assessing power reliability, data requirements, safety and operational considerations. With sufficient data, systems can be designed to target specific levels of confidence. Graphs of cost versus degree of confidence of preventing floor heave can be developed and used as an evaluation tool for planning a depressurization system.

COST CONSIDERATIONS

Once the depressurization amount has been determined, the next consideration is how to cost-effectively meet this depressurization amount. This is a reasonably simple but sometimes time-consuming task. For purposes of this cost consideration discussion, it is assumed that the basic geohydrology of the system has been thoroughly defined including:

1. Local and regional transmissivity.
2. Boundary conditions affecting drawdown including leakage, faults and outcrop areas.
3. Available drawdown.
4. Artesian storage coefficients and specific yields.
5. Variability of transmissivity at well sites.
6. Likely efficiency of production wells constructed.

Two cost considerations come into play in design of a depressurization system, (1) how most cost-effectively to remove the required rate of water, and (2) how most cost-effectively to meet the mine operators required recovery time prior to potential heave upon well or well field failure. To address the first issue, evaluations need to be conducted on probable well yields based on transmissivity, available drawdown, interference drawdown and likely well efficiencies. This evaluation is usually conducted for the maximum depressurization pumpage amount in a given mine area as interference drawdown is maximized. Based on this evaluation, these pumpage amounts are then used to determine the appropriate size for well casing(s) in accordance with applicable pump diameters and total head considerations. Additionally, a larger number of smaller-capacity wells versus fewer larger-capacity wells, based on contractor costs for constructing different sized wells should be evaluated. In the end, the most cost-efficient well needs to be based on the cost of the well and pumping equipment along with costs for electrical and discharge infrastructure. Generally, depressurization of the Simsboro is most cost-effective with 10-inch diameter wells, capable of pumping up to 1,200 gpm, when data indicate individual well yields likely will equal or exceed 700 to 800 gpm. In areas where the transmissivity, available drawdown, boundary conditions and other factors indicate well yields of less than about 700 gpm, a larger number of 8-inch wells are more cost-effective. Cost evaluations indicate the breakover point between 8- and 10-inch wells is at about 700 gpm.

A more difficult evaluation is how to most cost-effectively meet the mine operators recovery times prior to floor heave occurring. Considerations such as overpumping to increase the time to potential floor heave, if a well or well field fails, versus having more standby wells and generators needs to be evaluated. With the targeted amounts of pumpage and the cost for wells, power and electrical calculated, a graph can be made of the capital costs and operation and maintenance costs to overpump versus the capital and maintenance costs for standby generators and wells. The results of these evaluations often change from mine area to mine area, even within the same mine. Generally to cost-effectively design the final system requires properly and accurately scheduling out costs by mine year for depressurization of an entire mine area. The costs should include wells, pumps, generators, electrical, discharge, standby wells and all equipment for the various scenarios.

The detailed analysis to conduct such cost comparisons are too extensive to be included in this paper. However, various spreadsheets can be developed which can assist in conducting the calculations and result in the preferable, most cost-effective system. However, for many mines the system selected in the end must meet one additional critical factor. The system must have the flexibility to meet likely changes in the mine plan without significantly affecting the correctness of the decision on number, size and placement of wells, power and discharge.

INTEGRATED APPROACH

Successful and cost-effective depressurization generally requires a detailed plan to address the items discussed. This often means detailed interaction and planning between the geologist, ground-water hydrologist, mine engineer, civil engineer and electrical engineer. Figure 3 shows a general approach/flowchart for the design of such a system. As discussed, it begins with quantification/identification of power and depressurization system reliability and safety factors, evaluates the various considerations with respect to depressurization design, costs out in detail the actual depressurization system and then, re-evaluates the depressurization amount and design ensuring that all safety and operational considerations are addressed cost-effectively. Oftentimes, the iteration may involve several different scenarios. On occasion, the planning is even integrated and incorporated into the mine plan and methods. Interestingly, in the end the selection of the appropriate depressurization amount is based primarily on operational considerations (power and system reliability), rather than geohydrologic or geotechnical considerations.

Such an approach has resulted in successful large-scale depressurization activities in several surface lignite mines in Texas and more are planned. Some of the current larger systems have been in operation since 1988, and cost-effectively pump up to 30 million gallons per day. Floor heave has not occurred since inception of depressurization activities in these mines, thus demonstrating the success of such an approach to conducting depressurization operations.

FIGURE 3. General approach to depressurization system design

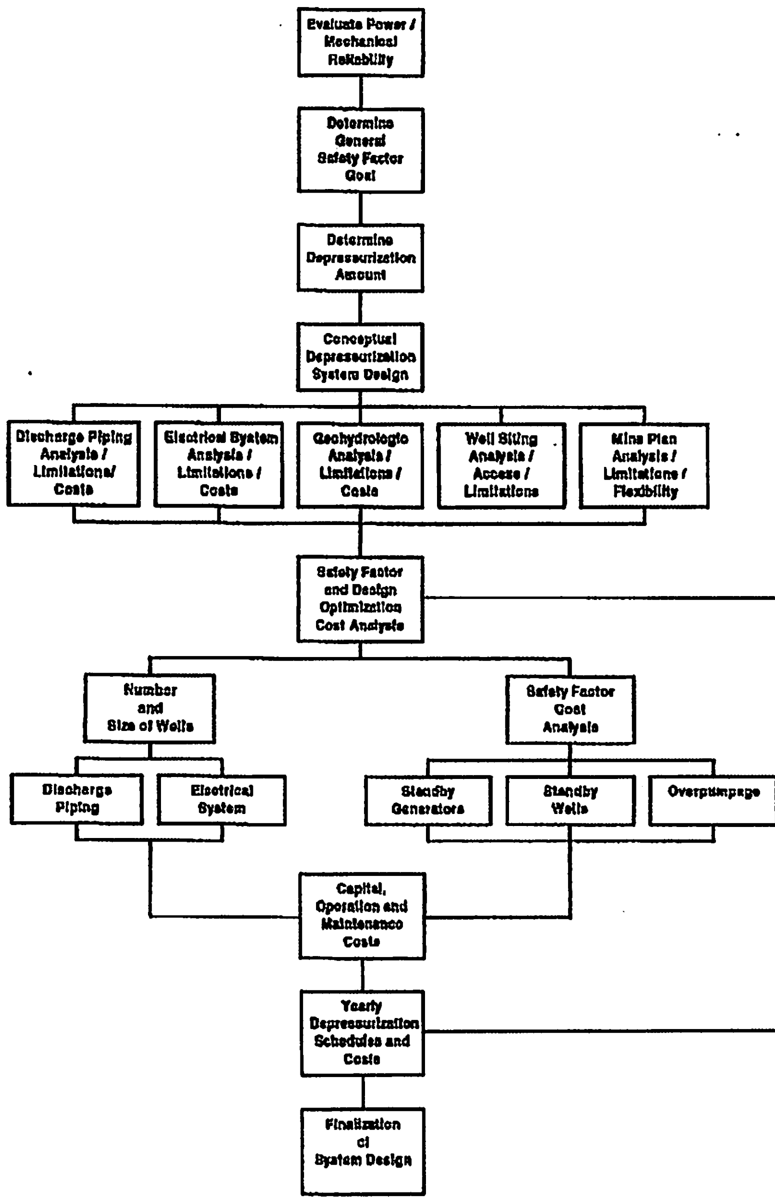


Exhibit 3

Presentation to GMA 14
by Kevin Spencer, P.G.

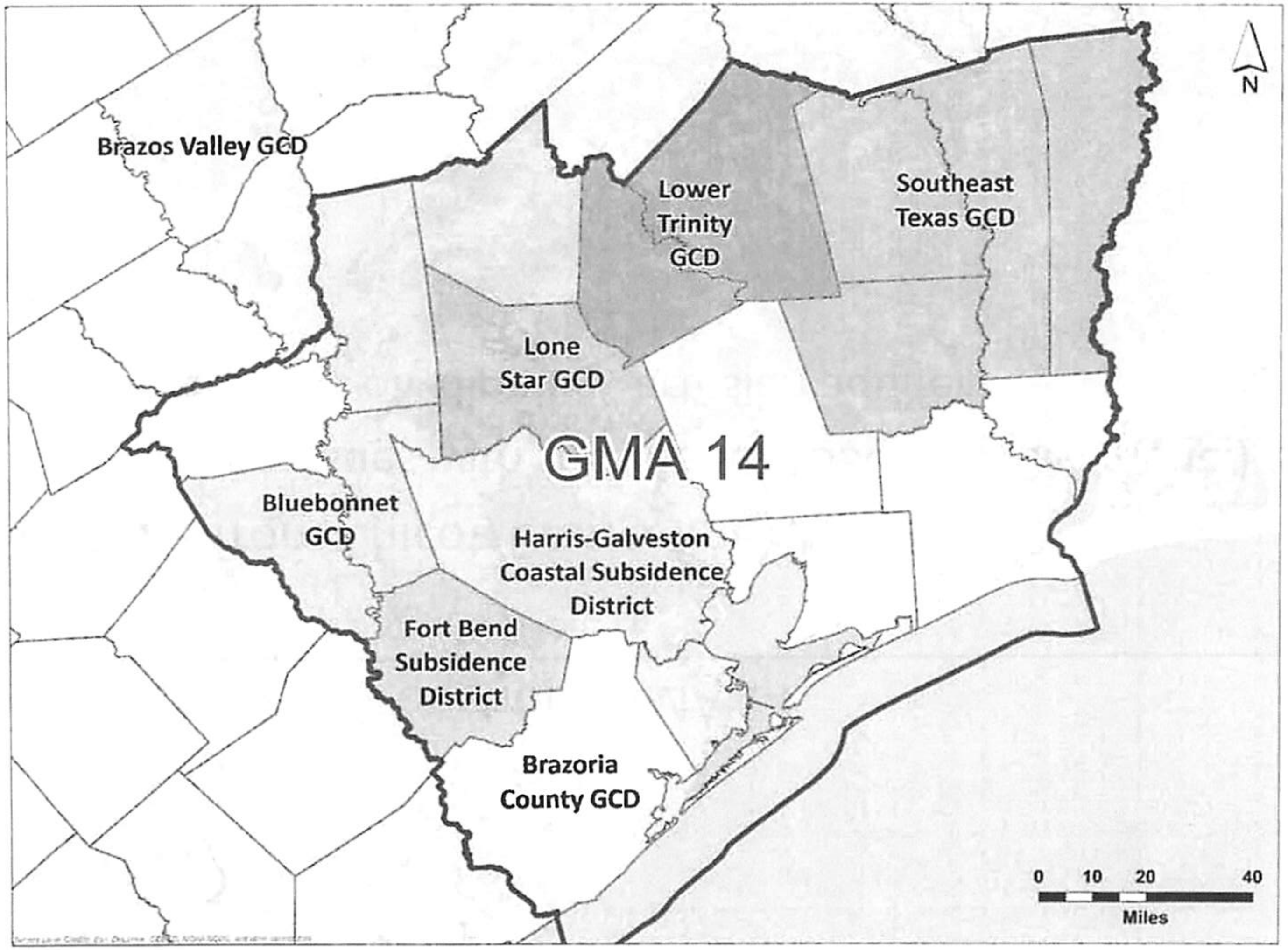
Aquifer Management Principles in Artesian Aquifers

A DFC Proposal

Kevin Spencer, P.G.
President
R.W. Harden & Associates, Inc.
Representing:
City of Conroe

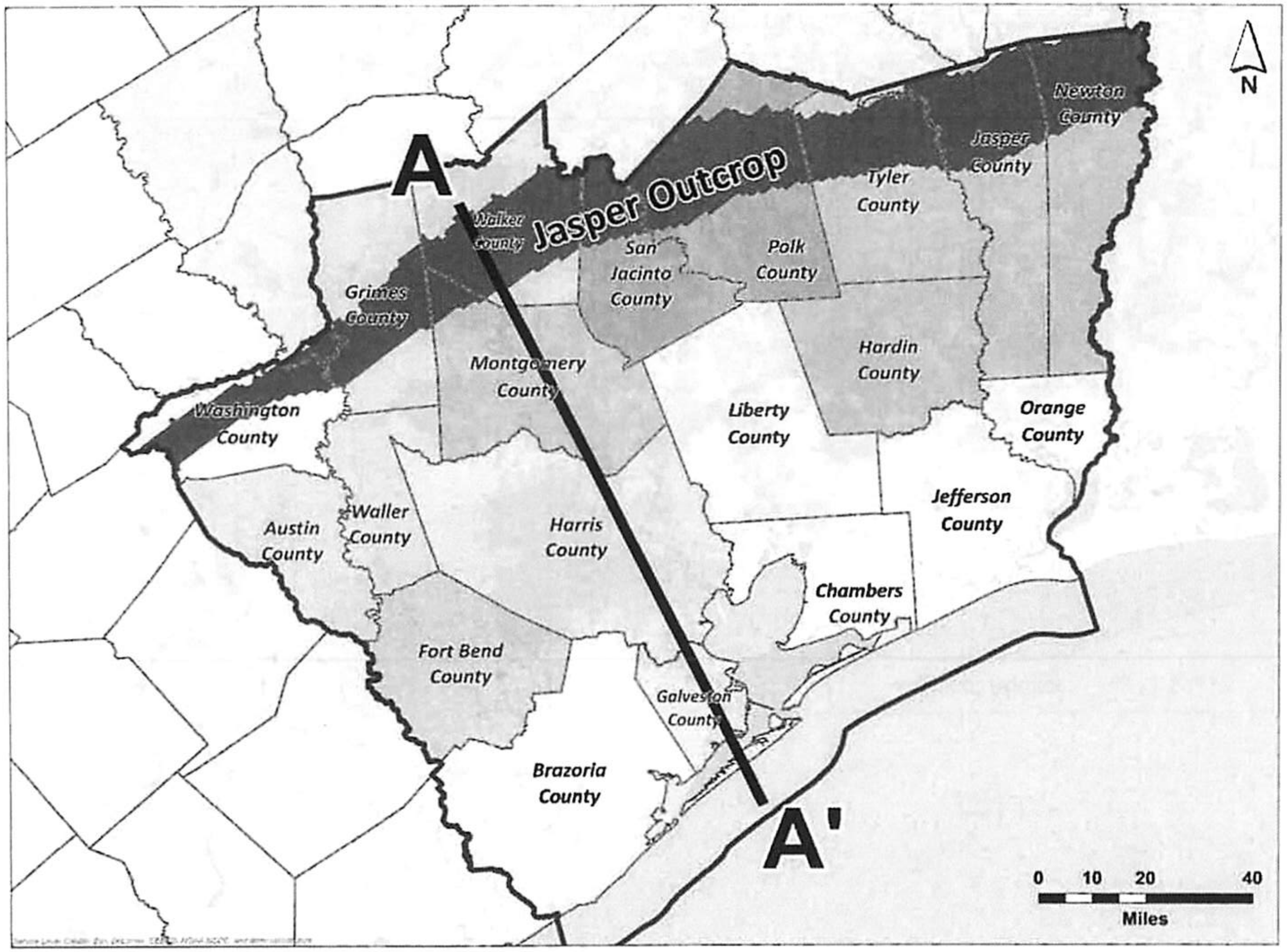
CITY OF CONROE

R W HARDEN &ASSOCIATES INC
HYDROLOGISTS GEOLOGISTS ENGINEERS

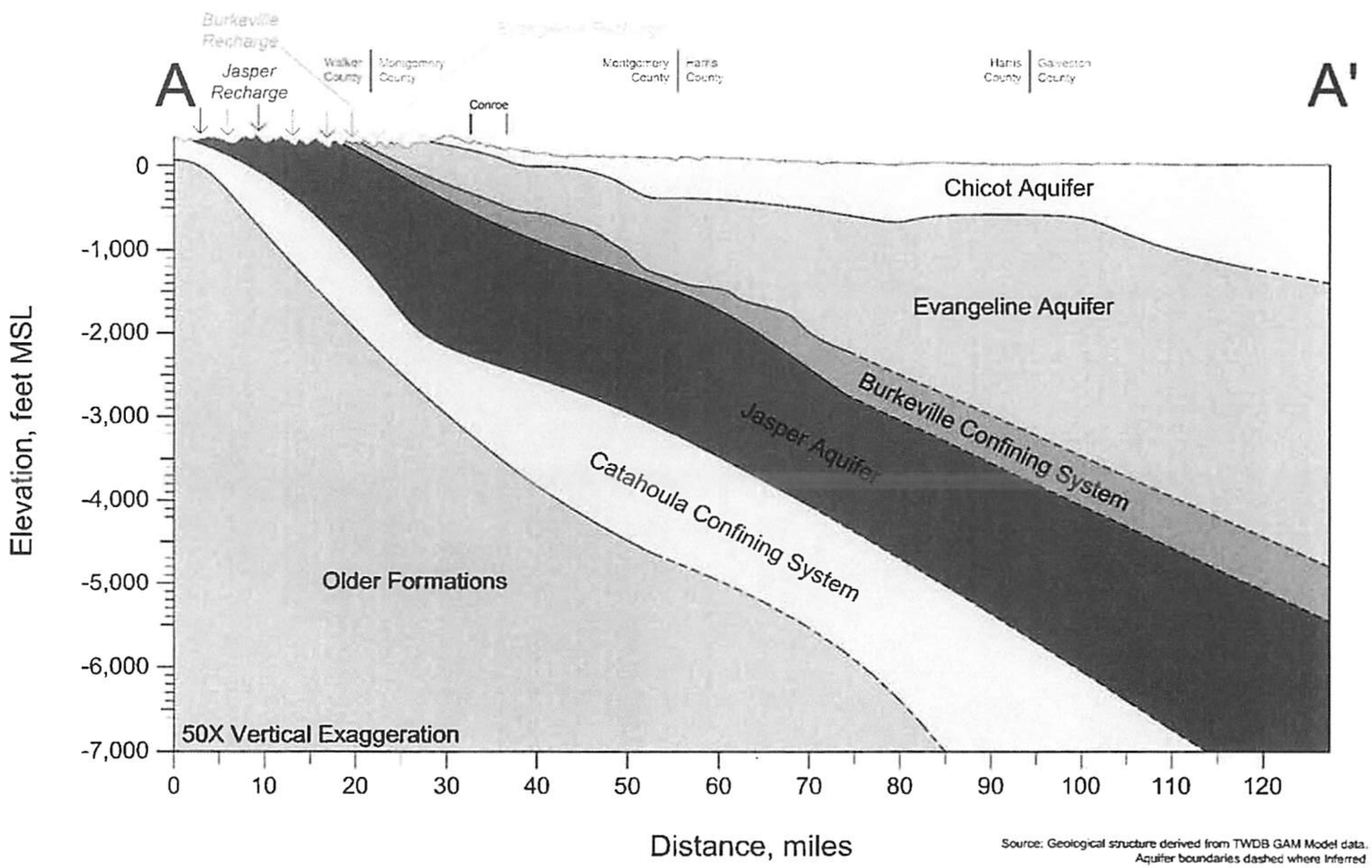

N
Brazos Valley GCD
Lower Trinity GCD
Southeast Texas GCD
Lone Star GCD
GMA 14
Bluebonnet GCD
Harris-Galveston Coastal Subsidence District
Fort Bend Subsidence District
Brazoria County GCD
0 10 20 40
Miles

Jasper Aquifer

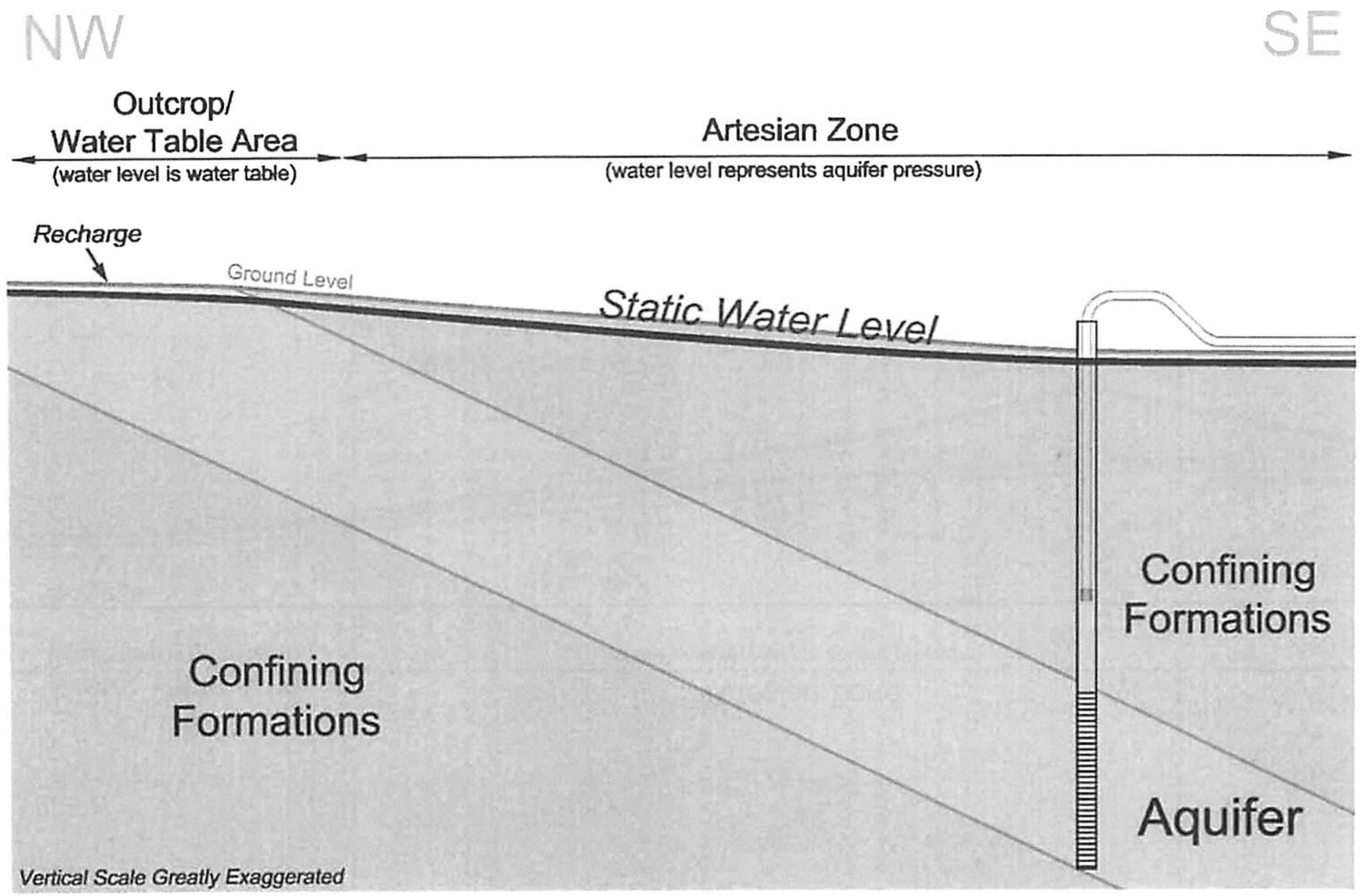
- Major aquifer throughout GMA 14
- Separate from Chicot/Evangeline
  - No known issues with subsidence (USGS, HAGM model)
  - Characteristic of “dipping” artesian aquifer

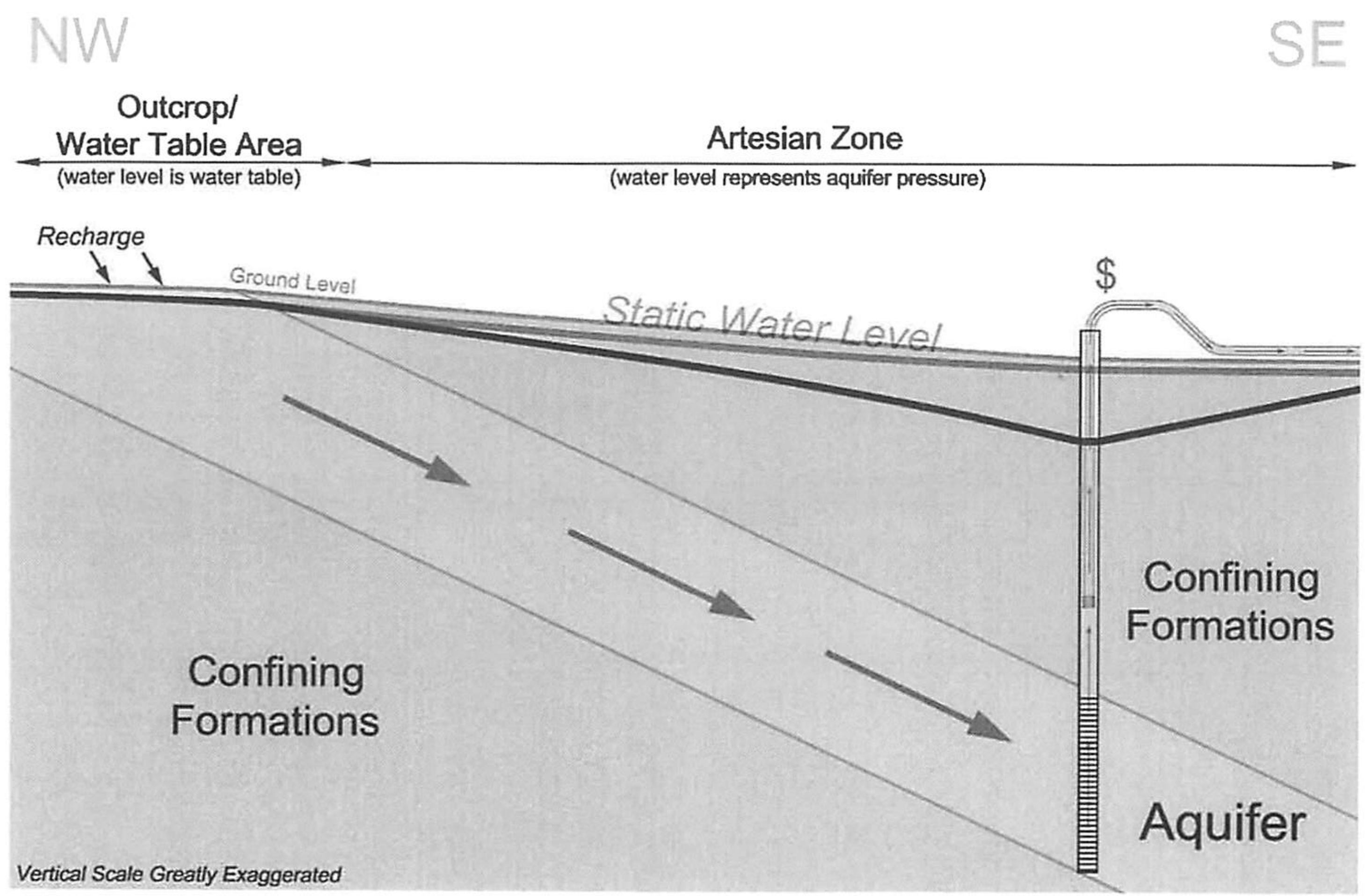


N
A
A'
Jasper Outcrop
Washington County
Grimes County
Walker County
San Jacinto County
Polk County
Tyler County
Jasper County
Newton County
Montgomery County
Hardin County
Liberty County
Orange County
Jefferson County
Austin County
Waller County
Harris County
Chambers County
Fort Bend County
Galveston County
Brazoria County
0 10 20 40
Miles



Source: Geological structure derived from TWDB GAM Model data. Aquifer boundaries dashed where inferred


NW
SE
Outcrop/
Water Table Area
(water level is water table)
Artesian Zone
(water level represents aquifer pressure)
Recharge
Ground Level
Static Water Level
Confining
Formations
Confining
Formations
Aquifer
Vertical Scale Greatly Exaggerated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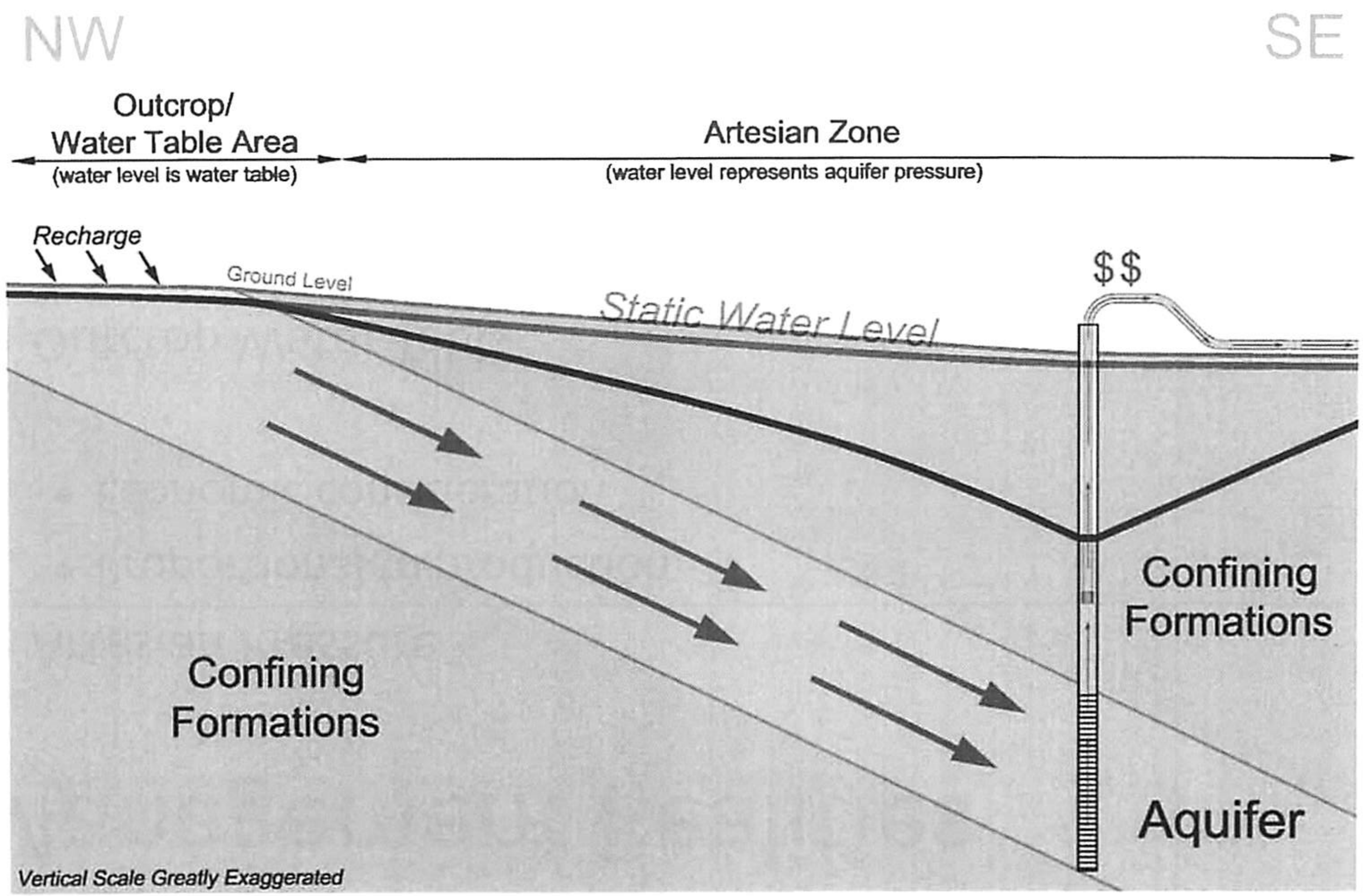
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Recharge
Ground Level
Static Water Level
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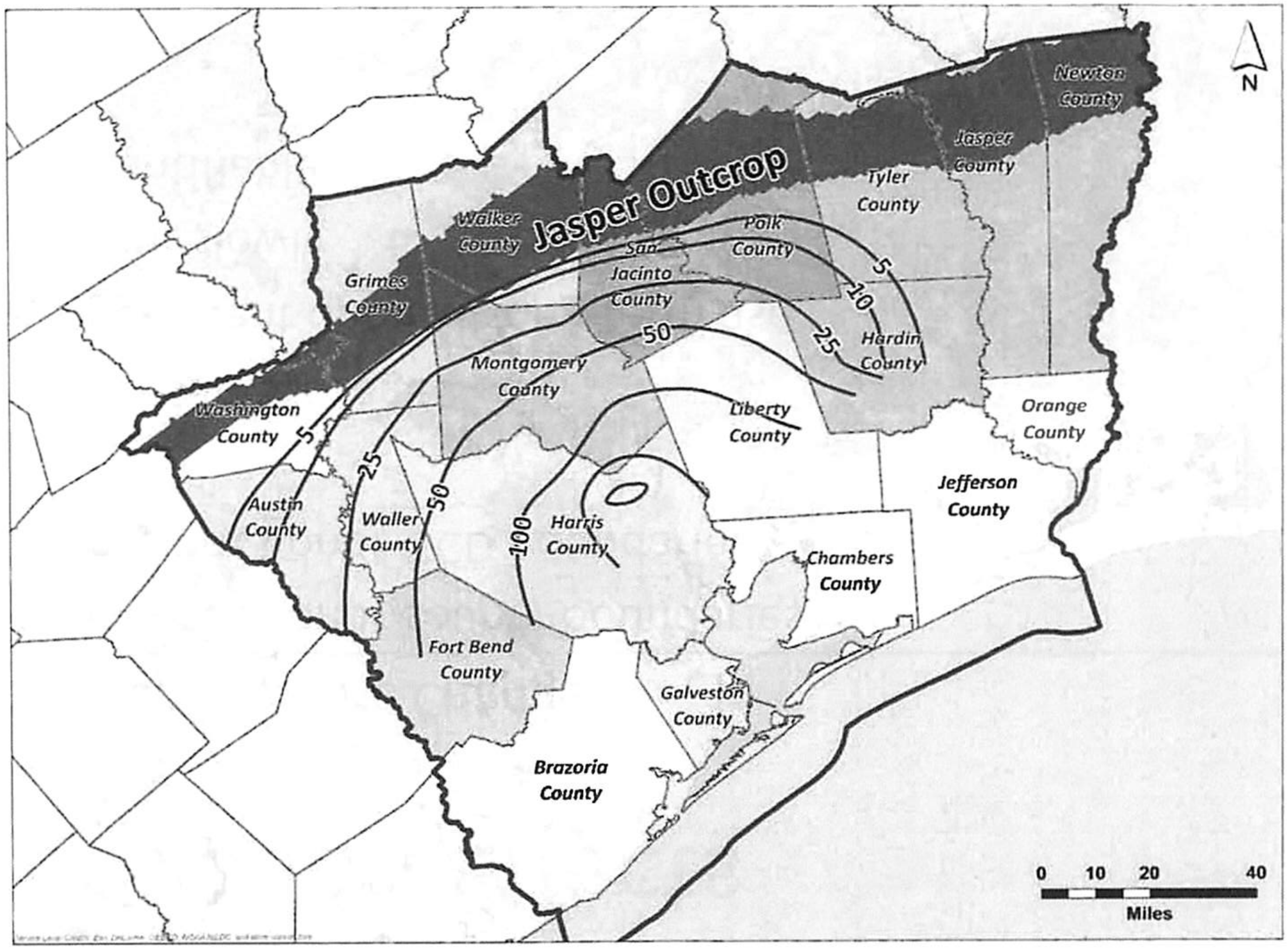
Confining
Formations
Confining
Formations
Aquifer
Vertical Scale Greatly Exaggerated

Management Realities

- Artesian Pressure
  - Proportional to production
  - Economic consideration

- Outcrop Water Table
  - Aquifer water budget
  - Long-term change in storage
    - Increases captured recharge
    - Quantifies sustainable use


Jasper Outcrop
Newton County
Jasper County
Tyler County
Polk County
San Jacinto County
Walker County
Grimes County
Washington County
Montgomery County
Hardin County
Liberty County
Orange County
Jefferson County
Chambers County
Harris County
Austin County
Waller County
Fort Bend County
Galveston County
Brazoria County
5
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25
50
100
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0 10 20 40
Miles

Production Effects

- Artesian Pressure Change
  - Does not honor county boundaries
  - Does not honor GCD boundaries
- Changes in Storage
  - Dependent upon all long-term use
  - Occur slowly
  - Quantifiable

Aquifer Management Should...

- Be regional
- Have a quantifiable management standard
- Quantify the amount of the resource
- Consider environmental effects
- Treat all users equally

A Proposed DFC

"No less than 95% of the total storage in the Jasper aquifer is to be remaining in 2070"

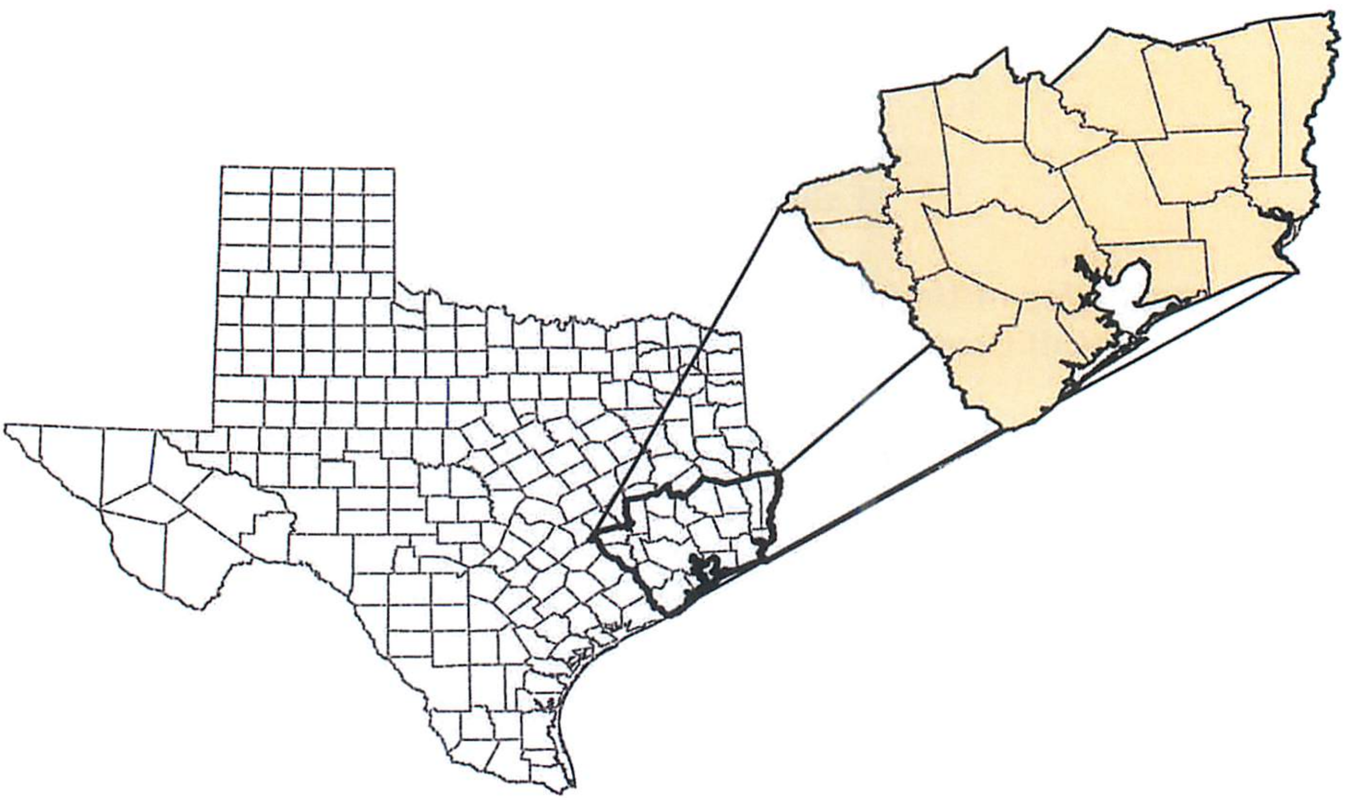
Exhibit 4

Evaluation of Desired Future Conditions for the Gulf Coast Aquifer Within GMA 14

Robert Harden, P.E.

EVALUATION OF DESIRED FUTURE CONDITIONS FOR THE GULF COAST AQUIFER WITHIN GMA 14

Relative to Public Comments Period
associated with GMA 14 Joint Planning



Prepared for:

CITY OF CONROE

Prepared by:

R W HARDEN & ASSOCIATES INC

HYDROLOGISTS GEOLOGISTS ENGINEERS

EVALUATION OF DESIRED FUTURE CONDITIONS FOR THE GULF COAST AQUIFER WITHIN GMA 14

Relative to Public Comments Period Associated With GMA 14 Joint Planning

Prepared for
City of Conroe, Texas

Prepared by
R.W. Harden and Associates, Inc.
Hydrologists – Geologists – Engineers
Austin, Texas

September 2015

STATE OF TEXAS
ROBERT HARDEN
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The seal appearing on this document was authorized by
Bob Harden, P.E #79290, on September 9, 2015.
R.W. Harden & Associates, Inc.
TBPE Firm Registration Number: F-1524

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Appendix A – GMA 14 Resolution No. 2015-01

Introduction

Background

For many decades, the State of Texas Legislature has promulgated statutes for the objective of providing suitable areas for the management of the underground water resources. Most recently, in 2001, the Texas Water Development Board (TWDB) was tasked with designating groundwater management areas covering all of the State's major and minor aquifers. Each groundwater management area is designated with the objective of providing the most suitable area for the management of the groundwater resources.

Groundwater Management Area 14 (GMA 14) was designated and covers 20 counties in southeast Texas. GMA 14 includes the regulatory districts of the Bluebonnet Groundwater Conservation District, the Brazoria County Groundwater Conservation District, the Lone Star Groundwater Conservation District, the Lower Trinity Groundwater Conservation District, and the Southeast Texas Groundwater Conservation District. GMA 14 also encompasses the regulatory areas of the Harris-Galveston Subsidence District and the Fort Bend Subsidence District although these districts are not members of GMA 14. Figure 1 shows the designated GMA 14 boundary in relation to the contained county and regulatory area boundaries. The primary aquifer within GMA 14 is the Gulf Coast aquifer.

By Resolution No. 2015-01, GMA 14 adopted proposed desired future conditions (DFCs) for each formation of the Gulf Coast aquifer, the Carrizo aquifer, the Queen City aquifer, the Sparta aquifer, and portions of the Yegua-Jackson aquifer. Pursuant to Texas Water Code 36.108(d-2), the groundwater districts which comprise GMA 14 are to hold public hearings for the purpose of describing the proposed DFCs and to receive public comment including any suggested revisions to the proposed DFCs and the basis for the proposed revisions.

Scope of This Study

This study and report have been conducted at the request of the City of Conroe and in support of other municipal water users in Montgomery County. These water users are interested in the development of desired future conditions that honor basic science principles and State statutes applicable to the regulation of groundwater in the State of Texas.

This report focuses on the Gulf Coast aquifer within GMA 14 and summarizes the results of the requested study. Similar studies could be conducted for the Carrizo, Queen City, Sparta, and Yegua-Jackson aquifers. The Gulf Coast aquifer investigations have focused on those hydrogeologic conditions and related statutory requirements which have the most bearing on the designation of desired future conditions appropriate for the Gulf Coast aquifer characteristics in GMA 14. The conclusions are based on review of published geologic, hydrologic, planning, and groundwater modeling reports, principally those of Texas water agencies, the Bureau of Economic Geology, and the United States Geological Survey. Also considered were available consulting reports, groundwater district rules and regulations, GMA 14 meeting minutes and presentations, and other compilations available in the public domain. A complete listing of reports maps and data reviewed in the preparation of this report is included in the bibliography.

Past and Current Studies

Extensive information is available on the Gulf Coast aquifer from past studies conducted by local, State and Federal agencies. The earliest studies focused on the Gulf Coast aquifer within Harris and Galveston counties where the predominant early use was located. Most recently, the USGS developed the Houston Area Groundwater Model (HAGM) which simulates groundwater flow and land-surface subsidence in the Gulf Coast aquifer throughout GMA 14 from predevelopment (before 1891) through 2009. The HAGM is a groundwater model that is useful for demonstrating the nature of the effects of production from the designated hydrostratigraphic units within the Gulf Coast aquifer system.

Texas Water Code Provisions

Certain provisions of Chapter 36 of the Texas Water Code require that hydrologic factors be considered in the regulation and management of groundwater including the designation of desired future conditions. Importantly, "groundwater reservoir" and "subdivision of groundwater reservoir" are defined in Section 36.001:

> Sec. 36.001. DEFINITIONS.
> 36.001(6) "Groundwater reservoir" means a specific subsurface water-bearing reservoir having ascertainable boundaries containing groundwater.
> 36.001(7) "Subdivision of a groundwater reservoir" means 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.

In 1949, the State first promulgated statute authorizing the creation of groundwater conservation districts. This early statute included definitions of groundwater reservoir and subdivision of a groundwater reservoir. In 1949 to today, variations of these definitions have been present in State statutes to provide guidance in identifying the most suitable areas for regulation of groundwater and the delineation of groundwater management areas. These definitions underscore the role of science in developing rational and sound groundwater management programs.

Today, many other provisions in Chapter 36 emphasize the importance of a groundwater reservoir or subdivision of a groundwater reservoir. Section 36.0015 states the purpose of groundwater regulation and groundwater management in the State. This section stresses the importance of groundwater reservoirs and groundwater reservoir subdivisions and the use of the best available science:

> Sec. 36.0015. PURPOSE. (a) In this section, ***"best available science"*** means conclusions that are logically and reasonably derived using statistical or quantitative data, techniques, analyses, and studies that are publicly available to reviewing scientists and can be employed to address a specific scientific question.
> (b) In order 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, Texas Constitution, groundwater conservation districts may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management in order to protect property rights, balance the conservation and development of groundwater to meet the needs of this state, and use the ***best available science*** in the conservation and development of groundwater through rules developed, adopted, and promulgated by a district in accordance with the provisions of this chapter. [Emphasis added]

Section 36.101 provides authority to groundwater district to make and enforce rules that apply to groundwater reservoirs and groundwater reservoir subdivisions:

> Sec. 36.101. RULEMAKING POWER. (a) A district may make and enforce rules, including rules limiting groundwater production based on tract size or the spacing of wells, to provide for conserving, preserving, protecting, and recharging of the groundwater or of ***a groundwater reservoir or its subdivisions*** in order to control subsidence, prevent degradation of water quality, or prevent waste

of groundwater and to carry out the powers and duties provided by this chapter.
(4) consider the public interest in conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of ***groundwater reservoirs or their subdivisions***, and in controlling subsidence caused by ***withdrawal of groundwater from those groundwater reservoirs or their subdivisions***, consistent with the objectives of Section 59, Article XVI, Texas Constitution; [Emphasis added]

Section 36.117(h) states a groundwater district may require well construction provisions to protect groundwater reservoirs:

36.117(h) A district shall require the owner of a water well to:
(2) equip and maintain the well to conform to the district's rules requiring installation of casing, pipe, and fittings to prevent the escape of groundwater from a ***groundwater reservoir to any reservoir not containing groundwater*** and to prevent the pollution or harmful alteration of the character of the ***water in any groundwater reservoir***. [Emphasis added]

Further, groundwater districts are provided authority to install equipment for the recharge of a groundwater reservoir or groundwater reservoir subdivision:

Sec. 36.103. IMPROVEMENTS AND FACILITIES. (a) A district may build, acquire, or obtain by any lawful means any property necessary for the district to carry out its purpose and the provisions of this chapter.
(b) A district may:
(4) install pumps and other equipment necessary to recharge a ***groundwater reservoir or its subdivision***; [Emphasis added]

And to conduct surveys of groundwater reservoirs and groundwater reservoir subdivisions:

Sec. 36.106. SURVEYS. A district may make surveys of the ***groundwater reservoir or subdivision*** and surveys of the facilities in order to determine the quantity of water available for production and use and to determine the improvements, development, and recharging needed by a ***reservoir or its subdivision***. [Emphasis added]

Authorization is provided to a district to collect any information regarding the practicability of recharging a groundwater reservoir:

> Sec. 36.109. COLLECTION OF INFORMATION. A district may collect any information the board deems necessary, including information regarding the use of groundwater, water conservation, and the practicability of recharging a ***groundwater reservoir***. [Emphasis added]

Chapter 36 contains important provisions in the establishing desired future conditions and in the regulation of groundwater to achieve desired future conditions. Section 36.108(d-1) states the following:

> 36.108(d-1) The districts may establish different desired future conditions for:
> (1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or
> (2) each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area.

Looking at Section 36-108(d-1)(1), aquifer and subdivision of an aquifer are defined by statute. The term geologic strata is well accepted as describing a layer of the subsurface geology with internally consistent characteristics so as to distinguish the layer from other adjoining geologic layers.

Section 36-108(d-1)(2) introduces a new term "geographic area" which is not defined in statute. However when considering statutory construction and a consistent State history, the regulatory powers and duties placed on groundwater districts it is necessary for geographic area is to have a hydrological basis. The long standing and clear definitions of groundwater reservoir and groundwater subdivision reflect this need for a hydrological basis.

Additionally, certain provisions in Chapter 36 indicate clearly that groundwater district regulatory programs are bound to the enforcement of rules designed to achieve the established DFCs. The statutory provisions reflect that the establishing of DFCs is not just a water planning exercise. Desired future conditions are essential elements for the adoption of rules and development of a groundwater district's management plan. Sections 36.1071, 36.108(4), 36.1082(6), 36.1082(7), 36.1085, 36.3011(5),36.3011(6) and 36.3011(7) all reference desired future conditions and enforcement of rules:

Sec. 36.1071. MANAGEMENT PLAN. - (8) addressing the desired future conditions adopted by the district under Section 36.108.

Sec. 36.108. JOINT PLANNING IN MANAGEMENT AREA.
(4) the degree to which each management plan achieves the desired future conditions established during the joint planning process.

Sec. 36.1082. PETITION FOR INQUIRY. -
(6) a district fails to update its rules to implement the applicable desired future conditions before the first anniversary of the date it updated its management plan with the adopted desired future conditions;
(7) the rules adopted by a district are not designed to achieve the desired future conditions adopted by the management area during the joint planning process;

Sec. 36.1085. MANAGEMENT PLAN GOALS AND OBJECTIVES. Each district in the management area shall ensure that its management plan contains goals and objectives consistent with achieving the desired future conditions of the relevant aquifers as adopted during the joint planning process.

Sec. 36.3011. COMMISSION ACTION REGARDING DISTRICT DUTIES. -
(5) the district has failed to update its management plan before the second anniversary of the adoption of desired future conditions by the management area;
(6) the district has failed to update its rules to implement the applicable desired future conditions before the first anniversary of the date it updated its management plan with the adopted desired future conditions;
(7) the rules adopted by the district are not designed to achieve the desired future conditions adopted by the management area during the joint planning process;

These statutes indicate that the established desired future conditions are fundamentally important in the regulation and management of groundwater in the State of Texas.

It is obvious from the statutory requirements listed above that available hydrogeologic knowledge and the best available science must be carefully considered when establishing desired future conditions. Furthermore, the zones to which desired future conditions apply must be appropriate for groundwater districts to carry out the powers and duties provided by Chapter 36.

The Gulf Coast Aquifer Within GMA 14

General Hydrogeology

The Gulf Coast aquifer is one of the most extensive aquifers in Texas. Extending from the Rio Grande northeastward to the Louisiana Texas border, the Gulf Coast aquifer provides water to all or parts of 54 counties. Municipal and irrigation uses account for 90% of the total use from the aquifer. The greater Houston metropolitan area is the portion of the aquifer with the largest municipal use. In GMA 14, total use from the Gulf Coast aquifer has historically been as high as 700,000 to 800,000 acre-feet per year.

The Gulf Coast aquifer is comprised of related geologic and hydrogeologic (or hydrostratigraphic) units consisting primarily of gravels, sands, silts, and clays. Sands and gravels constitute the most important water bearing units. Within GMA 14, the sands of the Gulf Coast aquifer are segregated into four major hydrogeologic units. From shallowest to deepest these are the Chicot aquifer, the Evangeline aquifer, the Burkeville confining layer, and the Jasper aquifer. The aquifers are recharged by precipitation and any streamflow losses in outcrop areas. Generally, the water bearing beds dip beneath the land surface towards the Gulf of Mexico, except in localized areas where salt domes or growth faults can cause reversals of dip or thickening or thinning of beds. The oldest units crop out in the northwest areas, while the younger beds crop out at successively lower elevations towards the Gulf of Mexico. Figure 2 depicts the extent of the individual aquifer outcrops in relation to GMA 14.

Within the Chicot and Evangeline, individual clay beds are generally not continuous. Individual thin beds of sand are interbedded with thin beds of clay. The sands are thought to be connected laterally and vertically with other beds of sand such that a certain amount of vertical groundwater movement can occur and the individual sand beds behave more like a single hydrogeologic unit. Conversely, the sand beds within the Jasper can behave more like distinct hydrogeologic units, and the individual sand beds of the Jasper are hydraulically separated from the Evangeline by the Burkeville confining layer consisting of large thicknesses of clay. Vertical groundwater movement between the Jasper and Evangeline strata is quite limited.

Type of Aquifers

Over most of their extents, the four hydrogeologic units comprising the Gulf Coast aquifer exist under artesian pressure conditions. Flowing wells were common during the early phases of groundwater development. The more significant withdrawals are from wells tapping sands under artesian conditions. Because of the groundwater withdrawals, widespread reductions in artesian pressure have occurred, and must occur. Understanding that artesian pressure declines always result from groundwater withdrawals in an artesian aquifer is to understand one of the most basic principles of groundwater science. Furthermore, the total artesian pressure decline is the result of the sum of pressure declines from all hydraulically connected pumping.

The sand rich beds within the Gulf Coast aquifer are the primary water bearing units. The sands typically have moderate permeabilities and total thickness of sand in the Gulf Coast aquifer can range up to more than 1,000 feet thick. These factors and the depth of the sands result in very favorable yield and groundwater availability characteristics.

Boundaries of the Aquifers

The boundaries of each aquifer include the shallowest boundary (northwestern), the deepest boundary (southeastern), and the two lateral boundaries (southwestern and northeastern). The shallowest northwestern most extent can be determined by the corresponding geologic units as shown on geologic maps. Figure 2 shows this northwestern boundary for each of the hydrostratigraphic units. The deepest, southeastern-most extent of each unit can be defined as the limit of usable groundwater, from a water quality standpoint, in the deep subsurface. As defined in the HAGM, the deepest, southeastern-most boundaries of the aquifers are defined as the down-dip limits of usable water (<10,000 mg/L of total dissolved solids).

Laterally, the Gulf Coast aquifer represents a continuous, unbroken hydrogeologic unit across Texas and extending all the way to Florida. Pursuant to legislative directive, the Texas Water Development Board was tasked with designating groundwater management areas for all major and minor aquifers in the state. For the Gulf Coast aquifer, the TWDB identified GMA 14, GMA 15, and GMA 16 as the most suitable areas for management of the groundwater resources. These areas were selected based on groundwater use, groundwater quality, the existence of interpreted groundwater divides and other factors. It was beyond the scope of this study to ascertain all of the hydrogeologic conditions that exist along the boundary between GMA 14 and GMA 15, and the reasonableness of this delineation. For purposes of this study, it is assumed that the boundary identified by the TWDB between GMA 14 and GMA 15 represents a reasonable boundary of an aquifer subdivision and that discernable differences in the nature of the producing sands and other characteristics exist along this boundary. For each hydrogeologic unit of the Gulf Coast aquifer in GMA 14, at a minimum, the southwestern lateral boundary is the boundary between GMA 14 and GMA 15, and the northeastern most boundary is the state boundary between Texas and Louisiana.

Variation and Importance of Zones

The various strata within the Gulf Coast aquifer have different degrees of importance as water supply sources. The primary strata for water supply development are the Chico, Evangeline, and Jasper aquifers.

The Burkeville is relatively insignificant for water supply purposes. The effects of production due to groundwater withdrawals also vary depending on the strata. Generally, all of the hydrogeologic units primarily exist under artesian conditions downdip from the outcrop (Figure 2). The Chico and Evangeline transmit water vertically more readily than the Burkeville confining zone. In addition, the clay lenses which exist in the Chico and Evangeline can experience compaction due to groundwater withdrawal and cause land-surface subsidence. The Jasper aquifer is segregated from the overlying Chicot and Evangeline by the Burkeville confining zone. The clays of the Jasper are believed to not be susceptible to the effects of compaction (USGS, HAGM). Hence, land-surface subsidence is not indicated as the result of groundwater withdrawals in the Jasper aquifer.

Accordingly, the most important hydrostratigraphic zones for defining desired future conditions are the Chicot, Evangeline and the Jasper aquifers.

General Development, Use, and Availability

The 2010 withdrawals from the Gulf Coast aquifer within GMA 14 are shown on Figure 3 for each of the hydrostratigraphic units. Approximately 700,000 acre-feet were withdrawn from the aquifer in 2010, most of which was for municipal use. Accordingly, the locations of withdrawal for municipal use generally correlate to population density. About 60,000 acre-feet/year of withdrawals support manufacturing use, and about 55,000 acre-feet/year are used for irrigation purposes primarily located in rural areas of the southwestern part of GMA 14.

Groundwater use is projected to increase in many areas of GMA 14. The largest increases are projected within the Evangeline and Jasper as the permeability, distribution, quality and depth of the producing sands in these aquifers are favorable for increased withdrawals. It is likely, as metropolitan areas grow, that conversion of irrigation to municipal use will also occur.

Effects of Production

Production of groundwater from a well in the Gulf Coast aquifer causes a cone of depression in water levels or artesian pressures in water bearing sands that grows downward and outward with pumping time. In water table areas, the cone of depression has a relatively small extent because the water is supplied by the draining of sands (pore water storage) in the vicinity of the well. Under artesian conditions, which prevail throughout most of the Gulf Coast aquifer, the sands remain fully saturated in the vicinity of pumping wells. The artesian pressure declines do not reflect depletion of pore water storage or "mining" of the aquifer. The pressure declines are caused from the resistance to movement of water through the sands. The pressure declines are transmitted relatively rapidly over larger areas. Ultimately, the pressure declines reflect the hydraulic gradient required to transmit water from sources of recharge to the pumping wells.

When artesian pressure is reduced in the Chicot or the Evangeline aquifers, compaction of unconsolidated clay layers can occur. This consolidation represents a depletion of pore water storage within the individual clay layers. This compaction provides a source of water that tends to suppress the growth of the artesian pressure cone. But the compaction provides only a one-time source of supply. Eventually, new sources of water must be found to support an ongoing withdrawal and the expansion of the artesian pressure cone will continue. This expansion continues until the reductions in artesian pressure encounter water table conditions. When this occurs, groundwater drains from pore water storage in the outcrop zone. The depletion of storage in the water table outcrop can provide the opportunity for recharge that was previously discharged via evaporation, transpiration, or through seeps and springs to now be redirected to the pumping well.

The source of all produced groundwater must come from some combination of depletion of storage and capture of recharge. But, it is vitally important to understand that the initiation and production of pumping from any new well must first cause a reduction in aquifer storage. Recharge cannot be captured by a well without a depletion of storage. It is the reduction of water table storage, and not artesian storage, which begins the process for increased recharge to subsequently sustain production through time.

Example Pressure Declines From a Well Field

To portray the magnitude and spatial extent of artesian pressure declines due to withdrawal from the Gulf Coast aquifer, example calculations have been made of representative declines in the Jasper aquifer due to pumping from a hypothetical well field. The HAGM model was used for these calculations. The assumed well field production rate is 20,000 ac-ft per year and no other groundwater withdrawals are included in the calculations.

Figures 4 through 7 show the progression of the reductions in artesian pressure with continuation of pumping time. From the initiation of pumping to an elapsed pumping time of one year the changes in artesian pressure radiate outwards until they encounter water table conditions in the aquifer outcrop. At this time, there begins a slow and gradual reduction of pore water storage in the outcrop which occurs over a large, expanding area. This reduction of the water table causes a reduction in natural discharge (evaporation, transpiration, seeps and springs). By reducing natural discharge, recharge is "captured" and now available to move towards the well field. Comparing longer pumping durations, between 1 year and 50 years for example, there is a continual expansion of the artesian pressure reduction in the down-dip artesian zone and a correspondingly larger area of outcrop that is now contributing recharge to move water towards the well field. This indicates that the recharge rate available to the well field is not constant through time, but rather increasing through time. The recharge rate continues to increase beyond a pe[illegible] of 50 years. The importance of this example is that changes to an aquifer's water table storage occur over periods of decades and centuries, while on a relative basis changes in artesian pressure occur very rapidly.

Similar aquifer responses would occur by groundwater withdrawals, located equidistant from the outcrop, throughout GMA 14. Additionally, the effects of multiple wells or well fields are additive. Figure 7 shows the regional scale of effect of production and the corresponding importance of including a sufficiently large area, consistent with present and potential future pumping and the resulting effects of such production, in designating the most suitable area for the adoption of a DFC.

Present Simulated Jasper Flow Directions

Figure 8 shows the HAGM simulated potentiometric surface contours and associated aquifer flow directions of the Jasper aquifer for the year 2010. As shown, the response of the aquifer to pumping is regional and spans many counties, and demonstrates the unreasonableness of managing a dipping, artesian aquifer like the Jasper on a county-by-county basis.

Proposed Desired Future Conditions for the Gulf Coast Aquifer Within GMA 14

Evaluation of GMA 14 Proposed Desired Future Conditions

By Resolution No. 2015-01, GMA 14 adopted proposed DFCs for each formation of the Gulf Coast aquifer. The groundwater districts in GMA 14 state that "The proposed DFCs approved by the district representatives of GMA 14 are described in terms of acceptable drawdown levels for each subdivision of the Gulf Coast aquifer, including the Chico, Evangeline, Burkeville, and Jasper, for each county located within GMA 14, or in land-surface subsidence, as applicable." Resolution No. 2015-01 is included in Appendix A.

As stated, the description of the GMA 14 proposed DFC's is scientifically inaccurate and misleading. Technically, the Chicot, Evangeline, Burkeville, and Jasper are individual hydrostratigraphic units of the Gulf Coast aquifer. The DFCs are described for each hydrostratigraphic unit by county, and each county in GMA 14 does not qualify as a valid aquifer subdivision as defined in Chapter 36.

The DFCs adopted by GMA 14 were developed by "assuming demand by county", and then calculating the effects of the assumed demands using the HAGM model. As stated in the GMA 14 meeting minutes dated June 26, 2013, GMA 14 consultants advised the GMA 14 representatives that "the most direct method would be to review the pumpage figures and projected demand for each entity and once agreed upon, put those numbers into the model and determine the resulting DFCs." The pumpage figures by entity were represented by groundwater withdrawals by aquifer in each county. Subsequently, the proposed DFCs were just reported from the model results. After the DFCs were calculated, the GMA 14 consultants suggested that they would be "taken through a process of nine points of consideration before finally voting on proposed DFCs".

The DFCs represent mostly change in artesian pressure within each county in GMA 14. Oddly, additional DFCs of feet of land-surface subsidence are designated for only each county in the Bluebonnet Groundwater Conservation District. Figure 9 shows the adopted land-surface subsidence for each of these four counties. It is remarkable that the designated DFCs for land-surface subsidence vary to such degree. The variations are over short distances relative to the extents of the subject aquifers and the remaining counties in GMA 14 have no land-surface subsidence criteria. GMA 14 has presented no information to justify these disparities, and it appears that the criteria are simply adopted model outputs rather than specific requirements necessary to be enforced via variable regulations by county.

The GMA 14 proposed DFCs do not follow the natural hydrogeologic boundaries of the Gulf Coast aquifer. Instead, they follow the 20 county boundaries within GMA 14. These political subdivision boundaries have no relationship to the geohydrology of the Gulf Coast aquifer. These political boundaries fail to meet the definition of a "subdivision of the Gulf Coast aquifer" as groundwater withdrawals in one county can and will appreciably affect the water supply in adjacent counties. This is because of the continuous extent of the individual aquifers across these political boundaries and the artesian characteristics of the important water-bearing units within the Gulf Coast aquifer. Groundwater withdrawals from wells under artesian conditions create wide-spread cones of reduced artesian pressure, and effects on underground water supply can be created by adjacent developments. The future demands projected by GMA 14 include greater use in many areas of GMA 14 and these new projected uses can and will affect the water supply over many counties.

Neither the size nor configuration of the small, politically-based, proposed DFC areas are appropriate for the performance and duties of regulating aquifers and their subdivisions as authorized by Chapter 36. Their small size and lack of a hydrogeologic relationship render them ineffective for the purpose stated in Section 36.101 "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"***,and "in order to protect property rights, balance the conservation and development of groundwater to meet the needs of this state, and use the ***best available science*** in the conservation and development of groundwater". [Emphasis added] The same is true about the rulemaking authority of the districts to make and enforce rules, including rules limiting groundwater production based on tract size or the spacing of wells, to provide for conserving, preserving, protecting, and recharging of the groundwater or of ***a groundwater reservoir or its subdivisions***. [Emphasis added] And it is especially true with respect to providing for the spacing of water wells and the regulation of the production of wells in order to minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure.

The small areas for the designation of desired future conditions are significantly handicapped by the hydrogeologic realities of the Gulf Coast aquifer. They are simply too small and covered too limited of a part of the aquifer to be effective in a comprehensive management approach. Pumping outside of one small DFC area could effectively make management within an adjoining DFC area impossible or to no avail. It is not feasible to regulate groundwater production in a manner to achieve the proposed desired future conditions and also equally protect the rights of private property owners. Monitoring of the aquifer to demonstrate the desired future conditions are being achieved is also not practicable or feasible. This is partly evident by looking at monitoring activity conducted within GMA 14 to date. Over the past five years, the representatives of GMA 14 have published no studies of aquifer monitoring activity demonstrating that the desired future conditions adopted in the last round of joint planning are being achieved.

Another remarkable outcome of the reverse-engineered DFC process used by GMA 14, is the fact that when the GMA 14 representatives "approved" the original pumpage by county numbers, the GMA 14 representatives actually ***chose the Modeled Available Groundwater (MAG) before ever knowing what the adopted desired future conditions would be***. This approach used by GMA 14 does not follow the most basic and commonly used procedures for determining groundwater availability as practiced in the State of Texas by many public and private professionals for many decades. Examples of these methods include the trough method, managed depletion, and other hydrologically based analyses. GMA 14 actions are not an application of the "best available science" to balance the conservation and development of groundwater to meet the needs of the State while protecting private property rights. Finally, Chapter 36.116 does not authorize groundwater districts to allocate groundwater, via appropriation, to political subdivision areas of counties.

In summary, the boundaries of the DFC areas designated by GMA 14 are solely delineated along county boundaries. The selected political-based boundaries do not coincide with the known aquifer boundaries and they do not constitute boundaries of aquifer subdivisions. As such, the selected boundaries are not suitable for the enforcement of rules to achieve the DFCs, while also providing for the fair and impartial protection of property rights. The adopted DFCs do not represent a use of the best available science for the purpose of striking a balance between conservation and development of groundwater for each common aquifer within GMA 14. Only by having a designated DFC area that is consistent with the hydrogeologic conditions, present groundwater development, and potential for future use is it possible to reasonably ensure that the selected area for establishing a desired future condition encompasses the "common" aquifer. Regulating and managing all of the common aquifer, as demonstrated by the State's groundwater management history since 1949, is necessary for many of the statutory provisions included Chapter 36.

Consideration of Alternative Desired Future Conditions

Identification of Most Suitable Area for Designation of Desired Future Conditions

The hydrogeologic considerations presented earlier in this report must be evaluated to provide the most suitable areas for designating a desired future condition. These hydrogeologic considerations include identifying the type of aquifer, the natural and lateral boundaries of the aquifer, the variations and importance of different zones, patterns of existing use and the potential for future use, and the nature of effects that occur due to groundwater withdrawal in the aquifer.

Texas Section 36.108(d-1) of the Texas water code states:

> 36.108(d-1) The districts may establish different desired future conditions for:
> (1) each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or
> (2) each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area.

The boundaries of the aquifers in the State are well established through decades of research and effort by numerous professionals. The concept of an aquifer subdivision is also well established in Texas groundwater history. As shown in Figures 4 through 8, production from a single well field, or multiple well fields can affect large areas within GMA 14. As stated earlier, both the Gulf Coast aquifer and the Chicot, Evangeline, and Jasper aquifers exist to each lateral boundary of GMA 14. Therefore, Section 36.018(d-1)(1) can be clearly applied for determining the boundary for adopting a DFC.

Geographic area is not defined in Chapter 36. It is unclear how any geographic area located "in whole or in part of an aquifer or aquifer subdivision" could be used as an appropriate area for managing an aquifer to achieve a DFC. By definition, the groundwater conditions within a geographic area that is smaller than an aquifer subdivision can be appreciably affected by withdrawing water from outside the geographic area. Therefore, groundwater conditions within the geographic area are dependent upon the nature of withdrawal of groundwater and the rules and regulation of production located both within and outside the geographic area. This dependency issue quickly gives rise to scientific dilemmas for definitive analysis and enigmas in regulations.

The scientific problems are these. A physical principle in hydrologic analysis is the idea of the conservation of mass, i.e. water cannot be created or destroyed out of thin air, but rather the changes in volume (storage) of water must be accounted for in an analysis of a hydrologic system. To facilitate such analysis, a box is drawn around the region of the earth to be analyzed. Next, the water flowing in and the water flowing out of the box must be properly accounted for in order to calculate what occurs inside. This inflow-outflow accounting is an application of the continuity equation of hydrology. When considering the spatial extent and magnitude of effects of production (Figures 4 through 8) and the wide variability of where future wells will actually be drilled and produced, it becomes apparent that many different future scenarios exist for future effects. Small geographic areas cannot properly account for, or predict, the many different possible inflows and outflows that could occur at their boundaries, because of the extents of effect of production and the randomness of where future wells will really be located. Even a slight shifting of pumpage within a county can affect the change in artesian pressure across adjacent and more distant counties.

Alternatively, the definition of aquifer subdivision more naturally follows the continuity principle. One doesn't have to look far to see a living example, which is the design of the HAGM by the USGS and its implementation by both the TWDB and GMA 14. The boundaries of this model were chosen in consideration of hydrologic continuity and to minimize the necessity for assumptions in the inflow and outflow of the model. More robust analysis is possible when the boundaries of a hydrological system are properly chosen.

Even the Texas Supreme Court has stated that hydrogeologic considerations are necessary for the regulation of groundwater. In Edwards Aquifer Authority v. Day, the Texas Supreme Court stated "one purpose of groundwater regulation is to afford each owner in a ***common, subsurface reservoir*** a fair share". [Emphasis added] The word "common" is consistent with the continuity principle of hydrology, and is consistent with the long standing provisions of the Texas Water Code which have purposefully recognized that a reservoir (aquifer) or the subdivision of a reservoir (aquifer) are the most suitable areas for managing the State's underground resources.

In consideration of the enumerated hydrogeologic considerations and the controlling scientific principles, at a minimum the most suitable area for the adoption of a DFC in the Gulf Coast aquifer is the area encompassed by the northwestern most extent of the aquifer's outcrop, the deepest southeastern usable portion of the reservoir, and laterally boundaries delineated by the boundary between GMA 14 and GMA 15 and the state boundaries of Texas and Louisiana.

Identification of Most Suitable Management Concern for Desired Future Conditions

By definition, a desired future condition is a hydrologic characteristic of an aquifer that can be affected by groundwater withdrawal. By looking at the effects of withdrawals, candidate management criteria can be identified. In the Gulf Coast aquifer within GMA 14, the initial effects of production are primarily reductions of artesian pressure in down-dip zones. These reductions of pressure do not represent reductions of pore water storage and the reductions of pressure will not sustain continued production over the long term without subsequent capture of recharge. The capture of recharge requires reductions of storage in the aquifer water table and a lowering of the water table surface. So the two main effects of production are changes in artesian pressure and subsequent reductions in water table storage.

Changes in artesian pressure are a poor choice for an aquifer management criteria for a variety of reasons. Some of these reasons are:

1) Artesian storage typically represents a miniscule fraction of the Total Estimated Recoverable Storage in the aquifer,
2) Artesian pressure fluctuations can occur relatively rapidly and over wide expanses of an aquifer,
3) Changes in artesian pressure are highly dependent on the locations of groundwater withdrawals which can only partially be controlled via regulation,
4) Artesian pressures are more prone to errors in measurement and trend evaluation making monitoring to demonstrate achieving a DFC less feasible,
5) Artesian pressure levels only indirectly affect the surface/groundwater interactions that occur in the near surface environment,
6) Artesian drawdown typically affects only the wellbore water levels of neighboring wells, thus the changes are mostly economic effects and not environmental in nature.

Changes in aquifer water table storage behave much differently than changes in artesian pressure. Changes in water table storage typically occur gradually. Changes in water table storage directly measure the water budget of the aquifer, and change in water table storage are the controlling factor in the interaction between groundwater and surface water. Often, it is misunderstood that reductions in storage must first occur to develop the flow conditions that create sustainability. The transition from initial aquifer development to the ultimate sustainable aquifer storage condition is a very slow and a long duration process. In the Gulf Coast aquifer, model analysis indicates that less than 1% of the aquifer storage has been depleted since groundwater use began in 1890. Looking to the future, model simulations indicate that storage will be reduced over the next 50 years while the captured recharge rate continues to increase.

Proposed DFC for the Jasper aquifer

In consideration of the regional effect of production in the Jasper aquifer, the area for a desired future condition is the extent of the Jasper within GMA 14, at a minimum. A potential DFC criterion for this area is no less than 98% of the predevelopment storage is to remain in 2070. This would allow for additional development to occur and more fully increase the long term sustainable yield of the Jasper in GMA 14. A limit of 2% of reduction in storage conserves much more of the groundwater than is practiced in other parts of our State. For instance, in the Texas Ogallala the management standards allow for up to 50% or more of the total storage to be depleted over a 50-year period with even larger reductions in storage since predevelopment times.

Proposed DFC for the Chicot and Evangeline aquifers

The most appropriate zone for the desired future condition for the Chicot and Evangeline aquifers is also, at a minimum, the extent of the usable water in these aquifers within GMA 14. While the extent of production from any one well or well field will be less regional than the more confined Jasper, greater and more widespread developments in the Chicot and Evangeline will occur because of the shallower depths and larger aquifer transmissivities. The common area of effect could encompass much of the area of these aquifers in GMA 14. A potential DFC criterion for these aquifers is no less than 99% of the predevelopment storage is to remain in 2070. This storage value is slightly higher than the Jasper in recognition of the large recharge area of the Chicot and the greater degree of hydraulic connection between the Chicot and Evangeline.

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Figure 1. GMA 14 boundary in relation to county and regulatory area boundaries

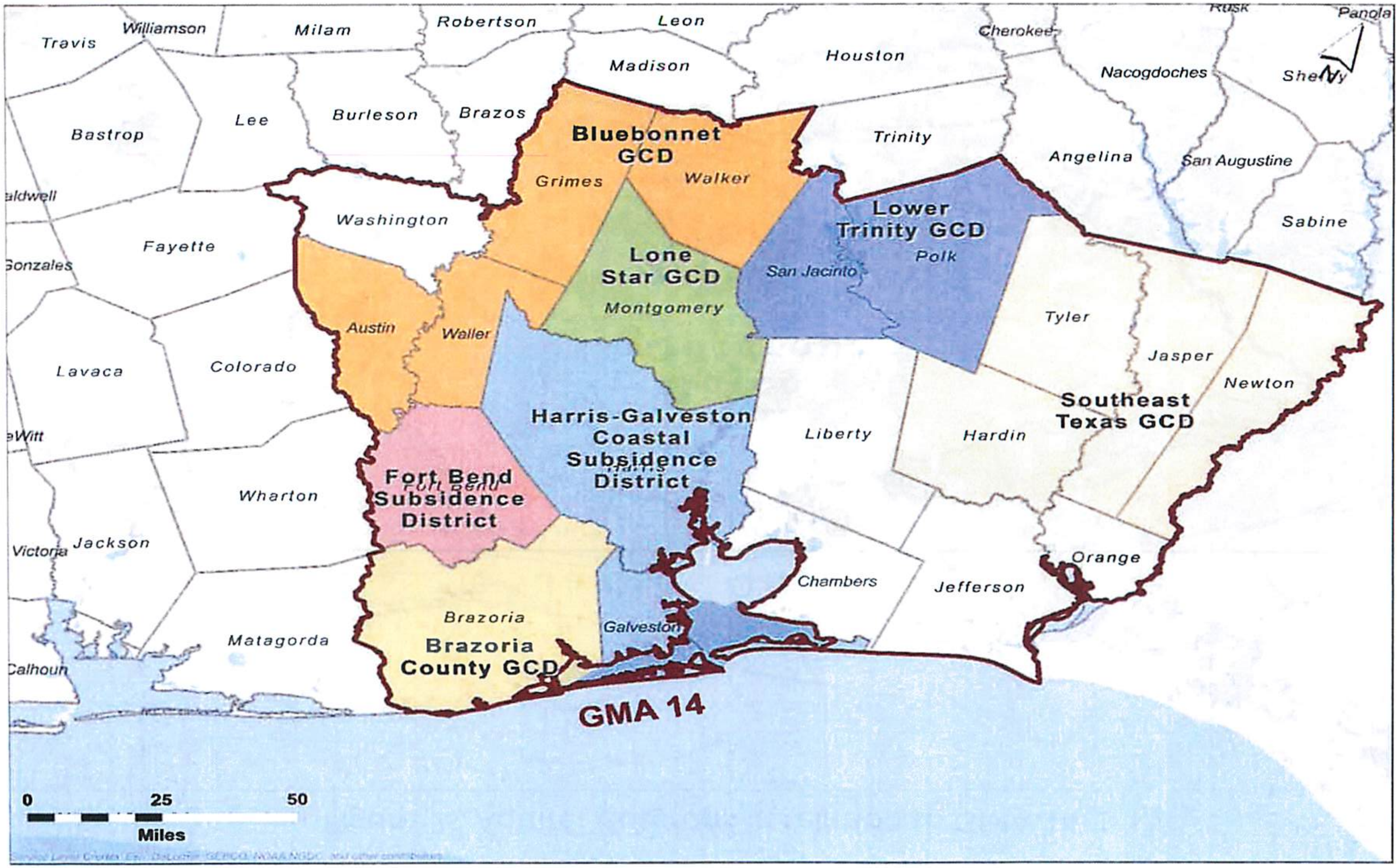


Figure 2. Aquifer outcrops in relation to GMA 14

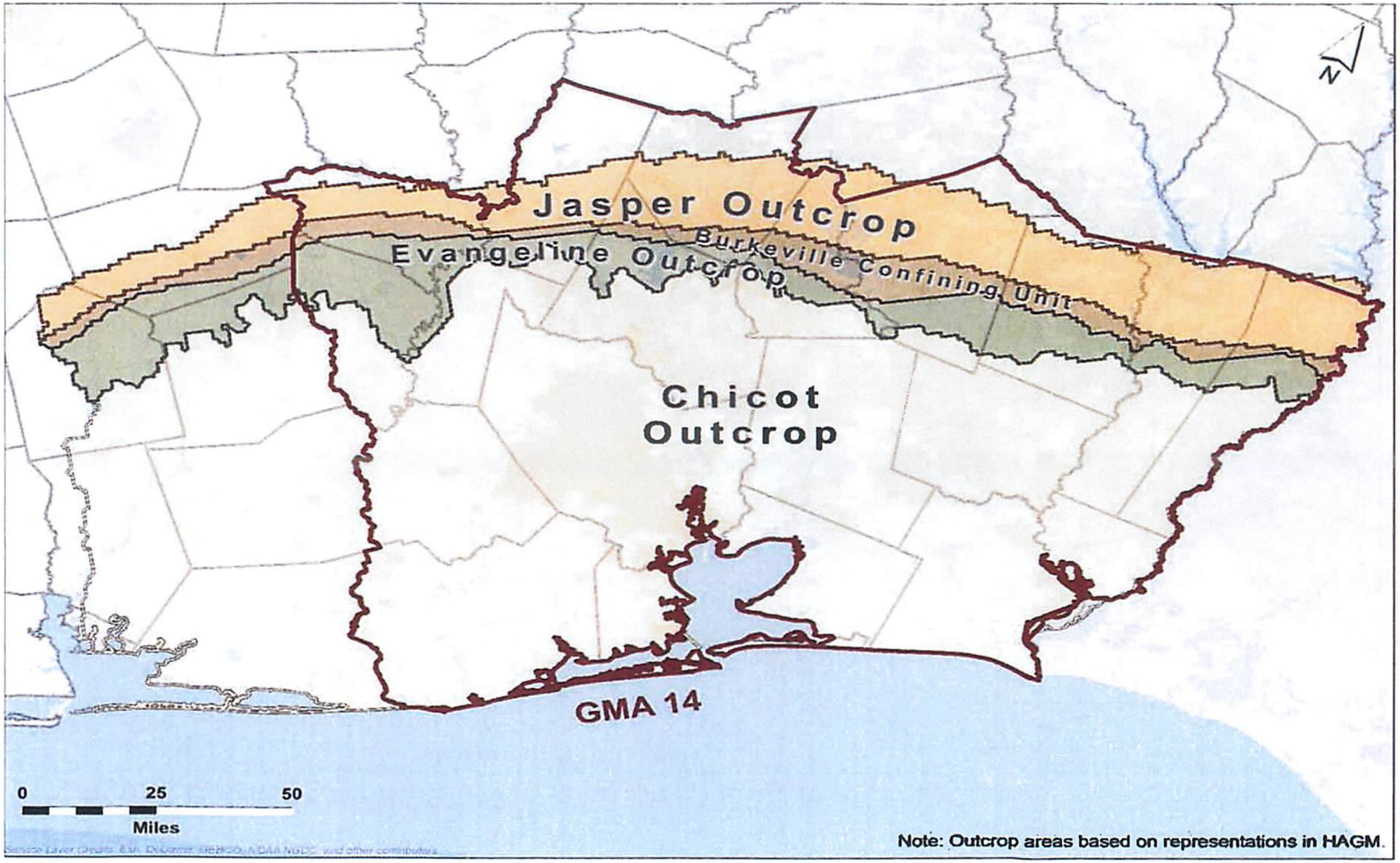
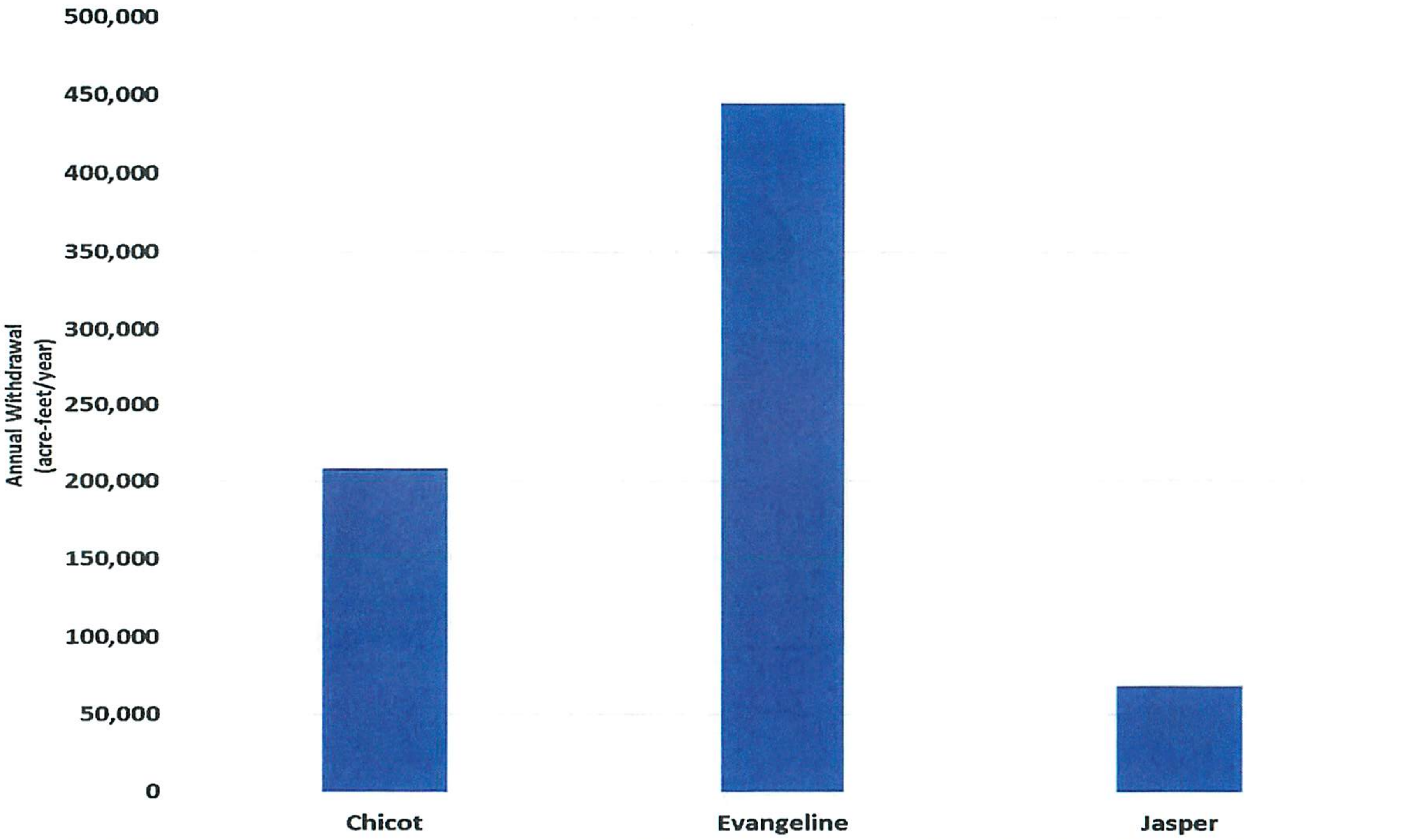


Figure 3. GMA 14 total 2010 groundwater withdrawals from Gulf Coast aquifer



Note: Source of withdrawal rates is HAGM

Figure 4. Simulated change in piezometric head after 1 week of pumping

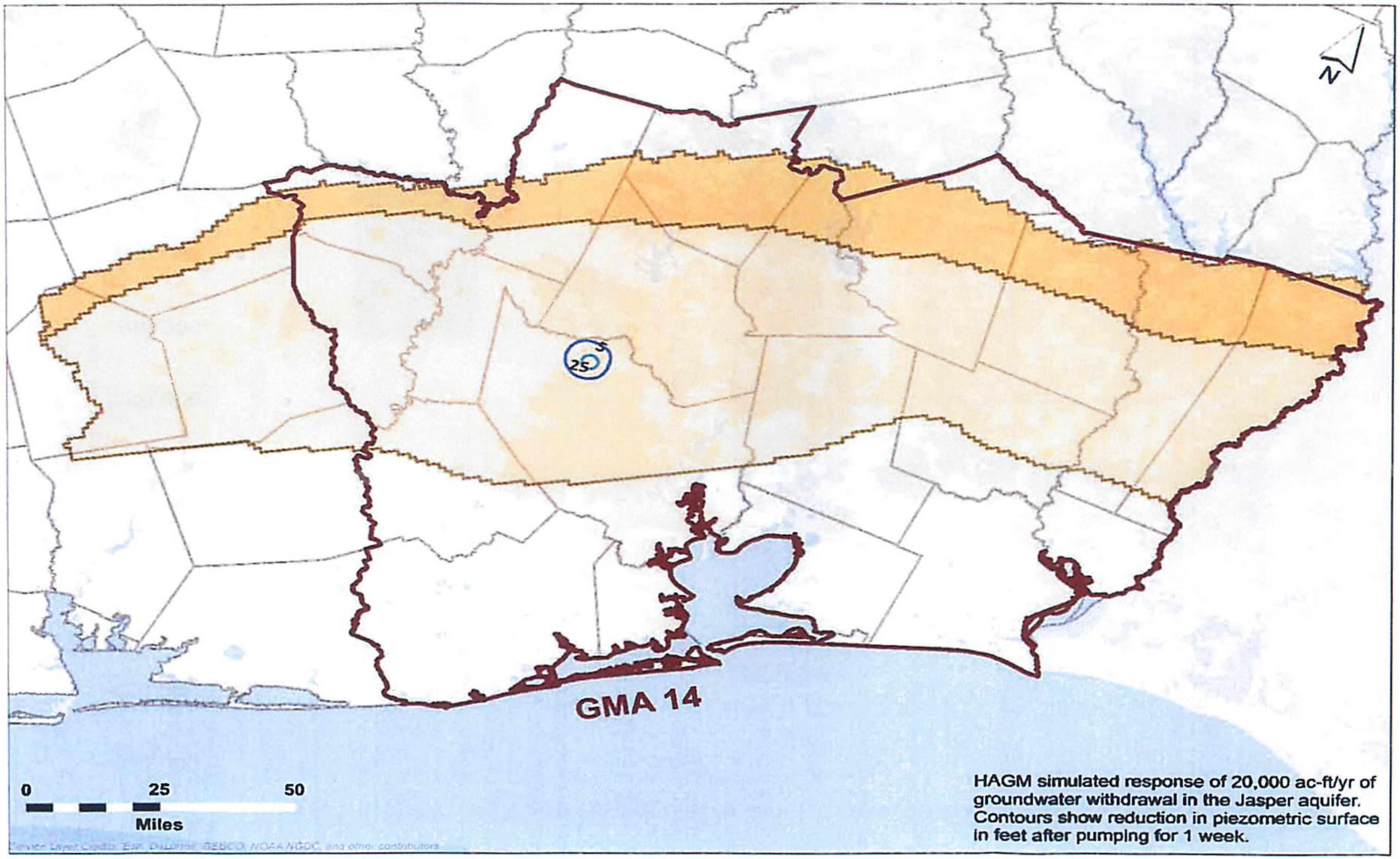


Figure 5. Simulated change in piezometric head after 1 year of pumping

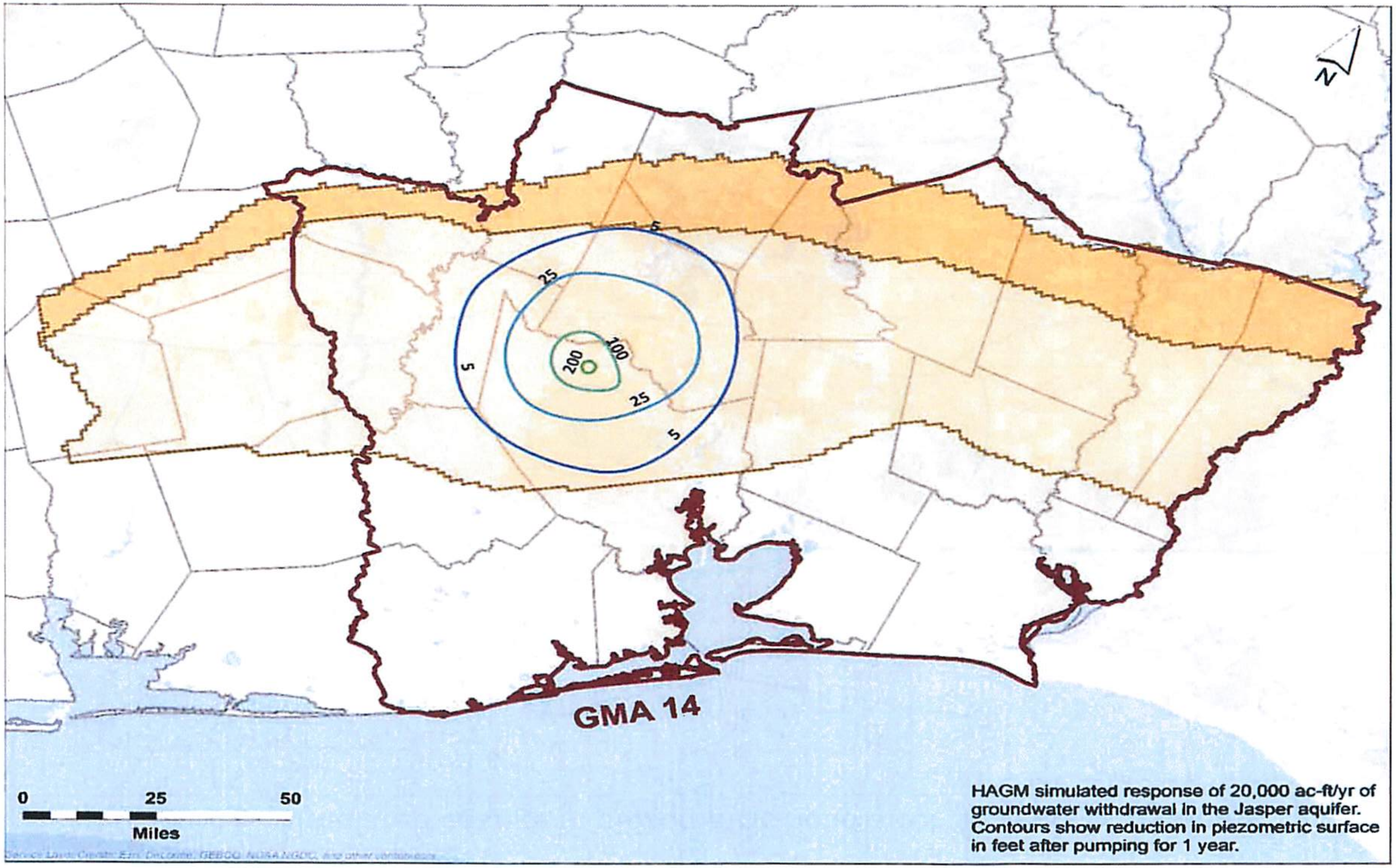


Figure 6. Simulated change in piezometric head after 10 years of pumping

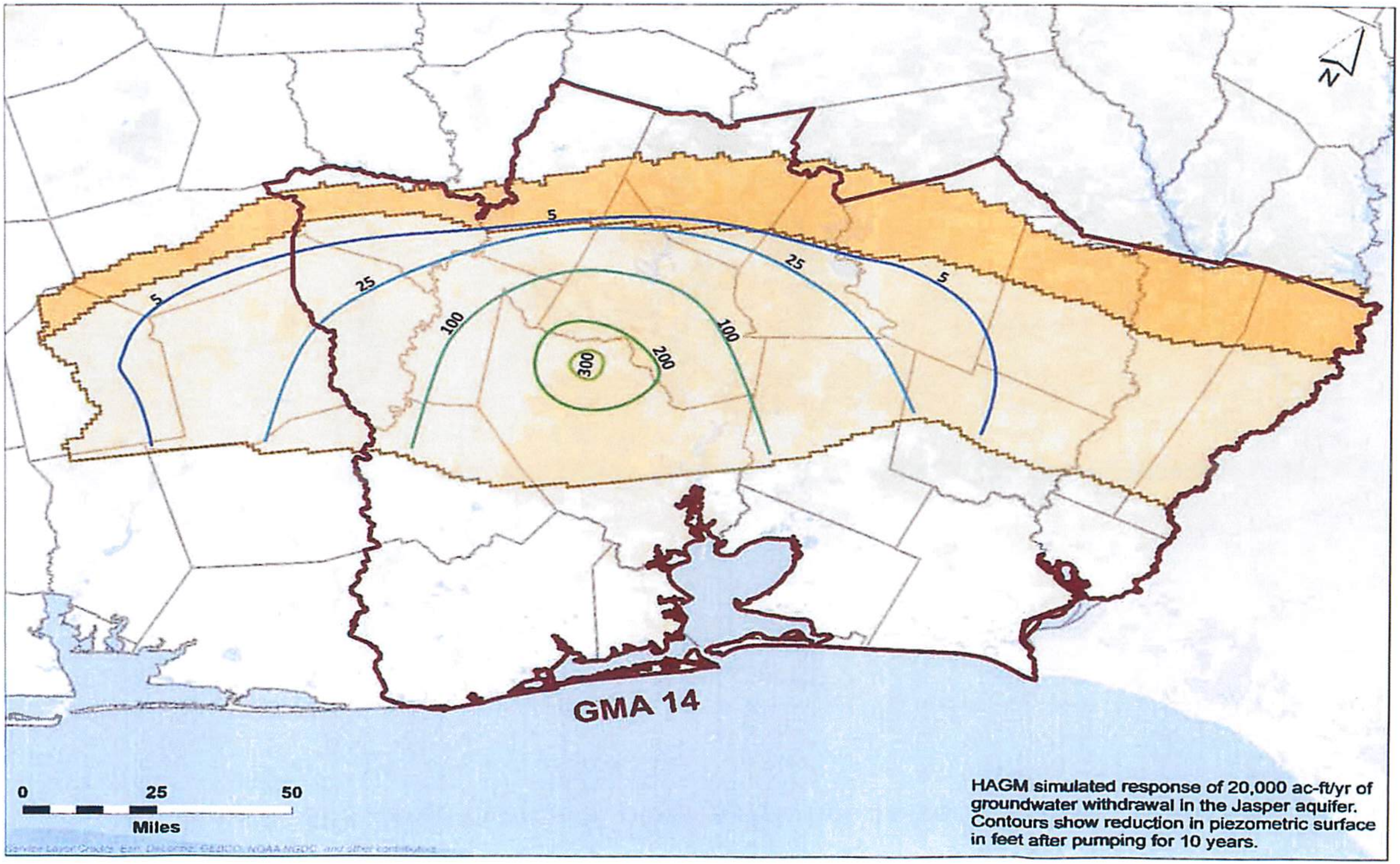


Figure 7. Simulated change in piezometric head after 50 years of pumping

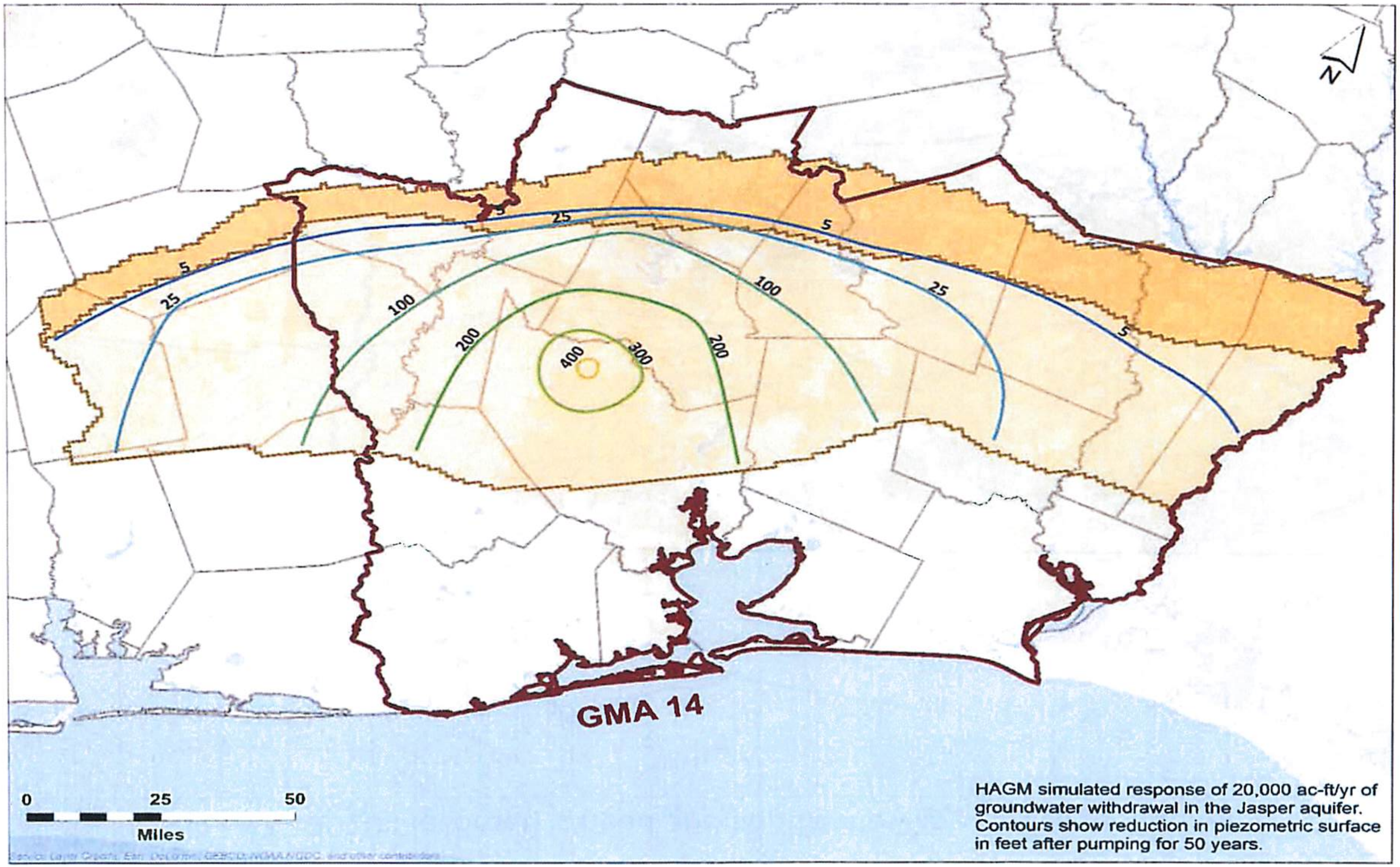


Figure 8. 2010 Piezometric head and aquifer flowlines in Jasper aquifer

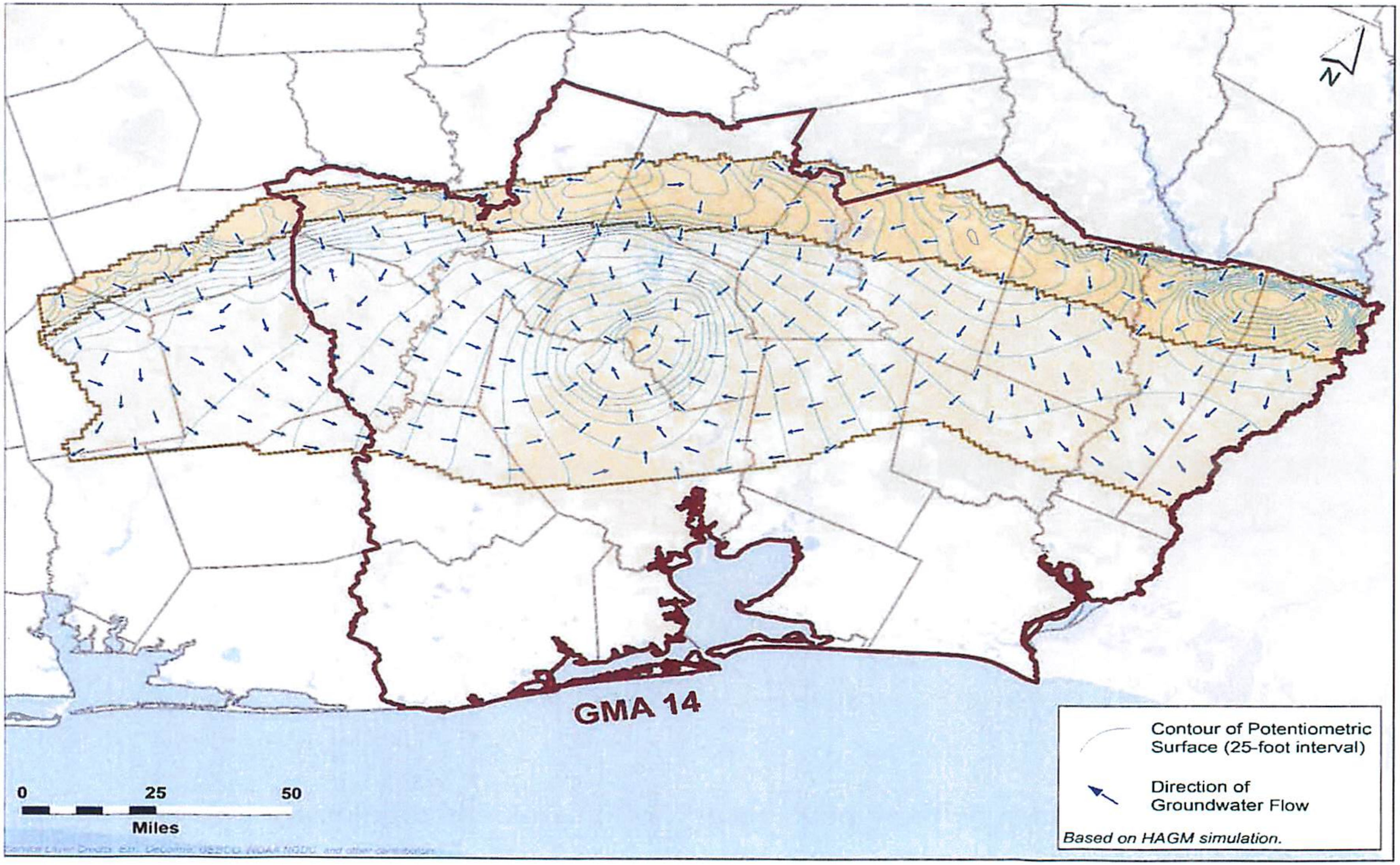
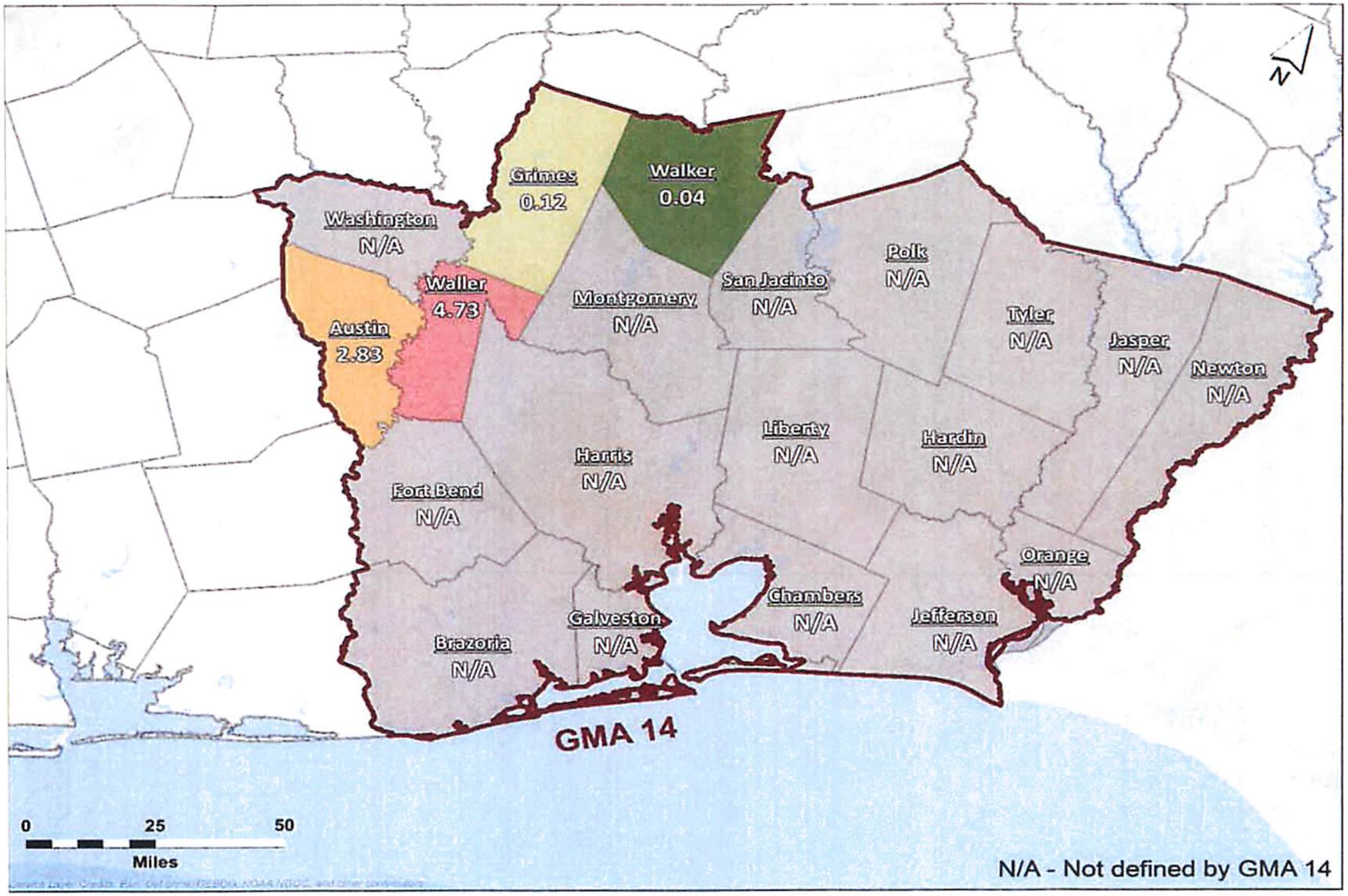


Figure 9. Proposed GMA 14 desired future conditions for land-surface subsidence



Appendix A.

Groundwater Management Area 14
Resolution 2015-01

RESOLUTION FOR THE APPROVAL OF PROPOSED DESIRED FUTURE CONDITIONS FOR ALL AQUIFERS IN GROUNDWATER MANAGEMENT AREA 14

Whereas, pursuant to Section 35.004 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas that, together, cover all major and minor aquifers in the state; and

Whereas, each groundwater management area was designated with the objective of providing the most suitable area for the management of groundwater resources; and

Whereas, through Title 31, Section 356.21 of the Texas Administrative Code, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

Whereas, GMA 14 includes all or portions of areas subject to groundwater regulation by Bluebonnet Groundwater Conservation District (Austin, Grimes, Walker, and Waller counties), Brazoria County Groundwater Conservation District (Brazoria County), Lone Star Groundwater Conservation District (Montgomery County), Lower Trinity Groundwater Conservation District (Polk and San Jacinto counties), and Southeast Texas Groundwater Conservation District (Hardin, Jasper, Newton, and Tyler counties) (the "Member Districts"); and

Whereas, the Member Districts are authorized by Chapter 36, Texas Water Code, to engage in joint planning activities for the coordinated management of the aquifers located in GMA 14, and in that regard, shall establish desired future conditions ("DFCs") for the relevant aquifers within GMA 14; and

Whereas Fort Bend Subsidence District (Fort Bend County), Harris-Galveston Subsidence District (Galveston and Harris counties), and other stakeholders within GMA 14 from Chambers County, and Washington County also contributed to the development of DFCs for GMA 14; and

Whereas, Section 36.108 of the Texas Water Code requires the Member Districts in GMA 14 to consider groundwater availability models and other data or information for the management area and vote on a proposal for the adoption of DFCs for each relevant aquifer within GMA 14 by May 1, 2016; and

Whereas, the Member Districts within GMA 14 secured hydrogeologic and engineering consulting services to provide technical support in their efforts to establish requisite DFCs; and

Whereas, in developing the proposed DFCs for the relevant aquifers within GMA 14, the Member Districts in GMA 14 considered the nine statutory factors set forth in Section 36.108(d) of the Texas Water Code:

- aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another,
- the water supply needs and water management strategies included in the state water plan,
- hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge,
- other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water,
- the impact on subsidence,
- socioeconomic impacts reasonably expected to occur,
- the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002,
- the feasibility of achieving the desired future condition, and
- any other information relevant to the specific desired future conditions; and

Whereas, pursuant to Section 36.108(d-2), the Member Districts also considered in their development of proposed DFCs the balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area; and

Whereas, the Member Districts used this information to developed proposed DFCs for the portions of the northern segment of the Gulf Coast Aquifer that occurs within the bounds of GMA 14; and

Whereas, TWDB conducted an evaluation of the Houston Area Groundwater Model ("HAGM") and adopted it as the updated Northern Gulf Coast Groundwater Availability Model ("GAM"); and

Whereas, the Members Districts conducted a model run of the updated Northern Gulf Coast GAM for the purpose of evaluating drawdown in the Northern Gulf Coast Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-052 MAG for the Carrizo-Wilcox Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-053 MAG for the Queen City Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-054 MAG for the Sparta Aquifer; and

Whereas, the TWDB has prepared a report for GAM Task 10-055 MAG for the Yegua-Jackson Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-30 MAG for the Brazos River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-31 MAG for the Navasota River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-32 MAG for the San Bernard River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-33 MAG for the San Jacinto River Alluvium Aquifer; and

Whereas, the TWDB has prepared a report for Aquifer Assessment Task 10-34 MAG for the Trinity River Alluvium Aquifer; and

Whereas, during joint meetings noticed and conducted pursuant to Section 36.108(e) of the Texas Water Code, the Member Districts considered GAMs and other data and information relevant to the development of DFCs for GMA 14, including input and comments from stakeholders within GMA 14; and

Whereas, the Member Districts find that all notice requirements for a meeting, held this day, to take up and consider the approval of the proposed DFCs as described herein for GMA 14 have been, and are, satisfied; and

Whereas, Texas Water Code Section 36.0015(b), as amended by House Bill 200 during the 84th Texas Legislature states that "(b) In order 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, Texas Constitution, groundwater conservation districts may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management in order to protect property rights, balance the conservation and development of groundwater to meet the needs of this state, and use the best available science in the conservation and development of groundwater through rules developed, adopted, and promulgated by a district in accordance with the provisions of this chapter"; and

Whereas, the Member Districts find that the proposed DFCs provided herein for establishment are each merited and necessary for the effective and prudent management of groundwater resources within GMA 14, and have otherwise been developed in accordance with, and do satisfy the obligations imposed by, Chapter 36 of the Texas Water Code and all other applicable laws of the State of Texas.

Now, therefore, be it resolved by the Member Districts of GMA 14 that the following proposed DFCs are each hereby established:

Formations of the Gulf Coast Aquifer

Austin County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 76 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Austin County should not exceed approximately 2.83 feet by the year 2070.

Brazoria County (BCGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 27 feet after 61 years.

Chambers County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 32 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 30 feet after 61 years.

Grimes County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 6 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 52 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Grimes County should not exceed approximately 0.12 feet by the year 2070.

Hardin County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 21 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 89 feet after 61 years.

Jasper County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 41 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 46 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 40 feet after 61 years.

Jefferson County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 17 feet after 61 years.

Liberty County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 25 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 120 feet after 61 years.

Montgomery County (LSGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 34 feet after 61 years.

Newton County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 45 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 44 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 37 feet after 61 years.

Orange County

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 14 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 16 feet after 61 years.

Polk County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 10 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 73 feet after 61 years.

San Jacinto County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 22 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 19 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 108 feet after 61.years.

Tyler County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 30 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 62 feet after 61 years.

Walker County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 9 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Walker County should not exceed approximately 0.04 feet by the year 2070.

Waller County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 101 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Waller County should not exceed approximately 4.73 feet by the year 2070.

Washington County

- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer should not exceed approximately 1 foot after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 16 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer should not exceed approximately 48 feet after 61 years.

Formations in Fort Bend, Galveston, and Harris counties

Groundwater Management Area 14 (GMA 14) efforts to determine DFCs is primarily an aquifer water-level based approach to describe the regional and local desires for the aquifer beneath them. The GMA process requires Groundwater Conservation Districts (GCDs) to determine the DFCs for the entire GMA, regardless of whether each county is included within a GCD. The Fort Bend Subsidence District (FBSD) and the Harris-Galveston Subsidence District (HGSD), operating in Fort Bend County and Harris and Galveston counties, respectively, regulate groundwater for the purpose of ending land surface subsidence within their jurisdiction. They are not GCDs and operate considerably different from the typical GCD. Therefore, in an official context these three counties are "unrepresented" but the GCDs within GMA-14 must still determine the DFC for these counties.

Both FBSD and HGSD have participated in an unofficial role to aid the GCDs within GMA-14 with their evaluation of Fort Bend, Galveston and Harris County information. The groundwater pumpage within these three counties even though regulated is still greater than the sum of all other counties within GMA-14. FBSD and HGSD recognize that the projected groundwater pumpage from these three counties will impact the decisions of GMA-14 throughout a large portion of the area. FBSD and HGSD have provided considerable historical and projected groundwater pumpage data and details of regulations to assist GMA-14 in incorporating these counties in the overall GMA-14 DFCs. FBSD and HGSD cannot however, present DFCs for these three counties in terms of aquifer water-level changes over time. The FBSD and HGSD regulations do not specifically address water-levels nor do they designate a specific pumping limit, rather the regulations are based on limitations of groundwater as a percentage of total water demand. The percentage of groundwater to total water demand is decreased over time, as total water demand increases.

The goal of both FBSD and HGSD is to end land surface subsidence that is caused by man's pumpage of groundwater. There is a clearly established link between the over-pumpage of groundwater and land surface subsidence. The DFCs within the aquifer beneath Fort Bend, Galveston, and Harris counties has no easily defined relationship to water-levels. The DFC for FBSD and HGSD is the reduction and halting of the compaction of clay layers within the aquifer caused by the over-pumpage of groundwater. Stated more simply, the DFC for these three counties is that future land surface subsidence be avoided. That stated, HGSD and FBSD have adopted regulations, most recently in 2013, that require the reduction of groundwater pumpage and the conversion to alternate water sources, while balancing with the realistic ability of the permittees to achieve compliance with these regulations. This effort was accomplished with the aid of computer models and information specific to the missions of FBSD and HGSD and outside of the revised Northern Gulf Coast GAM (NGCGAM) adopted by the TWDB.

Within HGSD, from central to southeastern Harris County and all of Galveston County (Regulatory Areas 1 and 2), virtually all permittees have achieved compliance with previous and current HGSD regulations. Subsidence has been halted and water-levels within the aquifer have risen dramatically in these areas. However, in northern and western areas of Harris County (Regulatory Area 3), the HGSD regulations have allowed groundwater pumpage to continue until the required reductions in 2010, 2025, and 2035. With these scheduled reductions in groundwater pumpage, subsidence will slow dramatically and even be halted with water-levels stabilizing and in later years rising.

Within FBSD, from central to northern and eastern Fort Bend County (Regulatory Area A), the regulations call for reductions of groundwater pumpage in 2014/2016, and 2025. Similar to HGSD's Regulatory Area 3, subsidence within FBSD Regulatory Area A will slow dramatically and even be halted with water-levels stabilizing and in later years rising.

In both HGSD and FBSD, because of the percentage based approach to regulations, groundwater pumpage will increase until scheduled reductions in milestone years (ex: 2010, 2014/2016, 2025, and 2035). In between milestone years, groundwater pumpage will increase with the assumed increase in total water demand from an assumed increase in population. In order to demonstrate the DFC of these three counties using water-level changes, the area of previous groundwater-to-alternative water conversions must be separated from future conversions AND each annual time step must be depicted.

The HGSD and FBSD have submitted to GMA-14 their current regulations and projected groundwater pumpage projections through the year 2070. This data has been divided into the grid cells/layers relative to the NGCGAM and utilized by the GCDs in development of their DFCs.

Groundwater pumpage within GMA-14 from Fort Bend, Galveston, and Harris counties is regulated by FBSD and HGSD, non GCD governmental agencies (the only GMA in Texas with this occurrence) and the missions of HGSD and FBSD are vastly different from GCDs and do not fit well with a water-level designed DFC process). The groundwater pumpage projections developed in recognition of the HGSD and FBSD regulatory plans have been utilized without adjustment by GMA14 in the DFC process. Therefore, the DFCs adopted by GMA-14 are consistent with the HGSD and FBSD regulatory plans.

Carrizo Sand Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 52.8 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 45.7 feet average draw down across the area of occurrence of the aquifer.

Queen City Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Queen City Aquifer should not exceed approximately 16.8 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Queen City Aquifer should not exceed approximately 21.0 feet average draw down across the area of occurrence of the aquifer.

Sparta Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Sparta Aquifer should not exceed approximately 14 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Sparta Aquifer should not exceed approximately 19.5 feet average draw down across the area of occurrence of the aquifer.

Yegua-Jackson Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Yegua should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Yegua should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Yegua should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Jackson should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Jackson should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Jackson should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

Jasper County (STGCD)

- The portion of the Yegua-Jackson occurring in Jasper County is declared non-relevant.

Newton County (STGCD)

- The portion of the Yegua-Jackson occurring in Newton County is declared non-relevant.

Polk County (LTGCD)

- The portion of the Yegua-Jackson occurring in Polk County is declared non-relevant.

Tyler County (STGCD)

- The portion of the Yegua-Jackson occurring in Tyler County is declared non-relevant.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Yegua should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Yegua should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Yegua should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Jackson should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Jackson should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Jackson should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

Washington County

- From estimated 2010 conditions, no additional drawdown of the Yegua Jackson across the area of occurrence of the aquifer.

River Alluvium Aquifers

Austin County (BGCD)

- The portion of the Brazos River Alluvium occurring in Austin County is declared non-relevant.

- The portion of the San Bernard River Alluvium occurring in Austin County is declared non-relevant.

Grimes County (BGCD)

- The portion of the Brazos River Alluvium occurring in Grimes County is declared non-relevant.
- The portion of the Navasota River Alluvium occurring in Grimes County is declared non-relevant.

Walker County (BGCD)

- The portion of the San Jacinto River Alluvium occurring in Walker County is declared non-relevant.
- The portion of the Trinity River Alluvium occurring in Walker County is declared non-relevant.

Waller County (BGCD)

- The portion of the Brazos River Alluvium occurring in Walker County is declared non-relevant.

Washington County

- The portion of the Brazos River Alluvium occurring in Washington County is declared non-relevant.

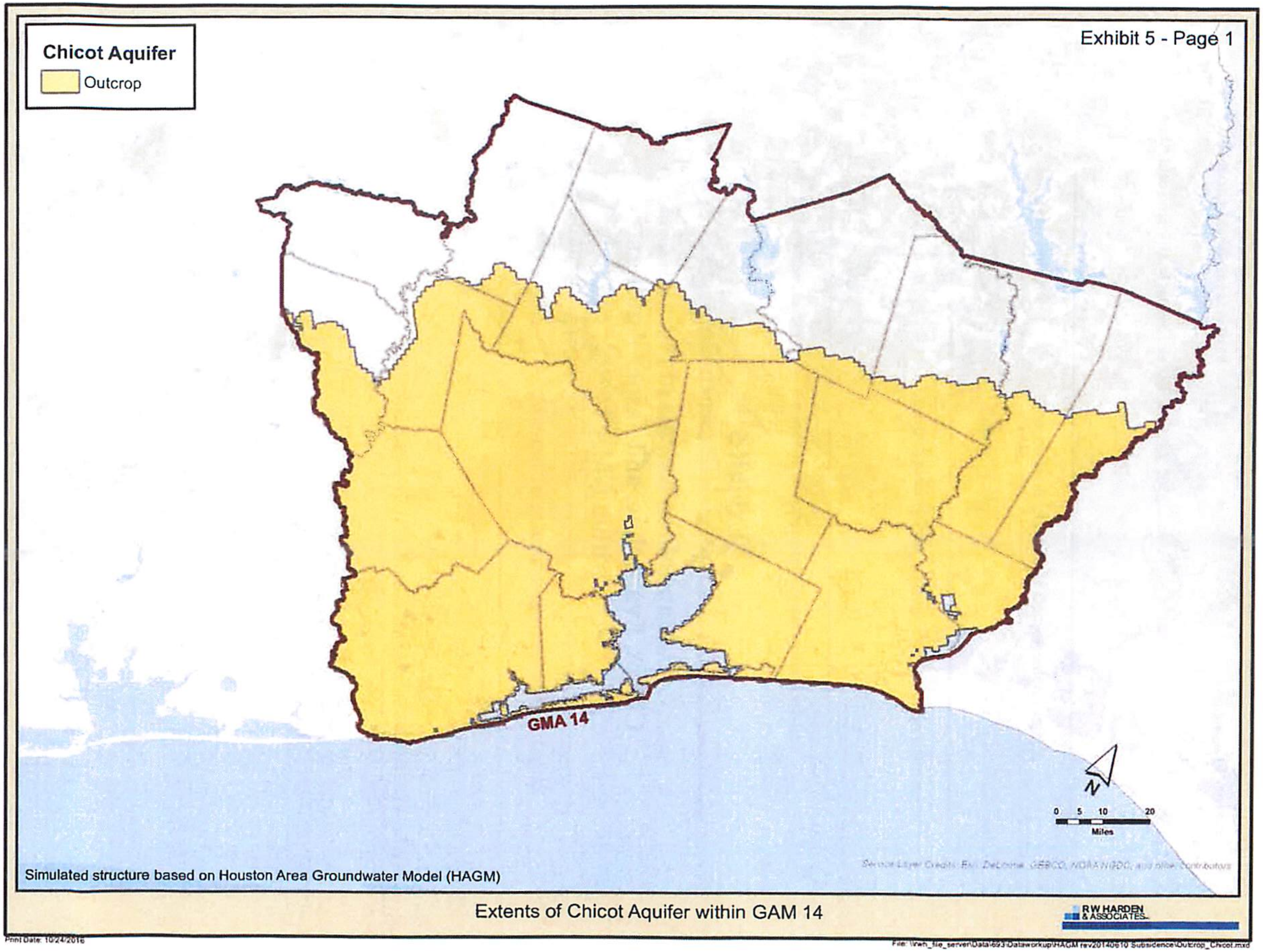


Exhibit 5 - Page 1
Chicot Aquifer
Outcrop
GMA 14
N
0 5 10 20
Miles
Simulated structure based on Houston Area Groundwater Model (HAGM)
Extents of Chicot Aquifer within GAM 14
RW HARDEN & ASSOCIATES
Print Date: 10/24/2016

Grimes County (BGCD)

- The portion of the Brazos River Alluvium occurring in Grimes County is declared non-relevant.
- The portion of the Navasota River Alluvium occurring in Grimes County is declared non-relevant.

Walker County (BGCD)

- The portion of the San Jacinto River Alluvium occurring in Walker County is declared non-relevant.
- The portion of the Trinity River Alluvium occurring in Walker County is declared non-relevant.

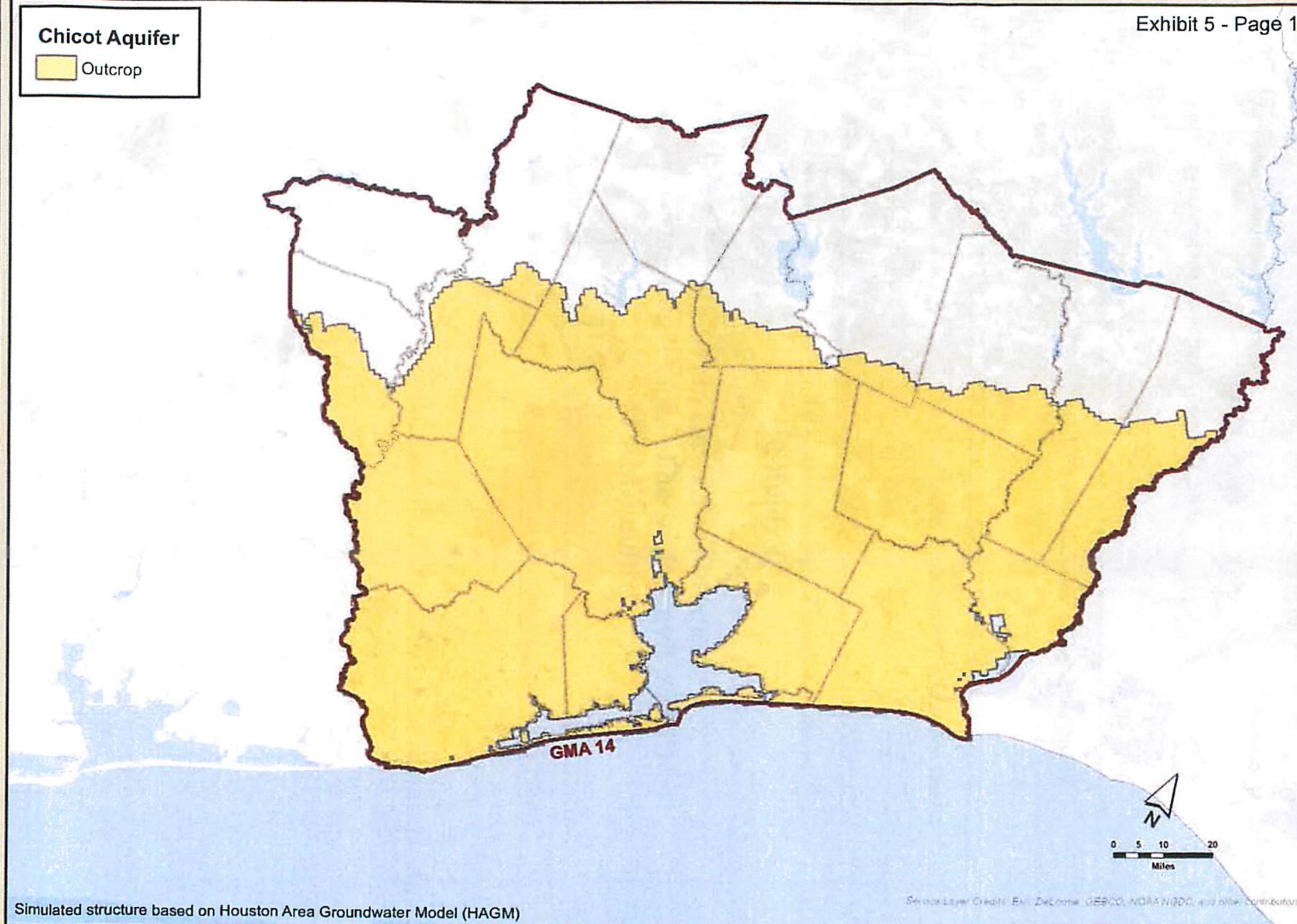
Waller County (BGCD)

- The portion of the Brazos River Alluvium occurring in Walker County is declared non-relevant.

Washington County

- The portion of the Brazos River Alluvium occurring in Washington County is declared non-relevant.

Exhibit 5 - Page 1



Extents of Chicot Aquifer within GAM 14

R W HARDEN & ASSOCIATES

Print Date: 10/24/2016

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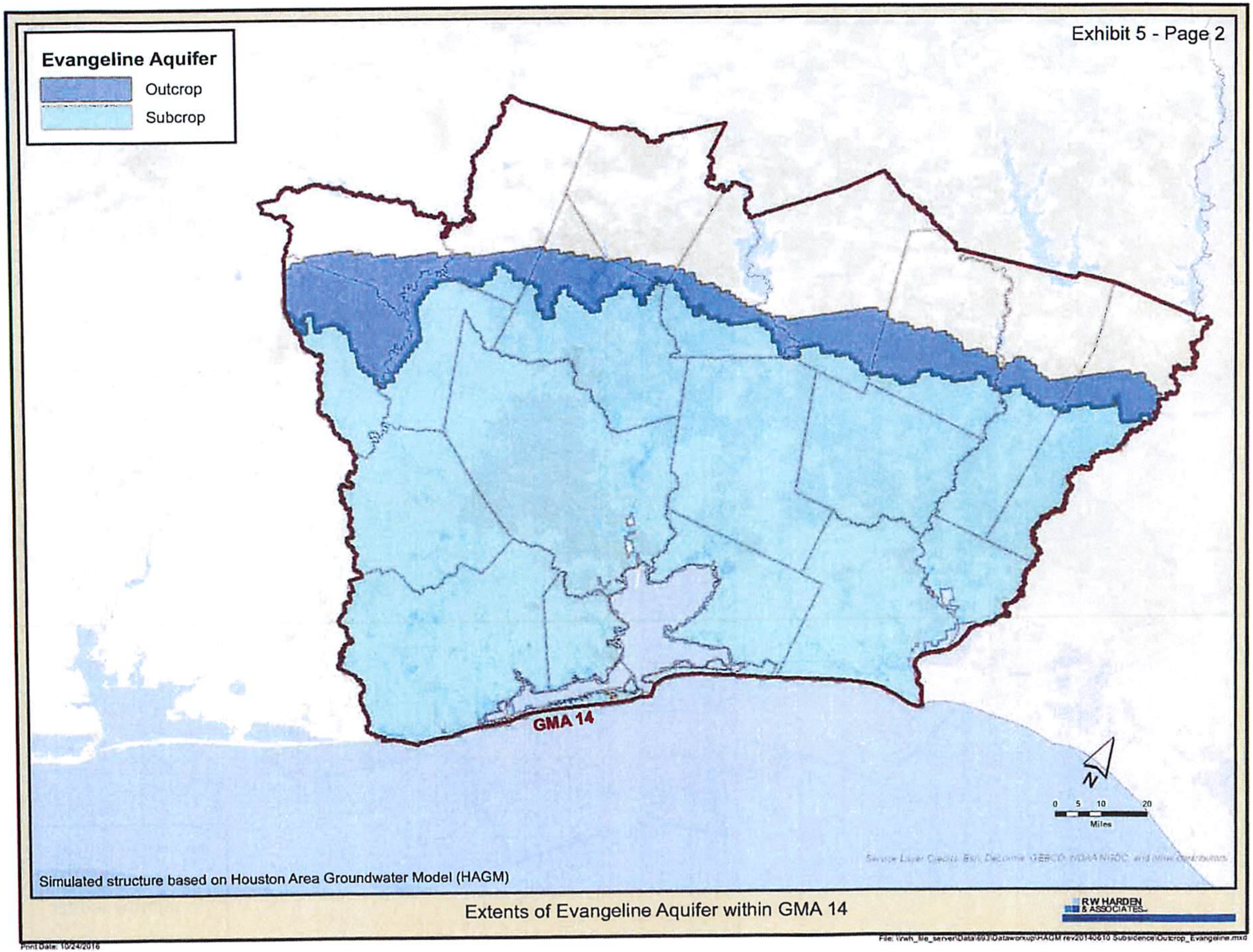
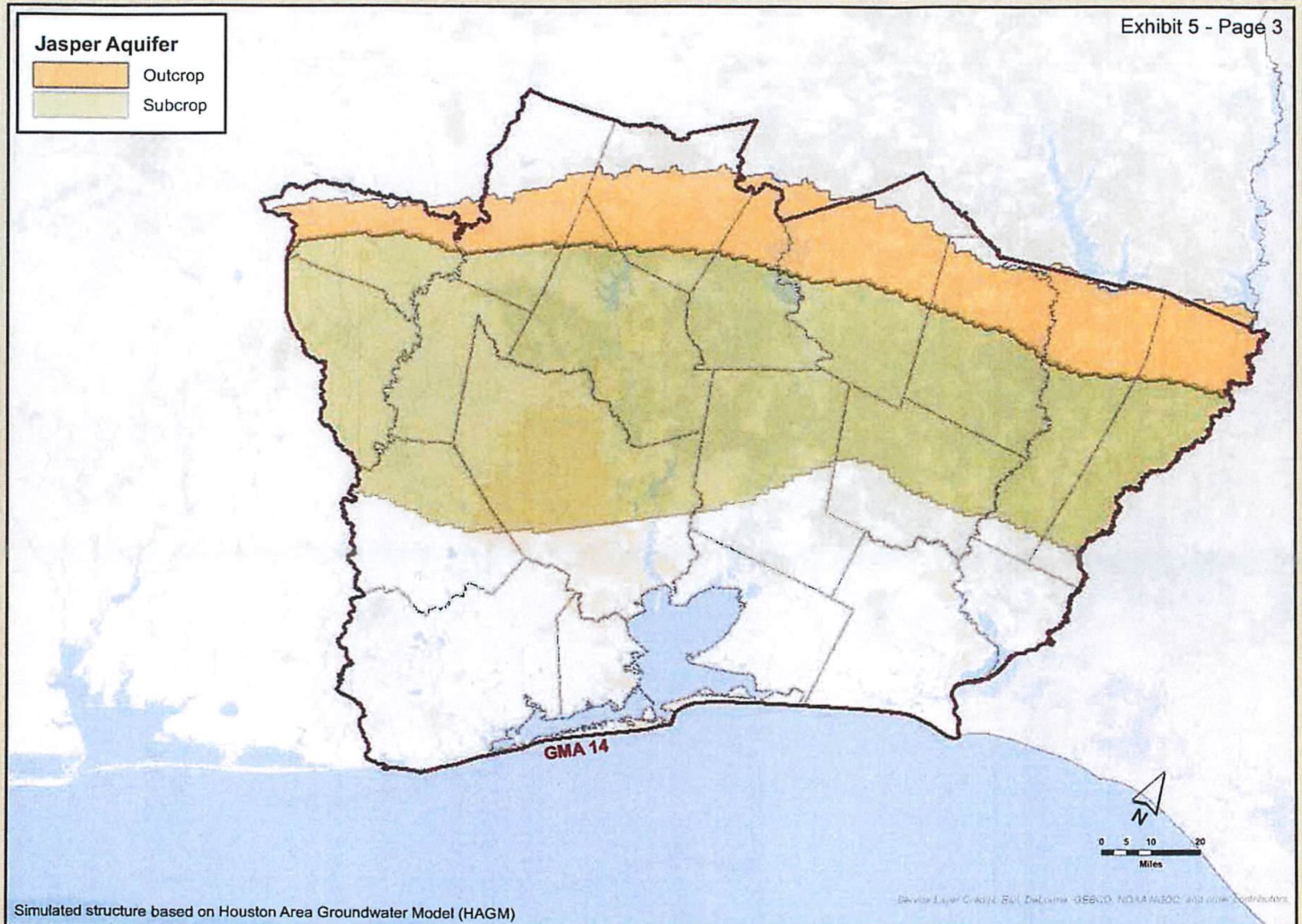


Exhibit 5 - Page 2
Evangeline Aquifer
Outcrop
Subcrop
GMA 14
N
0 5 10 20
Miles
Simulated structure based on Houston Area Groundwater Model (HAGM)
Extents of Evangeline Aquifer within GMA 14
RW HARDEN & ASSOCIATES
Print Date: 10/24/2016



Extents of Jasper Aquifer within GMA 14

R W HARDEN & ASSOCIATES

Print Date: 10/26/2016

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Exhibit 6

The Source of Water Derived by Wells

Dr. Charles V. Theis

The Source of Water Derived from Wells

Essential Factors Controlling the Response of an Aquifer to Development

FROM A PAPER PRESENTED BEFORE THE ARIZONA SECTION

By CHARLES V. THEIS

GEOLOGIST IN CHARGE OF GROUND-WATER INVESTIGATIONS IN NEW MEXICO, U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR, ALBUQUERQUE, N.MEX. (PUBLISHED WITH THE PERMISSION OF THE DIRECTOR OF THE GEOLOGICAL SURVEY)

THIS paper discusses in a general way the essential factors that control the response of an aquifer to development by wells. A knowledge of these factors, including the role of time, is necessary for the interpretation of existing records of water levels, and can yield the only method of predicting the effect of ground-water development in an area where records of long duration are lacking. Some of these factors have been long recognized but others have come to light in the last few years, and the intensive work now being done in quantitative ground-water hydrology will doubtless still further refine our concepts.

CONTINUED increase in the use of ground water for municipal and industrial purposes, and for irrigation, makes more pressing the question as to the extent of reserves of ground water and the advisability and methods of regulating its use. Proper regulation, of course, is conditioned upon the ability to forecast with some degree of accuracy the future history of water levels in wells in a given area. Mr. Theis here gives a clear picture of the factors that must be taken into account in such forecasts, and concludes with a brief summary of recommendations for "the ideal development of any aquifer from the standpoint of maximum utilization of the supply."

The essential factors controlling the action of an aquifer appear to be (1) the distance to, and character of, the recharge; (2) the distance to the locality of natural discharge; and (3) the character of the cone of depression in the given aquifer. Figure 1 illustrates diagrammatically the controlling factors in one type of aquifer.

CONDITIONS OF EQUILIBRIUM IN AN AQUIFER

All ground water of economic importance is in process of movement through a porous rock stratum from a place of intake or recharge to a place of disposal. Velocities of a few tens or a few hundreds of feet a year are probably those most commonly met with in aquifers not affected by wells. This movement has been going on through a part of geologic time. It is evident that on the average the rate of discharge from the aquifer during recent geologic time has been equal to the rate of input into it. Comparatively small changes in the quantity of water in the aquifer, with accompanying changes in water level, may occur as the result of temporary unbalance between discharge by natural processes and recharge, but such fluctuations balance each other over a complete season or climatic cycle. Under natural conditions, therefore, previous to development by wells, aquifers are in a state of approximate dynamic equilibrium. Discharge by wells is thus a new discharge superimposed upon a previously stable system, and it must be balanced by an increase in the recharge of the aquifer, or by a decrease in the old natural discharge, or by loss of storage in the aquifer, or by a combination of these.

CONDITIONS IN THE RECHARGE AREA

Recharge to the aquifer may result from the penetration of rainfall through the soil to the water table, or by seepage from streams or other bodies of surface water, or by movement vertically or laterally from another ground-water body. The latter process is more or less an incident in the movement of water underground, and will not be discussed here. Two possible conditions in the recharge area must be considered. The potential recharge rate may be so large in wet seasons or cycles, or even uniformly, as to exceed the rate at which water can flow laterally through the aquifer. In this case the aquifer becomes over-full and available recharge is rejected. The water table stands at or near the surface in the recharge area. There may be permanent or seasonal springs in low places discharging the excess water, or there may be marshes or other areas of vegetation drawing water from the zone of saturation and transpiring the excess. In such a case, it is evident that if use of ground water by means of wells can increase the rate of underground flow from the area, more water is available to replenish the flow. More water will go underground and the springs will flow less, or through-flowing streams will lose more water, or the vegetation will become more sparse.

On the other hand, the possible rate of recharge may be less than the rate at which the aquifer can carry the water away. The rate of recharge in this case is governed (1) by the rate at which the water is made available by precipitation or by the flow of streams, or (2) by the rate at which water can move vertically downward through the soil to the water table and thus escape evaporation. In recharge areas of this latter type, none of the recharge is rejected by the aquifer.

In attempting to determine where the water discharged by wells comes from, or, more accurately, what process

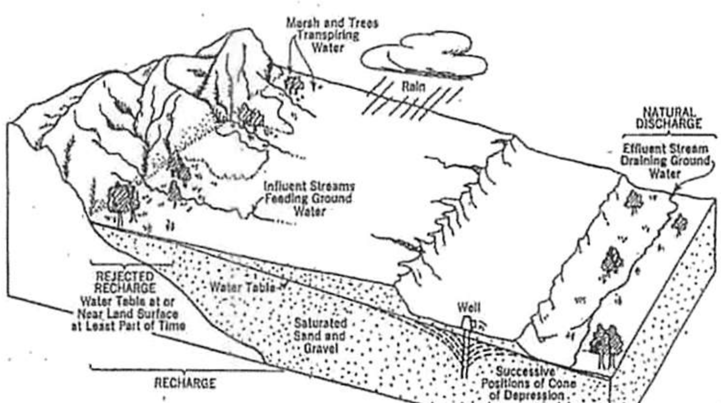


FIG. 1. FACTORS CONTROLLING RESPONSE OF AN AQUIFER TO DISCHARGE BY WELLS

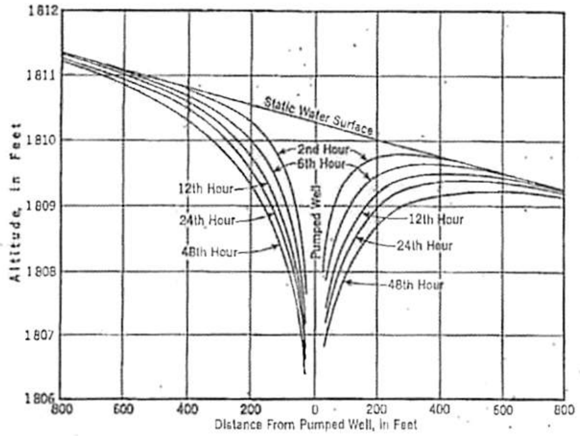


FIG. 2. GROWTH OF CONE OF DEPRESSION DURING PUMPING TEST IN PLATTE VALLEY, NEBR.

(After L. K. Wenzel, "The Thiem Method for Determining Permeability of Water-Bearing Materials," U.S. Geological Survey Water Supply Paper 679-A, Fig. 6, p. 39, 1936)

serves to balance the hydraulic system after the new discharge of the wells is imposed on it, this difference between rejected recharge and unrejected recharge must be kept clearly in mind. If water is rejected by the aquifer in the recharge area under natural conditions, then pumping of wells may draw more water into the aquifer. On the other hand, no matter how great the normal recharge, if under natural conditions none of it was rejected by the aquifer, then there is no possibility of balancing the well discharge by increased recharge, except by the use of artificial processes such as water spreading.

Figure 1 indicates diagrammatically the difference between these two conditions. Near the mountain border the water table is close to the surface, there is vegetation using ground water, and streams maintain their courses. This is the area of rejected recharge. A lowering of the water table in this zone will result in adding to the ground-water flow by decreasing the amount of transpiration and surface-water runoff. In the remainder of the area there is some recharge by rainfall, but the water table is so deep that no comparatively small change in its level can affect the amount of recharge. No recharge is rejected here and no lowering of the water table by pumping will cause more water to seep downward to the ground-water body.

The normal recharge of the aquifer is sometimes assumed to be the measure of the possible yield of the aquifer to wells. The theory is that if the wells take the recharge, then the natural discharge will be stopped. Under certain conditions, and especially where the wells are located close to the area of natural discharge, this may be at least approximately true, but it is recognized that generally wells are not able to stop all the natural discharge. Whether or not the natural discharge can be affected, or whether the recharge can be affected without too great a lowering of water level in the pumping area, depends on the conditions of flow in the aquifer.

CONDITIONS OF FLOW IN THE AQUIFER

Ground water flows through an aquifer according to the simple law enunciated by Darcy in 1856. The rate of flow is proportional to the pressure gradient in the water. Thus the flow of ground water bears a close resemblance to the flow of heat by conduction in a solid, or the flow of electricity through solid conductors.

Under Darcy's law there is only one way of reducing the flow in the areas of natural discharge or of increasing the flow in the areas of recharge. This is by changing the pressure gradient or the thickness of saturation of the aquifer in those areas, which in turn means changing the height to which water levels rise in wells throughout the area between the producing wells and the areas of natural recharge or discharge. This means a lowering of water level everywhere between the wells and the areas of natural discharge or recharge. In turn this means a reduction of storage in the aquifer and an abstraction of water from it.

There are two fundamental physical properties of any aquifer which largely control the movement of water through it. The first is the ease with which it transmits the water, analogous to the thermal conductivity of a solid in the theory of heat, or the electrical conductivity of an electrical circuit. This characteristic of the aquifer as a whole is called the coefficient of transmissibility and is defined as the number of gallons of water that will pass in one day through a vertical strip of the aquifer 1 ft wide under a unit pressure gradient.

The other important characteristic of the aquifer is the amount of water that will be released from storage when the head in the aquifer falls. This has been called the coefficient of storage, and is defined as the amount of water in cubic feet that will be released from storage in each vertical column of the aquifer having a base 1 ft square, when the water level falls 1 ft. For non-artesian aquifers the coefficient of storage is nearly identical with the specific yield of the material of the aquifer. For artesian aquifers the coefficient depends on the compressibility of the aquifer or of included or stratigraphically adjacent shaly beds and is much smaller.

THE CONE OF DEPRESSION

Consider a broad flat slab of a metal that has been brought to a uniform temperature and one or more edges of which are continuously maintained at that temperature. Somewhere near the middle of this slab let us place a colder rod and draw off heat through this rod at a uniform rate. The temperature of the plate in the vicinity of the rod will be reduced, and the depression of the temperature at any particular place will depend on the thermal conductivity of the metal, its specific heat, and its thickness. When a well is drawn upon a closely analogous process occurs. Water levels are drawn down in the vicinity of the well. Some water is removed from the vicinity concurrently with this

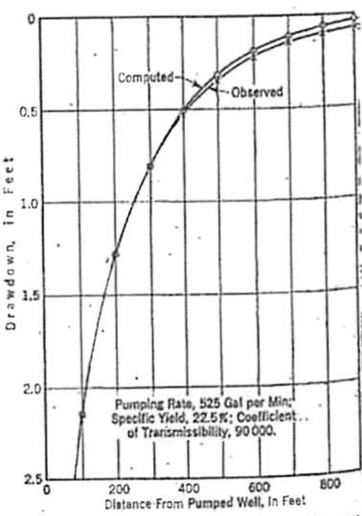


FIG. 3. OBSERVED AND COMPUTED DRAWDOWNS IN VICINITY OF A WELL AFTER PUMPING 48 HOURS

(After C. V. Theis, "The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage," *Transactions*, American Geophysical Union, 1935, p. 521) reduction in water levels, and a so-called cone of depression is formed. The shape of this cone is determined principally by the ease with which water flows through the aquifer—the coefficient of transmissibility—and by the coefficient of storage.

Figure 2 shows the position of the water table in the vicinity of a pumped well at several times during the course of pumping; that is, it shows the successive shapes and positions assumed by the cone of depression. With continued pumping the cone deepens and broadens. It is evident that the well is taking water out of storage in the vicinity and that as more and more water is removed by the well, the cone of depression affects more and more distant parts of the aquifer.

On the simplifying assumption that the removal of water is exactly analogous to the removal of heat from a metal plate, an equation for the drawdowns caused by pumping a well may be derived. That this equation is essentially true is shown in Fig. 3 by the comparison of computed and observed drawdowns after 48 hours of pumping in the test made by Mr. Wenzel. The observed values shown are the averages of all drawdowns measured in all the observation wells at the given distances from the pumping well. Throughout most of the cone the difference between observed and computed values is less than 0.01 ft, and the maximum error is less than 0.05 ft.

This formula for the cone of depression in the ideal homogeneous and isotropic aquifer assumed is:

$$v = \frac{114.6F}{T} \int_z^\infty (e^{-u}/u)du$$

in which

v = drawdown at any point, in ft
F = rate of discharge of the well, in gal per min
T = coefficient of transmissibility
z = $1.87\ r^2 s/Tt$
r = distance between pumped well and point of observation, in ft
s = coefficient of storage
t = time the well has been discharging, in days
u = a dimensionless quantity varying between the limits given

Some of the simplifying assumptions used in developing this formula are not rigidly realized in nature. However, the tolerance of the assumptions made appears to be sufficient for the purposes of this paper.

The characteristics of this formula should be noted. The quantity represented by the definite integral has a value depending only on the value of the lower limit, z, which involves distance, time, transmissibility, and storage ability. This quantity in effect determines the virtual radius of the cone of depression. The two factors outside the integral cause a variation in drawdown proportional to themselves. Specifically, the rate of pumping causes a proportional variation in the depth of the cone but does not affect its radius. The coefficient of storage, s, because of its relation to time, affects the rate of lateral spread of the cone, the rate of lateral growth being inversely proportional to its value. The coefficient of transmissibility affects both the radius of the cone and its depth, the radius for any given time increasing with increasing transmissibility, and the depth being inversely proportional to the transmissibility. The important general principle is that, according to the formula, which appears to hold except for very short periods of pumping, the rate of growth and the lateral extent of the cone of depression are independent of the rate of pumping. If we pump twice as hard the cone will be twice as deep at any point, but it will not extend to any more distant areas. The disturbance in the aquifer created by the discharge of the well may be likened to a wave: the amplitude depends on the strength of the disturbance but the rate of propagation depends only on the medium in which the wave is formed. The reservoir from which the well takes water is almost as closely circumscribed by time as it would be by any material boundary, and until sufficient

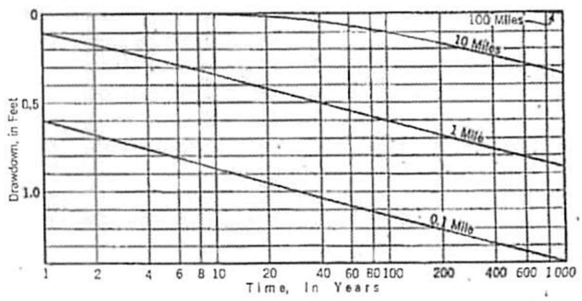


Fig. 4. Drawdown in an Ideal Aquifer Caused by Continuous Discharge of a Well at the Rate of 100 Gal per Min

(After C. V. Theis, "The Significance and Nature of the Cone of Depression in Ground-Water Bodies," *Economic Geology*, Vol. 33, No. 8, 1938, Fig. 1, p. 896)

time has elapsed for the cone to reach the areas of natural discharge and rejected recharge a new equilibrium in the aquifer cannot be established.

The importance of this time effect varies with the characteristics of the aquifer and the distance from the well to the areas of recharge and natural discharge. An idea of the order of magnitude of the effect may be gained from Figs. 4 and 5. These are drawn for an aquifer whose coefficient of transmissibility is 100,000 and whose coefficient of storage or specific yield is 20%. These values are in the range of magnitude of the respective coefficients for most important non-artesian aquifers. The rate of pumping is 100 gal a min, or about 160 acre-ft a year. As the drawdown is directly proportional to the rate of pumping, the drawdown for any other rate of pumping can be readily computed.

Figure 4 compares drawndown with time at several distances from the pumped well. Time is shown on a logarithmic scale. There is a definite time lapse after pumping begins before the effects are felt at any given distance from the well. After a period of adjustment the fall of the water table proceeds approximately at a logarithmic rate. If the aquifer is extensive areally, and all the water withdrawn from the well is represented by a loss of storage in the aquifer, the drawdown at a distance of 1 mile from the pumped well in the first 10 years of pumping is over half of what it will be in 100 years.

Figure 5 plots the same data for several times against the distance from the pumped well. These are profiles of the cone of depression, with distance expressed on a logarithmic scale. Through most of their extent, these lines on the semi-logarithmic graph are practically straight. Within the radii represented by the straight portions of these lines, the aquifer is acting essentially as a conduit, merely carrying the water from more distant areas with only insignificant additions along the way. The significant additions are made in the regions where the lines are curved. This is the part of the aquifer that acts largely as a reservoir. Although theoretically the profiles of the cone of depression are asymptotic to the zero line, that is, the original position of the water table, and never quite reach it, except at the boundaries of the aquifer, practically speaking the cone has a definite edge beyond which neither the movement of the water nor its quantity is affected by the well. This edge, however, is constantly retreating and is not fixed, as is implied in some of the texts on ground-water hydrology.

It has been said that the rate of growth of the cone is inversely proportional to the coefficient of storage. This point is of importance to the present discussion chiefly in its bearing on the difference between artesian and non-artesian aquifers. In artesian aquifers the coefficient of

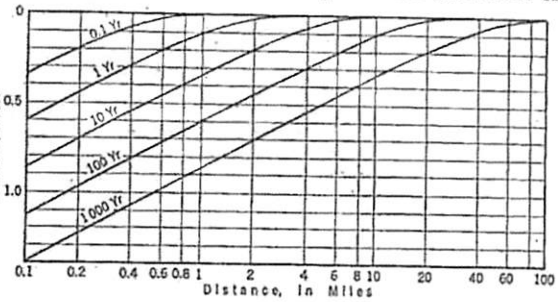


Fig. 5. Drawdown for Same Conditions as Those of Fig. 4, Plotted Against Distance from Discharging Well
(After C. V. Theis, "The Significance and Nature of the Cone of Depression in Ground-Water Bodies," *Economic Geology*, Vol. 33, No. 8, 1938, Fig. 2, p. 897)

storage is dependent on the compressibility of the aquifer and probably included or adjacent shaly beds, and is of a magnitude only a few per cent or a fraction of 1% of that of non-artesian aquifers. Hence the cone of depression in artesian aquifers grows very roughly 100 times as fast as it does in non-artesian aquifers. Hence artesian aquifers, excluding the very extensive ones, are brought into a new equilibrium almost immediately and most of the effects of a new ground-water development are soon felt.

After the cone of depression reaches areas of rejected recharge or natural discharge, it is modified by the effects of adding water in the former or preventing it from escaping in the latter. If the rate of pumping does not exceed the amount of water added in the recharge area and that prevented from escaping in the discharge area, the cone will eventually reach equilibrium, at least practically speaking. The approximate effects that occur after the cone has reached the boundaries of the aquifer can be estimated by means of various mathematical analyses. The effects of discontinuous pumping can also be evaluated.

In summing up this technical discussion from the standpoint of ground-water conservation and statutory or other regulation to that end, the following points should be emphasized:

1. All water discharged by wells is balanced by a loss of water somewhere.

2. This loss is always to some extent and in many cases largely from storage in the aquifer. Some ground water is always mined. The reservoir from which the water is taken is in effect bounded by time and by the structure of the aquifer as well as by material boundaries. The amount of water removed from any area is proportional to the drawdown, which in turn is proportional to the rate of pumping. Therefore, too great concentration of pumping in any area is to be discouraged and a uniform areal distribution of development over the area where the water is shallow should be encouraged, so far as is consistent with soil and marketing or other economic conditions.

3. After sufficient time has elapsed for the cone to reach the area of recharge, further discharge by wells will be made up at least in part by an increase in the recharge if previously there has been rejected recharge. If the recharge was previously rejected through transpiration from non-beneficial vegetation, no economic loss is suffered. If the recharge was rejected through springs or refusal of the aquifer to absorb surface waters, rights to these surface waters may be injured.

4. Again, after sufficient time has elapsed for the cone to reach the areas of natural discharge, further discharge by wells will be made up in part by a diminution in the natural discharge. If this natural discharge fed surface streams, prior rights to the surface water may be injured.

5. In most artesian aquifers—excluding very extensive ones, such as the Dakota sandstone—little of the water is taken from storage. In these aquifers, because the cones of depression spread with great rapidity, each well in a short time has its maximum effect on the whole aquifer and obtains most of its water by increase of recharge or decrease of natural discharge. Such an artesian basin can be treated as a unit, as is done in the New Mexico ground-water law, and the laws of some other western states that follow this law. In large non-artesian aquifers, where pumping is done at great distances from the localities of intake or outlet, however, the effects of each well are for a considerable time confined to a rather small radius and the water is taken from storage in the vicinity of the well. Hence these large ground-water bodies cannot be considered a unit in utilizing the ground water. Proper conservation measures will consider such large aquifers to be made up of smaller units, and will attempt to limit the development in each unit. Such procedure would also be advisable, although not as necessary, in an artesian aquifer.

6. The ideal development of any aquifer from the standpoint of the maximum utilization of the supply would follow these points:

(*a*) The pumps should be placed as close as economically possible to areas of rejected recharge or natural discharge where ground water is being lost by evaporation or transpiration by non-productive vegetation, or where the surface water fed by, or rejected by, the ground water cannot be used. By so doing this lost water would be utilized by the pumps with a minimum lowering of the water level in the aquifer.

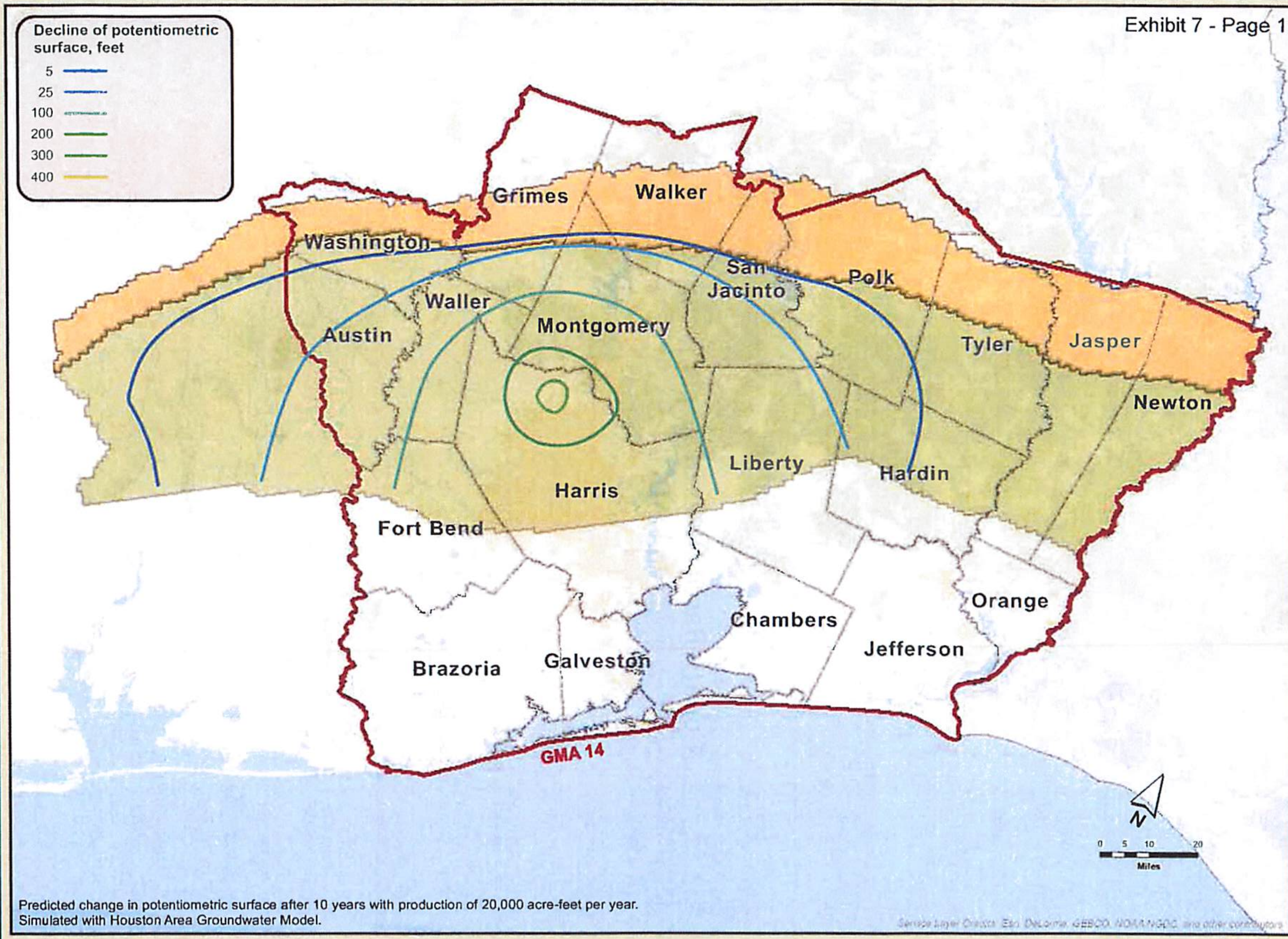
(*b*) In areas remote from zones of natural discharge or rejected recharge, the pumps should be spaced as uniformly as possible throughout the available area. By so doing the lowering of the water level in any one place would be held to a minimum and hence the life of the development would be extended.

(*c*) The amount of pumping in any one locality would be limited. For non-artesian aquifers with a comparatively small areal extent and for most artesian aquifers, there is a perennial safe yield equivalent to the amount of rejected recharge and natural discharge it is feasible to utilize. If this amount is not exceeded, the water levels will finally reach an equilibrium stage. If it is exceeded, water levels will continue to decline.

In localities developing water from non-artesian aquifers and remote from areas of rejected recharge or natural discharge, the condition of equilibrium connoted by the concept of perennial safe yield may never be reached in the predictable future and the water used may all be taken from storage. If pumping in such a locality is at a rate that will result in the course of ten years in a lowering of water level to a depth from which it is not feasible to pump, pumping at half this rate would not cause the same lowering in 100 years. Provided there is no interference by pumping from other wells, in the long run much more water could be taken from the aquifer at less expense.

Exhibit 7

Example of the Extents of Effects of Production
Jasper Aquifer



Extents of Effects of Production - Jasper Aquifer

R W HARDEN & ASSOCIATES

Print Date: 10/26/2016

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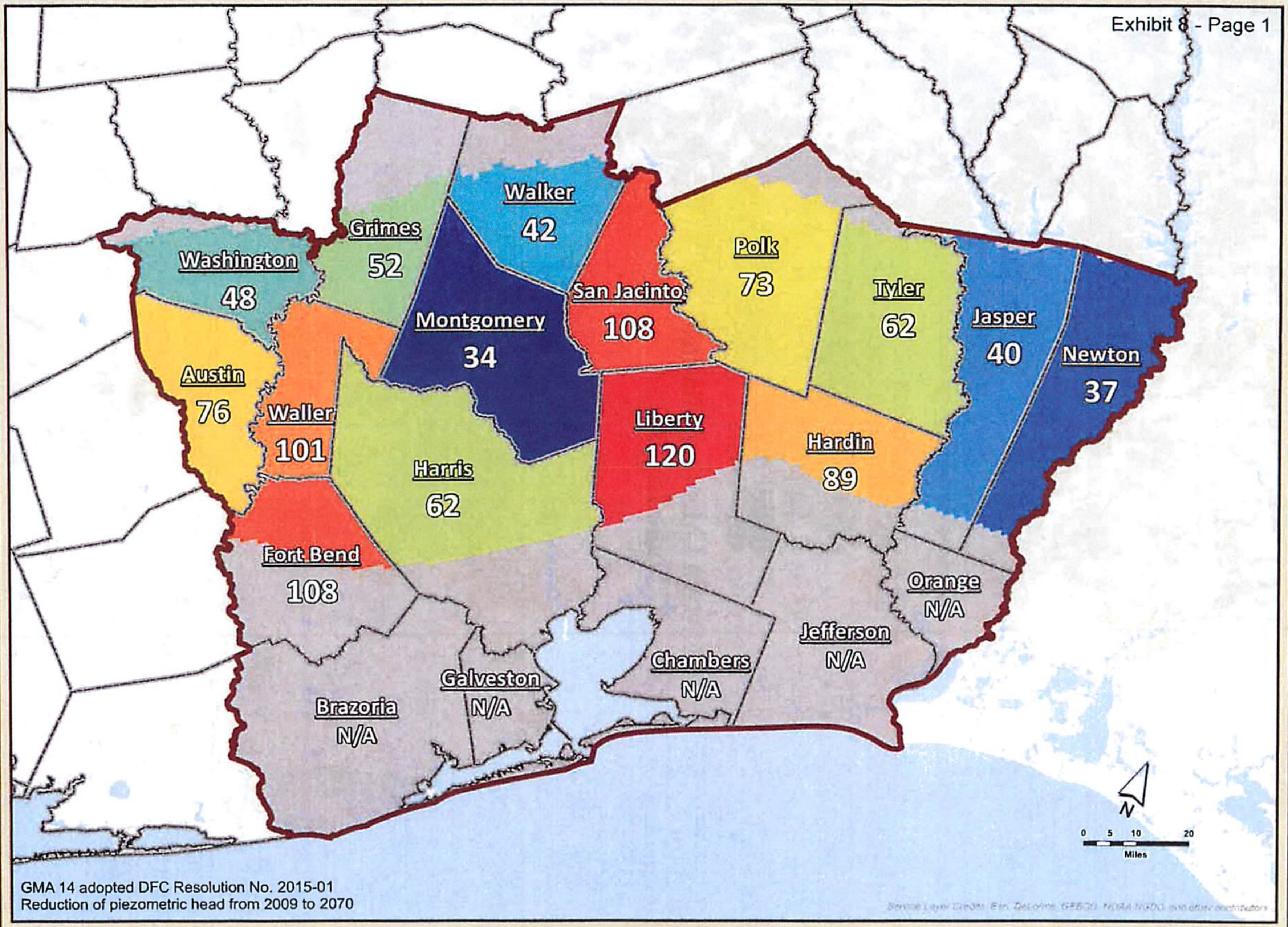
Exhibit 8

County-Based DFCs of Jasper Aquifer In GMA 14



Desired Future Conditions, Jasper Aquifer

R W HARDEN & ASSOCIATES

Print Date: 11/11/2016

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Exhibit 9

GMA 14 Meeting Minutes
June 26, 2013

UPPER GULF COAST AQUIFER PLANNING AREA (GMA 14)

Joint Planning Group Meeting

Wednesday, June 26, 2013
10:08 AM

MEETING MINUTES

A regular meeting of the Upper Gulf Coast Aquifer Planning Area (GMA 14) was held Wednesday, June 26, 2013, at 10:08 a.m., in the board room of the Lone Star Groundwater Conservation District located at 655 Conroe Park North Drive, Conroe, Texas.

The meeting was called to order by Kathy Turner Jones (Lone Star GCD) at 10:08 a.m. District representatives introduced themselves. Districts represented included: Lone Star GCD, Bluebonnet GCD, Lower Trinity GCD, Brazoria County GCD, Southeast Texas GCD and Brazos Valley GCD. Also in attendance at said meeting were: Larry French, and Sarah Backhouse with the Texas Water Development Board (TWDB), Ron Neighbors, Harris Galveston Subsidence District; Robert Thompson, Ft. Bend Subsidence District; The Honorable John Brieden, Washington County Judge; "Pudge" Willcox, Chambers County; Bill Mullican, Mullican and Associates, Jason Afinowicz and Bill Thaman with Freese and Nichols, Inc., Mark Evans, Chair of the Region H Planning Group; and members of the public. *(see Attachment "A" for a list of attendees).*

Kathy Jones began the meeting by asking for all present to introduce themselves and then called for any public comment. Having no one signed up to speak, Ms. Jones then asked for consideration of the approval of the minutes from the GMA 14 meeting of May 22, 2013. After discussion and upon a motion by Kent Burkett (Brazoria County GCD), seconded by Bill Jacobs (Lower Trinity GCD), the minutes for the May 22, 2013 meeting were approved. John Martin (Southeast Texas GCD) abstained from the vote.

Sarah Backhouse (TWDB) then distributed a new guidance document, providing information on how the TWDB will use official aquifer boundaries to estimate the recoverable storage and modeled available groundwater, what additional information the GMA needs to provide if aquifers are declared non-relevant, and what the DFC statement should include (identifying the aquifer, baseline year, and timetable). Mr. French (TWBD), then informed the group that the analysis of the Houston Area Groundwater Model had been completed and that a "preview" or draft copy of their findings had been presented to the USGS for their review and final comments. Mr. French stated that the overall analysis is that the Houston Area Groundwater Model is an improvement over the existing GAM. It is anticipated that the discussions with the USGS will be completed within a few weeks and at that time a final draft of findings will be given to the GMA 14 member districts for their review, comment, and questions as a part of the stakeholder process in adopting the new model. Upon conclusion of that review and comment period, the TWDB will publish a final report.

Ms. Jones then called for nominations for the vacant position of Secretary of the GMA 14 Joint Planning Group. Mr. Kent Burkett (Brazoria County GCD) nominated Mr. Zach Holland (Bluebonnet GCD) for said position. Hearing no other names, the nomination was seconded by Mr. Bill Jacobs (Lower Trinity GCD) and approved unanimously.

Meeting convened as a meeting of the GMA 14 Joint Planning Interlocal Agreement Participants.

The GMA 14 Planning Interlocal Agreement Participants meeting was called to order at 10:29 am.

Ms. Jones discussed the revised Interlocal Agreement that had been distributed to all GCDs and participating counties. Ms. Jones pointed out that the agreement contained the scopes of work for the consultants that had been revised since the last meeting. These revisions reflected the efforts to eliminate any duplications of effort between the 2 consultants, and broke down Freese and Nichols, Inc.'s effort into 2 phases. Phase I reflects a minimal cost to proceed with the process and contained no new model runs. Phase II would be initiated if it were determined that a new model run was required and the means of how to fund Phase II would be discussed when and if it were determined that additional work was necessary. Ms. Jones then discussed the preliminary recommendation of proposed contributions by the participants, totaling $51,560. Discussions of the need for Phase II and the product of Phase I ensued between the Participants and the Consultants. Ms. Jones suggested that the 2 presentations on technical findings that were on the agenda be presented by Freese and Nichols prior to a continuation of the discussion of work phasing and funding.

Prior to those presentations, Mr. Bill Mullican of Mullican and Associates, told the Participants that the presentation that was to be made by Freese and Nichols contained information that was a prescribed part of Chapter 36.108 and is actually 2 different parts of the DFC process. He further stated that 36.108, parts *(b)* and *(c)*, speak to what GMA's, during the joint planning process, should do on an annual basis, as well as to the review of management plans and looking at the best available science. Mr. Mullican also stated that 36.108 (d) requires that district representatives in a GMA , in a joint planning meeting, propose DFC's and then take those proposed DFC's through a process of 9 points of consideration before finally voting on proposed DFCs. Next, the DFC's will go out to the GCDs for public hearings. Looking at this particular model run is the first step in the process; deciding whether or not the DFC's resulting from the model that these are the DFC's the group wants to take through the consideration process, or if there is additional work that the group wants to do before the list is finalized. Mr. Mullican further stated that to go back to adjust proposed DFC's would require additional consideration of the 9 elements contained in 36.108(d)(1-9). He then told the group that with the presentation, the group was complying with 36.108 (d),

Jason Afinowicz of Freese and Nichols, Inc., then distributed a spreadsheet detailing all of the available layers in the Gulf Coast Aquifer and summarizing those layers by groundwater conservation district and by county. The data contrasted pumpage from the current TWDB GAM runs (from TWDB GAM Run 10-023, Scenario 3) from the last GMA joint-planning process (that concluded in 2010) with the pumpage and drawdown data from the most recent model (Houston Area Groundwater Model). Mr. Afinowicz then went through the various counties to demonstrate the differences in the results in the 2 models. He also noted that the new model (the Houston Area Groundwater Model) was done with a focus on a 5 county area (Brazoria, Fort Bend, Galveston, Harris, and Montgomery counties), and that no changes in pumpage or population/demand projections were applied to the counties and/or GMA's outside of those boundaries. A relatively direct comparison of the two models based on pumping projections from 2010 – 2060 was presented. Notable differences in drawdowns and pumping levels were noted for several counties in the GMA but outside the 5 county area of focus. Mr. Mullican added that the simplest and most straight forward way to approach this issue in the new model would be to take the pumping input files from GAM run 10-023 for all the counties except for the 5 counties considered in the most recent modeling effort and the modelers take the distribution of that pumping, which is what was agreed to during the last round of joint planning. Mr. Afinowicz pointed out that to adjust the pumpage to match a particular DFC would be very work intensive. The more direct method would be to review the pumpage figures and projected demands for each entity and once agreed upon, put those numbers into the model and determine the resulting DFC's.

A discussion of the budget summary sheet and suggested contributions then ensued. It was determined that with today's presentations and the work done to obtain the information presented, that the $8,000 Phase I was completed. It was further determined that in order to complete the technical support for the DFC process, the Freese and Nichols, Inc. Phase II work will need to be done. The fee for that work, included in the Interlocal agreement, is "not to exceed" $65,000. This scope of work did not include any model runs. It was the consensus of the group that at a minimum, one model run, using the parameters discussed above, would be required and it was estimated that such a run would require the expenditure of approximately $14,000. The budget to perform Phase I and Phase II, as well as the model and the scope submitted by Mullican and Associates was determined to total $129,000.

Once accepted by the group, Ms. Jones then led a discussion regarding how those costs should be equitably distributed. After discussion, it was the determination of the participants that Phase I and II costs (which includes Mr. Mullican's fee) would be distributed to the various GCD's, counties and subsidence districts based on an agreed upon percentage basis. It was further determined that the Lone Star GCD and the subsidence districts would not participate in the funding of the required additional model run, as they had participated in the creation of the new Houston Area Groundwater Model (also referred to as the new Upper Gulf Coast GAM). It was also decided that the additional model run would be funded based on county participation, therefore individual counties would pay a pro rata share of the total cost and the GCD's, other than Lone Star GCD, would pay shares based on the number of counties within their jurisdiction. Upon a motion made by Kent Burkett and seconded by Zach Holland, the proposal to divide the expenses as described above was unanimously approved by the participants. A copy of the breakdown of the distribution of budget contributions is attached hereto as *Attachment "B.*

After further discussion relative to approval of the Interlocal Agreement and funding schedule by the affected boards and commissioner courts, the GMA 14 Joint Planning Interlocal Agreement Participants was declared adjourned at 11:37 AM.

The GMA 14 Joint Planning Committee Meeting was re-opened. Larry French, of the TWDB gave a brief summary of the governance changes that would take place as a result of House Bill 4.

Discussion was held to set the date and time for next meeting. A meeting was tentatively scheduled for Wednesday, August 21, 2013, at 10:00 AM in the Lone Star GCD Board Room. Each District will be notified.

Without further discussion and there being no further business, the meeting was adjourned at 11:59 AM.

PASSED, APPROVED, AND ADOPTED THIS 18th day of September, 2013.

Chairman

ATTEST:

Secretary

Exhibit 10

GMA 14 Correspondence
Draft DFC Resolutions
and Work Summary Timeline

From:	Kathy Turner Jones <kjones@lonestargcd.org>
Sent:	Saturday, July 06, 2013 5:23 PM
To:	Alan Day; cojudge@co.liberty.tx.us; commissioner3@peoplepc.com; countyjudge@wacounty.com; cthibodeaux@co.orange.tx.us; eddiearnold@co.jeffersson.tx.us; jmartin@setgcd.org; Judge Jimmy Sylvia; Kent Burkett; Kathy Turner Jones; Lowry, Mark V.; ltgcdistrict@livingston.net; Paul Nelson; Pudge; Ron Neigbors; rthompson@subsidence.org; zholland@bluebonnetgroundwater.org
Cc:	Bill Mullican; Jason Afinowicz
Subject:	FW: Information for GMA 14 District Representatives
Attachments:	GAM run 10-023_Final_with_Seal_090910.pdf; GR10-23.xlsx; DB12_Usage.xls

GMA 14 District Representatives
As per our discussions during the June 26, 2013 meeting, the attached information has been assembled for your consideration. Attached you will find three items; (1) TWDB GAM Run 10-023, (2) an excel spreadsheet reflecting information on groundwater pumpage as reflected by aquifer and decade for the northern Gulf Coast Aquifer in GMA 14, and (3) a table prepared by Jason documenting groundwater use presented in the 2011 Region H Regional Water Plan.
Please review this information to determine whether or not projections of pumping by aquifer included in GAM Run 10-023 will be appropriate (satisfactory) for use in the next GAM model run to be prepared by the F/N Team for your consideration. Please let me know as soon as possible regarding the results of your review. I will follow up with you in a couple of weeks to see if you have any additional questions. F/N will not run the new simulation until your feedback has been received.

Thanks,
Bill Mullican

From: Kathy Turner Jones <kjones@lonestargcd.org>
Sent: Monday, July 22, 2013 2:57 PM
To: Alan Day; cojudge@co.liberty.tx.us; commissioner3@peoplepc.com; countyjudge@wacounty.com; cthibodeaux@co.orange.tx.us; eddiearnold@co.jeffersson.tx.us; jmartin@setgcd.org; Judge Jimmy Sylvia; Kent Burkett; Kathy Turner Jones; Lowry, Mark V.; ltgcdistrict@livingston.net; Paul Nelson; Pudge; Ron Neigbors; rthompson@subsidence.org; zholland@bluebonnetgroundwater.org
Cc: Bill Mullican
Subject: FW: GMA 14 Joint Planning Process
Attachments: FW: Information for GMA 14 District Representatives

GMA 14 District Representatives

I would like to follow up on my email to you dated July 6, 2013 (see attached) regarding the status of your reviews of groundwater pumping levels, by aquifer, to be utilized in the next GAM run. We are working on the agenda for the August 21 GMA 14 meeting at this time. At this meeting, in order to stay on schedule, it would be great if we could include a presentation on the results of this additional GAM run and at least two of the other "considerations" required in statute for the DFC process (probably 108(d)(1-2).

In order for this to happen, our consultants will need each GMA 14 participant to review the numbers provided in my previous email and respond as to whether or not you are good to go with those numbers by **no later than August 1**. This will be needed to allow sufficient time to (1) run the GAM, (2) prepare presentation materials on the model, water uses, hydrological conditions, water supply needs, and water management strategies, and (3) finalize agenda and post meeting notices.

So, please complete your reviews and let us know if your county(ies) are good to go with the pumping levels included in GAM 10-023 and the 2011 Region H Water Plan. If you have any questions, please let me know.
Thanks, and have a great weekend,

Thanks,
Bill Mullican

RESOLUTION FOR THE ADOPTION OF THE DESIRED FUTURE CONDITIONS FOR ALL AQUIFERS IN GROUNDWATER MANAGEMENT AREA 14

Whereas, pursuant to Section 35.004 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas that, together, cover all major and minor aquifers in the state; and

Whereas, each groundwater management area was designated with the objective of providing the most suitable area for the management of groundwater resources; and

Whereas, through title 31, Section 356.23 of the Texas Administrative Code, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

Whereas, GMA 14 includes all or portions of areas subject to groundwater regulation by Bluebonnet Groundwater Conservation District (Grimes, Walker, Austin, and Waller Counties), Brazoria County Groundwater Conservation District, Lone Star Groundwater Conservation District (Montgomery County), Lower Trinity Groundwater Conservation District (Polk and San Jacinto Counties), and Southeast Texas Groundwater Conservation District (Hardin, Jasper, Newton, and Tyler Counties) (the "Member Districts"); and

Whereas Fort Bend Subsidence District (Fort Bend County), Harris-Galveston Subsidence District (Galveston, Harris Counties), and other stakeholders within GMA 14 from Chambers County, Liberty County, and Washington County also contributed to the development of DFCs for GMA 14; and

Whereas, Section 36.108 of the Texas Water Code requires the Member Districts in GMA 14 to consider groundwater availability models and other data or information for the management area and establish a desired future condition ("DFC") for each relevant aquifer within GMA 14 by September 1, 2010 and every five years thereafter; and

Whereas, the Member Districts within GMA 14 secured hydrogeologic and engineering consulting services to provide technical support in their efforts to establish requisite DFCs; and

Whereas, in developing the DFCs for the relevant aquifers within GMA 14, the Member Districts in GMA 14 considered in their development and adoption of DFCs:

- aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another,
- the water supply needs and water management strategies included in the state water plan,

- hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge,
- other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water,
- the impact on subsidence,
- socioeconomic impacts reasonably expected to occur,
- the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002,
- the feasibility of achieving the desired future condition, and
- any other information relevant to the specific desired future conditions; and

Whereas, the Member Districts used this information to developed proposed DFCs for the portions of the northern segment of the Gulf Coast aquifer that occurs within the bounds of GMA 14; and

Whereas, TWDB conducted an evaluation of the Houston Area Groundwater Model (HAGM) and recommended its adoption as the Northern Gulf Coast GAM; and

Whereas, the Members Districts conducted a model run of the revised Northern Gulf Coast GAM (formerly the HAGM) for the purpose of evaluating drawdown in the Northern Gulf Coast Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-052 MAG for the Carrizo-Wilcox Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-053 MAG for the Queen City Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-054 MAG for the Sparta Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-055 MAG for the Yegua-Jackson Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-30 MAG for the Brazos River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-31 MAG for the Navasota River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-32 MAG for the San Bernard River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-33 MAG for the San Jacinto River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-34 MAG for the Trinity River Alluvium Aquifer; and

Whereas, during joint meetings noticed and conducted pursuant to Section 36.108(e) of the Texas Water Code, the Member Districts considered GAMs and other data and information relevant to the development of DFCs for GMA 14, including input and comments from stakeholders within GMA 14; and

Whereas, the Member Districts find that all notice requirements for a meeting, held this day, to take up and consider adoption of the DFCs proposed herein for GMA 14 have been, and are, satisfied; and

Whereas, the Member Districts find that the DFCs proposed herein for establishment are each merited and necessary for the effective and prudent management of groundwater resources within GMA 14, and have otherwise been developed in accordance with, and do satisfy the obligations imposed by, Chapter 36 of the Texas Water Code and all other applicable laws of the State of Texas.

Now, therefore, be it resolved by the Member Districts of GMA 14 that the following DFCs are each hereby established:

Formations of the Gulf Coast Aquifer

Austin County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 85 feet after 61 years.

Brazoria County (BCGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 24 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 28 feet after 61 years.

Chambers County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 33 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 31 feet after 61 years.

Fort Bend County (FBSD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 55 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 56 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 61 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 129 feet after 61 years.

Galveston County (HGSD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 34 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 31 feet after 61 years.

Grimes County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 6 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 65 feet after 61 years.

Hardin County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 21 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 28 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 94 feet after 61 years.

Harris County (HGSD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 31 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 6 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately -13 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 97 feet after 61 years.

Jasper County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 24 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 46 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 41 feet after 61 years.

Jefferson County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 16 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 18 feet after 61 years.

Liberty County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 28 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 30 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 144 feet after 61 years.

Montgomery County (LSGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 2 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 3 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 75 feet after 61 years.

Newton County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 45 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 45 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 37 feet after 61 years.

Orange County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 14 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 16 feet after 61 years.

Polk County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 10 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 16 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 75 feet after 61 years.

San Jacinto County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 20 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 123 feet after 61 years.

Tyler County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 36 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 30 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 63 feet after 61 years.

Walker County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 9 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 4 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 48 feet after 61 years.

Waller County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 41 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 126 feet after 61 years.

Washington County

- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 1 foot after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 16 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 50 feet after 61 years.

Carrizo Sand Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 52.8 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 45.7 feet average draw down across the area of occurrence of the aquifer.

Queen City Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Queen City Aquifer should not exceed approximately 16.8 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Queen City Aquifer should not exceed approximately 21.0 feet average draw down across the area of occurrence of the aquifer.

Sparta Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Sparta Aquifer should not exceed approximately 14 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Sparta Aquifer should not exceed approximately 19.5 feet average draw down across the area of occurrence of the aquifer.

Yegua-Jackson Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Yegua should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Yegua should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Yegua should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Jackson should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Jackson should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Jackson should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

Polk County (LTGCD)

- From estimated 2010 conditions, the average drawdown of the Yegua-Jackson should not exceed approximately 2 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Yegua should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Yegua should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Yegua should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Jackson should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Jackson should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Jackson should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

Washington County

- From estimated 2010 conditions, no additional drawdown of the Yegua Jackson across the area of occurrence of the aquifer.

River Alluvium Aquifers

Austin County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

- From estimated 2010 conditions, the saturated thickness of the San Bernard River Alluvium should be maintained at 90 percent.

Grimes County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

- From estimated 2010 conditions, the saturated thickness of the Navasota River Alluvium should be maintained at 90 percent.

Walker County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the San Jacinto River Alluvium should be maintained at 90 percent.

- From estimated 2010 conditions, the saturated thickness of the Trinity River Alluvium should be maintained at 90 percent.

Waller County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

Washington County

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

And it is so ordered and passed this XX day of XXX, 2014.

Signed ____

Mr. Zach Holland Bluebonnet Groundwater Conservation District

Signed ____

Mr. Kent Burkett Brazoria County Groundwater Conservation District

Signed ____

Ms. Kathy Jones Lone Star Groundwater Conservation District

Signed ____

Mr. Bill Jacobs Lower Trinity Groundwater Conservation District

Signed ____

Mr. John Martin Southeast Texas Groundwater Conservation District

From: Bill Mullican <bill@mullicanassociates.com>
Sent: Tuesday, June 03, 2014 9:28 AM
To: 'Jason Afinowicz'
Cc: Kathy Turner Jones; 'Mark Lowry'; Brian Sledge; bill@mullicanassociates.com
Subject: Revised Montgomery County Pumping for Model Run Number 2 for GMA 14 v 02.xlsx
Attachments: Revised Montgomery County Pumping for Model Run Number 2 for GMA 14 v 02.xlsx

Jason,
We have given this a lot of thought and have now made the final revisions as captured in the revised spreadsheet. Basically, we want to hold annual production from 2010 – 2015 at the previously developed estimate of 91,140 acre-feet per year. The aquifer by aquifer distribution of this pumping is provided in the attached spreadsheet. Then from 2016 – 2070, we want to use a total GW production of 64,000 acre-feet per year with the decadal aquifer breakdowns as stated in the attached spreadsheet. The marginal shifts between aquifers from one decade to the next may be addressed through a simple linear extrapolation from one decade to the next. Please let me know if you have any questions on these numbers. Thanks, Bill

RESOLUTION FOR THE ADOPTION OF THE DESIRED FUTURE CONDITIONS FOR ALL AQUIFERS IN GROUNDWATER MANAGEMENT AREA 14

Whereas, pursuant to Section 35.004 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas that, together, cover all major and minor aquifers in the state; and

Whereas, each groundwater management area was designated with the objective of providing the most suitable area for the management of groundwater resources; and

Whereas, through title 31, Section 356.23 of the Texas Administrative Code, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

Whereas, GMA 14 includes all or portions of areas subject to groundwater regulation by Bluebonnet Groundwater Conservation District (Grimes, Walker, Austin, and Waller Counties), Brazoria County Groundwater Conservation District, Lone Star Groundwater Conservation District (Montgomery County), Lower Trinity Groundwater Conservation District (Polk and San Jacinto Counties), and Southeast Texas Groundwater Conservation District (Hardin, Jasper, Newton, and Tyler Counties) (the "Member Districts"); and

Whereas Fort Bend Subsidence District (Fort Bend County), Harris-Galveston Subsidence District (Galveston, Harris Counties), and other stakeholders within GMA 14 from Chambers County, Liberty County, and Washington County also contributed to the development of DFCs for GMA 14; and

Whereas, Section 36.108 of the Texas Water Code requires the Member Districts in GMA 14 to consider groundwater availability models and other data or information for the management area and establish a desired future condition ("DFC") for each relevant aquifer within GMA 14 by September 1, 2010 and every five years thereafter; and

Whereas, the Member Districts within GMA 14 secured hydrogeologic and engineering consulting services to provide technical support in their efforts to establish requisite DFCs; and

Whereas, in developing the DFCs for the relevant aquifers within GMA 14, the Member Districts in GMA 14 considered in their development and adoption of DFCs:

- aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another,
- the water supply needs and water management strategies included in the state water plan,

- hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge,
- other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water,
- the impact on subsidence,
- socioeconomic impacts reasonably expected to occur,
- the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002,
- the feasibility of achieving the desired future condition, and
- any other information relevant to the specific desired future conditions; and

Whereas, the Member Districts used this information to developed proposed DFCs for the portions of the northern segment of the Gulf Coast aquifer that occurs within the bounds of GMA 14; and

Whereas, TWDB conducted an evaluation of the Houston Area Groundwater Model (HAGM) and recommended its adoption as the Northern Gulf Coast GAM; and

Whereas, the Members Districts conducted a model run of the revised Northern Gulf Coast GAM (formerly the HAGM) for the purpose of evaluating drawdown in the Northern Gulf Coast Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-052 MAG for the Carrizo-Wilcox Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-053 MAG for the Queen City Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-054 MAG for the Sparta Aquifer; and

Whereas, TWDB has prepared a report for GAM Task 10-055 MAG for the Yegua-Jackson Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-30 MAG for the Brazos River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-31 MAG for the Navasota River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-32 MAG for the San Bernard River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-33 MAG for the San Jacinto River Alluvium Aquifer; and

Whereas, TWDB has prepared a report for Aquifer Assessment Task 10-34 MAG for the Trinity River Alluvium Aquifer; and

Whereas, during joint meetings noticed and conducted pursuant to Section 36.108(e) of the Texas Water Code, the Member Districts considered GAMs and other data and information relevant to the development of DFCs for GMA 14, including input and comments from stakeholders within GMA 14; and

Whereas, the Member Districts find that all notice requirements for a meeting, held this day, to take up and consider adoption of the DFCs proposed herein for GMA 14 have been, and are, satisfied; and

Whereas, the Member Districts find that the DFCs proposed herein for establishment are each merited and necessary for the effective and prudent management of groundwater resources within GMA 14, and have otherwise been developed in accordance with, and do satisfy the obligations imposed by, Chapter 36 of the Texas Water Code and all other applicable laws of the State of Texas.

Now, therefore, be it resolved by the Member Districts of GMA 14 that the following DFCs are each hereby established:

Formations in Fort Bend, Galveston, and Harris Counties

The Groundwater Management Area (GMA) efforts to determine Desired Future Conditions (DFCs) is primarily an aquifer water-level based approach to describe the regional and local desires for the aquifer beneath them. The GMA process only requires Groundwater Conservation Districts (GCDs) to determine the DFCs for the entire GMA, regardless of whether each county is included within a GCD. The Fort Bend Subsidence District (FBSD) and the Harris-Galveston Subsidence District (HGSD), operating in Fort Bend County and Harris and Galveston Counties, respectively, regulate groundwater for the purpose of ending land surface subsidence within their jurisdiction. They are not GCDs and operate considerably different from the typical GCD. Therefore, in an official context these three counties are "unrepresented" but the GCDs within GMA-14 must still determine the DFC for these counties.

Both FBSD and HGSD have participated in an unofficial role to aid the GCDs within GMA-14 with their evaluation of Fort Bend, Galveston and Harris County information. The groundwater pumpage within these three counties even though regulated is still greater than the sum of all other counties within GMA-14. FBSD and HGSD recognize that the projected groundwater pumpage from these three counties will impact the decisions of GMA-14 throughout a large portion of the area. FBSD and HGSD have provided considerable historical and projected groundwater pumpage data and details of regulations to assist GMA-14 in incorporating these counties in the overall GMA-14 DFC. FBSD and HGSD cannot however, present DFCs for these three counties in terms of aquifer water-level changes over time. The FBSD and HGSD regulations do not specifically address water-levels nor do they designate a specific pumping limit, rather the regulations are based on limitations of groundwater as a percentage of total water demand. The percentage of groundwater to total water demand is decreased over time, as total water demand increases.

The goal of both FBSD and HGSD is to end land surface subsidence that is caused by man's pumpage of groundwater. There is a clearly established link between the over-pumpage of groundwater and land surface subsidence. The DFC within the aquifer beneath Fort Bend, Galveston, and Harris Counties has no easily defined relationship to water-levels. The Desired Future Condition for FBSD and HGSD is the reduction and halting of the compaction of clay layers within the aquifer caused by the over-pumpage of groundwater. Stated more simply, the DFC for these three counties is that future land surface subsidence be avoided. That stated HGSD and FBSD have adopted regulations, most recently in 2013, that require the reduction of groundwater pumpage and the conversion to alternate water sources, while balancing with the realistic ability of the permittees to achieve compliance with these regulations. This effort was accomplished with the aid of models and information specific to the missions of FBSD and HGSD and outside of the revised Northern Gulf Coast GAM utilized by the TWDB.

Within HGSD, from central to southeastern Harris County and all of Galveston County (Regulatory Areas 1 and 2), virtually all permittees have achieved compliance with previous and current HGSD regulations. Subsidence has been halted and water-levels within the aquifer have risen dramatically in these areas. However, in northern and western areas of Harris County (Regulatory Area 3), the HGSD regulations have allowed groundwater pumpage to continue until the required reductions in 2010, 2025, and 2035.

With these scheduled reductions in groundwater pumpage, subsidence will slow dramatically and even be halted with water-levels stabilizing and in later years rising.

Within FBSD, from central to northern and eastern Fort Bend County (Regulatory Area A), the regulations call for reductions of groundwater pumpage in 2013/2015, and 2025. Similar to HGSD's Regulatory Area 3, subsidence within FBSD Regulatory Area A will slow dramatically and even be halted with water-levels stabilizing and in later years rising.

In both HGSD and FBSD, because of the percentage based approach to regulations, groundwater pumpage will increase until scheduled reductions in milestone years (ex: 2010, 2013/2015, 2025, and 2035). In between milestone years, groundwater pumpage will increase with the assumed increase in total water demand from an assumed increase in population. In order to demonstrate the DFC of these three counties using water-level changes, the area of previous groundwater-to-alternative water conversions must be separated from future conversions AND each annual time step must be depicted. If a further separation in to layers of the aquifer is necessary, then it is quite apparent that describing the DFC in terms of water-levels is far too complicated and error prone.

The HGSD and FBSD have submitted to GMA-14 their current regulations and projected groundwater pumpages through the year 2070. This data has been divided into the grid cells/layers relative to the Northern Gulf Coast Groundwater Availability Model (NGCGAM) and utilized by the GCDs in development of their DFCs.

Groundwater pumpage within GMA-14 from Fort Bend, Galveston, and Harris Counties is regulated by FBSD and HGSD, non GCD governmental agencies (the only GMA with this occurrence) and the missions of HGSD and FBSD are vastly different from GCDs and do not fit well with a water-level designed DFC process). The groundwater pumpage projections developed in recognition of the HGSD and FBSD regulatory plans have been utilized without adjustment by GMA14 in the DFC process. Therefore, the DFCs adopted by GMA-14 are consistent with the HGSD and FBSD regulatory plans.

Formations of the Gulf Coast Aquifer

Austin County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 76 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Austin County should not exceed approximately 2.83 feet by the year 2070.

Brazoria County (BCGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 27 feet after 61 years.

Chambers County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 32 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 30 feet after 61 years.

Grimes County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 6 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 52 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Grimes County should not exceed approximately 0.12 feet by the year 2070.

Hardin County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 21 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 89 feet after 61 years.

Jasper County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 41 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 46 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 40 feet after 61 years.

Jefferson County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 17 feet after 61 years.

Liberty County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 25 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 120 feet after 61 years.

Montgomery County (LSGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 26 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 34 feet after 61 years.

Newton County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 45 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 44 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 37 feet after 61 years.

Orange County

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 14 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 16 feet after 61 years.

Polk County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 10 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 73 feet after 61 years.

San Jacinto County (LTGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 22 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 19 feet after 61 years.

- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 108 feet after 61 years.

Tyler County (STGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 30 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 62 feet after 61 years.

Walker County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 9 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 4 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Walker County should not exceed approximately 0.04 feet by the year 2070.

Waller County (BGCD)

- From estimated year 2009 conditions, the average draw down of the Chicot aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 101 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Waller County should not exceed approximately 4.73 feet by the year 2070.

Washington County

- From estimated year 2009 conditions, the average draw down of the Evangeline aquifer should not exceed approximately 1 foot after 61 years.
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit should not exceed approximately 16 feet after 61 years.
- From estimated year 2009 conditions, the average draw down of the Jasper aquifer should not exceed approximately 48 feet after 61 years.

Carrizo Sand Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 52.8 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 45.7 feet average draw down across the area of occurrence of the aquifer.

Queen City Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Queen City Aquifer should not exceed approximately 16.8 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Queen City Aquifer should not exceed approximately 21.0 feet average draw down across the area of occurrence of the aquifer.

Sparta Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Sparta Aquifer should not exceed approximately 14 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the Sparta Aquifer should not exceed approximately 19.5 feet average draw down across the area of occurrence of the aquifer.

Yegua-Jackson Aquifer

Grimes County (BGCD)

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Yegua should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.
- From estimated 2010 conditions, the average drawdown of the confined portion of the Yegua should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.
- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Yegua should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.
- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Jackson should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.
- From estimated 2010 conditions, the average drawdown of the confined portion of the Jackson should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.
- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Jackson should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

Polk County (LTGCD)

- From estimated 2010 conditions, the average drawdown of the Yegua-Jackson should not exceed approximately 2 feet average draw down across the area of occurrence of the aquifer.

Walker County (BGCD)

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Yegua should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Yegua should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Yegua should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the unconfined portion of the Jackson should not exceed approximately 10 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the confined portion of the Jackson should not exceed approximately 15 feet average draw down across the area of occurrence of the aquifer.

- From estimated 2010 conditions, the average drawdown of the brackish confined portion of the Jackson should not exceed approximately 20 feet average draw down across the area of occurrence of the aquifer.

Washington County

- From estimated 2010 conditions, no additional drawdown of the Yegua Jackson across the area of occurrence of the aquifer.

River Alluvium Aquifers

Austin County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

- From estimated 2010 conditions, the saturated thickness of the San Bernard River Alluvium should be maintained at 90 percent.

Grimes County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

- From estimated 2010 conditions, the saturated thickness of the Navasota River Alluvium should be maintained at 90 percent.

Walker County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the San Jacinto River Alluvium should be maintained at 90 percent.

- From estimated 2010 conditions, the saturated thickness of the Trinity River Alluvium should be maintained at 90 percent.

Waller County (BGCD)

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

Washington County

- From estimated 2010 conditions, the saturated thickness of the Brazos River Alluvium should be maintained at 90 percent.

And it is so ordered and passed this XX day of XXX, 2014.

Signed ______________________________

Mr. Zach Holland Bluebonnet Groundwater Conservation District

Signed ______________________________

Mr. Kent Burkett Brazoria County Groundwater Conservation District

Signed ______________________________

Ms. Kathy Jones Lone Star Groundwater Conservation District

Signed ______________________________

Mr. Bill Jacobs Lower Trinity Groundwater Conservation District

Signed ______________________________

Mr. John Martin Southeast Texas Groundwater Conservation District

Groundwater Management Area 14

Significant Activity Review, Status Update, and Remaining Milestones

As of July 2, 2015

April 24, 2013

- Briefed on results from the recently concluded Houston Area Groundwater Model project.
- Briefed on changes made to the joint-planning process as a result of passage of Senate Bill 660 in 2011.

May 22, 2013

- Texas Water Development Board (TWDB) briefed Groundwater Water Management Area 14 (GMA 14) regarding ongoing technical review of recently completed Houston Area Groundwater Model (HAGM) for possible consideration as the official TWDB Groundwater Availability Model.
- Approval for execution of professional services contracts with consultants for execution of the joint-planning process.

June 26, 2013

- TWDB briefed GMA 14 on status of technical review of recently completed Houston Area Groundwater Model (HAGM).
- Briefed on a comparison between GAM Run 10-023 utilizing the TWDB adopted Northern Gulf Coast Groundwater Availability Model (2003) during the first round of joint planning and the recently completed Houston Area Groundwater Model (HAGM).

September 18, 2013

- Discussion of draft results from the Houston Area Groundwater Model (HAGM) under review by TWDB.
- Briefing and consideration of aquifer uses or conditions, including conditions that differ substantially from one geographic area to another in GMA 14, as required by Texas Water Code 36.108 (d)(1).

- Briefing and consideration of water supply needs and water management strategies included in the 2012 Texas State Water Plan, as required by Texas Water Code 36.108 (d)(2).

January 29, 2014

- Posted meeting canceled due to hazardous travel conditions (ice storm).

March 4, 2014

- Posted meeting canceled due to hazardous travel conditions (ice storm).

April 30, 2014

- U.S. Geological Survey briefed GMA 14 on the approach, conceptual model development, model calibration, and review process for the Houston Area Groundwater Model (HAGM).
- TWDB briefed GMA 14 on TWDB approval of the HAGM as the official Groundwater Availability Model for the Northern Gulf Coast Aquifer System.
- Briefed on results from HAGM GAM Run #1 and discussion on approach and process for HAGM GAM Run #2.
- Discussion of draft statements of desired future conditions (DFCs) resulting from HAGM GAM Run #1.

June 24, 2014

- Discussion and approval of aquifers to be designated as non-relevant for the purpose of joint planning.
- TWDB briefed GMA 14 on completion of reports regarding total estimated recoverable storage.
- Briefed on results from HAGM GAM Run #2.
- Discussion of draft statements of desired future conditions (DFCs) resulting from HAGM GAM Run #2.
- Briefing and consideration of hydrological conditions, including for each aquifer in the management area, total estimated recoverable storage,

average annual recharge, inflows, and discharge, as required by Texas Water Code 36.108(d)(3).

- Briefing and consideration of environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water, as required by Texas Water Code 36.108(d)(4).
- Briefing and discussion of the impacts of draft proposed DFCs on subsidence, as required by Texas Water Code Chapter 36.108(d) (5).

September 23, 2014

- Briefing and consideration of the socioeconomic impacts of draft proposed DFCs, as required by Texas Water Code 36.108(d) (6).
- Briefing and consideration of the impact on the interests and rights in private property, as required by Texas Water Code 36.108(d) (7).
- Briefing and discussion of administrative procedures under consideration by GMA 14.

TWDB Board Member Beck Bruun provided overview of current activities at the TWDB.

November 18, 2014

- Consideration and approval of administrative procedures, with recognition of progress by GMA 14 to date.
- Briefing and consideration of the feasibility of achieving draft proposed DFCs, as required by Texas Water Code 36.108(d) (7).
- Consideration and approval of DFC option resulting from HAGM GAM Run #2 as a potential candidate for proposal and adoption by the Member Districts in accordance with Section 3.03 of the adopted administrative procedures.

May 27, 2015

- Consideration and approval of DFC option resulting from HAGM Run #2 as a candidate for adoption as a proposed DFC to be further reviewed in consideration of the nine statutory factors listed in Texas Water Code Section 36.108(1-9) and in accordance with Section 3.04 of the administrative procedures adopted by GMA 14.

June 24, 2015

- Consideration and approval of DFC option resulting from HAGM Run #2 for the Gulf Coast Aquifer System and from published TWDB GAM Runs for other relevant aquifers in GMA 14 as the proposed DFCs in accordance with Texas Water Code Section 36.108 (d) and (d-2) and in accordance with Section 3.05 of the administrative procedures adopted by GMA 14.

July 2 – 6, 2015

- Information considered by GMA 14 throughout current round of joint planning is distributed and made available to GCDs in GMA 14 and on the Lone Star GCD webpage for public review.

July 6 – October 3, 2015

- The public comment period for proposed DFCs shall be for 90 days. Each GCD is required to hold a public hearing on the proposed DFCs in accordance with requirements included in Texas Water Code Section 36.108 (d-2). During the public comment period, each GCD shall make available in the GCD office a copy of the proposed DFCs and any supporting materials such as documentation of factors considered under Texas Water Code Section 36.108 (d) and the groundwater availability model results. These materials shall include Each GCD shall hold a public hearing on the proposed DFCs relevant to the individual GCD.

October 4 – 28, 2015

- After the public hearing, each GCD shall compile for consideration at the next joint planning meeting a summary of relevant comments received along with any suggested revisions to the proposed DFCs, and the basis for the revisions.

October 28, 2015

- This is the tentative date for the next GMA 14 meeting. During this meeting, District Representatives shall consider summary reports submitted by each of the GCDs in GMA 14 and consider any proposals for alternative DFCs. Based on decisions made at this meeting, either the proposed DFCs may be adopted as final DFCs, or additional meetings may be scheduled to further discuss comments received. The DFCs must be adopted as a resolution by a two-thirds vote of all the District Representatives. The District Representatives shall produce a desired future conditions explanatory report for the management area and submit to the TWWDB and each GCD in the management area, including proof that notice was posted for the joint planning meeting, a copy of the resolution, and a copy of the explanatory report.

October 29, 2015 forward

- Development of the explanatory report will, in all likelihood, take one or more additional meetings of GMA 14. These meetings will be scheduled as necessary to complete the explanatory report.
- After submission of the adopted DFCs including the explanatory report to the TWDB, then the TWDB will review for administrative completeness and then conduct execution of the HAGM to calculate estimates of modeled available groundwater for GMA 14. This process at the TWDB may take from 6 – 8 months.
- In accordance with Texas Water Code Section 36.108 (d-4), as soon as possible after a GCD receives the adopted final DFC resolution and explanatory report, the GCD shall adopt the DFCs in the resolution and explanatory report that apply to the GCD.

Exhibit 11

Excerpt of Presentation Provided to Lone Star Groundwater Conservation District

by Mr. Van Kelley, P.G.

Desired Future Condition – 2% ?

- Artesian Pressure
  - **Proportional to production**
  - Economic consideration

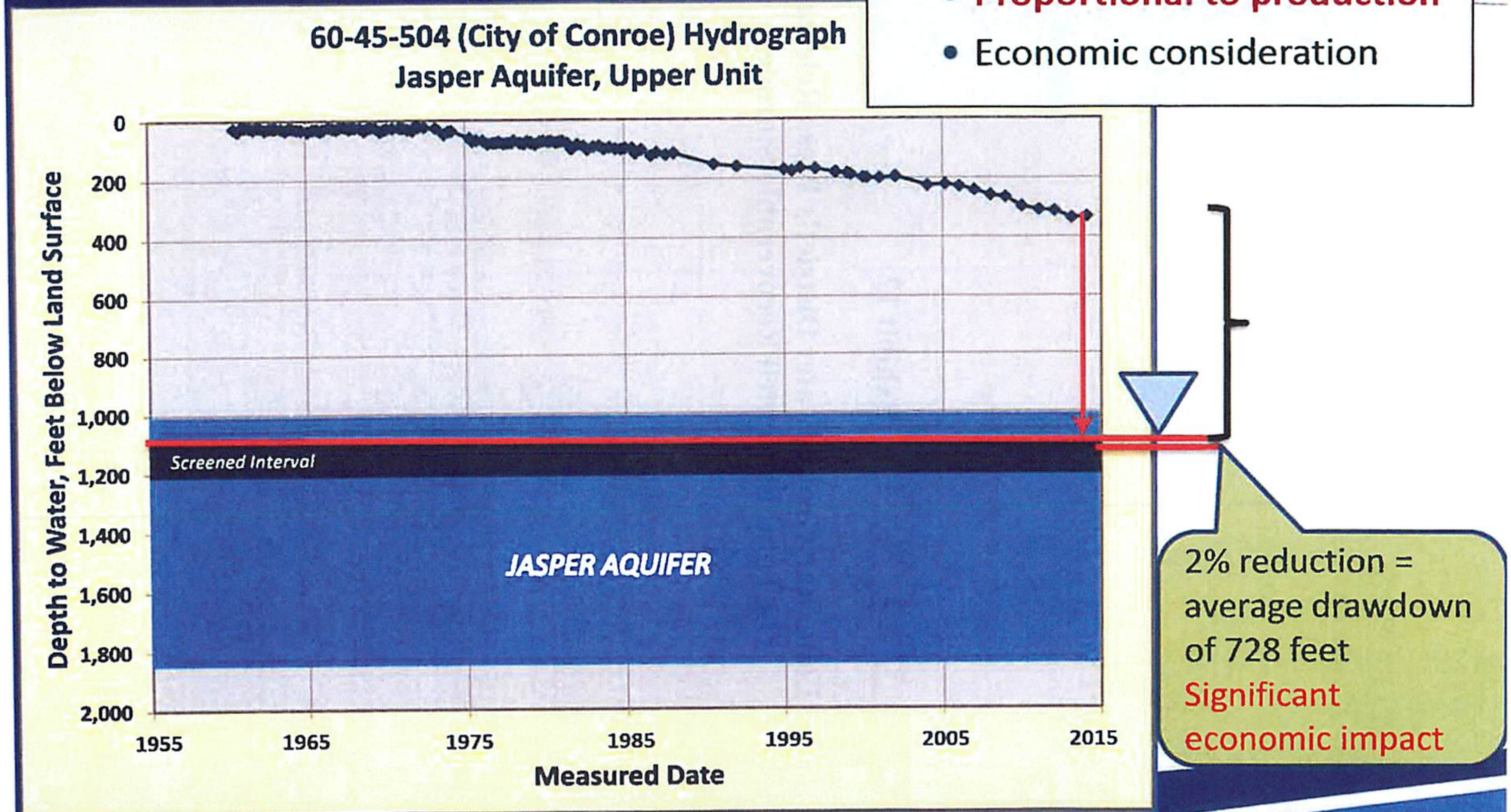

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Exhibit 12

Lone Star Groundwater District's Press Release On Total Estimated Recoverable Storage

TWDB Releases TERS Numbers

The Texas Water Development Board (TWDB) earlier this month released its total estimated recoverable storage (TERS) numbers for aquifers across the state, including those for Montgomery County and the Lone Star Groundwater Conservation District (Lone Star GCD). As expected, the figures, which are often misunderstood, are vastly larger for virtually every county across the state than the annual groundwater availability numbers that groundwater conservation districts use for pumping limits to achieve their 50-year planning goals in order to protect wells and well owners' abilities to access groundwater from their properties.

It is important to recognize that the very large water volumes provided in the TERS have limited to no applicability for the Lone Star GCD's setting of management goals for the aquifers underlying Montgomery County. This is due to the TERS calculation being somewhat irrelevant when compared to more pressing factors the district must balance in the management process.

The TERS numbers for Montgomery County are reported by the TWDB as a ballpark estimate in a range somewhere between 45 million and 135 million acre feet. As explained below, pumping of even less than 1 percent of that amount could result in catastrophic economic consequences for many well owners in Montgomery County.

Other Factors Considered: One of the primary reasons the Lone Star GCD enacted its rules and regulatory plan was to address the serious problems many landowners in the county were already having with groundwater level declines in the aquifers, ranging from 200 to 300 feet of water level declines in some areas of the Evangeline and Jasper Aquifers. Those declines have caused well owners many problems in making their wells perform properly and being able to pay for the drilling and operational costs to pump groundwater. Pumping even one-half of 1 percent of the average TERS numbers released for Montgomery County would cause further water level declines to the point of complete elimination of all artesian pressure in the aquifers in Montgomery County. It is that artesian pressure that pushes water into a well bore and towards a well pump so that it can easily and affordably be produced by the well owner. To protect well owners from further water level declines and the loss of artesian pressure, and to operate the aquifers on a long-term sustainable basis, the Lone Star GCD uses total effective recharge to the aquifer as the basis for how much groundwater it allows to be pumped annually.

Allowing pumping at the levels included in the TERS calculation would also result in significant land subsidence, and could have a significant impact on water levels in streams and creeks in Montgomery County.

Limitations of TERS: The TERS calculation does not consider many factors that limit the practical recovery of groundwater from storage such as:

1. Economic recoverability: As noted above, very large declines in water levels and well yields will occur with only a small fraction of one percent of the TERS removed. Using TWDB's information for Montgomery County, removing just 0.26% of the total storage in the aquifer, or 460,000 acre-feet, would result in additional average water level declines of 387 feet. The Evangeline and Jasper Aquifers, which supply over 95% of the groundwater pumped in the county, would experience average drawdowns of 78 and 710 feet, respectively. Those severe declines would be in addition to the 200 to 300 feet of declines the aquifers have already experienced. It would take a very high density of deep, closely spaced and low-yield wells to recover any significant portions of the TERS water. In addition to the cost of well installation, the power costs to pump water from wells increases significantly with large water level declines. In sum, allowing such further declines in the aquifer would prevent many Montgomery County landowners from being able to pump meaningful amounts of water from beneath their land because it would not be affordable to drill and operate wells capable of doing so.

2. Physical recoverability: Not all sediments within an aquifer are the same. Slow drainage from less permeable sediments like clays could significantly limit the recoverability of water that is included in the TERS.

3. Water quality: The TERS calculation is not limited to fresh water portions of aquifers, but includes all areas of the f Coast Aquifer system included in the state's computer model. This is important in the Lone Star GCD, where the Jasper Aquifer portion of the Gulf Coast Aquifer system contains both fresh and brackish water zones.

In conclusion, the TERS numbers are widely misunderstood and of limited value in their applicability to the groundwater management efforts of Lone Star GCD and other groundwater conservation districts in Texas, as they attempt to manage groundwater resources for the benefit of the residents today and in the future.

The Lone Star GCD encourages interested stakeholders to access additional material for more information on this subject. Links are provided below.

References

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Ridgeway, C., and L. French, *undated*. "Total estimated recoverable storage and modeled available groundwater, why they are different.", http://www.twdb.texas.gov/groundwater/docs/TotalEstimatedRecoverableStorage.pdf (http://www.twdb.texas.gov/groundwater/docs/TotalEstimatedRecoverableStorage.pdf)

Wade, S., D. Thorkildsen, R. Anaya, 2014. GAM Task 13-037: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 14. http://www.twdb.texas.gov/groundwater/docs/GAMruns/Task13-037.pdf (http://www.twdb.texas.gov/groundwater/docs/GAMruns/Task13-037.pdf)

-end-

← Previous Post (http://lonestargcd.org/1090/)

Meeting Notice – GMA 14 → (http://lonestargcd.org/notice-of-reschedule-gma-14-meeting/)

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Exhibit 13

**Comments of Mr. John Seifert, P.E.
on Lone Star Groundwater District's Press Release
on Total Estimated Recoverable Storage**

Comments on LSGCD Press Release June 27, 2014

Kathy,

The following provides some of our observations and comments regarding the above referenced press release. We discussed some of these comments with you within the past week.

1. An estimated range for TERS is given as 45 million to 135 million acre-feet per year (ac-ft/yr). Suggest that as those numbers are given it be explained that they would represent 25 to 75 percent of the overall estimated groundwater in storage of 180 million ac-ft/yr by the TWDB. Believe I would add that pumping 25 to 75 percent of the estimated amount of groundwater in storage is applicable to water table aquifers like the Ogallala that are shallow, buried sand and gravel deposits and is not applicable to artesian aquifers as occur in Montgomery County.

Other Factors Considered

2. Agree that artesian head declines have occurred and those occur whenever large quantities of groundwater are withdrawn from artesian aquifers. I am aware of those declines causing well owners to lower pumps and in some instances increase the horsepower of the motors or engines powering the pumps. I am not aware of wells performing improperly, but do agree that the cost of producing water increases with deeper pumping lifts. The development of surface water from reservoirs results in lake level lowering. No one likes it, but it is a tolerable consequence of supply development.

   The comment regarding "complete elimination of all artesian pressure" is applicable only if one half of 1 percent of storage is removed at one time. If it is removed gradually over time, the elimination of all of the artesian head would not occur because the aquifer is a dynamic system with recharge, discharge and water movement between the Chicot and Evangeline aquifers and between counties. There is a long-term sustainable supply available in Montgomery County and the magnitude of that supply is dependent upon recharge in Montgomery County and in areas outside Montgomery County and on the movement of water into the county from outside the county. The challenge as always for artesian aquifers, where recharge occurs, is balancing recharge, movement of water, limited reduction in storage and acceptable pumping effects.

3. It is my understanding that the statement regarding 460,000 ac-ft of water withdrawn from storage is that it would result in an additional average water level (artesian head) decline of 387 feet. It is my understanding that this is based on a one-time withdrawal of the 460,000 ac-ft occurring over a short period. This would be a static calculation. As stated previously, the system is dynamic and the system would have recharge entering it and lateral flow to the county and away from the county, which would produce different effects from a one-time withdrawal of 460,000 ac-ft.

4. The statement regarding taking a very high density of deep, closely spaced and low yielding wells to recovering any <u>significant</u> portions of the TERS water would be challenged by those taking the stance that TERS should be given reasonable credence. They would argue that the density of wells required could be about the same as required on the High Plains for areas that have high yielding (800 – 1,000 gpm) wells. If the word *significant* is referring to millions of acre feet of groundwater in storage being removed, that approach should be discouraged.

I do not know what will be the intent or the extent of significance that some will place on TERS. If their intent is to say that TERS are very, very significant and indicates millions of acre feet of groundwater in storage that could be removed, then model simulations could be performed along with other work to show the unapplicability of such an approach. If they are advocating something else, then a different response probably would be warranted.

Agree with the conclusion that the TERS numbers are widely misunderstood and of limited value in their applicability to the groundwater management efforts of Lone Star GCD. I believe I would have left out "other groundwater conservation districts in Texas" as the TERS are applicable to the districts on the High Plains.

Agree with Items 2 and 3 under limitations of TERS.

Expanded Version of Press Release

We reviewed the expanded version of the press release and the additional text helps answer some questions and helps put answers in context. The challenge is explaining the TERS concept to an audience with few understanding groundwater and the components of groundwater flow and availability.

If you have questions concerning any of the above, please do not hesitate to contact me. My comments are trying to anticipate questions that may be asked by those elevating the significance of TERS.

Sincerely,

John Seifert
LBG-Guyton Associates
11111 Katy Freeway, Suite 850
Houston, Texas 77079
713-468-8600
Texas PE Firm Reg. # F-4432

Exhibit 14

Excerpts from

Report On Ground-Water Conditions
In the Conroe-Woodlands Area, Texas

By William F. Guyton & Associates

REPORT ON GROUND-WATER CONDITIONS IN THE CONROE-WOODLANDS AREA, TEXAS

Prepared for

The City of Conroe
and
The Woodlands Development Corporation

By

William F. Guyton & Associates
Consulting Ground-Water Hydrologists
Austin - Houston, Texas

June 1975

NATURAL RECHARGE, MOVEMENT, AND DISCHARGE OF GROUND WATER

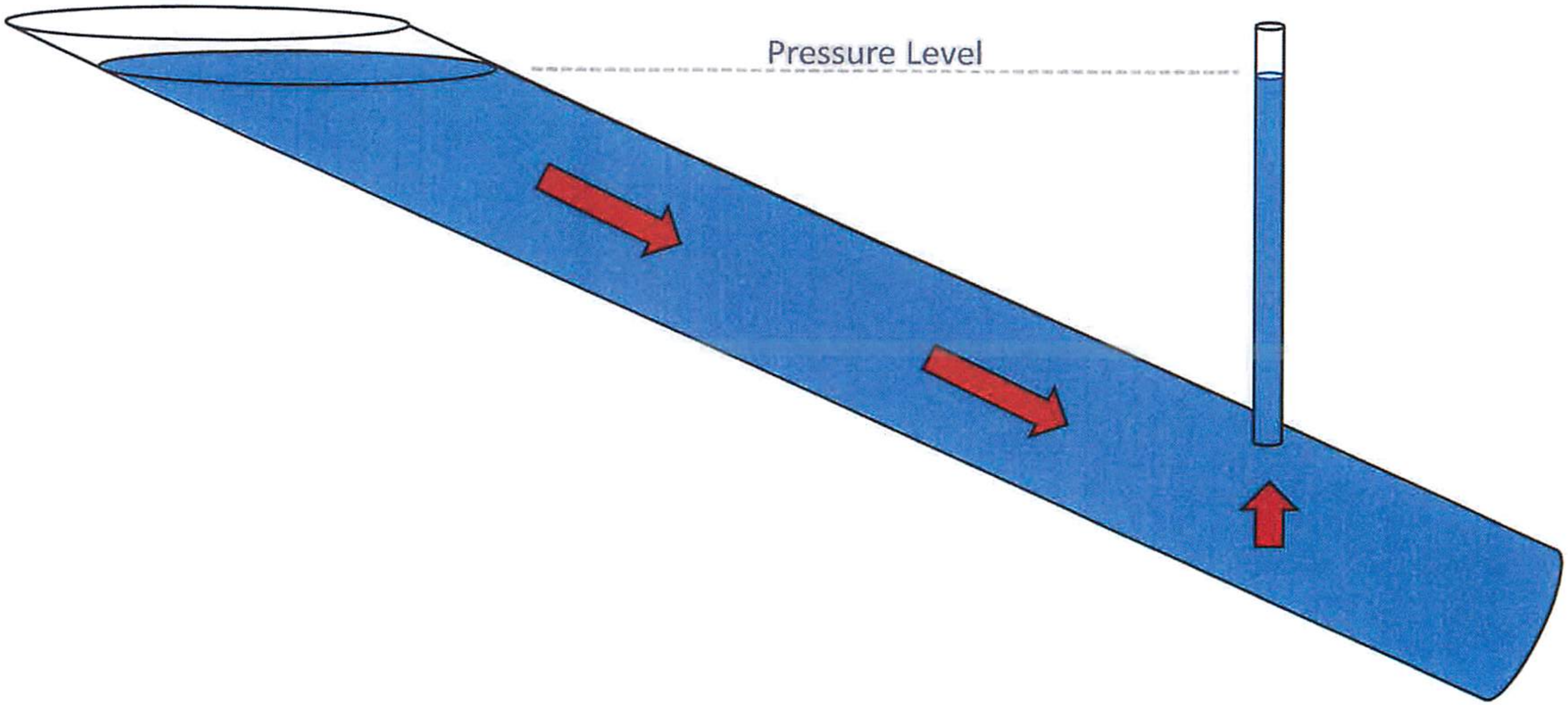
Recharge to the water-bearing sands in Montgomery County is from precipitation that falls on the land surface and from infiltration of streamflow. Most of the recharge to the Upper Jasper Aquifer probably occurs on its outcrop, although there may be some leakage from the Evangeline Aquifer through the Burkeville Aquiclude, especially north of Conroe. Part of the recharge to the Evangeline Aquifer occurs on its outcrop and part occurs on the outcrop of the Chicot Aquifer and leaks into the Evangeline Aquifer.

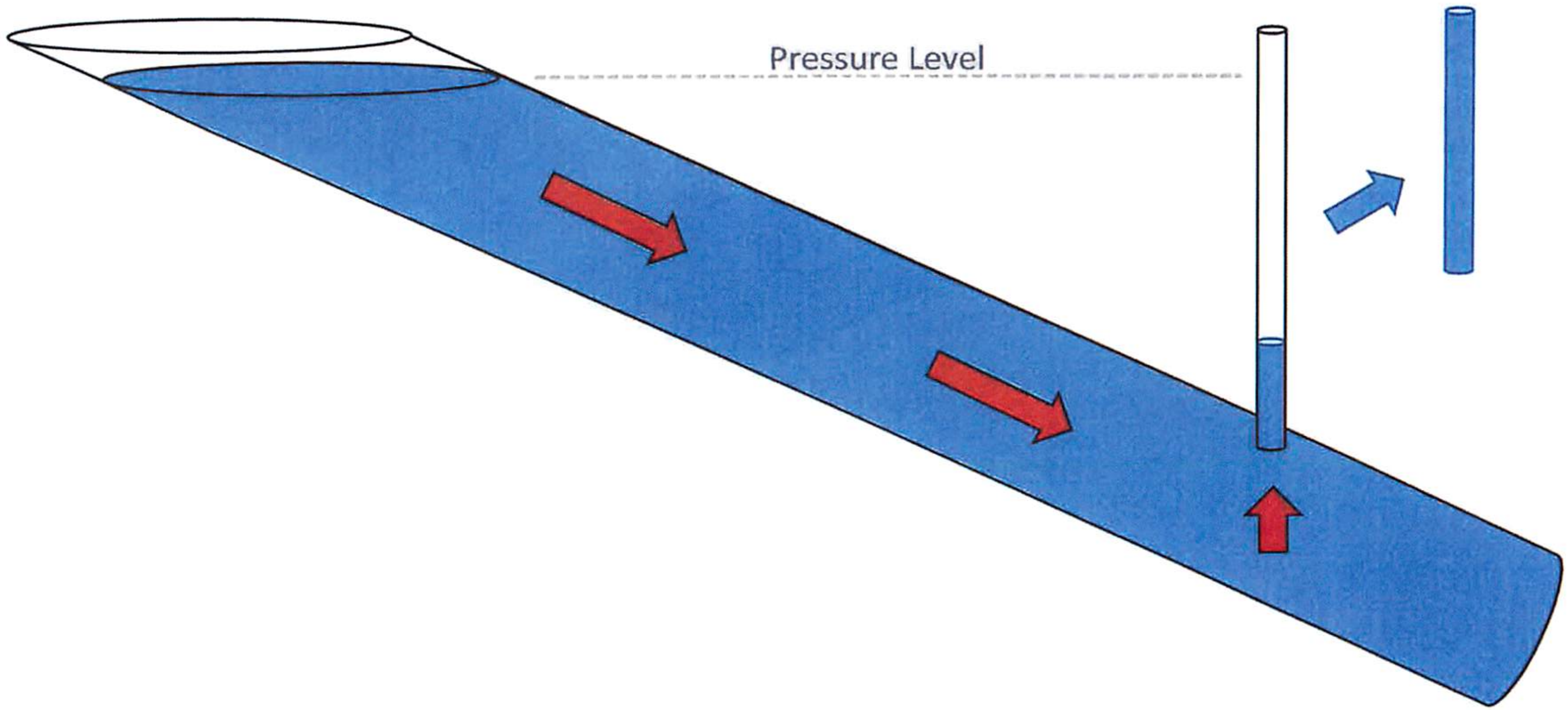
The precipitation averages about 47 inches a year, and a large amount of recharge is available for the sands. The sands are generally full up to the levels of stream valleys in their outcrops, and much recharge still is being discharged there locally. This local discharge is by evapotranspiration and by seepage and springs that supply the base flows of the streams. Water that moves down the dip of the sands past their outcrops toward the coast is withdrawn through wells or leaks upward into overlying formations in the downdip areas. The rates of movement of the water depend on the hydraulic gradient and the permeability of the sands. The rates of movement normally are relatively slow, probably being in the order of a few hundred feet a year or less except close to large wells and concentrated centers of pumping, where they are much faster.

Although in areas of concentrated pumping there are significant declines of water levels in wells, the declines represent only a drop in artesian pressure in the sands caused by friction of water moving through the sands from recharge areas to the wells. They do not represent dewatering of the sands. Pumping induces more recharge to move through the sands and less to be discharged in the outcrop areas, and the recharge is believed to be more than adequate to keep the sands full and supply the amount of water that can be pumped in the Conroe-Woodlands area. In addition, there is a tremendous volume of water in storage in the sands in their outcrop areas, and even if there were no additional recharge available, this storage would be sufficient to supply the water pumped for many years with only a small lowering of the water tables in the outcrop areas. The primary factors which will limit the amount of water that can be pumped from wells are the ability of the aquifers to transmit water from the outcrop areas to wells, the amounts of allowable drawdown of water level above sands to be screened in the shallower wells, and the economic limit of pumping lifts in the deeper wells.

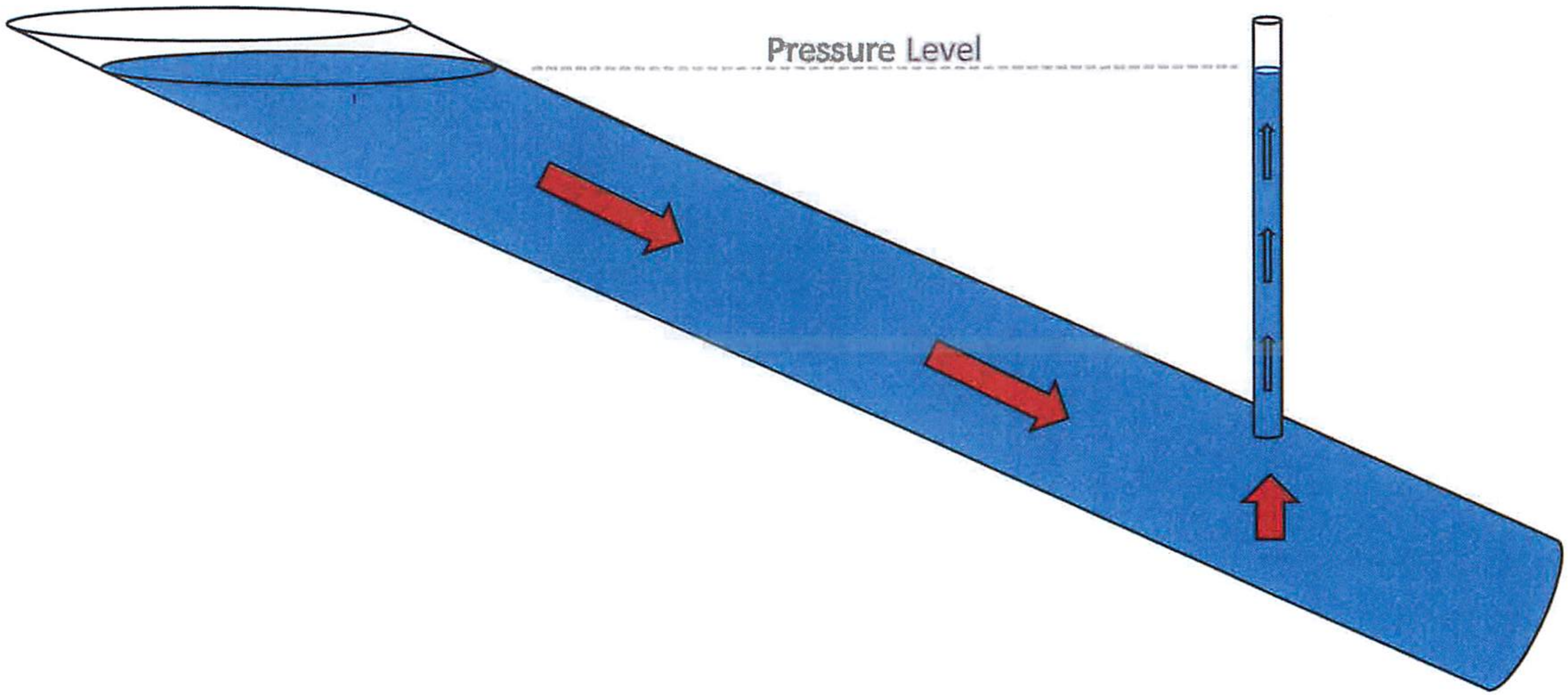
Exhibit 15

Schematic Representation of
Artesian Pressure and Water Table Storage


Pressure Level



R W HARDEN & ASSOCIATES INC
HYDROLOGISTS GEOLOGISTS ENGINEERS



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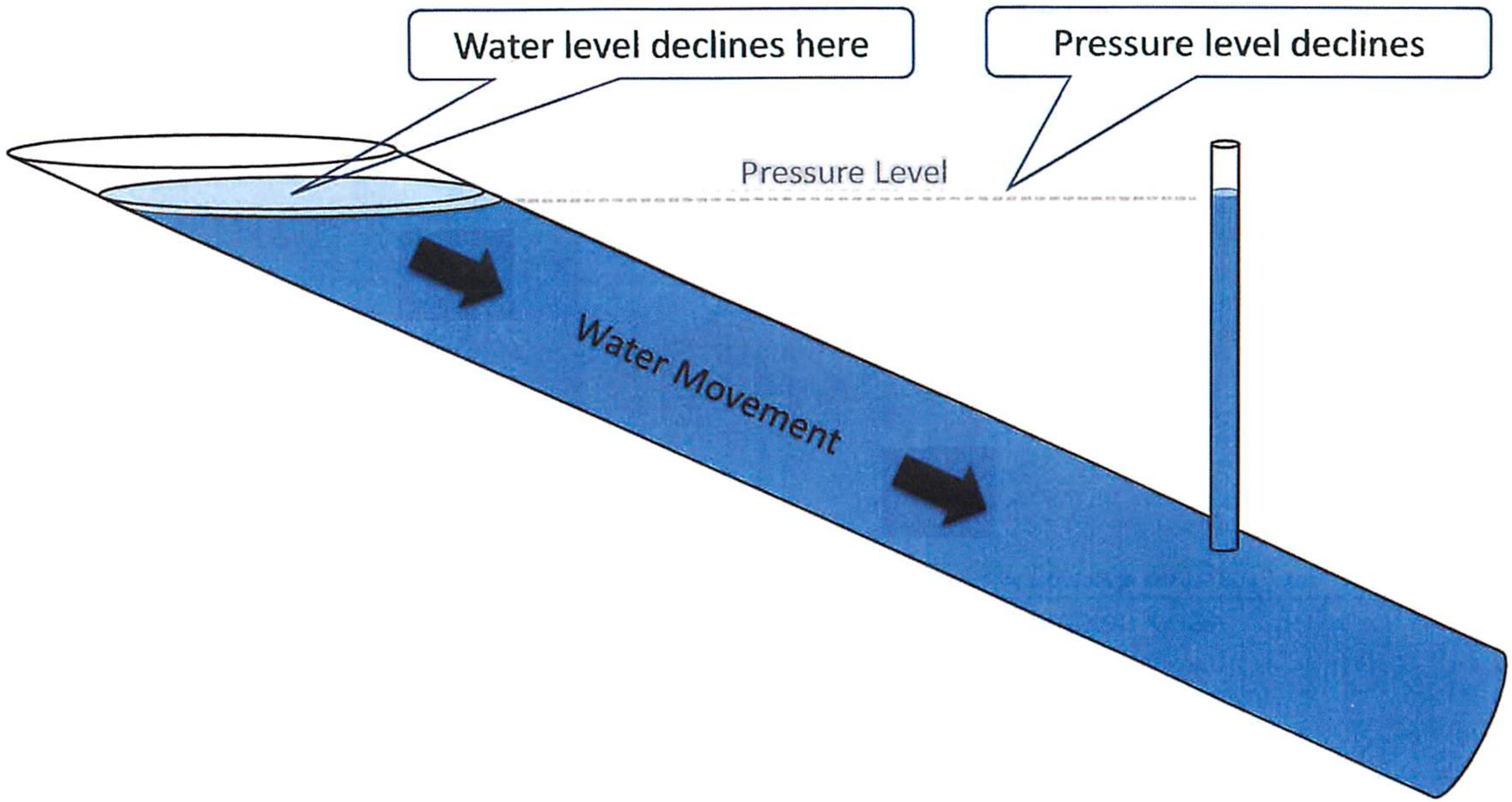

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Aquifer Cross Section

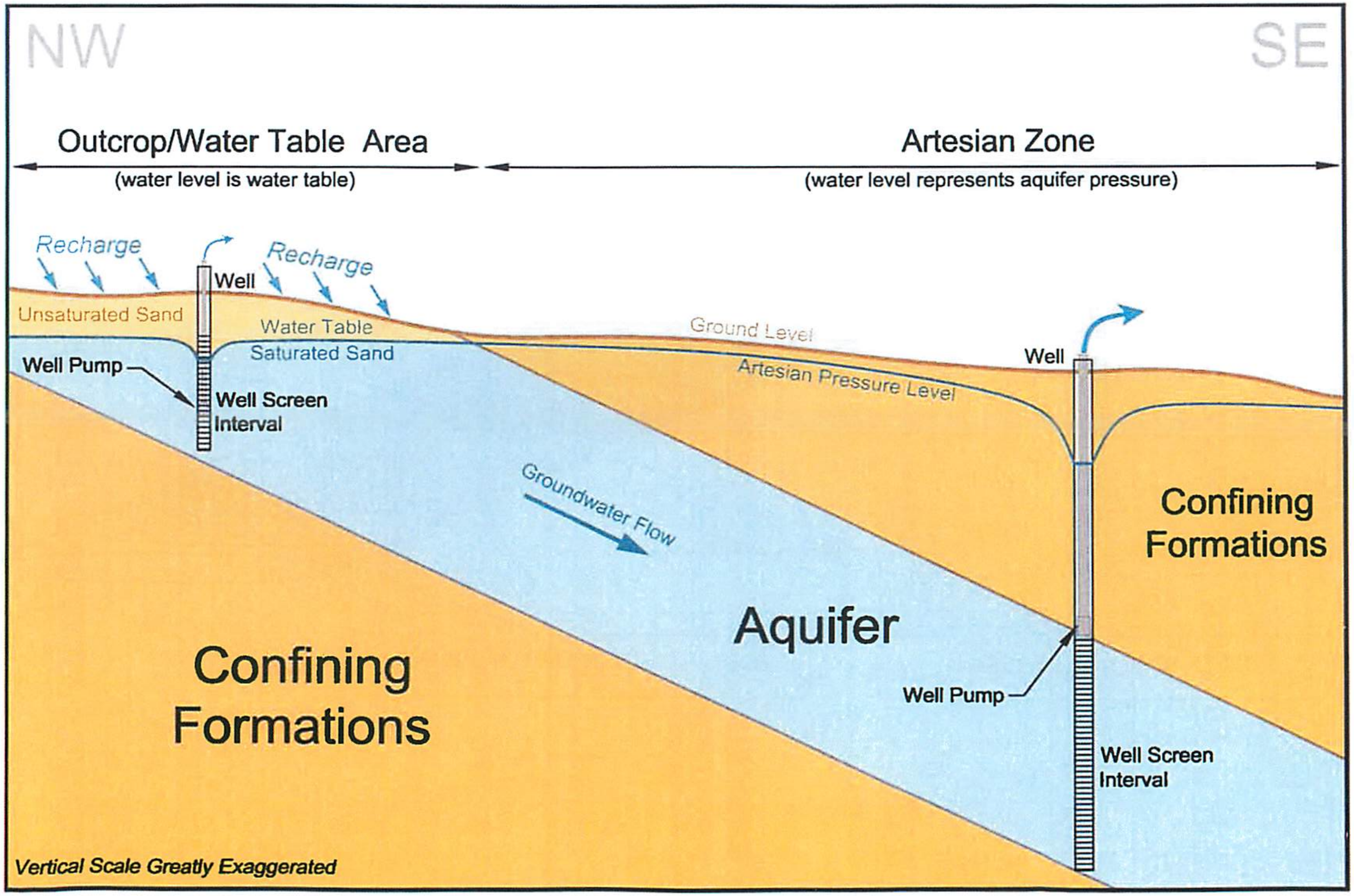
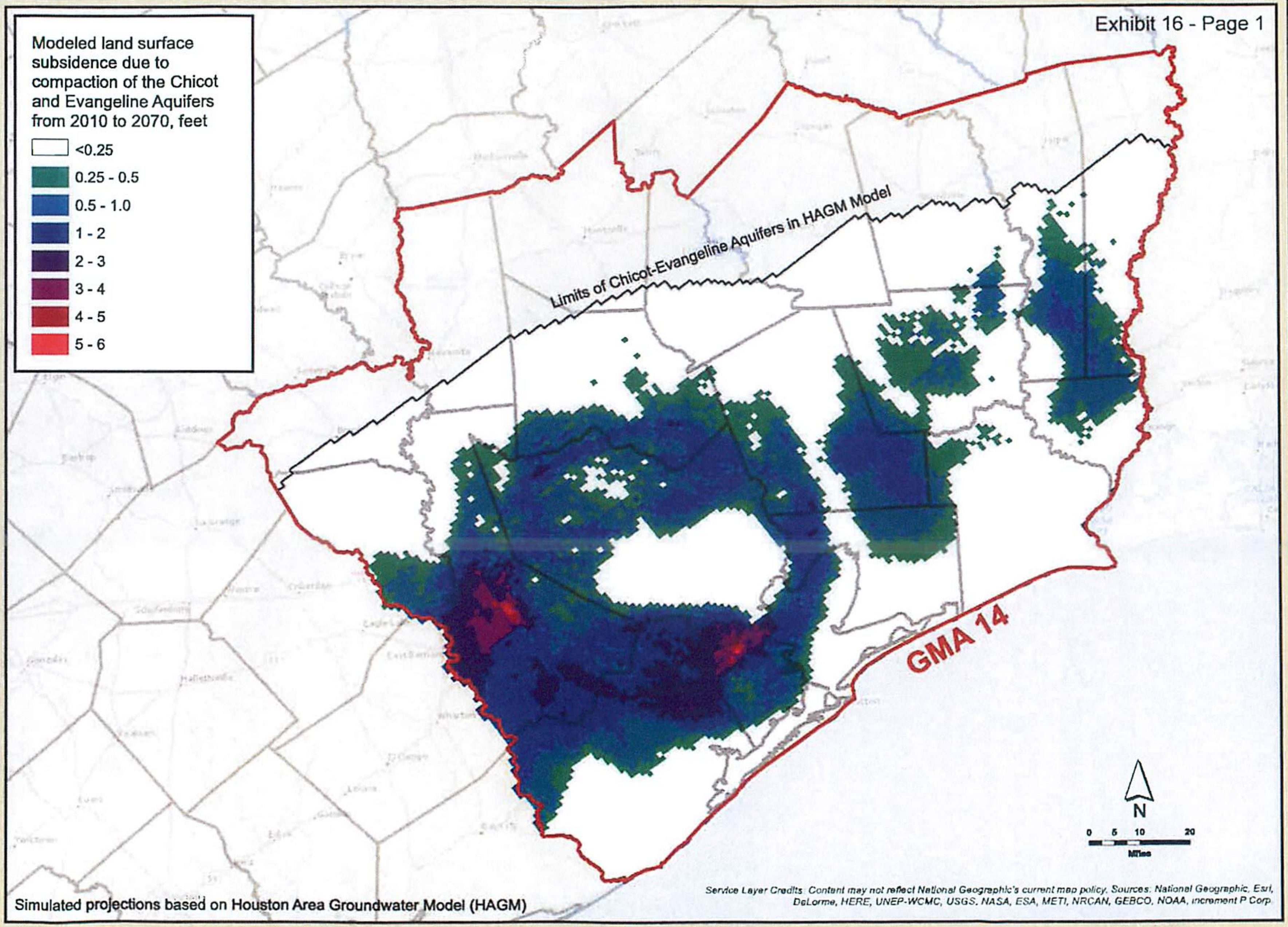


Exhibit 16

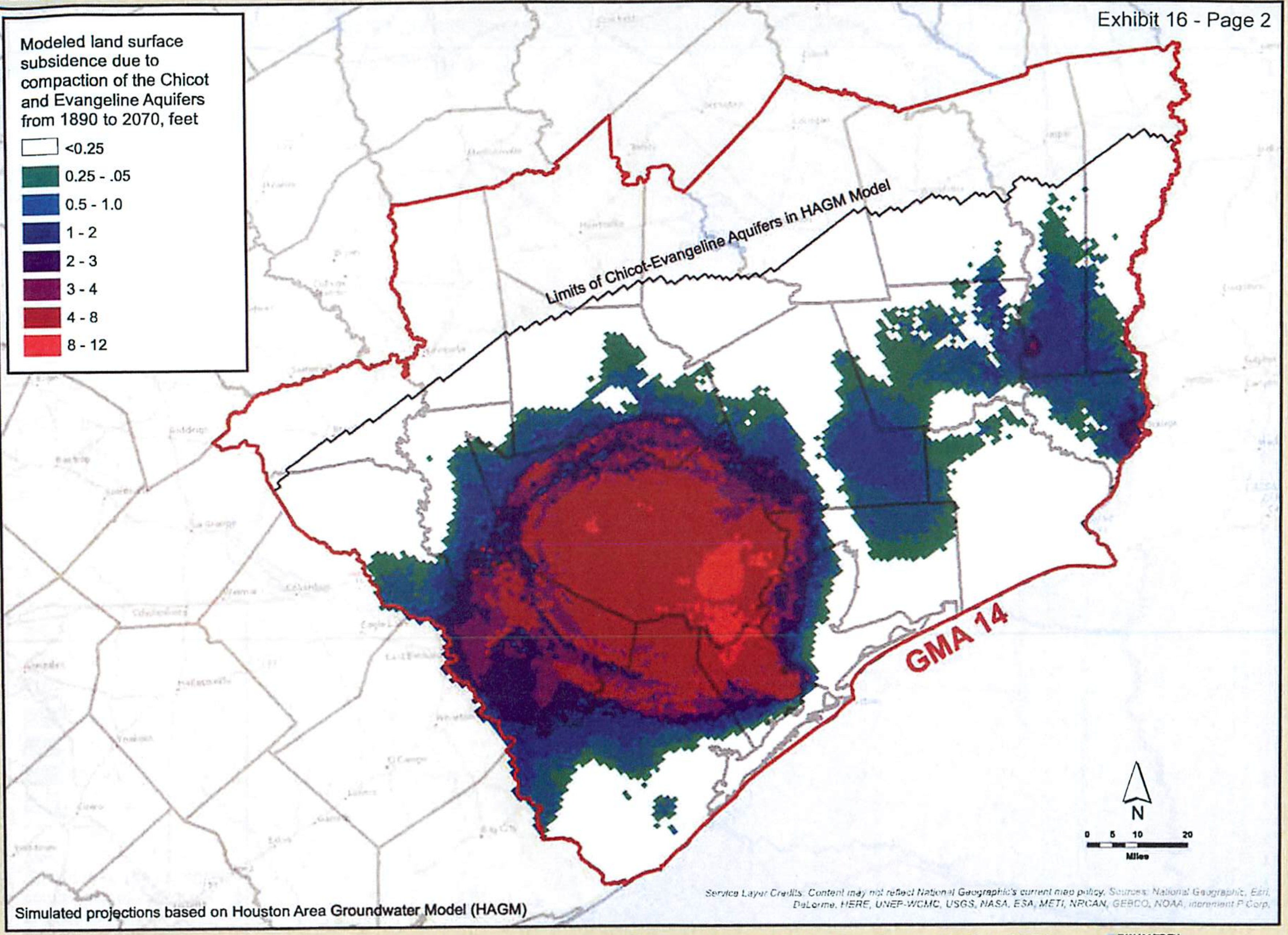
Maps of Projected Subsidence



Subsidence Due to Compaction of the Evangeline and Chicot Aquifers - 2010 to 2070

RW HARDEN & ASSOCIATES

Print Date: 11/11/2016



Subsidence Due to Compaction of the Evangeline and Chicot Aquifers - 1890 to 2070

RW HARDEN & ASSOCIATES

Print Date: 11/11/2016

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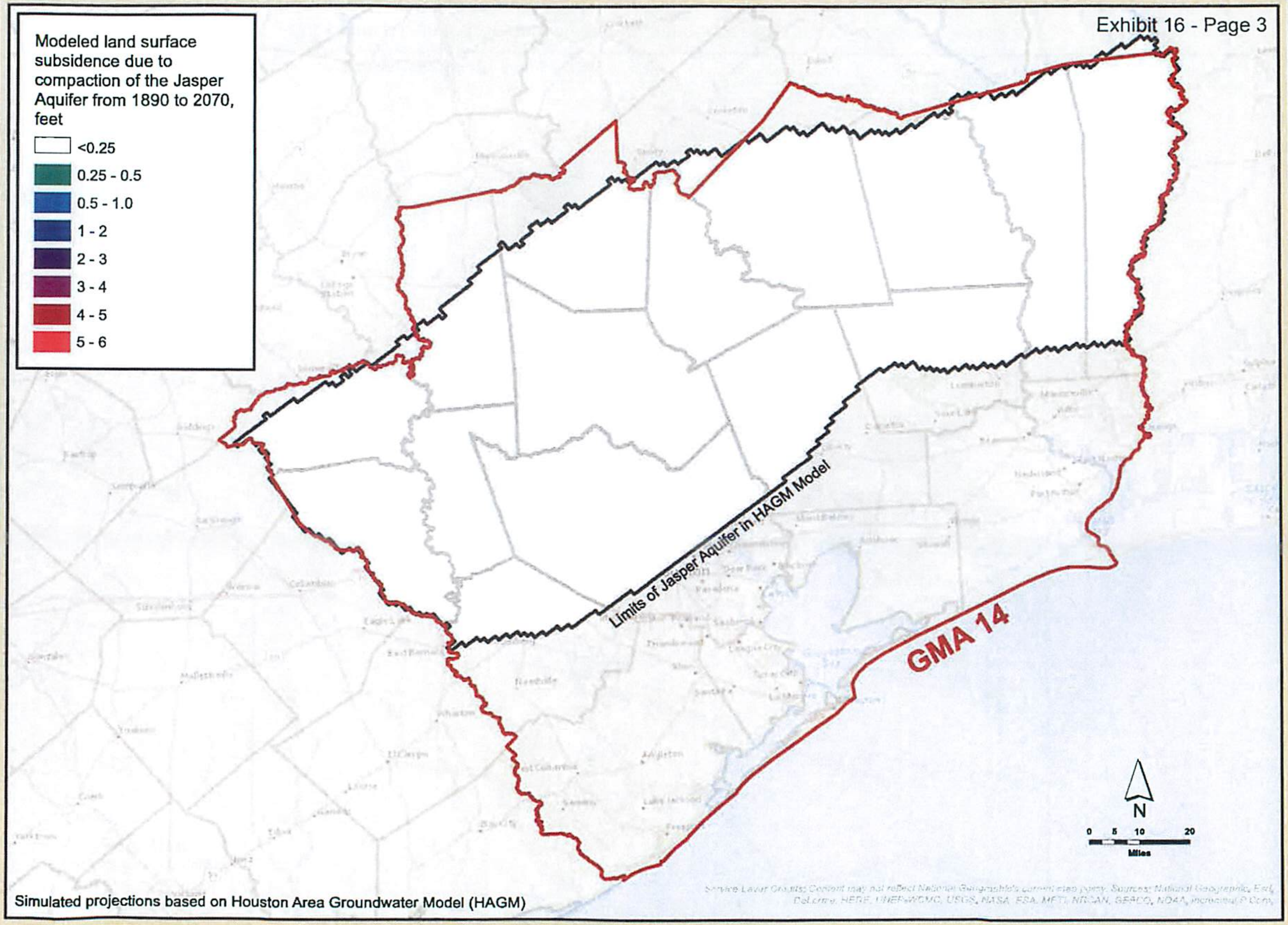

Simulated Subsidence Due to Compaction of the Jasper Aquifer - 1890 to 2070

RW HARDEN & ASSOCIATES

Print Date: 11/11/2016

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Exhibit 17

Lone Star Groundwater District's Resolution #16-006

RESOLUTION #16-006

RESOLUTION FOR THE ADOPTION OF THE DESIRED FUTURE CONDITIONS FOR THE GULF COAST AQUIFER THAT APPLY TO THE LONE STAR GROUDNWATER CONSERVATION DISTRICT

LONE STAR GROUNDWATER CONSERVATION DISTRICT

THE STATE OF TEXAS §

COUNTY OF MONTGOMERY §

WHEREAS, the Lone Star Groundwater Conservation District ("Lone Star") was created by the Legislature of the State of Texas by the Act of May 17, 2001, 77th Leg., R.S., ch. 1321, 2001 Tex. Gen. Laws 3246, as amended (the "Enabling Act"), as a groundwater conservation district operating under Chapter 36, Texas Water Code, and the Enabling Act; and

WHEREAS, pursuant to § 35.151 of the Texas Water Code, the Texas Water Development Board ("TWDB") has designated groundwater management areas that, together, cover all major and minor aquifers in the state, and, through Title 31 Texas Administrative Code §356.21, the TWDB has designated the area encompassing all of Austin, Brazoria, Chambers, Fort Bend, Galveston, Grimes, Hardin, Harris, Jasper, Jefferson, Liberty, Montgomery, Newton, Orange, Polk, San Jacinto, Tyler, Walker, Waller, and Washington counties as Groundwater Management Area No. 14 ("GMA 14"); and

WHEREAS, Lone Star and four other groundwater conservation districts, Bluebonnet Groundwater Conservation District, Brazoria Groundwater Conservation District, Lower Trinity Groundwater Conservation District, and Southeast Texas Groundwater Conservation District, (collectively referred to herein as the "Districts") are located wholly or partially within GMA 14; and

WHEREAS, the Districts are authorized by Chapter 36, Texas Water Code, to engage in joint planning activities for the coordinated management of the aquifers located in GMA 14, and in that regard, the Districts are required to establish desired future conditions ("DFCs") for the relevant aquifers within GMA 14; and

WHEREAS, Section 36.108 of the Texas Water Code requires representatives from the Districts to hold joint planning meetings for the consideration of DFC options, the proposal of DFCs for adoption, and after the contemplation of comments and suggested revisions provided by the public and Districts, the adoption of DFCs for each relevant aquifer in GMA 14 and the submission of an explanatory report to the TWDB for approval of the DFCs adopted; and

WHEREAS, as set forth in the attached Resolution for the Approval of Desired Future Conditions for All Aquifers in Groundwater Management Area 14 (the "Resolution"), attached hereto as Attachment A and incorporated by reference for all intents and purposes, the District representatives for GMA 14 have complied with the requirements provided by statute in Section 36.108, Texas Water Code, and on April 29, 2016, the District representatives for GMA 14 took final action to adopt the DFCs for the relevant aquifers in GMA 14 by approving the attached Resolution and the submission of the Desired Future Conditions Explanatory Report to the TWDB and the Districts as required by Section 36.108(d-3) of the Texas Water Code; and

WHEREAS, the DFCs adopted by the District representatives of GMA 14 are described in terms of acceptable drawdown levels for each subdivision of the Gulf Coast Aquifer, including the Chicot, Evangeline, Burkeville, and Jasper, for each county located within GMA 14, or in land surface subsidence, as applicable, and the DFCs were also adopted on aquifer-wide scales within GMA 14 for each of those aquifer subdivisions, which do not differ substantively in their application from the county-scale numbers; and

WHEREAS, the acceptable levels of drawdown for each subdivision of the aquifer underlying Montgomery County are measured in terms of water level drawdowns over the proposed current planning cycle measured in feet from 2009 estimated water levels; and

WHEREAS, Section 36.108(d-4) of the Texas Water Code provides that as soon as possible after a district receives the DFCs resolution and explanatory report under Subsection (d-3), the district shall adopt the DFCs in the resolution and report that apply to the district; and

WHEREAS, TWDB rules at Title 31, Texas Administrative Code §356.34 provide that as soon as possible after a district receives notice from the Executive Administrator of the TWDB that the DFC Submission Package submitted to the TWDB has been determined to be administratively complete, the district shall adopt the DFCs that apply to the district; and

WHEREAS, at this time, Lone Star has received a copy of the Resolution, as provided herein as Attachment A, and the Desired Future Conditions Explanatory Report prepared by GMA 14, and the Lone Star Board seeks to adopt the DFCs in the Resolution and the Explanatory Report that apply to Lone Star; and

WHEREAS, Lone Star received a letter from the TWDB, dated July 12, 2016, notifying Lone Star that the DFC Submission Package provided to the TWDB by the GMA 14 Districts has been determined to be administratively complete by the Executive Administrator of the TWDB, and therefore it is now appropriate for Lone Star to proceed with the adoption of the DFCs that apply to Lone Star in compliance with TWDB rules as set forth in Title 31, Texas Administrative Code §356.34; and

WHEREAS, the Board finds that the DFCs provided herein for adoption are reasonable and necessary for the effective and prudent management of groundwater resources within Montgomery County, and have otherwise been developed in accordance with, and do satisfy the obligations imposed by Chapter 36 of the Texas Water Code and all other applicable laws of the State of Texas; and

WHEREAS, the Board also finds that all notice requirements for a meeting, held this day, to take up and consider the adoption of the DFCs described herein that apply to Lone Star have been, and are, satisfied;

NOW, THEREFORE, be it resolved by the Board of Directors of the Lone Star Groundwater Conservation District that the following DFCs are hereby established for the Gulf Coast Aquifer as the DFCs that apply to Lone Star:

- From estimated year 2009 conditions, the average draw down of the Chicot Aquifer in Montgomery County should not exceed approximately 26 feet after 61 years;
- From estimated year 2009 conditions, the average draw down of the Evangeline Aquifer in Montgomery County should not exceed approximately -4 feet after 61 years;
- From estimated year 2009 conditions, the average draw down of the Burkeville confining unit in Montgomery County should not exceed approximately -4 feet after 61 years;
- From estimated year 2009 conditions, the average draw down of the Jasper Aquifer in Montgomery County should not exceed approximately 34 feet after 61 years; and
- The Board also adopts as applicable to Lone Star the aquifer-wide scale average draw down numbers within GMA 14 for the Chicot Aquifer, Evangeline Aquifer, Burkeville confining unit, and the Jasper Aquifer as specifically set forth in the attached Resolution for the Approval of Desired Future Conditions for All Aquifers in Groundwater Management Area 14 (Attachment A).

AND IT IS SO ORDERED.

PASSED AND ADOPTED on this 9th day of August, 2016.

LONE STAR GROUNDWATER CONSERVATION DISTRICT

By: ______________________
Richard J. Tramm, Board President

ATTEST:

____
Rick Moffatt, Secretary