For GMA-9's Consideration During Current (Oct 1 – Dec 31, 2015) Public Comment Period on Desired Future Conditions

(Dec 22, 2015)
Rene A. Barker

1) As a hydrogeologist experienced in karst hydrology and former groundwater modeling (credentials, below), I am concerned that GMA-9's current Desired Future Conditions (DFC) that allow for an additional 30 feet of regionally averaged (regionalized) water-level decline will significantly impact the production and reliability of individual groundwater wells in addition to causing springflow and stream baseflow rates to drop permanently below historical conditions. ***It is likely that the conditions dictated by this DFC—simulated by TWDB's Groundwater Availability Model (GAM) to cause an additional 19 feet of "average" water-level decline across Hays Country—will result, especially during extended future droughts, in untold numbers of dry wells and prolonged periods of significantly reduced (or zero) springflow and baseflow to streams.***

2) The so-called "30-foot" DFC was, of course, decided on the basis of a computer (digital) model that was developed and calibrated with the best-available expertise and data at the time (2009). Any groundwater-flow model is limited in its representation of the physical system due to simplifications and assumptions whose appropriateness can vary greatly. Results from any model simulation typically reflect the effects of some erroneous information because detailed three-dimensional distributions of aquifer characteristics are rarely, if ever, available. Future groundwater conditions, as projected with the out-of-date Trinity aquifer (Hill Country) GAM, incorporate uncertainties due to the model's relatively large spatial and temporal resolution (one-square mile grid cells and annual stress periods). In addition to the GAM's inability to simulate local hydrologic conditions, these uncertainties limit the model's abilities to simulate groundwater-surface water interaction and the effects of boundary conditions shared with the downgradient Edwards aquifer. Such limitations are duly noted in TWDB's documentation of this model (Jones et al., 2009, p. 33):

> ***"As calibrated, this model is most accurate in assessing regional-scale groundwater issues, such as predicting aquifer-wide water level changes and trends in the groundwater budget that may result from different proposed water management strategies, on an annual timescale. Accuracy and applicability of the model decrease when moving from addressing regional- to local-scale issues because of limitations of the information used in model construction and the model cell size that determines spatial resolution of the model. Consequently, this model is not likely to accurately predict water level declines associated with a single well or spring because (1) these water level declines depend on site specific hydrologic properties not included in detail in regional-scale models and (2) the cell size used in the model is too large to resolve changes in water levels that occur over relatively short distances. Addressing local-scale issues requires a more detailed model, with local estimates of hydrologic properties, or an analytical model. This model is more useful in determining the impacts of groups of wells or well fields distributed over a few square miles. The model can be used to predict changes in ambient water levels rather than actual water level changes at specific locations, such as an individual well."***

3) The model's developers (Jones et al., 2009, p. 34) also note the need for periodical improvements and updates:

> ***"The TWDB plans periodically to update, and thus improve, its groundwater availability models. This model may be improved by incorporating greater complexity or hydrologic information that was not available when it was updated. Model uncertainty may be reduced with additional information on streamflow, hydraulic properties, water level elevations, and recharge. Additional hydraulic head measurements and aquifer-test data are required for the Hill Country portion of the Trinity Aquifer System. This information can be used to improve calibration of the model by increasing the number and spatial distribution of sites and the frequency of measurements for comparing measured and simulated water levels. Aquifer tests will facilitate determination of whether improving the model by more complex spatial distribution of hydraulic conductivity, specific storage, and specific yield can be justified. Future updates of this model might include using the Stream-flow Routing Package (Prudic, 1989) to simulate streams. Using the Stream-flow Routing Package would simulate two-way interaction between the aquifer and rivers or streams. This approach is a potentially superior alternative to the Drain Package and may allow better simulation of recharge from Cibolo Creek."***

4) Given the variables and uncertainties associated with the current GAM, it is impossible to predict the actual locations and longevity of dried-up wells, baseflow, and springs that will likely result from the current "30-foot" DFC. However, available GAM results coupled with the Trinity aquifer's history of springflow reductions during past droughts indicate that future decreases in spring discharge caused by the DFC-sanctioned 32,000 acre-feet of additional pumpage (relative to that in 2008) will impact not only Jacob's Well but also hundreds of smaller springs and seeps and an unknown number of shallower wells. ***In consideration of the environmental and economic issues at stake, the current "30-foot" DFC is inconsistent with conservative thinking—much less with long-term sustainability and sound water-resource management.***

5) Because the current GAM was calibrated on the basis of one square-mile grid cells and average-annual rates of recharge and discharge, the simulated conditions used to formulate the DFC are likely incompatible with respect to desired local and short-term (monthly or seasonal) conditions. Because the model was calibrated to simulate regional, average annual conditions, it is incapable of projecting water level, springflow, and water-budget conditions on a local or short-term basis. ***Without adequate local and short-term resolution, there is no assurance that the conditions simulated to manage the DFC will provide either desirable supplies of groundwater for existing wells or desirable rates of discharge from specific springs or streamflow in any given stream reach.***

6) In order for the GAM to represent the real groundwater-flow system, it simulates the average or net effect of all modeled conditions and stresses that are accounted for within areas represented by a single model cell. As a consequence, the regional-scale GAM typically underestimates the magnitude of actual water-level fluctuations in individual wells that result from nearby pumping. Although the difference between simulated water-level conditions (applicable to one-square mile model cells) and actual, real world conditions depends on several factors, it is not uncommon in heavily pumped areas for individual wells, stream reaches, or springs to go dry or cease flowing at levels significantly different than simulated counterparts that represent net conditions—conditions averaged across entire (one-square mile) grid cells. ***In other words, the regional-scale design of the GAM limits its capacity to simulate worst-case or conservative perspectives relative to site-specific conditions associated with single wells, specific stream reaches, and small springs and seeps.***

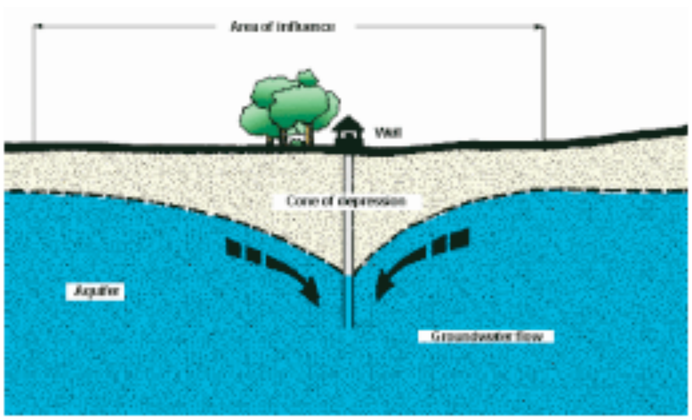
7) Although limitations associated with the GAM's scale of application (associated with one-square mile grid cells and annual stress periods) are thoroughly explained in the model's documentation (Jones et al., 2009, p. 33), the manifestations were evidently overlooked by those who agreed back in 2010 to allow an additional 30 feet of water-level decline—the so-called "drawdown" that was to be somehow measured across GMA-9's entire area of jurisdiction. ***Without the incorporation of substantial expertise and human judgment, future model results could be interpreted as conservative, worst-case information when, in fact, they could be optimistic representations of local and/or short-term (sub-annual) conditions.***

8) One of the earliest indications of unsustainable development is groundwater mining, as evidenced by long-term water-level decline. Available water-level data for the Trinity aquifer indicate that the effect of historical pumping has already tapped the threshold of what most hydrologists consider groundwater mining or unsustainable development. ***The combination of water-level declines in the Hill Country that in places exceed 50 feet and the fact that that during the mid-1800's flowing wells could be developed "nearly everywhere," according to Brune, (1981), indicates that the Trinity aquifer's limits for sustainable pumping were reached prior to the DFC's adoption in 2010.***

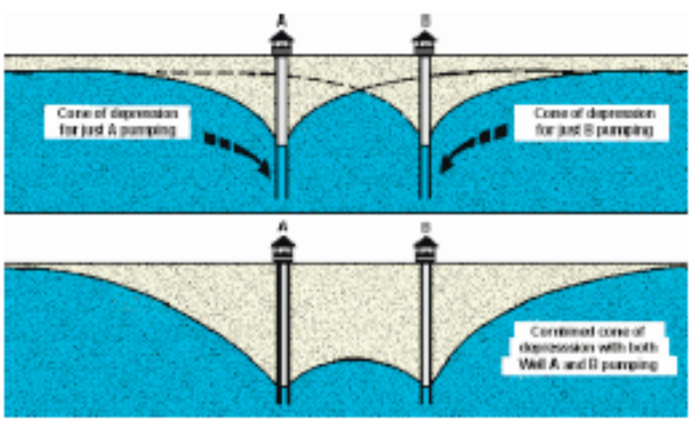
9) Informed citizens are justifiably concerned that the GAM's projections should be interpreted, not as favorable for additional development but, rather, as foresight that continuation of the "30-foot" DFC will only exacerbate existing problems. In addition to the expense of deepening wells and pumping from greater depths, future issues will likely include wells, springs, and baseflow to streams that dry up such as observed during recent droughts—events far less severe than several droughts documented to have occurred during past centuries (Cleaveland, 2006). ***Considering the imminence of drought in Central Texas and an appreciation for the need of prudent water-management practice, Cleaveland (2006) concludes, "It would appear unwise for civil authorities to assume that the 1950s drought represents the worst-case scenario to be used for planning purposes in water resource management in the South Central and Edwards Plateau climate divisions of Texas."***

10) Despite the wisdom and conservative implications of Cleaveland's (2006) assessment, the rates of future pumping that the "30-foot" DFC ostensibly supports are based on long-term, average annual rates of precipitation and associated rates of simulated aquifer recharge—values that tend to mask the most intense aspects of severe droughts. In other words, the simulated conditions upon which the current DFC was "justified" were simulated apparently without the full impact of droughts as intense as the 1947-56 drought-of-record, much less any drought resembling worst-case scenarios as exemplified in historical tree-ring data. ***As a result, the groundwater declines projected through year 2060 are likely damped and, therefore, may appear less detrimental due to the simulation of a relatively steady (annual average) stream of recharge (Hutchison and Hassan, 2011).***

11) Given that the current "30-foot" DFC allows for additional development of an already heavily pumping groundwater supply, it is inevitable that future wells will be closer together, thereby increasing the potential for well interference. The illustration below shows how closely packed wells compete for the same groundwater, thus causing water levels to be substantially lower in intervening areas of overlapping drawdown. ***A continuation of the "30-foot" DFC will likely exacerbate the potential for well interference and additional water-level decline in areas affected by existing groundwater development.***



(A) Typical cone of depression without influence of nearby pumping.



(B) Well interference caused by overlapping cones of depression that results from insufficient well spacing.

12) GAM Results (Hutchison, 2010a; Hutchison, 2010b) in relation to current "30-Foot" DFC…

Based on the results of GAM simulations similar to those used to define the current "30-foot" DFC (Hutchison, 2010a, p. 8), the 30 feet of additional (regionalized) groundwater decline would ostensibly provide for pumping increases of about 32,000 acre-feet per year (acre-ft/yr)—for a total pumpage of about 92,000 acre-ft/yr—by year 2060. This pumping rate of 92,000 acre-ft/yr is projected by the GAM to cause an additional groundwater decline of 29 feet (averaged across GMA-9) by the end of the 50-year projection period (Hutchison, 2010b, fig. 15). ***Of the many questions regarding these simulated conditions, one of the most relevant is: how is the so-called "average drawdown" to be defined and how will it be measured, given that the Trinity aquifer is a multi-layered flow system with significantly different conditions in each of its three basic layers?***

Hutchison (2010a, p. 9) further states: "As expected, pumping increases result in reductions in spring and base flow as the pumping captures this water prior to its discharge." The impact of pumping the projected 92,000 acre-ft/yr (about 1.5 times the 2008 pumping rate of about 60,000 acre-ft/yr) would reduce spring and base flow by 14,000 acre-ft/yr. ***Based on a usage rate of 135 gal/day per household, this 14,000 acre-feet of water would provide for 92,500 Hays County homes.***

Hutchison (2010a, p. 9) continues to state that the 32,000 acre-ft/yr of additional pumping would reduce recharge to the Edwards aquifer by about 12,000 acre-ft/yr by virtue of the same amount of decreased discharge from the upgradient Trinity aquifer. This 12,000 acre-ft/yr decrease in Edwards recharge would represent 38 percent of the additionally permitted GMA-9 pumping. ***In other words, according to TWDB's model analysis, 38 percent of the DFC-sanctioned 32,000 acre-ft/yr of additional pumping would result from the interception (capture) of groundwater that would otherwise discharge across the Trinity-Edwards interface to recharge the Edwards aquifer, thereby helping to maintain groundwater levels and sustaining endangered species habitats in the Edwards aquifer.***

13) Given the GAM's limitations with respect to its regional, long-term perspective versus the reality of local conditions and specific events, it seems problematic to use this model's output in any context that would affect the fate of individual wells, small springs, or specific stream reaches. To use such output to unequivocally justify pumping increases enabling an additional 30 feet of regionalized water-level decline is inconsistent with sustainable groundwater development, particularly when the likelihood and potentially devastating effect of future droughts are considered. ***For these reasons, I strongly support a significant reduction in the magnitude of allowable future "drawdowns" relative to those associated with the so-called "30-foot" DFC that was adopted by GMA-9 back in July 2010.***

14) Although TWDB had the funding and an excellent team of groundwater modelers to develop their 2009 version of the Trinity aquifer GAM (Jones et al.), the legislature—as I understand it—subsequently cut the agency's budget to the extent that key modelers were released or reassigned. As a result, the GAM is today a shell of what it could and should be. Rather than reappraising the original (2010) "30-foot" DFC as thoroughly as it should be at this five-year juncture, we are now faced with having neither the appropriate model nor the money to initiate the simulations critical for making the correct evaluations and associated decisions. This dilemma exists despite the overwhelming need and undeniable evidence that such could be accomplished if only funding were available to assign the required personnel to develop an over-due groundwater-management tool. To get the job done, of course, requires an updated, relatively fine-resolution computer model that is consistent with today's (2015) understanding of hydrogeologic conditions (including boundary conditions where the Trinity and Edwards flow regimes merge) and is capable additionally of simulating local (as opposed to only regional) groundwater-surface water interactions. (Only a model with such capability could be used to appropriately evaluate questions such as those raised recently in regard to Electro Purification's proposed pumping scenarios.) ***In summary, adequate funding must be found to support state-of-the-art modeling technology through experienced personnel assigned to build, calibrate, and use the best-possible GAM designed to reproduce current hydrologic conditions and, in particular, explore the possibility of sustainable Desired Future Conditions.***

List of Cited References

Brune, G., 1981, Springs of Texas, v. 1: Fort Worth, Texas, Branch-Smith Inc., 566 p.

Cleaveland, Malcolm K., 2006. Extended Chronology of Drought in the San Antonio Area; Report to the Guadalupe-Blanco River Authority, 29 p.

Hutchison, W.R., 2010a, GAM Task 10-005; Texas Water Development Board unpublished report submitted to GMA 9, 13 p.

Hutchison, W.R., 2010b, Draft GAM Runs 09-011, 09-012, and 09-24, Supplement; Texas Water Development Board unpublished report submitted to GMA 9, 38 p.

Hutchison, W.R., and M.M. Hassan, 2011, GAM Task 10–031: Supplement to GAM Task 10–005; Texas Water Development Board unpublished report submitted to GMA 9, 16 p.

Jones, I.C., Anaya, R. and Wade, S., 2009, Groundwater Availability Model for the Hill Country portion of the Trinity Aquifer System, Texas; Texas Water Development Board unpublished report, 178 p.

Credentials

Rene A. Barker is licensed as professional geohydrologist with the Texas Board of Professional Geoscientists. Rene has a Bachelor's degree in Geology from Fresno State University and a Masters degree in Hydrology from Stanford University. During his 35-year employment with the U.S. Geological Survey (1967-1999), Rene worked in Austin (1988-1999) on the hydrogeology of Edwards-Trinity aquifer system, including the Hill Country's Trinity aquifer. During 1988-1996, as Project Geologist on the Edwards-Trinity Regional Aquifer System Analysis (RASA), Rene authored USGS Professional Paper 1421-B, entitled "Hydrogeologic framework of the Edwards-Trinity aquifer system, west-central Texas." Since retiring from the USGS, Rene has worked on karstic- and structurally altered groundwater-flow conditions in central Texas as a staff Hydrogeologist with Edwards Aquifer Research & Data Center, Texas State University.

State of Texas · Rene A. Barker · Geology · 5592 · Licensed · Professional Geoscientist

Rene A. Barker
Professional Geologist

Rene A. Barker