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TO: Board Members

THROUGH: Robert Mace, Deputy Executive Administrator, Water Science and Conservation
Kenneth L. Petersen, General Counsel

FROM: Bill Hutchison, Director, Groundwater Resources
Joe Reynolds, Attorney

DATE: January 13, 2010

SUBJECT: Report on Appeal of the Reasonableness of the Desired Future Condition Adopted by the Groundwater Conservation Districts in Groundwater Management Area 9 for the Edwards-Trinity (Plateau) Aquifer

Preamble

This report and the attached technical analysis constitute the staff analysis associated with the Board's consideration of petitions filed by legally defined interests in groundwater in Groundwater Management Area 9 (GMA 9) that appeal the adoption of the desired future condition (DFC) for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. In addition, this report and technical analysis make findings regarding whether the DFC is reasonable based on the evidence in the record. Staff recommends that the Board find that the DFC adopted by GMA 9 is not reasonable based on the findings and analysis set out in this report.

Procedural History

The groundwater conservation districts (GCDs) in GMA 9[1] adopted DFCs for the Edwards Group of the Edwards-Trinity (Plateau), Ellenberger, and Hickory aquifers on August 29, 2008. All of the GCDs except the Headwaters Groundwater Conservation District voted for the DFCs. Between August 25 and August 28, 2009, the GCDs received copies of petitions from the Plateau Regional Water Planning Group, Kerr County Commissioners Court, and the Upper Guadalupe River Authority (Petitioners) appealing the reasonableness of the adopted DFCs (Kerr

[1] Bandera County River Authority and Groundwater Conservation District, Barton Springs/Edwards Aquifer Conservation District, Blanco Pedernales Groundwater Conservation District, Cow Creek Groundwater Conservation District, Edwards Aquifer Authority, Hays Trinity Groundwater Conservation District, Headwaters Groundwater Conservation District, Medina County Groundwater Conservation District, Trinity Glen Rose Groundwater Conservation District.

County filed petitions relating to DFCs for all three aquifers; the Upper Guadalupe River Authority (UGRA) and the Plateau Regional Water Planning Group (Region 7) filed petitions relating to the Edwards Group of the Edwards-Trinity (Plateau) Aquifer). On August 28, 2009, the Texas Water Development Board (Board) received requests from the Petitioners asking for waivers of 31 Tex. Admin. Code § 356.43(a)(5), which requires that any appeal of a DFC be submitted to the Board within one year of the adoption of the DFC by the GCDs. In a letter dated September 3, 2009, the Board, through the Executive Administrator, granted the requests for a waiver of the rule, in accordance with 31 Tex. Admin. Code § 356.43(a)(6), upon a showing of good cause—namely, apparent confusion over interpretation of the rule and the fact that no party was prejudiced by the decision to grant the waiver. As the GCDs did not request the 60-day extension of time under 31 Tex. Admin. Code § 356.43(d), a hearing on the petitions was set for November 2, 2009 in Kerrville, Texas to hear testimony and evidence from Petitioners and respondent GCDs.

The hearing began at 10:00 A.M. at the offices of the Upper Guadalupe River Authority and concluded at 2:22 P.M. the same day. The record remained open until November 17, 2009, to receive additional evidence from other interested persons, as required by 31 Tex. Admin. Code § 356.44(f). Board staff received one additional comment.

On November 30, 2009, representatives of the GCDs in GMA 9 met and adopted a resolution clarifying the extent of the DFCs for the Ellenberger and the Hickory aquifers. Based on this action, the Petitioners withdrew their petitions relating to the DFCs for the Ellenberger and Hickory aquifers on December 14, 2009. Therefore, this report only addresses evidence and testimony relating to the reasonableness of the DFC for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer.

Certain facts presented in the testimony were not disputed. The Edwards Group of the Edwards-Trinity (Plateau) Aquifer is an unconfined karst aquifer that is geographically extensive and highly variable lithologically. TWDB staff developed two models for estimating groundwater availability in the Edwards Group of the Edwards Trinity (Plateau) Aquifer: the Hill Country Trinity Model (HCTM) and the Edwards-Trinity (Plateau) Model (ETPM). The GCDs in GMA 9 used the HCTM in developing its DFC for the Edwards.

Petitioners' Testimony

Petitioners questioned whether GMA 9 followed the expected procedures and reviewed relevant data and the best available data. Petitioners also questioned apparent conflicts in the numbers produced by the two models used, and urged that spring flow be the focus of a DFC rather than drawdown.

Procedural Challenges

Petitioners note that regional water planning statutes mandate a public and open process. They assert that the GCDs in GMA 9 adopted the DFC prematurely, with insufficient and incomplete data. They claim that public requests to postpone approval of the DFC were ignored and that proper consideration was not given to groundwater use, to the socio-economic impacts

reasonably expected to occur, or to the impact on private property rights. Thus, according to Petitioners, the GCDs in GMA 9 acted contrary to the legislative intent of the process by making a decision too quickly, in spite of requests to delay in order to acquire better information.

Inadequate Data

Petitioners contend that the HCTM does not cover all of the Edwards Group of the Edwards Trinity (Plateau) Aquifer in Kerr County and, therefore, does not adequately represent the dynamics of the Edwards Group of the Edwards Trinity (Plateau) Aquifer in Kerr County. Petitioners rely on the work of the Plateau Regional Water Planning Group (Region J), which includes Kerr and Bandera counties and which used the ETPM in developing their 2006 Regional Water Plan. Petitioners also contend that activities in the counties to the west and north of GMA 9 (in GMA 7) impact the Edwards. Consequently, Petitioners assert that the GCDs in GMA 9 should have conferred with the GCDs in GMA 7 and with Region J before approving their DFC for the Edwards.

Petitioners further assert that the 2006 Regional Water Plan was not considered when the GCDs set the DFC. Petitioners claim that the GCDs did not try to reconcile the DFC with Region J estimates of groundwater availability.

In testimony presented during the hearing, Petitioners observed that the primary source of base flow to the Guadalupe River is from springs that emanate from the Edwards. They expressed concern that the DFC is not capable of implementation and enforcement, and therefore does not provide adequate protection to the spring flow or the base flow for the Guadalupe. Petitioners assert that any proposal must ensure protection and preservation of spring flows.

Petitioners note that the majority of the wells in Kerr and Bandera counties are exempt wells. Exempt wells are not regulated by the GCDs as long as production is limited to 25,000 gallons per day for livestock and domestic use on tracts of land larger than 10 acres. Additionally, Petitioners note that there is only one monitor well in western Kerr County. Petitioners claim that one monitor well is insufficient and that zero net increase in average drawdown is not possible when only nonexempt use is considered. Therefore, Petitioners claim, a DFC based on preventing any increase in aquifer drawdown in Kerr and Bandera Counties is not reasonable because it cannot be implemented.

Conflicting Models

In the hearing, the Petitioners relied on the testimony of Dr. Charles W. Kreitler with LBG-Guyton Associates for technical support of their petitions. Dr. Kreitler testified that the Edwards Aquifer covers two separate areas—one in Kerr County and another, separate segment in Kendall County. Dr. Kreitler further testified that the model utilized for calculation of the MAG in its current form does not accurately account for the dynamic water levels in the aquifer, nor did he believe the managed available groundwater (MAG) is a reliable figure for purposes of managing groundwater resources. Dr. Kreitler contended that a zero net drawdown on an average basis can not be measured or implemented. Consequently, he contended that the DFC and the

MAG are technically deficient in many respects as tools for effective management of the aquifer. Mr. Kreitler suggested that a more logical approach would be management of spring flows.

Petitioners premise their contention that the models are deficient on the disparity in the amount of available groundwater determined by the different models. Petitioners presented a series of calculations to show that the total amount of groundwater available under the MAG would serve only 46 exempt wells in Kerr County. At several points, Petitioners expressed concern over what they characterized as the disparity between the groundwater available under the ETPM of 16,410 acre-feet per year and the managed available groundwater set by the HCTM based on a MAG of 1,263 acre-feet per year.

Petitioners' claims thus rest on certain assumptions:

1. the primary source of the base flow to the Guadalupe River are the springs emanating from the Edwards;
2. the GCDs have established only one DFC, which does not take into account the division of the Edwards Aquifer into two separate geographic areas;
3. there is only one monitoring well in western Kerr County, which is insufficient to determine an average value for the water level of the Edwards;
4. the DFC does not protect the spring flow or the base flow for the Guadalupe because it cannot be implemented or enforced;
5. to be reasonable, a DFC must be capable of implementation and enforcement, and must be quantifiable;
6. zero net drawdown on an average basis cannot be implemented;
7. the models in their current forms are not useful to predict groundwater levels for the next 50 years;
8. the MAG is not a reliable figure for purposes of managing groundwater resources; and
9. a more logical approach would be to manage spring flows.

Respondents' Testimony

Respondent GCDs asserted that they have met or exceeded the requirements described in Texas Water Code Chapter 36. Respondents claimed that they actively sought the involvement of stakeholders in the joint planning process. To this end, Respondents noted that they held 23 committee meetings, most of which provided a public comment period for stakeholder input. Respondents pointed to the fact that 6 of the 23 meetings were formally designated "Public Meetings," were held in multiple locations across the GMA, and were specifically designed to inform stakeholders about the DFC process and obtain additional stakeholder input. Thus, Respondents claimed the votes on the DFC followed extensive public input.

In short, Respondents asserted that the process they followed was laid out in Texas Water Code Chapter 36. They began holding meetings in September 2005 and had worked closely with TWDB staff attending those meetings to ensure that they were in compliance in all respects with the requirements of the statute.

Inadequate Data and Conflicting Models

Regarding the modeling tools used, Respondents noted that the selection of the model was not their responsibility. Rather, Respondents claimed the TWDB determined what modeling tool would be used to develop a MAG from the DFC. Even so, Respondents claimed that the GMA 9 Technical Group discussed the ETPM, water balance equations, and two-dimensional spreadsheet models in addition to the HCTM, to address concerns that a portion of Kerr County was not covered under the HCTM. According to Respondents, the Technical Group also was aware of modeling-related issues with certain areas of GMA 9 and that new data might indicate that one modeling tool would prove to be more appropriate for GMA 9. In the end, Respondents asserted that the Technical Group used by GMA 9 could find no grounds for recommending any other modeling tool as an alternative to the use of the HCTM.

Regarding regulation of pumping in the GMA, Respondents assert that all wells, exempt and non-exempt, are managed to varying degrees by individual GCD rules promulgated in accordance with Chapter 36 and any specific GCD's enabling legislation. Although determining the number of exempt wells can be difficult, Respondents asserted that there are a number of commonly used methods to calculate or estimate exempt pumpage and that the results from such efforts can be accurate enough to serve local and regional planning needs.

As GCDs cannot deny an owner of more than 10 acres the right to drill a well that provides no more than 25,000 gallons per day and is used solely for domestic or livestock watering purposes, Respondents asserted that the DFC for the Edwards Aquifer was primarily set to discourage non-exempt use and to protect spring flow. Local GCDs either have already taken steps to restrict non-exempt drilling or plan to do so in the near future. Respondents pointed to the Blanco Pedernales GCD's rules that prohibit the issuance of a permit for any new non-exempt well that proposes to produce water from the Edwards. Respondents also referred to the Headwaters GCD in Kerr County, which has had a similar rule in effect for some time. On July 1, 2009, the Cow Creek GCD adopted an order prohibiting the drilling of any new wells that propose to produce water from the Edwards.

Spring Flow and Base Flow

Respondents stated that one of the primary considerations in setting the DFC for the Edwards Aquifer was the widespread support for protection of base flow to springs, creeks, and rivers. Respondents claimed that the most appropriate way to achieve preservation of base flow to springs, creeks, and rivers consistent with stakeholder input, is to protect the primary source water, i.e., spring flow from the Edwards. Since the primary threat to such spring flow, according to Respondents, would be increased pumpage, they decided to set a DFC that would discourage drilling of new non-exempt wells and provided for a minimal MAG quantity that would be used primarily for exempt wells. According to Respondents, setting a DFC of "no net increase in average drawdown (from current conditions)" meets those conditions. Respondents assert that they considered groundwater availability quantities developed by Region J, but that other considerations were judged more important than trying to match Region J's numbers.

In short, Respondents claim that:

1. much of petitioners argument concerned disagreements with the processes involved, which are essentially legislative or statutory mandates with which the GCDs must comply;
2. petitioners' claims that some activities, processes, and decisions of the GCDs were contrary to TWDB Rules and Chapter 36 of the Water Code are without merit; and
3. the GCDs have met or exceeded all the procedural requirements for setting DFCs, including holding open and public meetings, encouraging and obtaining stakeholder input, obtaining hydrogeologic data on the various aquifers under consideration, coordinating with and giving due consideration to other local and regional authorities, and complying with the TWDB Rules and Texas Water Code § 36.108.

Analysis

The parties appear to agree that maintaining spring flow is a priority. Petitioners rely on the Region J plan that describes a spring flow "constraint" on groundwater availability as follows:

> *"a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in the rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions"*

The Respondents asserted that the DFC approved by the GCDs that allows "for no net increase in average drawdown (from current conditions) in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer" also protects spring flow by discouraging non-exempt use. Under both conditions the goal is essentially the same, although the Region J goal allows "acceptable" impact to the aquifer.

Procedural Issues

The Petitioners stated that the process for establishing a DFC and determining the MAG is a large part of the appeal. Petitioners presented technical testimony that focused on an assessment of the sufficiency of the data and the accuracy of the models used to calculate the MAG. They also criticized the process that the GCDs went through to determine the DFC. The statute authorizes an appeal of the DFC; whereas the MAG number, which results from the DFC, is not appealable under the statute. The petition process cannot be used for the purpose of challenging the MAG number. This proceeding appeals the DFC adopted by the GCDs and not the validity of the models used or the process employed by the GCDs to derive a DFC.

Petitioners reviewed the history of the deliberations that led up to the adoption of the DFC. They asserted that, in spite of urgings to postpone approval of the DFC, the GCDs proceeded to adopt a DFC with insufficient and incomplete data. Respondents testified that six public meetings were held in multiple locations, designed to inform stakeholders about the DFC process and to obtain stakeholder input. Providing a public and open process does not guarantee certain results. None

of these assertions by the Petitioners provided any evidence that the DFC is not reasonable. The Petitioners' points again address the process involved, not the DFC itself.

Inadequate and Conflicting Data

Strictly speaking, the petition process is not intended for the appeal of issues related to the development of managed available groundwater values. The petition process is limited to addressing the reasonableness of an adopted desired future condition. Staff generally views the managed available groundwater development process as a technical issue. However, because the policy decision of a desired future condition and the development of a managed available groundwater value are so intimately linked, and because of certain statements in the petitions, the nature of some of the submitted material by the petitioners, and because of certain statements contained in the hearing transcript, a discussion of managed available groundwater values is presented in the attached technical analysis.

In particular, Petitioners relied on the work done by Region J in asserting that the discrepancy between the numbers in the two models (ETPM and HCTM) indicates that the process is flawed and the DFC is unreasonable. At several points, Petitioners refer to what they characterized as the disparity between a groundwater available of 16,410 acre-feet per year using the ETPM and the MAG of 1,263 acre-feet per year using the HCTM. The attached technical analysis by TWDB staff addresses this disparity. In short, the two models give very similar results for the DFC (a MAG of 5,208 acre-feet per year for HCTM and a MAG of 1,263 acre-feet per year for ETPM). The apparent disparity is due to (1) the fact that the 16,410 acre-feet per year is the groundwater availability for the entire Edwards-Trinity (Plateau) Aquifer and not just the Edwards Group of the Edwards Trinity (Plateau) Aquifer and (2) the fact that Region J groundwater availability estimate provided for additional impacts to the aquifer (water level declines and decreases in spring flow). In contrast, the DFC does not allow for additional impacts. Staff's analysis found that 5,208 acre-feet per year of pumping, the groundwater availability estimate of Region J, would actually allow for between 8 and 19 feet of drawdown in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer after 50 years.

Petitioners presented a series of calculations to show that the total amount of groundwater available under the MAG would serve only 46 exempt wells in Kerr County. The Petitioners themselves noted that this was "not a real number." The calculations are based on an assumption that all exempt wells would pump 25,000 gallons per day, 365 days per year, which is unrealistic. These calculations do not provide particular numbers for population, use, or other factors specific to the area. Consequently, the calculations provide no factual basis for a determination that the DFC is unreasonable.

Having clarified that the two models actually yield similar results, and, thereby reconciling the alleged differences between the MAG and the groundwater availability estimate developed by Region J, staff considered future groundwater use applying the modeling approach favored by the Petitioners. This analysis provides a basis for projecting usage as compared with the values for managed available groundwater. The attached technical analysis describes this process.

Finally, Petitioners assert the GCDs did not give proper consideration to groundwater use, the socio-economic impacts expected to occur, or the impact on private property rights. The question is not whether the GCDs gave sufficient consideration to these factors, but whether the DFC impacts these factors to such an extent that the DFC is unreasonable. Petitioners produced no evidence of specific, actual, or imminent impacts in these areas. Therefore, without such evidence there is no basis for a determination that the DFC is unreasonable.

As discussed above, the Petitioners' attempt to demonstrate that the MAG associated with the adopted DFC would not provide sufficient groundwater for projected growth was rejected by staff. However, the TWDB rules provide that consideration must be given to groundwater use. Accordingly, staff did complete an analysis that considered projected exempt use in the Edwards Group of the Edwards Trinity (Plateau) Aquifer in Kerr County to evaluate whether the DFC was achievable. This analysis is attached.

In short, staff's analysis demonstrated that, when pumping is zero, spring flow is approximately 9,232 acre-feet per year. But as pumping increases, spring flow decreases. When pumping is set to the groundwater availability estimates of 5,208 acre-feet per year developed by the Plateau Water Planning Group (Region J), spring flow is about 7,700 acre-feet per year, a 16 percent decline. A second scenario in staff's analysis suggests that zero drawdown can be achieved with pumping up to about 3,000 acre-feet per year; but spring flow would be about 8,400 acre-feet per year, or an impact of about 9 percent from the spring flow associated with zero pumping. If pumping were limited to about 1,300 acre-feet per year, spring flow would be reduced about 4 percent from the springflow associated with zero pumping.

The Edwards Group of the Edwards Trinity (Plateau) Aquifer in GMA 9 has experienced and will continue to experience growth in the number of exempt wells. Both parties noted that most, if not all, of the wells in the Edwards Group of the Edwards Trinity (Plateau) Aquifer are exempt wells. The DFC is "no net increase in average drawdown." The DFC fails to account for the anticipated increase in drawdown that will occur as exempt pumping in the area increases. The DFC attempts to limit non-exempt pumping in order to avoid or minimize impacts on spring flow and river baseflow. But unresolved is the disagreement as to what constitutes an acceptable level of impact.

Historic pumping from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County based on data discussed in staff's analysis was extrapolated forward through 2060. In this analysis, 2060 pumping estimates range from about 1,800 acre-feet per year to about 5,600 acre-feet per year. The managed available groundwater value issued by the Texas Water Development Board for Kerr County in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is 1,263 acre-feet per year. Based on staff's analysis, this managed available groundwater value will be exceeded, in one scenario, in about 2050 and, in another scenario in 2009. An average of these two increase scenarios suggests that pumping in 2060 would exceed 3,600 acre-feet per year, and pumping would exceed the managed available groundwater value of 1,263 acre-feet per year in about 2014. Based on this analysis, the desired future condition cannot be achieved.

Testimony in the record indicates that the Headwaters GCD, the only GCD in Kerr County, currently does not issue permits for wells in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. Thus, one can assume that any increases in pumping will be the result of increases in exempt wells. Under the scenarios modeled by staff, drawdown can occur with acceptable levels of impact. But, extrapolating the data on pumping estimates provided in the model, staff analysis suggests that the DFC as stated is not achievable because pumping will exceed the managed available groundwater value well before the 50-year horizon envisioned by the DFC.

A reasonable approach, based on the model used by Region J, as referenced repeatedly in the testimony and indicated by staff's analysis, is to project the growth in exempt pumping and calculate the amount of drawdown that may be expected on a reasonable regulatory horizon. That determines a reasonable (and therefore achievable) DFC under a scheme that continues to not permit any nonexempt wells.

Findings

The Board has considered the testimony, evidence, this report and staff's analysis and makes the following findings:

1. The GCDs in GMA 9 adopted desired future conditions in accordance with Texas Water Code § 36.108(d) and Board rules, 31 Tex. Admin. Code §§356.31–356.35.

2. Administratively complete petitions were submitted by the Plateau Water Planning Group, the Kerr County Commissioners Court, and the Upper Guadalupe River Authority in accordance with Board rules, 31 Tex. Admin. Code § 356.43(a).

3. A hearing on the petitions was held on November 2, 2009, and one additional comment was received by the Board following the hearing.

4. The record closed on November 17, 2009, in accordance with Board rules, 31 Tex. Admin. Code § 356.44(f).

5. Issues related to the DFCs for the Hickory and Ellenberger aquifers were resolved by the parties following the hearing and, therefore, were removed as subjects of this appeal.

6. The three petitions submitted generally cover the same basic issues, several of which focus on the hydrogeology of the area and the manner of developing the MAG value.

7. The petition process is not intended for the appeal of issues related to the development of MAG values.

8. The petition process is limited to addressing the reasonableness of an adopted DFC.

9. The petition process only considers evidence presented based on actual, particular facts; claims that are speculative or conjectural are not considered.

10. Available data depicts an aquifer with limited use (as evidenced by the historic pumping estimates), and the uses are almost completely from exempt wells.

11. The Headwaters GCD in Kerr County intends to limit use to exempt wells by not granting permits for nonexempt uses in order to avoid (or at least minimize) impacts to spring flow and river baseflow.

12. The DFC adopted by the GCDs for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is to "allow for no net increase in average drawdown" in the Edwards.

13. Within GMA 9, the Edwards Group of the Edwards Trinity (Plateau) Aquifer occurs in Bandera, Kendall, and Kerr counties.

14. Within these three counties, the Edwards Group is the upper unit of the Edwards-Trinity (Plateau) Aquifer, and the Trinity Group is the lower unit.

15. The groundwater availability value developed in the ETPM and used by the Plateau Water Planning Group, for the Edwards-Trinity (Plateau) Aquifer in Kerr County was approximately 16,410 acre-feet per year, consisting of 5,208 acre-feet per year in the Edwards Group and 11,202 acre-feet per year in the Trinity Group, as shown in Table 3 of staff's analysis.

16. The MAG values for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer as presented in Chowdhury (2009) are 683 acre-feet per year for Bandera County, 318 acre-feet per year for Kendall County, and 1,263 acre-feet per year for Kerr County, as shown in Table 1 of staff's analysis.

17. Based on Findings 15 and 16, the groundwater availability values to compare when discussing the Edwards Group of the Edwards Trinity (Plateau) Aquifer in Kerr County are 1,263 acre-feet per year (the managed available groundwater value) and 5,208 acre-feet per year (the groundwater availability value associated with the Plateau Water Planning Group (Region J) plan.

18. The 1,263 acre-feet per year value in the Edwards Group of the Edwards Trinity (Plateau) Aquifer in Kerr County would result in a zero net drawdown, and the 5,208 acre-feet per year is associated with 8 to 19 feet of drawdown per year, based on staff's analysis.

19. Groundwater pumping from the Edwards Group of the Edwards Trinity (Plateau) Aquifer in Kerr County is less than 900 acre-feet per year.

20. Anaya and Jones (2009) estimated that total Kerr County pumping in 2000 was nearly 10,000 acre-feet per year.

21. The Edwards Group of the Edwards Trinity (Plateau) Aquifer supplies less than 10 percent of all groundwater use in Kerr County.

22. Based on estimates from Anaya and Jones (2009), the Edwards Group of the Edwards Trinity (Plateau) Aquifer supplied about 1 percent of groundwater use in Bandera County in 2000.

23. Based on estimates from Anaya and Jones (2009), the Edwards Group of the Edwards Trinity (Plateau) Aquifer supplied about 6 percent of groundwater use in Kendall County in 1997.

24. Based on Findings 19 through 23, the Board finds that, in these three counties, the Edwards Group of the Edwards Trinity (Plateau) Aquifer has more significance in Kerr County as compared to Bandera and Kendall Counties.

25. The reasonableness of the adopted DFC can be evaluated by analyzing whether it is possible to achieve "no net increase in average drawdown" given the relatively small volume of pumping by exempt wells which is expected to increase over the next 50 years.

26. Because it is likely that exempt pumping will exceed the MAG, the DFC is not achievable and, therefore, is not reasonable.

Kerr County

27. Based on staff's analysis, when pumping is zero, spring flow is approximately 9,232 acre-feet per year.

28. When pumping is set to the groundwater availability estimates developed by the Plateau Water Planning Group (Region J), spring flow is about 7,700 acre-feet per year, a 16 percent decline according to staff's analysis.

29. Zero drawdown can be achieved with pumping up to about 3,000 acre-feet per year; but spring flow would be about 8,400 acre-feet per year, or an impact of about 9 percent from the spring flow associated with zero pumping according to staff's analysis.

30. If pumping were limited to about 1,300 acre-feet per year, spring flow would be reduced about 4 percent from the spring flow associated with zero pumping.

31. The managed available groundwater value issued by the Texas Water Development Board for Kerr County in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is 1,263 acre-feet per year.

32. Staff's analysis suggests that pumping in 2060 would exceed 3,600 acre-feet per year, and pumping would exceed the managed available groundwater value of 1,263 acre-feet per year in about 2014.

33. Based on this analysis, the desired future condition cannot be achieved.

Bandera County and Kendall County

34. Historic pumping from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer has been estimated to be less than 200 acre-feet per year in Bandera County and Kendall County. Because of the generally low amount of pumping, and the fact that all pumping is from exempt wells, staff's analysis suggests that the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is not relevant for purposes of the joint planning process.

Recommendation

Staff recommends that the Board find that the desired future condition for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer adopted by the GCDs in GMA 9 is unreasonable because the DFC is not achievable.

If the Board finds that the DFC is not reasonable, then staff proposes that the Board recommend the following revisions to the DFC:

- an average drawdown of 9 feet in Kerr County and
- a declaration that the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is not relevant in Bandera County and Kendall County.

This DFC would result in a 12 percent decrease from a no-pumping scenario (1,100 acre-feet year) in average spring flow in Kerr County. The DFC would also result in about 2,000 acre-feet per year increase of stream recharge in Kerr County, which is an increase of 2,000 acre-feet per year because under the current level of pumping, there is a no net stream recharge or baseflow in Kerr County from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. This DFC allows for a 2060 pumping rate of about 4,000 acre-feet per year from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County, enough to accommodate the probable growth of exempt pumping in the county.

Attachment(s): Technical Analysis

Attachment

Technical Analysis

The groundwater conservation districts in Groundwater Management Area 9 adopted a desired future condition for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer on August 29, 2008. Within Groundwater Management Area 9, the Edwards Group occurs in Bandera, Kendall, and Kerr counties. As shown in Figures 1 and 2, within these three counties, the Edwards Group is the upper unit of the Edwards-Trinity (Plateau) Aquifer, and the Trinity Group is the lower unit. Further east, the Edwards Group is not present, and the aquifer name changes to the Trinity Aquifer.

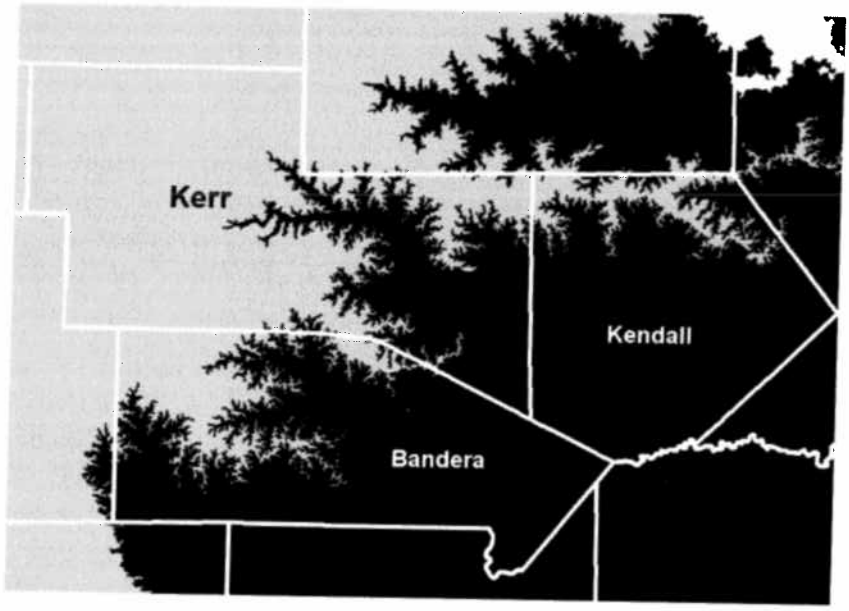

Figure 1. Aquifer designations in Bandera, Kendall and Kerr counties. Gray represents the Edwards-Trinity (Plateau) Aquifer and black represents the Trinity Aquifer.

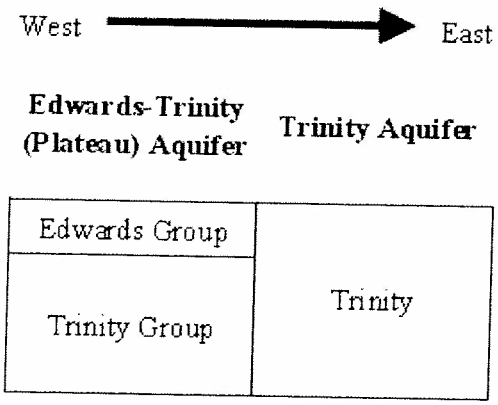

Figure 2. Conceptual cross-section of units within the Edwards-Trinity (Plateau) Aquifer in Bandera, Kendall, and Kerr counties

The desired future condition adopted by the groundwater conservation districts in Groundwater Management Area 9 for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer was "allow for no net increase in average drawdown" in the aquifer. On March 6, 2009, the Texas Water Development Board issued "GAM Run 09-90mag" (Chowdhury, 2009), which summarized the managed available groundwater value for this desired future condition. The managed available groundwater value was developed based on the groundwater availability model for the Hill Country portion of the Trinity Aquifer developed by Mace and others (2000). As described in Chowdhury (2009), a portion of the Edwards Group in Kerr County lies outside the domain of the groundwater availability model, and the managed available groundwater value in that portion was developed by extrapolating pumping inside the model domain to areas outside the model domain. The managed available groundwater values for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer as presented in Chowdhury (2009) are presented in Table 1.

Table 1. Managed available groundwater values as reported in Chowdhury (2009)

Bandera County	683 acre-feet per year
Kendall County	318 acre-feet per year
Kerr County	1,263 acre-feet per year
Total	**2,264 acre-feet per year**

In September 2009, the Plateau Water Planning Group (Region J), Kerr County, and the Upper Guadalupe River Authority filed petitions with the Texas Water Development Board, appealing the desired future condition of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer adopted by the Groundwater Conservation Districts in Groundwater Management Area 9. The petitions from the three parties assert that the desired future condition is not reasonable for various reasons. The three petitions generally cover the same basic issues, several of which are focused on the hydrogeology of the area and the manner of developing the managed available groundwater value.

Strictly speaking, the petition process is not intended for the appeal of issues related to the development of managed available groundwater values. The petition process is limited to addressing the reasonableness of an adopted desired future condition. TWDB staff generally view the managed available groundwater development process as a technical issue. However, because the policy decision of a desired future condition and the development of a managed available groundwater value are so intimately linked, and because of certain statements in the petitions, the nature of some of the submitted material by the petitioners, and because of certain statements contained in the hearing transcript, a discussion of managed available groundwater values is presented later in this analysis.

This analysis begins with an introductory section regarding historic pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Next, it presents a discussion of the pertinent issues related to the hydrogeology.

Specifically, this discussion focuses on the historic interrelationship between recharge, springflow, river baseflow, groundwater pumping, and drawdown, and on the predicted impacts to groundwater levels, springflow, and river baseflow to future pumping scenarios. Finally, the analysis presents a discussion on the reasonableness of the adopted desired future condition in the context of projected future pumping.

Historic Pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer

There are three sources for estimates of historic groundwater pumping for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer: (1) the groundwater availability model for the Hill Country portion of the Trinity Aquifer developed by Mace and others (2000), (2) the updated groundwater availability model for the Hill Country portion of the Trinity Aquifer developed by Jones and others (2009), and (3) the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). Anaya and Jones (2009) is the final numbered report for the groundwater availability model. An earlier version of the report was released as an unnumbered "GAM Report" (Anaya and Jones, 2004).

The groundwater availability model developed by Mace and others (2000) was previously used by TWDB staff in the development of the managed available groundwater value associated with the adopted desired future condition. The groundwater availability model developed by Anaya and Jones (2009) was used in the development of the groundwater availability estimated used in the Plateau Water Planning Group (Region J). The petitioners referred to both of these groundwater availability models and have queried on the decision to choose one model over another (e.g. p. 25 of the hearing transcript).

Estimates of groundwater pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer for each of the three relevant counties within Groundwater Management Area 9 are presented in Table 2. Mace and others (2000) included estimates for only three years, 1975, 1996, and 1997. A portion of Kerr County lies outside the model domain in this model. Jones and others (2009) represented an update to Mace and others (2000) and included annual estimates from 1980 to 1997. The same portion of Kerr County excluded from Mace and others (2000) is also excluded from Jones and others (2009). Finally, Anaya and Jones (2009) included annual estimates from 1981 to 2000 and included all of Kerr and Bandera counties, but the model domain did not include the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kendall County.

A comparison of the estimates for common years in Table 2 shows that estimates from Mace and others (2000) are generally higher than from Jones and others (2009) and Anaya and Jones (2009). Also, the estimated pumping amounts in Anaya and Jones (2009) are slightly lower than Jones and others (2009) in Bandera and Kerr counties; no similar comparison can be made in Kendall County due to its exclusion from the model developed by Anaya and Jones (2009).

Table 2. Summary of historic groundwater pumping estimates from three groundwater availability models for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer (all values in acre-feet per year, blank values means model calibration period did not include a particular year and/or county)

Year	Bandera County			Kendall County			Kerr County		
	Mace and others (2000)	Jones and others (2009)	Anaya and Jones (2009)	Mace and others (2000)	Jones and others (2009)	Anaya and Jones (2009)	Mace and others (2000)	Jones and others (2009)	Anaya and Jones (2009)
1975	162			189			465		
1976									
1977									
1978									
1979									
1980		63			77			605	
1981		65	23		89			589	397
1982		67	23		83			600	395
1983		69	23		96			599	396
1984		70	23		109			622	398
1985		71	22		104			611	389
1986		72	21		110			589	348
1987		75	23		87			604	370
1988		80	25		123			632	379
1989		82	25		131			646	410
1990		84	22		131			684	552
1991		90	22		106			707	568
1992		95	22		98			755	615
1993		98	22		107			755	610
1994		106	25		123			769	617
1995		111	25		146			775	586
1996	450	112	23	309	167		2,087	775	594
1997	520	115	23	309	221		2,271	791	602
1998			24						594
1999			27						625
2000			33						867

As presented in Table 2, groundwater pumping from the Edwards Group in Kerr County is less than 900 acre-feet per year. Anaya and Jones (2009) estimated that total Kerr County pumping in 2000 was nearly 10,000 acre-feet per year. Thus, the Edwards Group supplies less than 10 percent of all groundwater uses in Kerr County. Based on estimates in Table 2 and estimates from Anaya and Jones (2009), the Edwards Group supplied about 1 percent of groundwater uses in Bandera County in 2000. Based on estimates from Jones and others (2009), the Edwards Group supplied about 6 percent of groundwater uses and in Kendall County in 1997.

In general, the estimates suggest that, in these three counties, the Edwards Group has more significance in Kerr County as compared to Bandera and Kendall counties. The geographic extent of the Edwards Group as shown previously in Figure 1 is more significant in Kerr County as compared to Bandera and Kendall counties. Finally, the groundwater availability model described in Anaya and Jones (2009) is the only one that includes all of the Edwards Group in Kerr County. Therefore, the following discussion of the hydrogeologic issues relevant to the petitions is focused on the Anaya and Jones (2009) results as they relate to Kerr County.

Overview of Hydrogeologic Issues

The minutes of the Groundwater Management Area 9 meeting of August 29, 2008, document the adopted desired future condition for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. Those minutes report that Ron Fieseler noted that the Edwards Group and the underlying Upper Glen Rose (Upper Trinity) were "important to local spring, creek, and river base flow". Mr. Fieseler also noted that "production was usually rather limited and that very few non-exempt wells were producing from these two aquifers". At the petition hearing, Diane McMahon, president of the Headwaters Groundwater Conservation District (encompassing Kerr County), noted that her district does not issue permits for wells in the Edwards Group and the "only wells are the domestic or the exempt use" (p. 37-38 of the hearing transcript).

These statements depict an aquifer with limited use (as evidenced by the historic pumping estimates previously presented in Table 2), where the uses are all from exempt wells. Moreover, the district in Kerr County appears to intend to limit use to exempt wells in order to avoid (or at least minimize) impacts to spring flow and river baseflow. Indeed, the Plateau Water Planning Group (Region J) have parallel concerns regarding the impacts of groundwater pumping as evidenced in their petition via a quote from their regional water plan that described a springflow "constraint" on groundwater availability as follows:

> *"a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in the rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions"*

This same statement was read into the record and expanded on during the hearing by Kerr County Commissioner Jonathan Letz (hearing record p. 42, line 24 to p. 43 line 16).

There is a distinct difference between the desired future condition adopted by Groundwater Management Area 9 ("no net increase in average drawdown") and the "constraint" to groundwater availability adopted by the Plateau Water Planning Group (Region J), which provided for "acceptable" aquifer impacts that would not "significantly" affect rivers and streams.

The technical aspects of the reasonableness of the adopted desired future condition can be evaluated by analyzing whether it is possible to achieve "no net increase in average drawdown" given the relatively small volume of pumping by exempt wells which is likely to increase over the next 50 years. This analysis can then be extended to quantifying impacts associated with groundwater pumping on springflow and river baseflow and evaluating those impacts in the context of what the Plateau Water Regional Planning Group (Region J) considered "acceptable" and "significant".

The results from the groundwater availability model described by Anaya and Jones (2009) in Kerr County can be used to explore the relationships between recharge, groundwater levels, springflow, and river baseflow in the Edwards Group in Kerr County. This historical context is a foundation to a subsequent discussion of the reasonableness of the adopted desired future condition based on the record associated with the petitions.

Historic Relationships between Recharge, Groundwater Levels, Spring Flow and River Baseflow

Groundwater recharge to the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County averaged nearly 20,000 acre-feet per year from 1981 to 2000 (data from Anaya and Jones, 2009). Annual estimates of recharge from 1981 to 2000 are presented in Figure 3, including a reference line that depicts the average during this period.

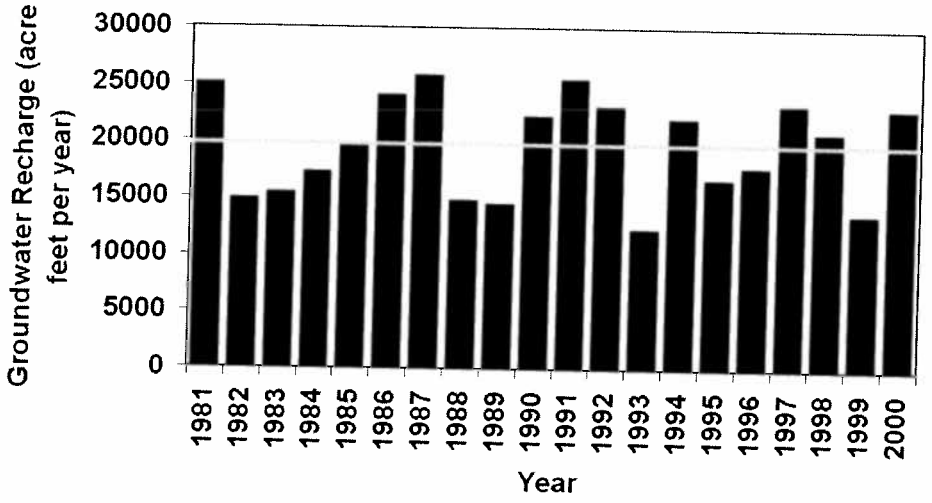

Figure 3. Historic recharge, Kerr County – Edwards Group, 1981 to 2000

Variations in precipitation result in variations in recharge. Recharge ranges from about 63 percent of average in 1993 to about 132 percent of average in 1987. Recharge represents the only significant inflow into the system. The variable recharge results in variations in groundwater levels, variations in springflow, and variations in river baseflow.

A history of groundwater level changes from 1981 to 2000 is presented in Figure 4. Groundwater levels generally rose during periods of high recharge and declined during periods of low recharge. The highest annual decline was about 18 feet from 1992 to 1993, and the largest annual rise (aside from the first year of the model) was about 11 feet from 1989 to 1990 and from 1999 to 2000.

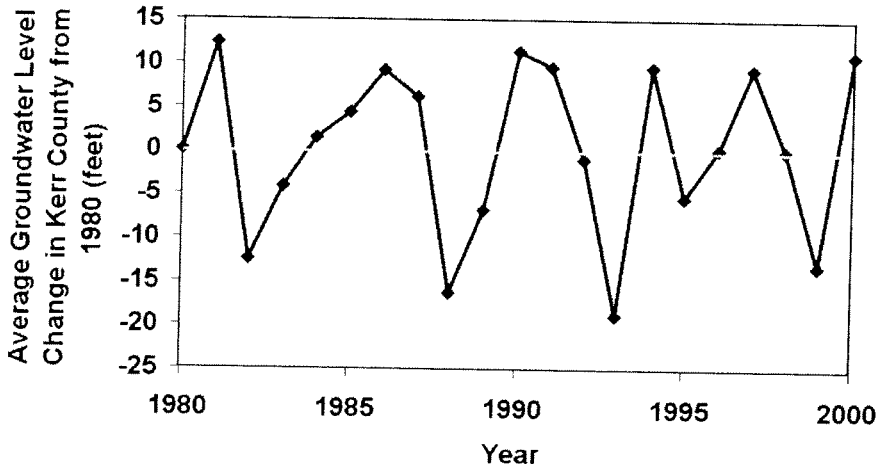

Figure 4. Historic average groundwater level changes, Kerr County – Edwards Group, 1981 to 2000

Figure 5 presents the relationship between recharge and average groundwater level change in the Edwards Group in Kerr County. As recharge increases, average groundwater level increases, and the increase is not linear. In fact, the best-fit line that is plotted along with the model results suggests that annual groundwater level change reaches a maximum of about 10 to 12 feet. This is consistent with the conceptualization of the groundwater flow system that high groundwater levels result in high spring flow and river baseflow. As groundwater levels rise, water is discharged via springs and baseflow, thus limiting the amount of the groundwater level rise. The best-fit line suggests that about 86 percent of the change in average groundwater level is attributable to variation in recharge.

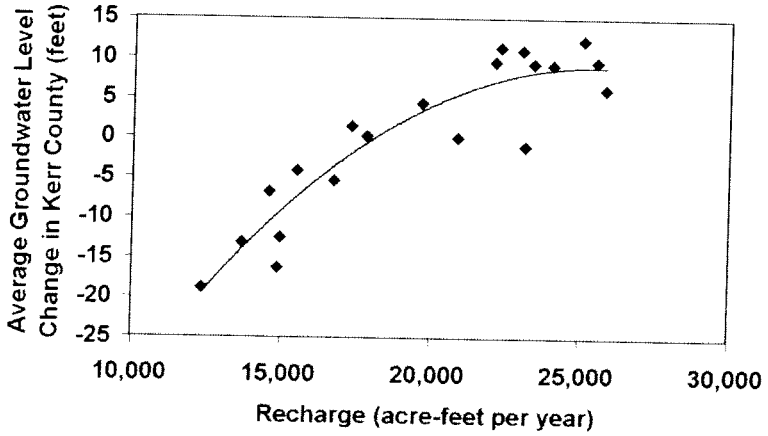

Figure 5. Recharge versus average groundwater level change, Kerr County – Edwards Group, 1981 to 2000

Figure 6 is a plot of recharge versus springflow in Kerr County. As recharge increases, springflow increases, and the increase is not linear. Increases in springflow are primarily driven by higher groundwater levels that are associated with high recharge as previously

presented in Figure 5. A best-fit line is plotted to depict the non-linear relationship. This best-fit line suggests that about 93 percent of the variation in springflow can be attributed to variation in recharge. Average springflow is about 9,300 acre-feet per year.

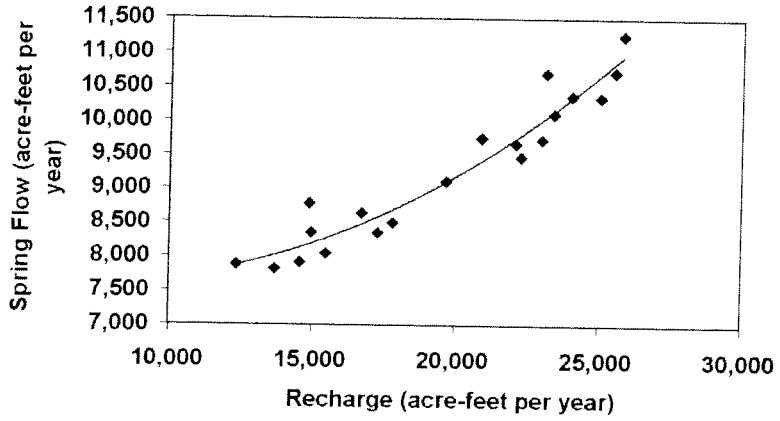

Figure 6. Recharge versus springflow, Kerr County – Edwards Group, 1981 to 2000

Figure 7 is a plot of recharge versus river baseflow/recharge in Kerr County. When recharge is higher than about 20,000 acre-feet per year, groundwater is discharging to streams and rivers and providing baseflow (negative flow values in Figure 7). When recharge is less than about 20,000 acre-feet per year, streams and rivers are acting as a source of aquifer recharge (positive flow values in Figure 7). The best-fit line plotted with the model results that depicts the non-linear relationship suggests that about 94 percent of the variation in groundwater discharge to streams and groundwater recharge from streams can be attributed to recharge.

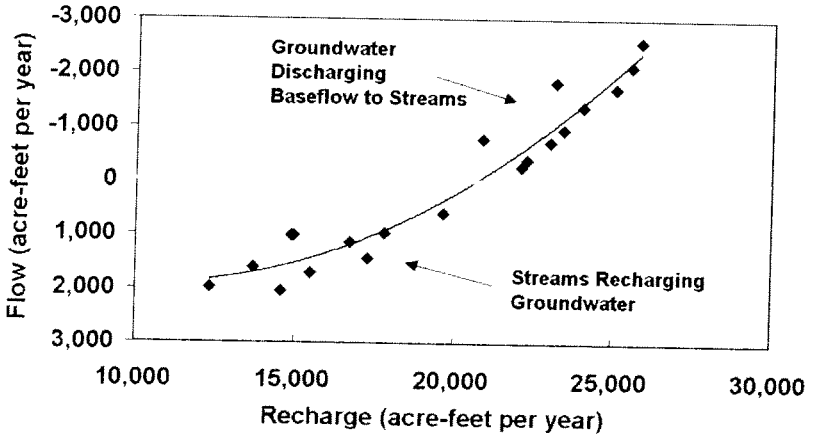

Figure 7. Recharge versus groundwater discharge to streams (negative flow values) and groundwater recharge from streams (positive flow values), Kerr County – Edwards Group, 1981 to 2000

Estimated Impacts to Groundwater Levels, Springflow and River Baseflow under Alternative Future Pumping Scenarios

In order to analyze potential impacts associated with future pumping, an estimate of future pumping is required. Development of future pumping estimates can begin with an examination of current groundwater availability estimates previously developed by the Plateau Water Planning Group (Region J).

The groundwater availability model described by Anaya and Jones (2009) was used by the Plateau Water Planning Group (Region J) in the development of their groundwater availability estimates in their 2006 Regional Water Plan. The regional water plan estimates of groundwater availability were subsequently incorporated into the 2007 State Water Plan and are summarized in Table 3.

Table 3. Summary of groundwater availability estimates developed by the Plateau Water Planning Group (Region J)

Aquifer	Sub-Aquifer	Groundwater Availability (acre-feet per year)	
		Bandera County	Kerr County
Edwards-Trinity (Plateau) Aquifer	Edwards Group	160	5,208
	Trinity Group	152	11,202
Trinity Aquifer		16,998	17,324

The total groundwater availability in Bandera and Kerr counties is the sum of the two sub-aquifers associated with the Edwards-Trinity (Plateau) Aquifer and the Trinity Aquifer. The sum of these three values is 17,310 acre-feet per year for Bandera County, and 33,734 acre-feet per year in Kerr County.

In the petitions, Bandera County groundwater availability is cited as 17,310 acre-feet per year, and Kerr County groundwater availability is cited as 16,410 acre-feet per year. It can be seen in Table 3 that the cited Bandera County groundwater availability represents the sum of both groups of the Edward-Trinity (Plateau) Aquifer and the Trinity Aquifer. It can also be seen that the cited Kerr County groundwater availability represents the sum of the Edwards Group and the Trinity Group of the Edwards-Trinity (Plateau) Aquifer. However, in the testimony of Kerr County Commissioner Jonathan Letz (hearing transcript, pg 43 lines 12 to pg 44 line 3), the 16,410 acre-feet per year value for Kerr County was compared to the managed available groundwater value previously presented in Table 1 (1,263 acre-feet per year) for the Edwards Group of the Edwards-Trinity

(Plateau) Aquifer. Mr Letz characterized the difference in the two estimates "alarming" (hearing transcript, p. 43, line 20).

A more consistent comparison in Kerr County is the managed available groundwater value from Table 1 (1,263 acre-feet per year) and the 2006 Regional Water Plan groundwater availability estimates for the Edwards Group of the Edwards-Trinity (Plateau) from Table 3 (5,208 acre-feet per year).

Further analyses were completed to develop a more comprehensive comparison of the groundwater availability estimates developed by the Plateau Water Planning Group (Region J) and the managed available groundwater values that were developed based on the desired future condition adopted by Groundwater Management Area 9. These analyses started by using the groundwater availability values described above as a starting point and used the groundwater availability model described by Anaya and Jones (2009). These analyses used the groundwater availability model described in Anaya and Jones (2009).

The initial runs of the model simulated impacts associated with the pumping values that are equal to the groundwater availability estimates previously presented in Table 3. Groundwater pumping in all three units (Edwards Group and Trinity Group of the Edwards-Trinity (Plateau) Aquifer and the Trinity Aquifer) was then incrementally increased and decreased to examine the impacts of increased and decreased pumping on groundwater level changes, spring flow and river baseflow in Bandera and Kerr Counties. The simulations included an assumption of average and constant recharge for the entire simulation period (50 years) in order to focus attention on pumping impacts.

Because the desired future condition is expressed in terms of drawdown, it is necessary to define a starting point to calculate drawdown, which is defined as the groundwater level at the beginning of the simulation minus the groundwater level at the end of the simulation. Two groups of simulations were completed: one with a starting point equal to the end of 1999 (the second to last year of the calibration period), and one with a starting point equal to the end of 2000 (the last year of the calibration period). These two conditions were chosen because they represent a generally low starting point (1999) and a generally high starting point (2000).

Kerr County Results

Results of the simulations include estimates of average drawdown in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County under a range of pumping (Figure 8). When the starting groundwater levels are generally high (2000 Initial Condition), even zero pumping results in some degree of drawdown. This is because the groundwater levels are at a temporarily high state and are equilibrating to the lower recharge, in this case average recharge over a 50-year period. In contrast, when the starting groundwater levels are generally low (1999 Initial Condition), zero drawdown can be achieved in Kerr County even with about 3,000 acre-feet per year of constant pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County.

This is because the groundwater system begins at a temporarily low state is and is rising to meet a new equilibrium given the higher recharge, in this case average recharge over a 50 year period.

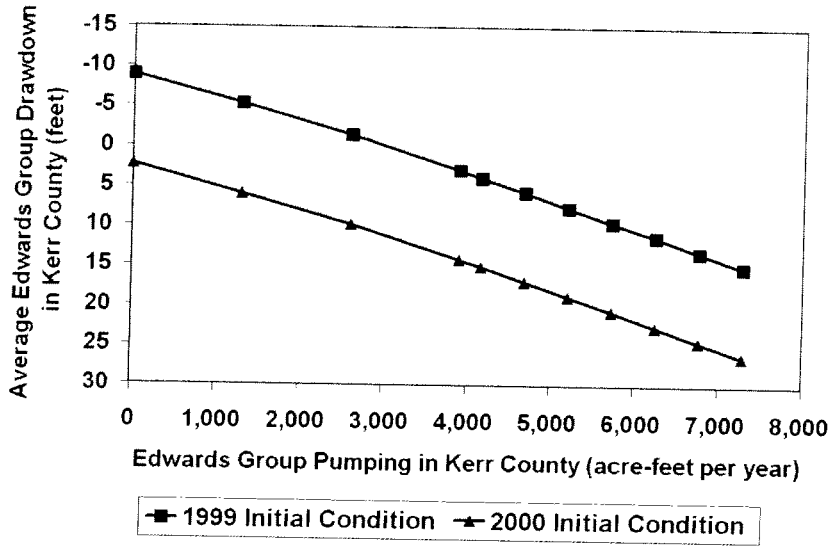

Figure 8. Simulated pumping versus drawdown in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County under alternative initial conditions

Based on the results summarized in Figure 8, it can be seen that when pumping is about 1,300 acre-feet per year under 1999 Initial Conditions (generally low groundwater levels), the groundwater levels will rise about 5.5 feet in the Kerr County portion of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. In contrast, when pumping is 1,300 acre-feet per year under 2000 Initial Conditions (generally high groundwater levels), the groundwater levels will decline about 5.5 feet in the Kerr County portion of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. Thus, it can be inferred that under "average" initial conditions, 1,300 acre-feet per year of pumping in the Kerr County portion of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer would result in zero drawdown after 50 years. This estimate compares favorably with the managed available groundwater value of 1,263 acre-feet per year that was developed by TWDB staff using the groundwater availability model developed by Mace and others (2000), and extrapolating the results to areas of Kerr County that are outside the model domain. Thus, it can be concluded that the two models yield approximately the same result when simulating pumping to achieve zero drawdown over a 50-year period.

When pumping is set to the values presented in Table 3 (the groundwater availability estimates developed by Region J), drawdown ranges from about 8 to about 19 feet. Because the Plateau Water Planning Group (Region J) assigned its groundwater availability numbers according to "a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact", then it follows that the Plateau Water Planning Group (Region J) considered this amount of drawdown to be "acceptable".

Pumping impacts to springflow in Kerr County are presented in Figure 9. Only one curve is presented as both initial condition scenarios yielded results that were less than one acre-foot per year different. When pumping is zero, springflow (9,232 acre-feet per year) is nearly identical to the average springflow from the calibration period (9,255 acre-feet per year), previously presented in Figure 6. As pumping increases, springflow decreases due to the pumping. This is consistent with the conceptualization that any increase in pumping will result in some degree of impact.

When pumping is set to the values previously presented in Table 3 (the groundwater availability estimates developed by Region J), springflow is about 7,700 acre-feet per year, a 16 percent decline. Because the Plateau Water Planning Group (Region J) assigned its groundwater availability numbers according to "a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact", then it follows that the Plateau Water Planning Group (Region J) considered this reduction of springflow to be "acceptable".

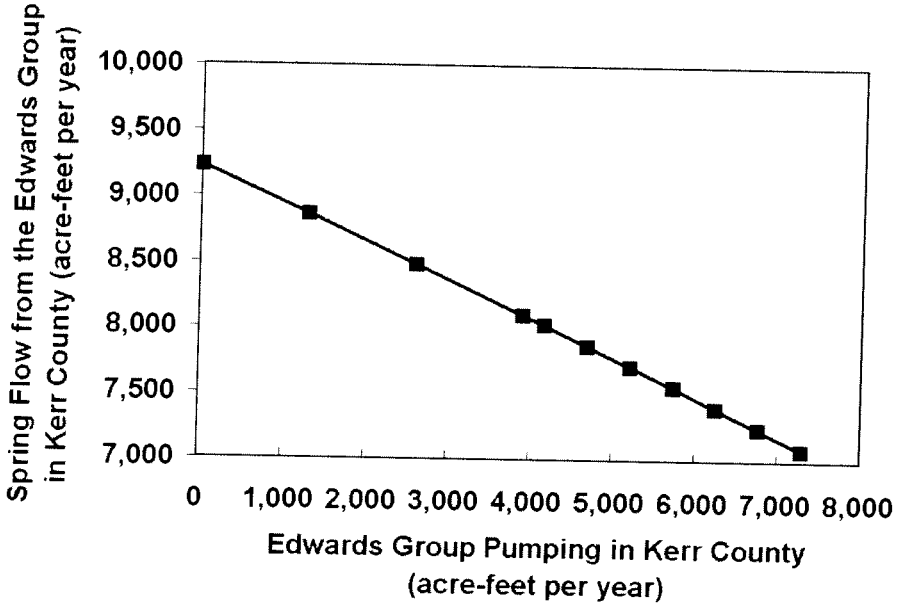

Figure 9. Simulated pumping versus springflow from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County

Under the 1999 Initial Condition scenario, zero drawdown can be achieved with pumping up to about 3,000 acre-feet per year. However, as previously noted, this is based on a temporarily low groundwater level condition as the starting point. It can be seen that under that condition, zero drawdown can be achieved, but spring flow would be about 8,400 acre-feet per year, or an impact of about 9 percent from the springflow associated with zero pumping. If pumping were limited to 1,300 acre-feet per year (zero drawdown under average initial conditions and approximately equal to the managed available groundwater value), springflow would be reduced about 4 percent from the springflow associated with zero pumping.

Pumping impacts to the interaction between groundwater and streams are presented in Figure 10. Only one curve is presented as both initial condition scenarios yielded results that were less than one acre-foot per year different. When pumping is zero, groundwater contributes about 75 acre-feet per year to streams as baseflow within the Edwards Group of the Edwards-Trinity (Plateau) in Kerr County. This is consistent with the results previously presented in Figure 7 that suggested that under average recharge conditions and minimal pumping, there is essentially zero net recharge from streams or nearly zero baseflow to streams from groundwater.

As depicted in Figure 10, when pumping increases, recharge from streams increases. This can be interpreted as another form of impact of increased pumping, and is consistent with the conceptualization that any increase in pumping will result in some degree of impact.

When pumping is set to the values previously presented in Table 3, which represent the groundwater availability estimates developed by the Plateau Water Planning Group (Region J), recharge from streams is about 2,600 acre-feet per year, as compared with an average of about zero acre-feet per year. Based on the results of the groundwater availability model developed by Anaya and Jones (2009) presented in Figure 7, groundwater provides baseflow only in high recharge years. Because the Plateau Water Planning Group (Region J) assigned its groundwater availability numbers according to "a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact", then it follows that the Plateau Water Planning Group (Region J) considered this impact to be "acceptable".

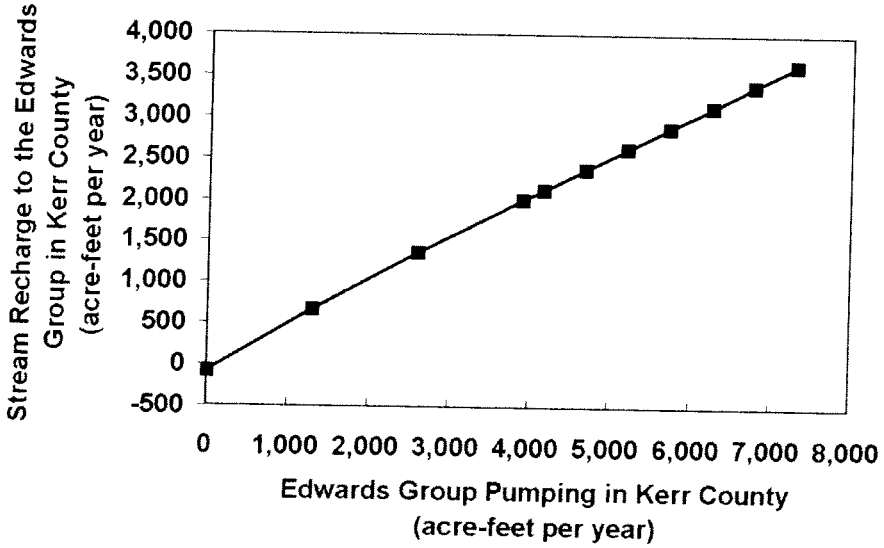

Figure 10. Simulated Pumping vs. Stream Recharge in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County

Bandera County Results

Results of the simulations include estimates of average drawdown in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Bandera County under a range of pumping (Figure 11). When the starting groundwater levels are generally high (2000 Initial Condition), even zero pumping results in some degree of drawdown. This is because the system begins at a temporarily high state and is equilibrating to the lower recharge, in this case average recharge over a 50-year period. In contrast, when the initial condition is generally low (1999 Initial Condition), zero drawdown can be achieved in Bandera County even with about 90 acre-feet per year of constant pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Bandera County. This is because the groundwater system begins at a temporarily low state and is rising to meet a new equilibrium given the higher recharge, in this case average recharge over a 50 year period.

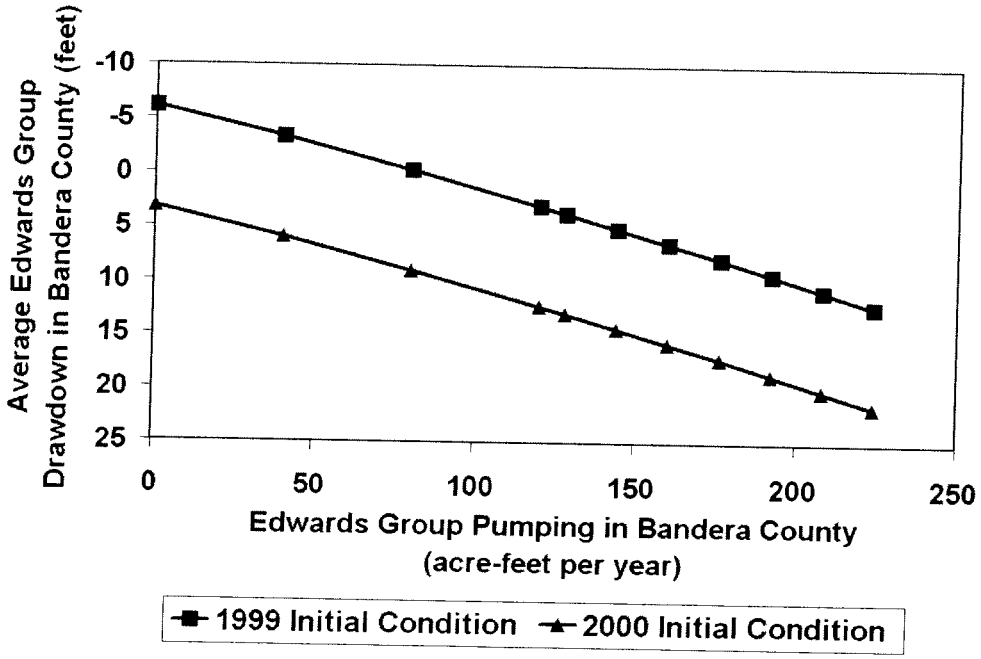

Figure 11. Simulated pumping versus drawdown in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Bandera County under alternative initial conditions

Based on the results summarized in Figure 11, it can be seen that when pumping is about 20 acre-feet per year under 1999 Initial Conditions (generally low groundwater levels), the groundwater levels will rise about 4.6 feet in the Bandera County portion of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. In contrast, when pumping is 20 acre-feet per year under 2000 Initial Conditions (generally high groundwater levels), the groundwater levels will decline about 4.6 feet in the Bandera County portion of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. Thus, it can be inferred that under "average" initial conditions, 20 acre-feet per year of pumping in the Bandera County portion of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer would result in zero drawdown after 50 years. This estimate is much lower than the managed

available groundwater value of 683 acre-feet per year that was developed by TWDB staff using the groundwater availability model developed by Mace and others (2000).

When pumping is set to the values previously presented in Table 3 (the groundwater availability estimates developed by Region J), drawdown ranges from about 6 to about 16 feet. Because the Plateau Water Planning Group (Region J) assigned its groundwater availability numbers according to "a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact", then it follows that the Plateau Water Planning Group (Region J) considered this amount of drawdown to be "acceptable".

Impacts to springflow in Bandera County are presented in Figure 12. Only one curve is presented as both initial condition scenarios yielded results that were less than one acre-foot per year different. As pumping increases, spring flow decreases due to the pumping. This is consistent with the conceptualization that any increase in pumping will result in some degree of impact.

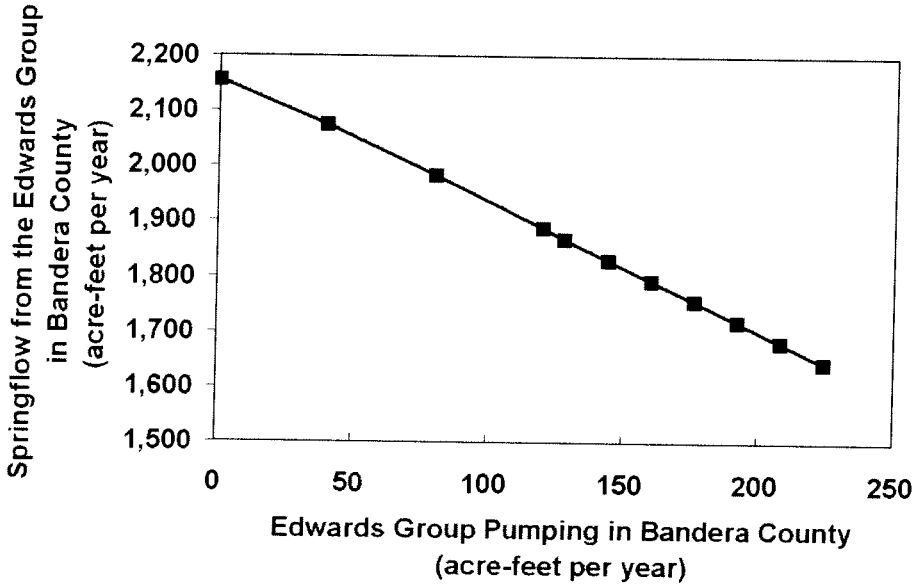

Figure 12. Simulated pumping versus springflow from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Bandera County

Under the 1999 Initial Condition scenario, zero drawdown can be achieved with pumping up to about 90 acre-feet per year. However, as previously noted, this is based on a temporarily low groundwater level condition as the starting point. It can be seen that under that condition, zero drawdown can be achieved, but springflow would be about 1,950 acre-feet per year, or an impact of about 20 percent from the springflow associated with zero pumping.

Impacts to the interaction between groundwater and streams are presented in Figure 13. Only one curve is presented as both initial condition scenarios yielded results that were less than one acre-foot per year different. When pumping is zero, stream recharge is

slightly above 2,400 acre-feet per year within the Edwards Group of the Edwards-Trinity (Plateau) in Bandera County. When pumping increases, recharge from streams increases. This is consistent with the conceptualization that any increase in pumping will result in some degree of impact.

When pumping is set to the values previously presented in Table 3 (the groundwater availability estimates developed by Region J), recharge from streams is about 2,650 acre-feet per year, an increase of about 250 AF/yr as compared to the zero drawdown scenario, or about a 9 percent increase.

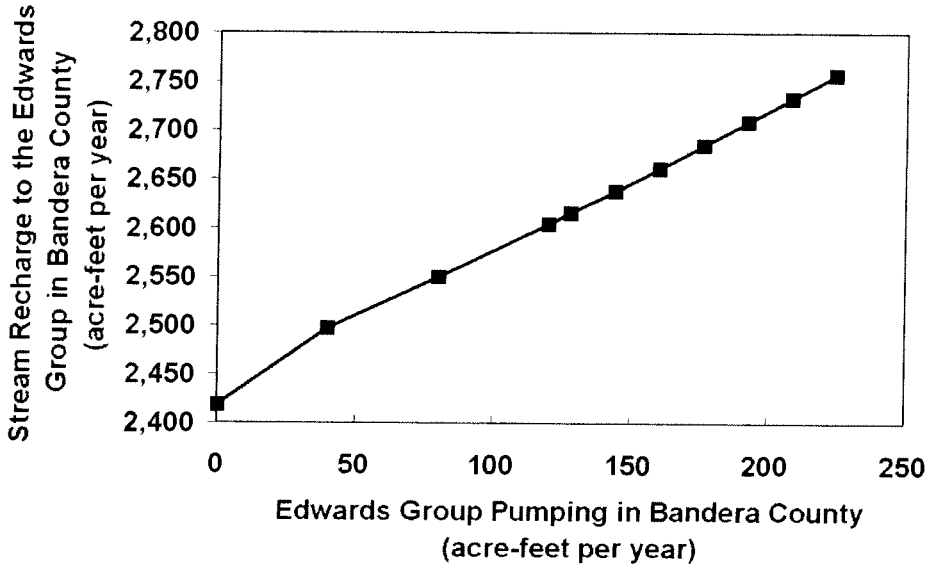

Figure 13. Simulated pumping versus stream recharge in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Bandera County

Under the 1999 Initial Condition scenario, zero drawdown can be achieved with pumping up to about 90 acre-feet per year. However, as previously noted, this is based on a temporarily low groundwater level condition as the starting point. Under that condition, zero drawdown can be achieved, but stream recharge would slightly above 2,500 acre-feet per year, which is an impact of about 150 acre-feet per year when compared to zero pumping or about a 6 percent increase.

Discussion of Reasonableness of Adopted Desired Future Condition

The Edwards Group of the Edwards Trinity (Plateau) Aquifer presents a rather unique situation in that all of the groundwater pumping is from exempt wells (or at least nearly all). Furthermore, the expressed desire of the groundwater conservation districts in Groundwater Management Area 9 and the petitioners is that pumping be limited in order to avoid or at least minimize impacts on springflow and river baseflow. In contrast, the Plateau Water Planning Group (Region J) previously developed groundwater availability estimates based on "acceptable" impacts on groundwater level drawdown and springflow.

This discussion focuses on conditions in Kerr County due to the relative significance of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County. Data on historic pumping presented earlier in Table 2 show that pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Bandera and Kendall counties has been less than 200 acre-feet per year, and that the Edwards Group supplies about 1 percent of groundwater use in Bandera County and about 6 percent of groundwater use in Kendall County. Because of the generally low amount of pumping, and the fact that all pumping is from exempt wells, staff's analysis suggests that the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is not relevant for purposes of the joint planning process

Headwaters Groundwater Conservation District does not issue permits for wells in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, and, thus, groundwater pumping is limited to exempt domestic and livestock wells. Therefore, it is reasonable to assume that any increases in pumping will be the result of increases in exempt wells (primarily domestic wells). Figure 13 presents historic pumping from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County based on data from Anaya and Jones (2009), and previously presented in Table 2 along with two curves that estimate the future increase in pumping through 2060 by extrapolating the 1981 to 2000 trend. Scenario 1 represents the pumping increase by connecting the relative maxima in the historic 1981 to 2000 data; Scenario 2 represents the pumping increase by connecting the relative minima in the historic 1981 to 2000 data. Estimated 2000 pumping was about 870 acre-feet per year. Estimated pumping in 2060 ranges from about 1,800 acre-feet per year to about 5,600 acre-feet per year.

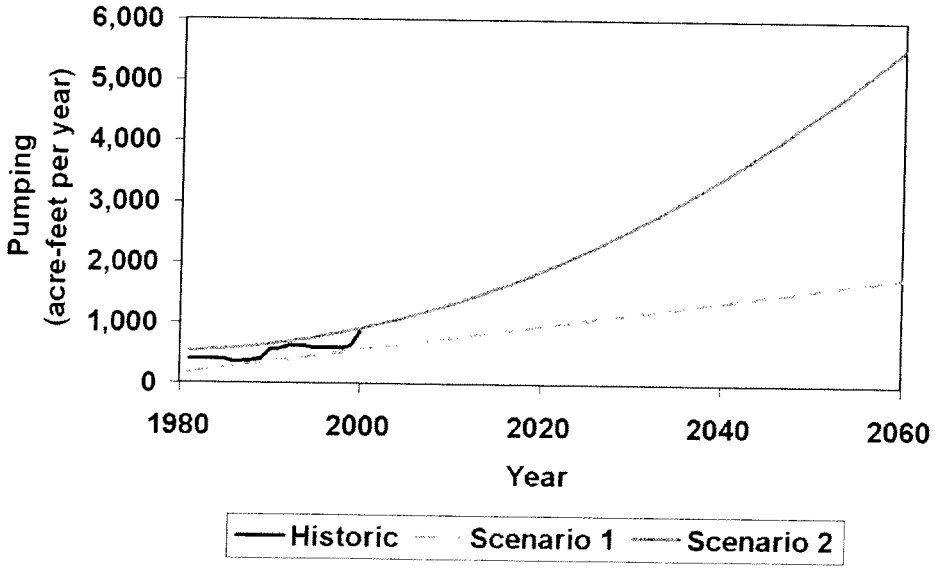

Figure 14. Historic pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County, and two alternative estimates of future pumping

The managed available groundwater value issued by the Texas Water Development Board for Kerr County in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is 1,263 acre-feet per year. Based on Scenario 1, this managed available groundwater value

will be exceeded in about 2050. Under Scenario 2, pumping exceeded the managed available groundwater value in 2009.

An average of these two increase scenarios yields that pumping in 2060 would exceed 3,600 acre-feet per year in 2060, and pumping would exceed the managed available groundwater value in about 2014. Based on this analysis, pumping is likely to exceed the managed available groundwater prior to 2060, and thus the desired future condition cannot be achieved.

As previously discussed, however, the choice of an initial condition on which to base a drawdown calculation is an important consideration that was not explicitly stated in the adopted desired future condition. If the initial condition is low, pumping in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer could be as high as 3,000 acre-feet per year in Kerr County. If this value were set as the managed available groundwater, pumping would not exceed 3,000 acre-feet per year under Scenario 1. Under Scenario 2, pumping would not exceed 3,000 acre-feet per year until after about 2035. Under an average of these two scenarios, pumping would not exceed 3,000 acre-feet per year until after 2050. The analyses demonstrated that pumping at this amount would have impacts to spring flow and stream baseflow. Because pumping is likely to exceed the managed available groundwater prior to 2060, the desired future condition cannot be achieved.

Recommendations

This recommendation is based on a conclusion that the current desired future condition is unachievable based on two scenarios of expected increases in exempt well pumping. The stated goal of both the groundwater conservation districts in Groundwater Management Area 9 and the petitioners is to avoid or minimize impacts to spring flow and river baseflow. However, because all pumping in Kerr County in the Edwards Group of the Edwards Trinity (Plateau) Aquifer is from exempt wells and because the Headwaters Groundwater Conservation District currently does not issue permits for wells in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, the development of an achievable desired future condition is directly linked to estimates of future increases in exempt pumping, with virtually no means to regulate that pumping once the wells are constructed.

The establishment of a desired future condition for the Edwards Group of the Edwards Trinity (Plateau) Aquifer is dependent on the estimated future pumping from exempt wells. Based on the analysis presented, a 2060 pumping rate of about 4,000 acre-feet per year from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County appears to be an intermediate estimate of the two pumping increase scenarios previously presented in Figure 13. This would result in between 3 and 15 feet of drawdown (depending on the initial condition), about a 12 percent impact to springflow, and about 2,000 acre-feet per year of increased stream recharge. Under "average" initial conditions, drawdown associated with 4,000 acre-feet per year of pumping from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer would result in about 9 feet of drawdown, about

a 12 percent impact to springflow and about 2,000 acre-feet per year of increased stream recharge.

Staff recommends that the Board find that the desired future condition for the Edwards part of the Edwards-Trinity (Plateau) Aquifer adopted by the GCDs in GMA 9 is unreasonable because the DFC is not achievable.

If the Board finds that the DFC is not reasonable, then staff proposes that the Board recommend the following revisions to the DFC:

- an average drawdown of 9 feet in Kerr County and
- and a declaration that the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is not relevant in Bandera County and Kendall County

This DFC would result in a 12 percent decrease from a no-pumping scenario (1,100 acre-feet year) in average spring flow in Kerr County. The DFC would also result in about 2,000 acre-feet per year increase of stream recharge in Kerr County, which is an increase of 2,000 acre-feet per year because under a zero acre-feet per year pumping scenario, there is a no net stream recharge or baseflow in Kerr County from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. This DFC allows for a 2060 pumping rate of about 4,000 acre-feet per year from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr County, enough to accommodate the probable growth of exempt pumping in the county.

References

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