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July 23, 2022

Texas Water Development Board
Attn: Groundwater Modeling
Daryn Hardwick, Ph.D.
1700 North Congress Avenue
P.O. Box 13231
Austin, Texas 78711-3231

RE: Goliad County Groundwater Conservation District (GCGCD) comments on the new TWDB GAM for GMA-15 & 16.

GCGCD staff and consultants worked with Dr. Shi and others at the TWDB for months providing comments and corrected data for the new GAM. Upon release of the new GAM, GCGCD contracted with LRE Water to run the new GAM on its water level monitor wells. Their comments are attached. Despite the TWDB's and GCGCD's best efforts, the new GAM gives a similar rising water level trend as the old GAM in Goliad County. Unless the new GAM is corrected, it is of no value in the management and planning of groundwater in Goliad County by the GCGCD.

The new GAM covers the area of GMA-15 & 16. It is considered a Regional GAM. Is it possible to model a large area as this and accurately model what is occurring in Goliad County? If this is not feasible and doable, then TWDB and GCDs should use local data and localized models that accurately represent what is occurring in that GCD and is usable to manage groundwater and to set a practical DFCs and associated MAGs. This direction must be provided early to provide an efficient plan by the GMAs.

The new GAM was developed using base data from 1980 to 2015. There was a gradual increase in groundwater pumping in Goliad County during those years primarily due to a steady slow increase in population and additional irrigation installations with a resulting steady decrease in water level. In contrast, there were significant changes in groundwater use in both the updip and downdip counties.

In the downdip counties, in earlier records going back to the 1950's, there was substantial municipal and irrigation use of groundwater. Over the years, irrigation use of groundwater has decreased substantially with the decrease of rice production being one major component. Cities such as Victoria and Port Lavaca have converted from groundwater to river water. One example is a City of Victoria well that measured at 82 foot level in 1958 and had a drawdown to 150 feet in 1992. With the reduction of

irrigation and the conversion to river water by cities, the downdip Counties to Goliad County are in a groundwater rising (recovery) mode.

In the updip counties, Eagleford Shale production started around 2010 and has been a large new user of groundwater. There are many large, lined reservoirs in evidence to support this large increase in groundwater use. There also have been many service calls for well pump lowering and new wells. A well belonging to a director of Evergreen UWCD went dry prompting Evergreen to curtail pumping from the Gulf Coast Aquifer for hydraulic fracturing in the area. Not only has groundwater usage increased for hydraulic fracturing in Karnes and Dewitt County, but it has also increased due to a large increase in temporary workers in those counties. The pumping numbers in Appendices C and D (water budget) of the Numerical Model Report do not reflect these increases. This causes ground water flowing into Goliad County to be higher than what it is.

In Goliad County pumping in the model does not fit amount of pumping that is occurring at a given location. For instance, Well # 7913501 undergoes an order of magnitude increase in pump from 4,979 to 37,589 cubic feet per day between 2002 and 2003. Then pumping increases to 60,639 cubic feet per day (508 acre-feet per year) in 2015. A single well in the model represents one sixth of the documented irrigation pumping in Goliad County in 2015. It is unlikely the above well has been used this century and is likely no longer in use. Modeled pumping for Well # 7919302 is from 18780 to 74192 cubic feet per day (157 to 622 acre feet per year respectively). This was an oil exploration well that was modified to water production. There isn't any data that this well was ever used. Modeled pumping for Well # 7923401 is from 14642 to 15351 cubic feet per day (123 to 129 acre feet per year respectively). This is the Fannin Battle Ground State Historic Site. It is a 13 acre site according to the Texas Historical Commission. Irrigating the whole site with 2 feet per year would only be 26 acre feet per year. In order for the modeled pumping to be correct around 100 acre feet of water would be used for restrooms, cleaning, etc. This well was a windmill that has not be used since 1967. The well that replaced it is deeper. For a model to be accurate on the local level it must in some degree match local conditions. For example, Well # 7921601 is a City of Goliad Well. The modeled pumping drops from 167,377 cubic feet per day in 2008 to 94057 cubic feet per day in 2015. There has not been the business and population decrease in the City of Goliad that would be necessary to make the decrease in modeled pumping make any physical, real-world sense. Well # 7923205 is an exempt domestic well. Modeled pumping is 22864 cubic feet per day in 2010. This is almost seven times what an exempt well is authorized to produce by statute. There is much more that should be discussed about the modeled pumping. This is a good overall view.

Most of the wells chosen by the TWDB for calibration do not have any water level readings within the calibration period, 1980 to 2015, or any water level readings at all. This makes it impossible to check or correlate rising and falling water levels with rising and falling modeled pumping.

Some of the Calibration Corrections utilized are way too large. Just their size should have raised questions and led to looking for cause and correction. Well # 7905707 is a windmill. TWDB records show that it is in Dewitt County not Goliad County. The Calibration Correction applied to it ranges from 494 to 747 cubic feet per day. This a too large a correction for a windmill. The Calibration Correction for Well #

7923401 ranges from 8,259 to 30,207 cubic feet per day. The is the well for the Fannin Battleground State Historic Site discussed above. The Calibration Correction is as much as twice the modeled pumping. The Calibration Correction for Well #7928101 ranges from 10,722 to 35,171 cubic feet per day. The is a well on Naval Auxiliary Landing Field Berclair. It is simply a landing strip for Naval Air Training Command. Water use is limited. It would be domestic and firefighting. Nothing in the range of modeled pumping or the Calibration Correction. There are other wells with Calibration Corrections that are too large. Instead of making these large Calibration Corrections the TWDB should have determined why the model was modeling these pumping values and fixed it.

The TWDB doesn't have any storativity values for Goliad County. Any method used to determine storativity values from nothing could be problematic. This a known problem that for many years the TWDB has failed to correct. Even the Total Estimated Recoverable Storage (TERS) for Goliad County is highly suspect without any storativity values. This along with modeled pumping probably explains some of the large deviations we are seeing in measured and modeled water levels in Goliad County as illustrated in the attached comments from LRE Water.

The recharge values shown in Table C14 of the Numerical Model Report for Goliad County are totally unrealistic. These values are generated using a curve developed based on stream baseflow data. This curve may be valid to be used in an aquifer application like the Edwards Aquifer, but it is absurd to use this methodology for Goliad County recharge. Dr Shi by his own comments state that rainfall patterns such as duration and intensity do influence groundwater recharge. He further stated that there was a lack of data and other influencing factors which would alter the use of the curve. His final comment was that "was the best I could do". Referring to the report titled "Estimation of Groundwater Recharge to the Gulf Coast Aquifer in Texas, USA" prepared for TWDB in 2011, estimated groundwater recharge in Goliad County is shown to be approximately 0.25 to 0.5 inches per year. Based on the recharge studies being conducted by GCGCD working with Texas Tech University, these numbers are shown to be too high. On page 3 of the referenced report, comments are made about the validity of using streamflow hydrographs. Recharge values must be revised to be at least reasonable and defensible.

The water budget values for Goliad County for aquifer to stream flow and for evapotranspiration are not representative of the scientific studies in which GCGCD is involved. Aquifer to stream flow values is much too high. Many years ago, there was extensive spring flow and artesian wells flowing. With the steady decline of the aquifer since 1980, there are virtually no streams or artesian wells flowing. TWDB is requested to provide physical information to counter this observation. As to evapotranspiration, this value for Goliad County is much too low. The brush and hardwood tree cover that currently exists in Goliad County is a major user of shallow groundwater. The TWDB chose to assume that all evapotranspiration for the aquifer stopped once the water level was greater than 10 feet. While this assumption may be valid in most of GMA-15 and GMA-16, it is not accurate for Goliad County. Much of Goliad County is covered by Large Oak, Mesquite, Huisache and other varieties of trees that are known to root 20 feet and deeper. In large parts of Goliad County evapotranspiration from the aquifer would occur to 20 feet, possibly deeper.

In conclusion, if the new draft GAM is not revised to reflect a declining water level and a realistic groundwater level drawdown for Goliad County, GCGCD will not be able to use the new GAM for management of groundwater in Goliad County. It will be necessary to create a local model that will reflect the aquifer conditions that GCGCD has recorded in the last 20 years and provide a realistic DFC. GCGCD requests that the TWDB do a local calibration, local error checking or a local model utilizing our monitor wells to provide an accurate modeled groundwater level for Goliad County. GCGCD also requests that more time be allowed for comments to allow other districts and stakeholders to comment.

Respectfully,

GCGCD Board of Directors

August 10, 2022

Daryn Hardwick, PhD
Groundwater Modeling Manager
Texas Water Development Board
Daryn.hardwick@twdb.texas.gov
512-475-0470

RE: Comments on the Gulf Coast Aquifer System Groundwater Availability Model

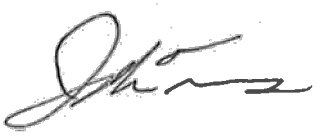
Dear Dr. Hardwick,

LRE Water ("LRE") was engaged by the Goliad County Groundwater Conservation District (GCGCD) to review how the newly developed Gulf Coast Aquifer System Groundwater Availability Model (GAM) represents observed groundwater trends within Goliad County. Our review was limited in scope only to Goliad County, and the comments we provide in this document stem from this review performed by my modeling team.

I hold a PhD in Civil Engineering from the University of Texas at Austin, and have been working in the Texas water resources area for over 22 years. I am a licensed professional engineer (#97316) and geologist (#11002) in Texas, and have been a testifying expert in water rights cases before the Texas Commission on Environmental Quality and the State Office of Administrative Hearings. I am well qualified to review GAMs produced by the Texas Water Development Board (TWDB), and I professionally oversee a team of four expert groundwater modelers skilled in MODFLOW and Groundwater Vistas.

Based on our review and the comments provided here, LRE cannot support GCGCD's acceptance of the Gulf Coast Aquifer System GAM as the modeling tool it uses to manage groundwater within Goliad County. The GAM is incapable of reproducing the decreasing water level trends evident in GCGCD's extensive monitoring network data, and often greatly under predicts or over predicts observed water levels.

Sincerely,



Jordan Furnans, PhD, PE, PG

COMMENTS ON THE GULF COAST AQUIFER SYSTEM GAM

The TWDB has an "official" GAM model including Goliad County, which was recently used in completing the 3rd round of joint planning for GMA-15. This official model is referred to as the "Old Model" for the purposes of these comments. Goliad County Groundwater Conservation District (GCGCD) has previously informed TWDB that it does not find that the Old Model is acceptable with respect to its ability to model observed declining water levels in wells located throughout the county. In a 2021 study performed by LRE Water for the GCGCD, it was determined that model re-calibration could increase the agreement between observed water levels and those computed by the Old Model. Specifically, LRE Water obtained improved modeling results when eliminating recharge within Goliad County and when modifying the modeled hydraulic conductivity values for all cells within model layer 2 within Goliad County.

TWDB has recently created a "New Model" for simulating water levels within the entire GMA 15 and GMA 16 planning regions, which includes Goliad County. LRE Water was asked to review this "New Model" on behalf of GCGCD, and to ascertain if the "New Model" adequately reproduces observed decreasing trends in water levels within Goliad County. The "New Model" is the Gulf Coast Aquifer System GAM detailed by TWDB at the URL:

https://www.twdb.texas.gov/groundwater/models/gam/gma15_16/gma15_16.asp

To perform this review, I compared water levels measured from GCGCD observation wells to modeled water levels at the well locations. I reviewed comparisons of time-histories for 81 pairs of observed and modeled water levels. My comparisons were performed in bulk, where I compared modeled and observed elevations over time and calculated statistics on the agreement between the two datasets. I used the same statistics as reported by TWDB within their draft report on the "New Model," and found my statistics for Goliad County were in general agreement with the overall model statistics reported by TWDB (pertaining to the entire model domain). I also compared modeled and observed time-histories of water levels for each of the 81 observation wells within the GCGCD monitoring network. Through this comparison, I found that the New Model does not accurately reproduce the decreasing water level trends observed in Goliad County.

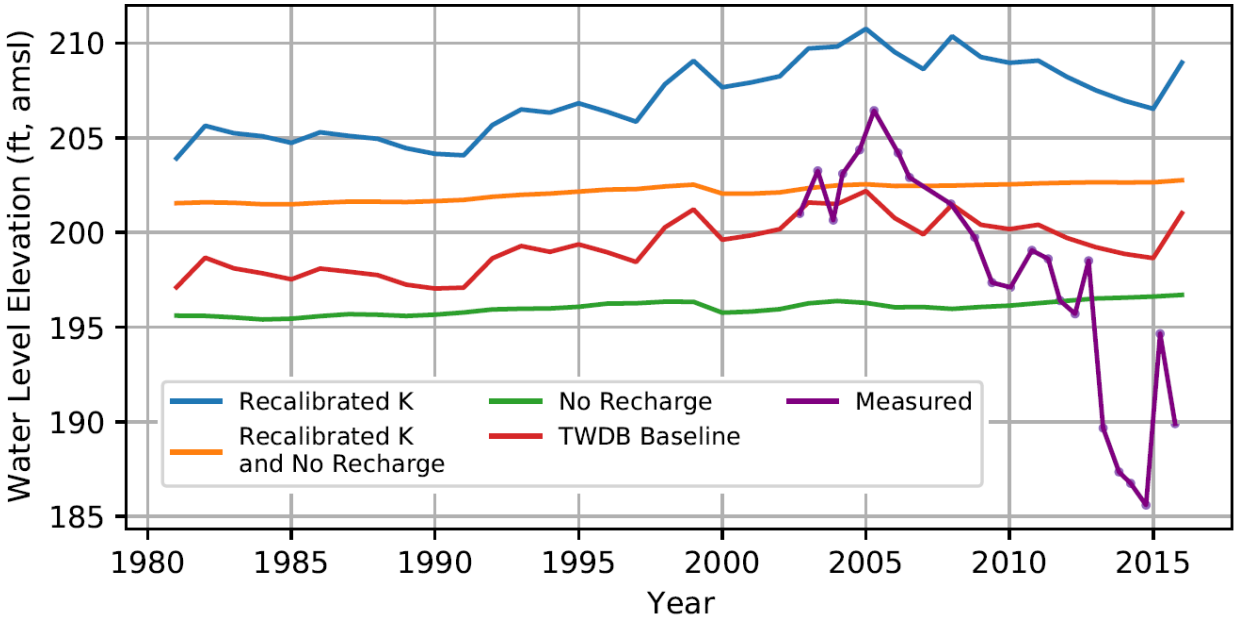


Figure 1 – Modeled and Observed Water Levels in Observation Well 7913223 within Goliad County.

Figure 1 presents plots of modeled and observed water levels for well 7913223, located within Goliad County. The modeled water levels are computed at the center of the grid cell location containing the physical well 7913223; I did not interpolate water levels to the exact well location (as TWDB has reportedly done as documented in their draft report detailing the "New Model.") I also did not adjust the modeled water levels to simulate drawdown expected from a pumping well, as TWDB did for this particular well. This topic will be discussed later.

As shown in Figure 1, there is an observed decrease in measured water levels, from approximately 201 ft MSL in 2003 to 190 ft MSL in 2016 with year-to-year fluctuations in between. Water levels modeled by the "New Model" (Shown in red as the "TWDB Baseline" results) suggest water level fluctuations over this time period, but do not indicate a decline in water levels. In fact, over the entire model period, the TWDB Baseline results suggest water levels range from 197 ft to 202 ft MSL, and show a generally increasing trend.

To assess the sensitivity of the modeled results to recharge and hydraulic conductivity values, I modified the New Model to incorporate changes that yielded improvement to the Old Model's ability to reproduce GCGCD observed water levels. The modified New Model results are shown in Figure 1 as the "No Recharge," "Recalibrated K," and "Recalibrated K and No Recharge" results. These result sets indicate that by eliminating recharge, the modeled year-to-year annual water level fluctuations are greatly reduced, resulting in a much "flatter" time series. These flatter time-series datasets also indicate that water levels were generally increasing over the modeled period of record. Through changing the modeled hydraulic

conductivity, the modeled water levels tended to increase or decrease relative to the TWDB Baseline water levels. Similar changes to the modeled time histories were observed for other GCGCD wells. County-wide gross statistics resulting from each modeled vs. observed water level dataset (i.e. the "No Recharge," "Recalibrated K," and "Recalibrated K and No Recharge") did not indicate generally better or worse agreement than indicated statistically by the TWDB Baseline model.

Based on Figure 1, it is possible to imagine that better agreement between modeled and observed water levels for well 7913223 could be achieved through further fine-tuning of the hydraulic conductivity of the model cells adjacent to the well, perhaps along with refining the magnitude of the aquifer response to changes in annual recharge. Within Appendix A of their draft "New Model" report, TWDB indicated that it used data from this well when compiling its regional model statistics. I concluded that TWDB actually used modeled water levels (from the TWDB baseline model) and then modified them to simulate the effects of local drawdown due to well pumping. I was able to calculate the same water levels as TWDB published in Appendix A when I ran the model and applied TWDB's simulated effects of local drawdown due to well pumping. However, I determined that well 7913223 is NOT a pumping well, and therefore TWDB incorrectly applied the well pumping adjustments to this well. As such, the agreement between the modeled and observed water levels at this location is artificially high within the TWDB New Model database. I do not know if TWDB made similar errors at other well locations listed within Appendix A, but this discovery with respect to well 7913223 does not provide confidence in TWDB's overall model verification process.

Other examples of the disagreement between modeled water levels and those obtained from wells within the GCGCD monitoring network are shown in subsequent images. Each graphic was selected to illustrate the various ways in which the modeled and observed water levels differed. For example, the observed water level in well 722903 is approximately 15 ft higher than the modeled water levels (Figure 2). In contrast, measured water levels for well 7913111 were about 25 ft below the modeled water levels (Figure 3). In both instances, a decreasing trend in observed water levels is evident.

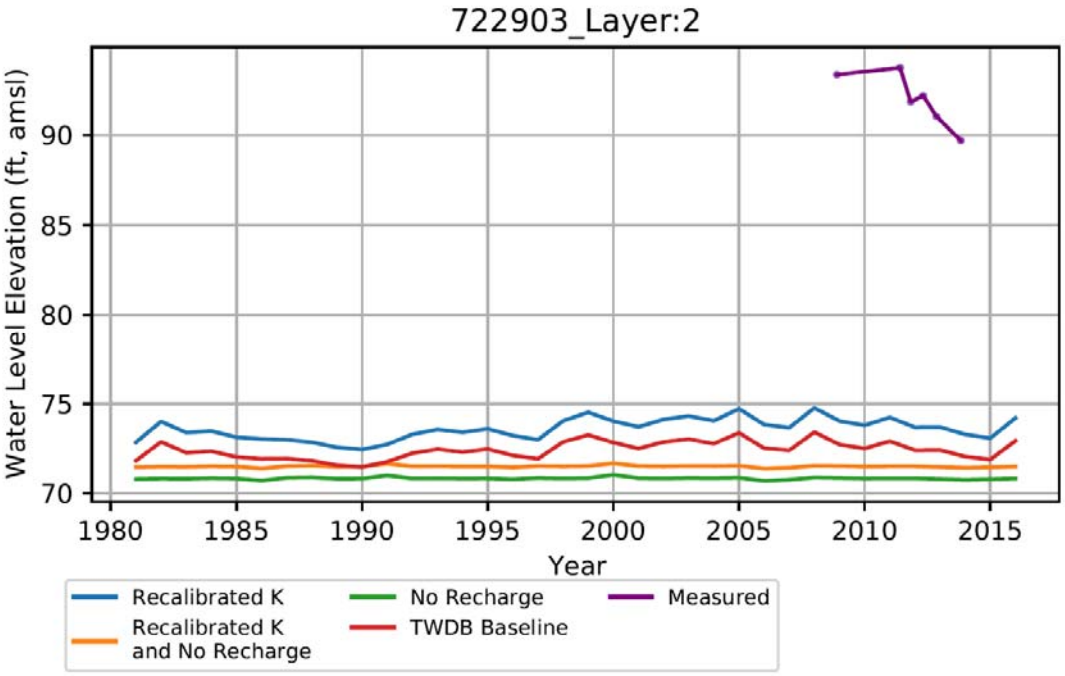


Figure 2 - Modeled and Observed Water Levels in Observation Well 722903 within Goliad County.

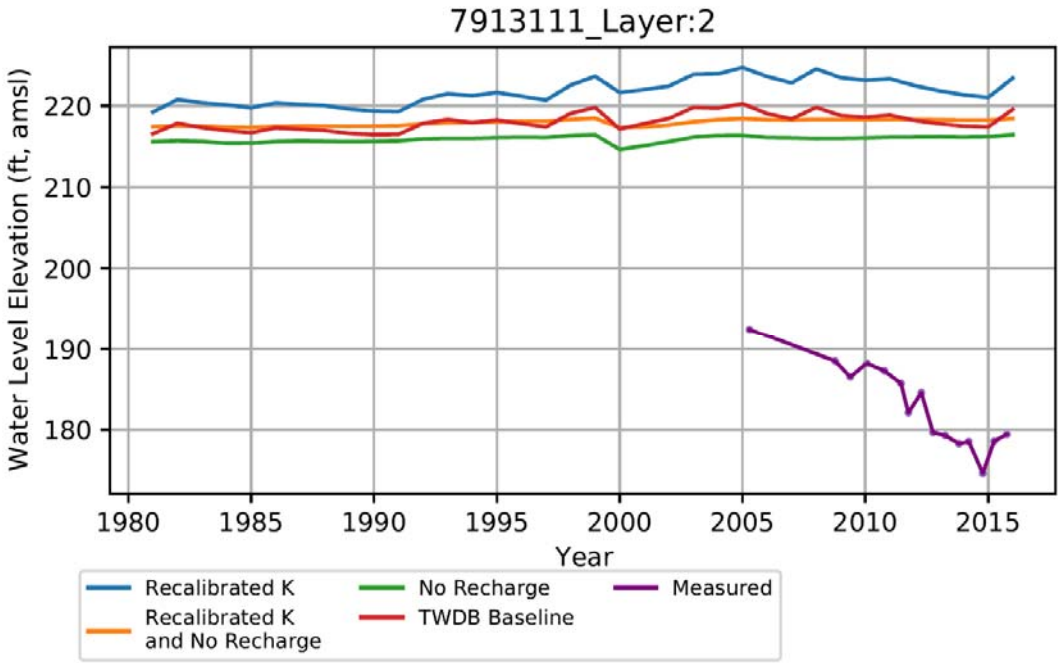


Figure 3 - Modeled and Observed Water Levels in Observation Well 7913111 within Goliad County.

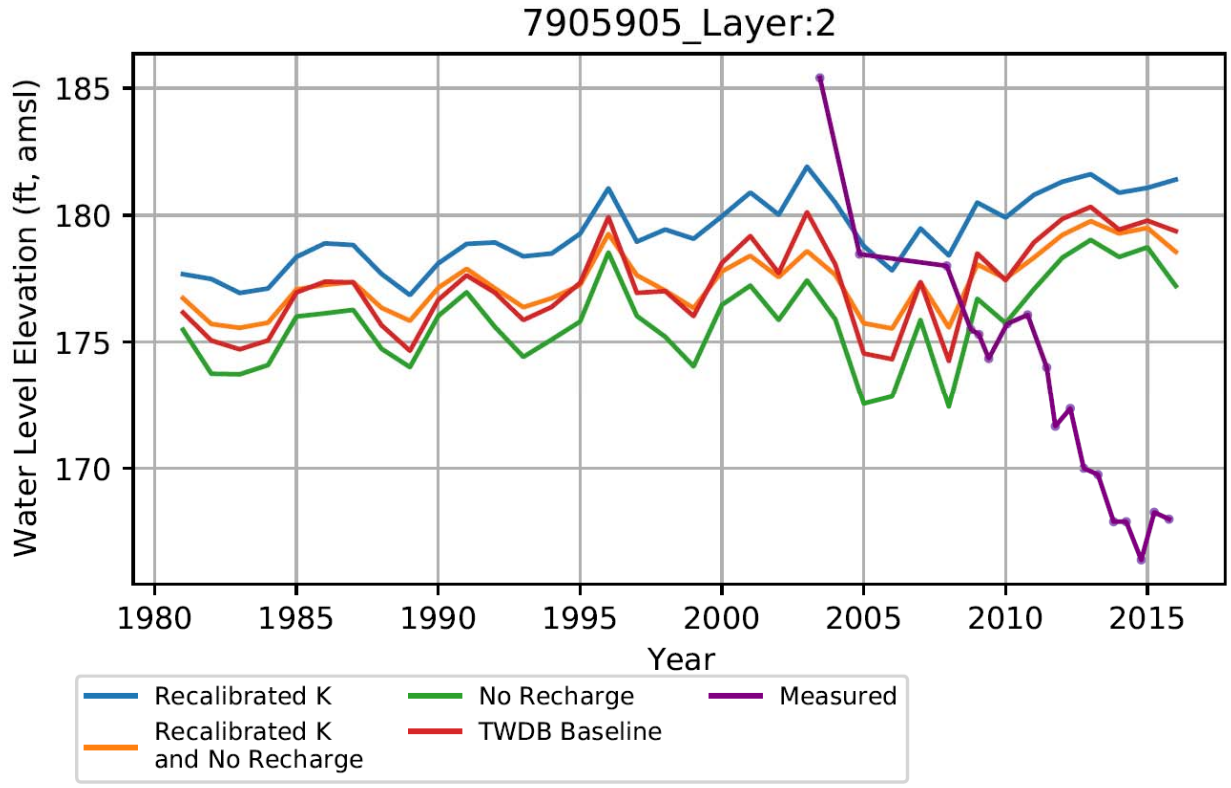


Figure 4 - Modeled and Observed Water Levels in Observation Well 7905905 within Goliad County.

For well 7905905, the 2004 water level exceeded the TWDB Baseline water level by approximately 8 ft, but by 2016 observed water levels were about 10 ft below modeled water levels (Figure 4). For well 7905606, the magnitude and range of modeled water levels match the observed magnitude and range of the measured water level, yet modeled levels show and increasing trend whereas the observed water levels decreased from 2004 to 2016 (Figure 5).

Of the 81 modeled vs. measured well comparisons for the GCGCD monitoring well network, each comparison told the same story. The modeled water levels do not exhibit the decreasing trends evident within each GCGCD monitoring well time-series of water levels.

As the TWDB model for GMA 15-16 is unable to reproduce the observed trends in water levels within Goliad County, it would be impossible for Goliad County GCD to effectively use the model to manage available groundwater within the county. Any DFCs set using the GMA 15-16 model would be impossible for the GCD to enforce, as observed water level declines are not indicated within the GMA 15-16 model output.

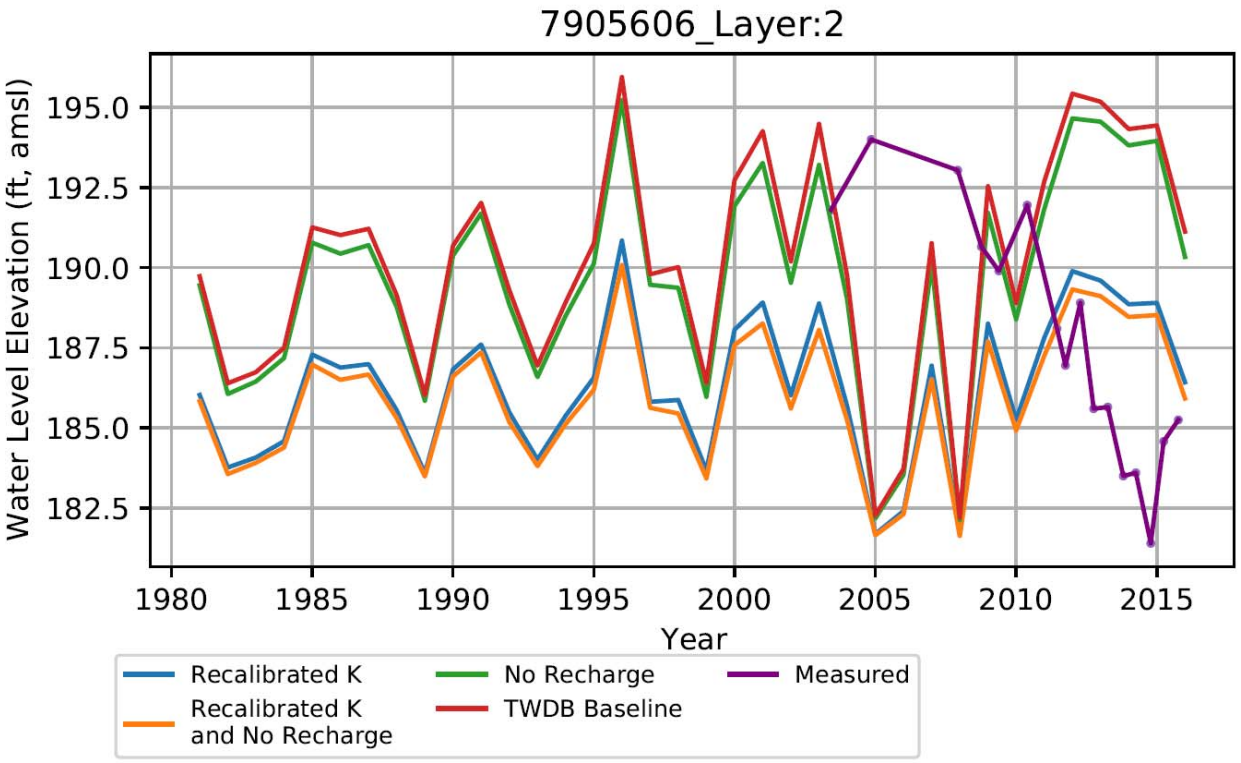


Figure 5 - Modeled and Observed Water Levels in Observation Well 7905606 within Goliad County.