SOAH DOCKET NO. 952-19-0705

APPLICATION OF LOWER COLORADO RIVER AUTHORITY FOR OPERATING AND TRANSPORT PERMITS FOR EIGHT WELLS IN BASTROP COUNTY, TEXAS	**§**	**BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS**

LOWER COLORADO RIVER AUTHORITY'S PREFILED DIRECT TESTIMONY OF STEVE YOUNG

LIST OF EXHIBITS

LCRA Exhibit No. 28	Prefiled Direct Testimony of Steve Young
LCRA Exhibit No. 29	Resume of Steve Young
LCRA Exhibit No. 30	Geologic Map in Vicinity of LCRA's Proposed Wells
LCRA Exhibit No. 31	Structural Cross-Section of Carrizo-Wilcox Aquifer in Vicinity of LCRA's Proposed Wells
LCRA Exhibit No. 32	Geophysical Log - Location A5 on LCRA Exhibit No. 30
LCRA Exhibit No. 33	Geophysical Log - Location A7 on LCRA Exhibit No. 30
LCRA Exhibit No. 34	Technical Memorandum by Andrew Donnelly (District Hydrogeologist) – Review of LCRA Permit Application Package, April 6, 2018
LCRA Exhibit No. 35	Drawdown Caused by LCRA's Proposed Pumping, as Predicted by Former GAM
LCRA Exhibit No. 36	Close-up of Drawdown Caused by LCRA's Proposed Pumping, as Predicted by Former GAM
LCRA Exhibit No. 37	Drawdown Caused by LCRA's Proposed Pumping, as Predicted by Revised GAM
LCRA Exhibit No. 38	Close-up of Drawdown Caused by LCRA's Proposed Pumping, as Predicted by Revised GAM
LCRA Exhibit No. 39	Comparison of Drawdowns Predicted by Former and Revised GAMs
LCRA Exhibit No. 40	Conceptual Example of "Available Drawdown"
LCRA Exhibit No. 41	Available Drawdown in 2070, as Predicted by Revised GAM
LCRA Exhibit No. 42	Close-up of Available Drawdown in 2070, as Predicted by Revised GAM
LCRA Exhibit No. 43	Comparison of Available Drawdowns Predicted by Former and Revised GAMs

LIST OF ACRONYMS & ABBREVIATIONS

The following acronyms and abbreviations are used throughout LCRA's testimony and provided for ease of reference:

AMSL	above mean sea level
COA	Certificate of Adjudication
DFC	Desired Future Condition
BEG	University of Texas- Austin Bureau of Economic Geology
BGS	below ground surface
BSA	Boy Scouts of America-Capital Area Council
FPP	Fayette Power Project
GAM	Groundwater Availability Model
GCD	Groundwater Conservation District
GLR	Griffith League Ranch
GM	General Manager of Lost Pines GCD
GMA	Groundwater Management Area
GPM	gallons per minute
HB	Texas House Bill
LCRA	Lower Colorado River Authority
LPGCD	Lost Pines GCD
MAG	Modeled Available Groundwater
POSGCD	Post Oak Savannah GCD
TWDB	Texas Water Development Board
TCEQ	Texas Commission on Environmental Quality
WSRP	LCRA Water Supply Resource Plan

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I. INTRODUCTION AND EXPERIENCE

Q: Please state your name.

A: My name is Steve Young.

Q: On whose behalf are you presenting testimony in this proceeding?

A: I am presenting testimony on behalf of the Lower Colorado River Authority (LCRA).

Q: With whom are you currently employed?

A: I am employed by INTERA, Inc., a Texas headquartered geoscience and engineering company.

Q: Describe your involvement with the LCRA's groundwater permit applications that are the subject of this proceeding (Applications).

A: I was retained by LCRA in the fall of 2018 to provide expert testimony on LCRA's behalf in this proceeding.

Q: Please summarize your education and experience.

A: My education and experience are summarized in my current resume, which is LCRA Exhibit No. 29.

Q: Did you prepare LCRA Exhibit No. 29?

A: Yes.

Q: Does LCRA Exhibit No. 29 accurately reflect your education and experience?

A: Yes, it does.

Q: Please describe your experience with groundwater modeling, the development of Desired Future Conditions (DFCs), and Modeled Available Groundwater (MAG).

A: I have been developing groundwater models since 1982. I taught a graduate-level course in groundwater modeling at the University of Tennessee. Over the last 20 years, I have regularly served as the project manager and lead modeler for projects involving groundwater modeling. My resume summarizes many of these modeling projects, including the development of several GAMs.

I have been involved with the development of DFCs since the passage of HB 1763 in 2005. Since 2004, I have served as a hydrogeological consultant for Post Oak Savannah GCD (POSGCD) and have represented POSGCD in GMA-12 to help develop and evaluate DFCs. I have also served as the lead hydrogeological consultant for GMA-15 to develop and evaluate DFCs. I have worked with several GCDs to assist them with joint planning activities that include evaluating DFCs.

I have been involved with the development of several groundwater availability models (GAMs) including those for the Northern Trinity and Woodbine Aquifers (Kelley and others, 2014), the Yegua-Jackson (Deeds and others, 2010), and the Central portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers. I

was the project manager for the recent update of the GAM for the central portion of the Sparta, Queen City, and Carrizo-Wilcox GAM (Young and others, 2018).

Q: Please describe your specific experience with the hydrogeology of the Central Carrizo-Wilcox Aquifers.

A: In addition to my experience as the hydrogeological consultant for POSGCD discussed above, m`y experience with the Central Carrizo-Wilcox Aquifers, extending from Caldwell County to Freestone County, includes the analysis of geophysical logs, aquifer pumping tests, recharge analysis, surface water-groundwater analysis, water levels, sands and clay profiles, historical pumping and water quality classifications. In the last ten years, I have served as the project manager for the following projects primed by INTERA, Inc.: 1) a project funding by the Texas Water Development Board (TWDB) to revise the Central Sparta/Queen City/Carrizo GAM; 2) TWDB funded project to investigate surface groundwater interaction along the Colorado River; and 3) a groundwater availability study funded by the Tarrant Regional Water District and the City of Wichita Falls. In addition, I served as project manager for the following projects for which INTERA was a major subcontractor: 1) a TWDB funded project to perform HB 30 (2015) brackish groundwater study of brackish groundwater across GMA-13; and 2) a feasibility study for Aquifer Storage and Recovery funded by the Guadalupe-Blanco River Authority.

Q: Please describe your experience in groundwater management in GMA-12.

A: My experience in groundwater management in GMA-12 includes work serving as the POSGCD's lead hydrogeologist and one of the consulting hydrogeologist for GMA-12.

My management experience with POSGCD includes assisting with the development of governing documents and guidance documents. These governing documents include POSGCD Management Plan and POSGCD rules. These guidance documents include POSGCD "Groundwater Assistance Program" and POSGCD "Guidance Document for Evaluating Compliance with Desired Future Conditions and Protective Drawdown Limits." My POSGCD management experience also includes reviews of well operating permits. The reviews address whether the permits are administratively complete and whether the applicant has adequately evaluated the impact of the proposed permitted pumping on groundwater resources. Two of the large permits I have reviewed are the Blue Water permits totaling 51,000 AFY from the Carrizo-Wilcox Aquifer and the Alcoa permits totaling 40,000 AFY from the Carrizo-Wilcox Aquifer. My POSGCD management experience also includes evaluating compliance with DFCs. This experience includes the design of groundwater monitoring programs for water levels and the development of technical approaches to demonstrate compliance with DFCs. My POSGCD management experience also includes presenting hydrogeology workshops to POSGCD Board and staff that include explaining the

aquifer systems underlying POSGCD, the technical basis for POSGCD rules and different approaches for developing and evaluating DFCs and well spacing rules.

My management experience with GMA-12 includes working on behalf of POSGCD to assist with the development and evaluation of DFCs and to help integrate ideas and information introduced by stakeholders and GCDs into the joint planning process.

Q: Please describe your experience with evaluating subsidence in Texas aquifers?

A: I have considered research and prepared reports regarding the prediction of land subsidence for the LCRA-SAWS Water Project (Young and others, 2009; URS, 2007), the Harris Galveston Subsidence District (Kelley and others, 2018), an Electro Purification Project in Waller County (Young, 2013); GCDs in GMA-14 (Young, 2016), GCDs in GMA-16 (Young, 2018).

Q: Please describe the information you have reviewed and relied upon for your testimony.

A: In preparation of my testimony, I have relied upon and reviewed:

- My own experience as a hydrogeologist working in Texas and the Carrizo for over 15 years;
- My prior work and reports, which are identified in my resume;
- Documents provided to LCRA through discovery in this proceeding;
- The District Hydrogeologist's technical evaluation of LCRA's Applications;

- The GM Draft Operating Permit;
- The GM Draft Transport Permit;
- Prefiled Testimony and Exhibits of other LCRA witnesses in this case;
- LCRA's Applications;
- LCRA's Draft Operating Permit;
- LCRA's Draft Transport Permit;
- The reports and supporting documents for the Central Sparta/Queen City/Carrizo-Wilcox GAM developed by INTERA (Kelley and others, 2004) and the recently revised Central Sparta/Queen City/Carrizo-Wilcox GAM developed by INTERA (Young and others, 2018);
- Lost Pines Groundwater Conservation District's (LPGCD or the District) Management Plan and Rules as well as the management plan and rules for other GCDs in GMA-12;
- Dutton, A. R., Harden, B., Nicot, JP, and O'Rourke, D., 2003. Groundwater Availability Model for the Central Part of the Carrizo-Wilcox Aquifer in Texas; report prepared for the Texas Water Development Board;
- Young, S., 2013. Expert Report Evaluating Drawdown and Subsidence form Proposed Groundwater Production by ElectroPurification," prepared for Mr. Tim Throckmorton, Electro Purification, Houston, TX, prepared by INTERA Inc, Austin TX;

- BEG, 1974 Geologic Atlas of Texas, Austin Sheet, by C. V. Proctor, Jr., T. E. Brown, J. H. McGowen, and N. B. Waechter, Bureau of Economic Geology. Austin, Texas;
- Daniel B Stephens, INTERA Inc., LBG Guyton & Associates, and Uliana, M. 2017. Desired Future Condition Explanatory Report for Groundwater Management 12, prepared for Brazos Valley GCD, Fayette County GCD, Lost Pines GCD, Mid-East Texas GCD, and Post Oak Savannah GCD, October 2017;
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- Donnelly, A., 2018. Memorandum to Jim Totten, General Manager, Lost Pines GCD with Subject Heading: Review of LCRA Permit Application Packet, Prepared by Daniel B Stephen & Associates, Inc., Austin, TX;
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- Kelley, V.A., N. Deeds, D.G. Fryar, and J.P. Nicot, 2004. Groundwater Availability Model for the Queen City and Sparta Aquifers. Report to the Texas Water Development Board, 867 p.;
- Kelley, V.A., J. Ewing, T.L. Jones, S.C. Young, N. Deeds, and S. Hamlin, eds., 2014. Updated Groundwater Availability Model of the Northern Trinity and Woodbine Aquifers. Prepared for the North Texas, Northern Trinity, Prairielands, and Upper Trinity Groundwater Conservation Districts;
- Kelley, V.A., N. Deeds, S. Young and J. Pinkard, 2018. Subsidence Risk Assessment and Regulatory Considerations for the Brackish Jasper Aquifer, Report prepared by INTERA, Inc. for the Harris-Galveston Subsidence District, May 2018, 69 p.;
- Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2013, MODFLOW-USG version 1: An unstructured grid version

of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.;

- URS, Corporation, 2007. Incorporation of Subsidence Modules into the Interim LSWP Model. Prepared for LCRA, Prepared by INTERA;
- Wade, S., and Shi, J., 2014. GAM Task 13-035 Version 2: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 12. Prepared by the Texas Water Development Board. May 16, 2014;
- Wade, S., and Ballew, N., 2017. GAM Ru 17-030 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium Aquifers in Groundwater Management Area 12, prepared by Texas Water Development Board, Austin, TX;
- Young, S., 2015. Investigation of Declining Water Levels in Shallow Wells near Lissie, Texas. Prepared for Coastal Bend GCD, prepared by INTERA, Inc, Austin, Texas;
- Young, S., 2016. Estimates of Land Subsidence in GMA-15 Based on Ground Surface Elevation Data and Model Results, Prepared for Calhoun County GCD, Coastal Bend GCD, Coastal Plains GCD, Pecan Valley GCD, Refugio County GCD, Texana GCD, and Victoria County GCD, prepared by INTERA Inc., Austin;

- Young, S., Jigmond, M., Jones, T., and Ewing. T. 2018. Groundwater Availability Model for Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifer, prepared for the TWDB, unnumbered report, September 2018;
- Young, S., 2018. Evaluation of the Potential for Land Subsidence and Review of the Rio Grande Flow and Transport Model for the Lower Region Grande Valley, prepared for Brush Country GCD, Duval County GCD, Red Sands GCD, and Kenedy County GCD, prepared by INTERA Inc., Austin, TX; and
- Young. S.C., Kelley, V., Budge, T., Deeds, N., and Knox, P., 2009. Development of the LCRB Groundwater Flow Model for the Chicot and Evangeline Aquifers in Colorado, Wharton, and Matagorda Counties: prepared for the Lower Colorado River Authority, prepared by INTERA, Inc.

Q: Please provide an overview of your testimony and terminology you use as part of your testimony.

A: My testimony addresses the nature of the Central Carrizo-Wilcox aquifer, with particular focus in the area of the LCRA's proposed wells, and discusses the predicted impacts of LCRA's proposed pumping as relevant to the various factors the District is required to consider in reviewing requests for operating and transport permits. Some of my testimony relies on hydrogeologic concepts and terminology. As these are introduced, I will provide background and define key terminology unique to hydrogeology.

II. THE CARRIZO-WILCOX AQUIFER SYSTEM NEAR LCRA's PROPOSED WELLS

Q: Please describe the various aquifers beneath the Griffith League Ranch property.

A: Mr. Van Kelley provided a general description of the Carrizo-Wilcox Aquifer System and the geology associated with the Griffith League Ranch (GLR). I will build on the concepts and information that Mr. Kelley presented.

I will use information obtained from interpreting geophysical logs to describe the Carrizo-Wilcox Aquifer System in the vicinity of GLR. Geophysical logs are logs created by raising or lowering a set of probes and/or sondes in a borehole or well. The probes take continuous or discrete measurements of subsurface which can be used to estimate specific lithology and hydrologic properties. The type of information interpreted from these geophysical logs includes aquifer formation depth and elevation (top and bottom) and lithology of the formations and aquifers. Hydrogeologists traditionally use geophysical logs to study stratigraphy, determine aquifer lithology, develop geologic structure, and estimate water salinity (quality).

LCRA Exhibit No. 30, which was prepared by INTERA under my direction and control, is similar to LCRA Exhibit No. 21, but includes the location of nine geophysical logs that were used to develop a vertical cross-section of the Carrizo-Wilcox Aquifer System along the Transect A-A'. LCRA Exhibit No. 30 also shows the property boundary of the Griffith League Ranch as well as the proposed LCRA

well locations and well number (one through eight) assigned by LCRA and which are referred to in the GM Draft Operating Permit. (LCRA Exhibit No. 5).

The base map for LCRA Exhibit No. 30 shows outcrops of where formations and aquifers are exposed on the ground surface. The basemap of outcrops for this exhibit is the Bureau of Economic Geology (BEG), 1974. Geologic Atlas of Texas, Austin Sheet. The labels used to identify the formations begin with a letter that provides information on the age of the formation. The outcrops that cover the Griffith League Ranch include the Calvert Bluff formation, the Carrizo Aquifer, and the Reklaw formation. The Reklaw formation consists of fine-grained and clayey deposits that serve as a confining unit and aquitard for the Carrizo Aquifer.

Q: Please describe <u>LCRA Exhibit No. 31</u>.

A: LCRA Exhibit No. 31, which was prepared by INTERA under my direction and control, is a structural cross-section of the Carrizo-Wilcox Aquifer in the project area created from the information contained in nine geophysical logs (see LCRA Exhibit No. 31 for the location of the cross section). The structural cross-section depicts the formations which comprise the Carrizo-Wilcox Aquifer along Transect A-A'. The vertical axis of this figure is elevation above mean sea level (amsl). The horizontal axis depicts distance along the cross-section in miles. The formation dip to the southeast, which means that the depth of the formations increase in a southeast direction along Transect A-A'.

Below GLR, the Simsboro Formation has an average thickness of about 350 feet. At the up dip and down dip extent of the GLR property boundary, the top of the Simsboro Formation is at depths below ground surface of approximately 400 feet and 1000 feet, respectively. The blue line near ground surface represents the hydraulic head in the Simsboro Formation for the year 2010. This value on the profile for hydraulic head was obtained from the revised GAM for the Central Sparta/Queen City/Carrizo-Wilcox GAM (Young and others, 2018). One of the important considerations for siting a well field is the distance between the elevation of the hydraulic head in the aquifer and the elevation of the top of the aquifer. The greater the distance the greater the available drawdown for pumping before the aquifer begins to desaturate. An inspection of LCRA Exhibit No. 31 shows that the available drawdown in the Simsboro Formation is much greater (about double) in the down dip area than in the up dip area of GLR. The ability to have greater drawdown while pumping translates into the ability to pump more groundwater from the down-dip (or southeast) portion of GLR than the up-dip (or northwest) portion of GLR.

Within the District, the Simsboro Formation contains approximately 46 million acre-feet of stored water (Wade and Shi, 2014) and the aquifer is considered drought resistant. Being “drought resistant” means that the water level in the aquifer has a relatively low sensitivity to climate variability and has a low vulnerability to drought. Unlike the water levels in the Edwards Aquifer, the water

levels in the Carrizo-Wilcox Aquifer remain relatively stable in the outcrops during periods of low precipitation unless there is a significant increase in the pumping rates.

LCRA Exhibit No. 31 also shows a geologic fault at a distance of about 2.6 miles along Transect A-A' from the property boundary of Griffith League Ranch.

Q: What is the significance of a fault?

A: A ***fault*** is a zone over which displacement of geologic sediments has occurred. Sometimes they can act as hydraulic boundaries which impede horizontal groundwater flow and act a hydraulic conduits that facilitate vertical groundwater flow. A discussion of the location of fault that intersect the Carrizo-Wilcox Aquifer in GMA-12 and their potential effect on groundwater flow is provided by (Young and others (2018), Ewing (2018), and Ewing and Young (2018). At this particular fault location, the formations have been displaced such that the formation on the southeast side of the fault are lower than on the northwest side of the fault. Based on my analysis, this fault acts as a hydraulic barrier that partially impedes horizontal groundwater flow.

Q: Please describe <u>LCRA Exhibit Nos. 32 and 33</u>.

A: LCRA Exhibit Nos. 32 and 33, which were prepared by INTERA under my direction and control, show two of the geophysical logs that were used to construct the structural cross-section in LCRA Exhibit No. 31. LCRA Exhibit No. 32 shows Log A5. Log A5 is for a groundwater well that is located on the GLR that was drilled to

produce water from the Simsboro Formation (Guyton, 2010). LCRA Exhibit No. 33 shows Log A7. Log A7 is for an oil & gas test borehole located approximately 1.5 miles down dip of the property boundary of Griffith League Ranch.

LCRA Exhibit Nos. 32 and 33 each include five columns of information for each geophysical log. Table 1 presents describes the information in each column.

Table 1

Information in Columns 1 through 6 in LCRA Exhibits Nos. 32 and 33

Column	Description
1	Formation
2	Description of the depositional environment associated with sands or clay
3	Sequence of sand and clay layers interpreted from the geophysical logs
4	Plots of the resistivity and spontaneous potential (SP) curve. Shaded areas indicate the presence of productive sands
5	Elevation (feet) relative to sea level

The deposits that make up the Carrizo-Wilcox Aquifer System in the vicinity of GLR are comprised of a series of channel sands (coarse and with high permeability) and muds and clays (fine and with low permeability). The sands, muds, and clays

were deposited as river channels moved across GLR. The times of the channel deposits are marked by the sand layers, while the floodplains and overwash deposits are marked by mud and clay. The coal layers were created during times of swamp-like conditions.

Q: Please describe the Simsboro Formation and its relationship with the other aquifers depicted on LCRA Exhibit Nos. 32 and 33.

A: LCRA Exhibit Nos. 32 and 33 show that the Simsboro Formation is predominantly a sand rich formation comprised of multistory, multilateral stacked sand sequences. In the the Bastrop area, the formation is 350-400 feet thick west of the Paige graben (Ewing, 2018; Young and others, 2018), but increases to 600-800 feet thick in the graben. The unit generally contains 1-3 sand bodies over 100 feet thick. West of the graben, sand percentage is high (60-80%), decreasing to the southwest; the unit does not contain significant coals. Within the graben, sand percentage is lower and the unit contains a number clay-rich and coaly interbeds. Rapid subsidence of the graben during Simsboro time has allowed the fine-grained units to be preserved from erosion by large river channels, whereas fine-grained deposits west of the graben were eroded shortly after deposition. The thick and well-connected sands of the Simsboro makes it one of the most transmissive aquifers in Texas and the most transmissive aquifer in the Carrizo-Wilcox Aquifer System in Bastrop County and Central Texas. The term “transmissive” is used by hydrogeologists to characterize an aquifer’s ability to produce groundwater when

pumped. You typically want to screen a well across a transmissive aquifer in order to achieve a high production rate relative to the amount of drawdown.

The Calvert Bluff Formation overlies the Simsboro Formation. The Calvert Bluff represents a change in depositional environments, with few major river channels (thick fluvial sands) and abundant bay / floodplain deposits. The Calvert Bluff is characterized by appreciably more fine grained and clayey deposits than the Simsboro Formation. These fine-grained deposits cause the Calvert Bluff Formation to be significantly less transmissive than the Simsboro Formation. The stratification of finer-grained and lower hydraulic conductivity interbeds in the Calvert Bluff Formation acts to restrict vertical groundwater flow relative to horizontal direction. The restriction of vertical movement of groundwater protects the shallow groundwater flow zone from drawdowns in the Simsboro. Across most of central Texas, the Calvert Bluff Formation acts a semiconfining formation to the Simsboro Formation because of layers of the fine-grained deposits. At the base is a persistent zone of coal development overlying the Simsboro fluvial deposits. In the Bastrop area, the Calvert Bluff is 800-850 feet thick west of the Paige graben (Ewing, 2018; Young and others, 2018), and greater than 1000 feet thick within the graben.

Overlying the Calvert Bluff Formation is the Carrizo Formation. As shown in LCRA Exhibit Nos. 32 and 33, the Carrizo Formation is predominantly composed of sandy channel deposits. The deposits make the Carrizo Formation the second

most transmissive formation that comprise the Carrizo-Wilcox Aquifer System in Bastrop County. Underlying the Simsboro Formation is the Hooper Formation. Across most of central Texas, the Hooper Formation, like the Calvert Bluff Formation, acts a semiconfining formation to the Simsboro Formation because of layers of the fine-grained deposits. The lower half to two-thirds of the Hooper Formation consists of marginal marine sandstone and shale with occasional to abundant channel sandstones generally less than 60 feet thick. In the vicinity of GLR, the generally moderate to fine grain deposits are interspersed with occasional thick units of permeable channel sands, which likely provide localized areas of transmissive deposits. The base of the Hooper is gradational with the underlying marine Midway Formation.

III. CONSIDERATIONS FOR OPERATING PERMITS

Q: Please summarize what the District must consider when deciding to grant an application for an Operating Permit.

A: District Rule 5.2.D., which implements Texas Water Code § 36.113(d)(2), describes what the District must consider when evaluating an application, and deciding whether to issue a permit. The Board must consider whether: (1) the application conforms to the requirements of Texas Water Code Chapter 36, and the District Rules; (2) the proposed use unreasonably affects existing groundwater and surface water resources or existing permit holders; (3) whether the proposed use is for a Beneficial Use (as that term is defined by the District Rules and state

law); (4) the proposed use avoids waste and achieves conservation; (5) the applicant agrees to protect groundwater quality and follow plugging guidelines; (6) granting the application is consistent with the District's duty to manage total groundwater production on a long-term basis to achieve the applicable DFC; (7) the permit minimizes as far as practicable the drawdown of the water table or the reduction of artesian pressure, or lessens the interference between wells. The District must also consider the history of the applicant regarding compliance with District Rules and Chapter 36 of the Water Code. In the consideration of whether the application is consistent with the District's duty to manage total groundwater production on a long-term basis to achieve the applicable DFC, the Board must consider the MAG, the TWDB's estimate of current and projected exempt groundwater produced, a reasonable estimate of the actual amount of groundwater produced under permits issued by the District, and yearly precipitation and production patterns.

IV. EVALUATION OF LCRA'S APPLICATIONS AND PERMITS

Q: Have you evaluated LCRA's Applications and the proposed Operating Permits to assess the effects they may have on those items listed in District Rule 5.2.D.?

A: Yes.

Q: What was the purpose of your evaluation?

A: The purpose of my evaluation was to: (1) understand the intent and purpose of the requirements specified in the Operating Permits; (2) to evaluate whether or not the proposed calculations and conditions in the permits will accomplish the intended purpose of the Operating Permits; (3) to determine if there is potential bias associated with the data or assumptions used to characterize the aquifer conditions, future recharge and surface water conditions used in the calculations for permit calculations, the predictions from the former GAM and the recently revised GAM, and determination of the DFC values; and (4) to determine what changes to the GM Draft Operating Permit should be considered in order to improve the data collection and analysis used to evaluate how the LCRA pumping will impact future water levels in the Simsboro Formation.

Q: What specific information did you consider?

A: Specifically, I considered: (1) Texas Water Code Chapter 36, District Rules, and the District's management plan; (2) the approach and calculations specified in the both the GM Draft Operating Permit and the LCRA Draft Operating Permit for management of total groundwater production on a long-term basis to achieve DFC; (3) existing reports that have evaluated the impacts of pumping a well field at Griffith League Ranch on groundwater resources inclusive of the District's review of the LCRA permit application by Mr. Andrew Donnelly dated April 6, 2018 (LCRA Exhibit No. 34); (4) predictions of pumping impacts from the LCRA well field using

both the previous GAM (Kelley and others, 2004) and recently updated GAM (Young and others, 2018); (5) results from aquifer testing and water levels measured in the District; (6) analysis of geophysical logs in the District; (7) the development and calibration of the recently developed GAM (Young and others, 2018); and (8) my personal experience developing management plans and rules for GCDs, providing GMA-12 with technical support for preparing the explanatory report, and developing the revising GAM for the Central portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers.

I also considered predictions of drawdown as modeled using the former GAM and revised GAM.

Q: Please describe what you mean by former GAM and revised GAM.

A: The former GAM refers to the Central Sparta/Queen City/Carrizo-Wilcox GAM (Kelley and others, 2004). The revised refers the Central Sparta/Queen City/Carrizo-Wilcox GAM (Young and others, 2018). I was the project manager and lead modeler for the development of the revised GAM.

Q: Why is it important to consider both GAM predictions?

A: The former GAM was used by GMA-12 to help establish DFCs in the last two joint planning sessions and by the District to evaluate the LCRA permit (Donnelly, 2018). The revised GAM was completed in 2018 and adopted for used by GMA-12. The TWDB GAM program has a commitment to update the GAMs to improve the predictive accuracy with new information that is developed as funding becomes

available. The update of the former GAM was motived by the GCDs in GMA-12 who provided significant co-funding to update the GAM.

The major reasons for updating the GAM are the following: (1) delineate the locations the faults in the central Carrizo-Wilcox Aquifer, specifically those in the Milano Fault Zone, and provide an appropriate method for representing those faults in the model; (2) extend the former GAM calibration period of 25-years (1975 to 2000) to an 80-year calibration period (1930 to 2010); (3) upgrade the model structure from MODFLOW-96 (Harbaugh and McDonald, 1996) to MODFLOW-USG (Panday and others, 2013) in the revised GAM in order to enhance the ability of the model to support localized refinement of model layers and grid cells in areas of interest; (4) add two model layers that increase the number of model layers from 8 layers in the former GAM to 10 layers in the revised GAM in order to provide an improved capability to simulate recharge to the water table, groundwater flow in the shallow groundwater flow zone, and groundwater-surface water interaction; and (5) reduce the grid cell size in the vicinity of the Colorado River Alluvium and the Brazos River Alluvium to improve the simulation of groundwater-surface water interaction.

It is important to note that there are limitations of GAMs, which are primarily built to be used a tool in regional water planning. GAMs may not account for local hydrogeological conditions such as vertical variations in the aquifer properties or changes in the aquifer properties over distances of a few miles. However, despite

these limitations, the GAM is an appropriate tool to evaluate unreasonable impacts and represents the best available tool for such evaluation.

Q: How was the former GAM used in evaluating LCRA's Applications?

A: The District hydrogeologist, Andrew Donnelly, used the former GAM to estimate potential drawdown caused by LCRA's proposed pumping by running the model with and without LCRA's proposed pumping. This is the standard approach for evaluating the effects of proposed pumping. The "without" simulation represents a baseline and includes all of the anticipated pumping in GMA-12 exclusive of LCRA's proposed pumping. The "with" simulation includes exactly the same pumping as the baseline simulation but also includes LCRA's proposed pumping. Then, he calculated the difference in the drawdowns predicted by two model simulations by subtracting the water levels predicted by the two simulations. For example, if the "without" simulation predicted 8 feet of drawdown and the "with" predicted 10 feet of drawdown, then the amount of drawdown caused by LCRA's proposed pumping would be 2 feet, which is the difference between 8 feet and 10 feet.

For the modeling of LCRA's pumping, the District assumed LCRA would increase its pumping in three phases, which is what LCRA requested. Phase I consists of 8,000 acre-feet per year of pumping from wells 7 and 8. Phase II consists of 15,000 acre-feet per year of pumping from wells 5 through 8. Phase III consists of 25,000 acre-feet per year pumping from all eight wells. For the

purposes of modeling, the District assumed that Phases I and II would each last three years, and that Phase I would begin in 2020. I understand, however, that increases in LCRA's pumping could actually occur more slowly.

In the District hydrogeologist's evaluation of the LCRA permit (Donnelly, 2018), Mr. Donnelly also equally distributed proposed total pumping among the available LCRA wells. For instance, during the Phase III pumping of 25,000 acre-feet per year, each of the eight wells was assumed to be pumping 3,125 acre-feet per year. LCRA may not operate its wells in this manner and may adjust the pumping between wells. For the purposes of assessing drawdown impacts, some reduction in the predicted drawdowns close to Griffith League Ranch could be achieved by adjusting the pumping rate among the wells.

Q: Please describe LCRA Exhibit No. 34.

A: LCRA Exhibit No. 34 is the District Hydrogeologist's evaluation of LCRA's Applications. This memo shows the contours of drawdown in the Simsboro Formation attributed to the pumping from LCRA'S proposed wells as predicted by the District. According to Figures 2 and 3 of LCRA Exhibit No. 34, these drawdown contours were generated by plotting the difference in drawdown generated by the District's well file 125 and the District's well file 151, for a 50-year period starting in 2020 (Donnelly, 2018). However, the two well files provided by the District to LCRA during discovery end in 2060, which is only 40 years after the LCRA pumping

began in 2020. My assumption is that LCRA Exhibit No. 34 actually shows drawdown for a 40-year period and not a 50-year period.

Based on this analysis, the District's hydrogeologist concluded:

1. Although the GAM estimates that the proposed LCRA project pumpage results in over 200 feet of drawdown after full production through 2060 in some nearby wells or proposed well locations, these nearby wells have static water levels that are approximately 550 to 600 feet above the top of the Simsboro Formation in the LCRA Lake Bastrop well field, and approximately 900 to 1000 feet above the top of the Simsboro in the three Aqua wells. Therefore, although the proposed LCRA project pumpage will cause water levels in these adjacent wells to decline significantly, this decline may not unreasonably impact these wells or other users in the District. (Donnelly, pg 5)

Q: What analysis have you done using the GAMs?

A: First, I used the former GAM to verify the predicted impacts with the same assumptions and tool used by the District's hydrogeologist (Donnelly, 2018). I also used the revised GAM to predict impacts because it is a superior model for predicting groundwater impacts from pumping than the former GAM.

Q: Please describe LCRA Exhibit Nos. 35 and 36.

A: LCRA Exhibit Nos. 35 and 36, which were prepared by INTERA staff under my direction and control, reflect the results of analysis performed by INTERA that shows the drawdown predicted using the former GAM and assumptions using the approach described by the District's hydrogeologist in LCRA Exhibit No. 34. These results show drawdown in the Simsboro Formation in 2060, as calculated by INTERA, produced the same contours of drawdown contained in the District's analysis shown in Figures 2 and 3 in LCRA Exhibit No. 34. LCRA Exhibit No. 35 is comparable to Figure 2 in LCRA Exhibit No. 34, and LCRA Exhibit No. 36 shows the area immediately around Griffith League in more detail, comparable to Figure 3 in LCRA Exhibit No. 34. LCRA Exhibits No. 35 and 36 show the location of the faults in the former GAM. In the vicinity of Griffith League Ranch, the former GAM represents the faults as barriers with significant resistance to horizontal flow. If the faults were not in the former GAM, the predicted drawdown would be lower. The significant impact that the faults south of Griffith League Ranch have on groundwater flow is illustrated by the large change in drawdown that occur across the fault location.

Q: Please describe LCRA Exhibits Nos. 37 and 38.

A: LCRA Exhibits Nos. 37 and 38, which were prepared by INTERA staff under my direction and control, reflect analysis performed by INTERA using the revised GAM, which I will discuss further below. INTERA performed model simulations with

the revised GAM using a modified version of GMA-12's DFC Pumping Scenario PS-12, which was submitted to the TWDB along with the Explanatory Report as part of GMA-12 joint planning activities. Pumping Scenario PS-12 was modified to reflect the historical pumping used by the revised GAM from 2000 to 2010 and to redistribute pumping at the local scale because of changes in the size of the grid cells. The District used the Modified PS-12 file for several analyses presented at GMA-12.

INTERA ran the revised GAM with the Modified PS-12 pumping files with and without the LCRA pumping. LCRA Exhibit No. 37 and 38 show contours of drawdown predicted in the Simsboro Formation from pumping at the LCRA wells over the a 50-year period from 2020 to 2070 in a form similar to those produced by the District in LCRA Exhibit No. 34. Both LCRA Exhibit Nos. 37 and 38 were generated with the same data, but LCRA Exhibit No. 38 shows the area immediately around Griffith League in more detail. Included in both exhibits are the fault locations in the revised GAM. These faults differ in location and their resistance to horizontal flows to the faults in the former GAM. Each fault is color coded to reflect the amount of vertical offset that occurs between the formation locations on both side of the fault. The greater the offset distance, the greater the resistance to horizontal flow in the flow.

Q: How do these predicted drawdowns from the revised GAM analysis compare to the District's analysis?

A: The drawdowns predicted from the INTERA runs with the revised GAM show less drawdown in the Simsboro Formation as a result of LCRA pumping than the simulations performed by the District hydrogeologist (Donnelly, 2018), which is shown in LCRA Exhibit Nos. 37 and 38.

Q: Please identify LCRA Exhibit Nos. 39.

A: LCRA Exhibit No. 39, which was prepared by INTERA staff under my direction and control, reflects an analysis comparing predicted drawdown in the identified wells in the Simsboro Formation that are owned by the named parties in this case using both GAMs. This analysis shows that the predicted drawdown in these wells is lower using the revised GAM.

LCRA Exhibit No. 39 compares the different predictions of drawdown provided by the GAMs at each well. Each dot in LCRA Exhibit No. 39 represents two predicted drawdowns at a well location. The values for drawdowns are read from the x-axis and y-axis of the plot. The values on the x-axis represent estimated drawdowns in 2060 attributed to LCRA pumping based on simulations using the former GAM. The values on the y-axis represent estimated drawdown in 2060 attributed to LCRA pumping based on simulations using the revised GAM. For the circled well, the x-axis produces a drawdown of 267 feet for the former GAM simulation, whereas the location of the circled well on the y-axis produces a

drawdown of 220 feet for the revised GAM simulation, or about 18% less drawdown. Across the board, the revised GAM predicts less drawdown.

Q: Please describe the concept of available drawdown and its potential relevance for assessing drawdown impacts caused by pumping.

A: The term "available drawdown" at a well represents the difference between the elevation of the water level in a well and the top surface of a confined aquifer in which the well is screened. For a confined aquifer, available drawdown is the additional drawdown that can occur at a well before the aquifer begins to desaturate. Available drawdown is a measure that I have commonly used to evaluate permits to assess the relative impact of drawdown at a well screened in a confined aquifer.

LCRA Exhibit No. 40, which was prepared by INTERA under my direction and control, illustrates this concept. This exhibit illustrates the concept of available drawdown and how it can be impacted by pumping. In LCRA Exhibit No. 40, the water level in the well prior to pumping is 500 feet amsl and the top of the aquifer is at 200 feet amsl. After pumping at Well A, the water level is at 400 feet amsl. The pumping at Well A has caused a drawdown of 100 feet (500 feet amsl – 400 feet amsl), but there remains 200 feet of available drawdown (400 feet amsl – 200 feet amsl). Despite Well A experiencing a relatively large drawdown of 100 feet, there is an additional 200 feet of available drawdown that could be pumped without the saturated thickness of the aquifer being affected.

Q: Have you evaluated the impacts to available drawdown of LCRA's Applications?

A: Yes. **LCRA Exhibit Nos. 41, 42, and 43**, which were prepared by INTERA staff under my direction and control, show the results of this evaluation. This analysis shows that the predicted available drawdown in well locations identified in the Simsboro Formation that are owned by the named parties in this case is generally greater in the simulation using the revised GAM than the former GAM. LCRA Exhibit Nos. 41 and 42 show the available drawdown in 2070 predicted by the revised GAM simulation for the Simsboro Formation. LCRA Exhibit No. 43 is a similar analysis using the same wells in LCRA Exhibit No 37, but compares predicted available drawdown between the former and revised GAMs. Each dot in LCRA Exhibit No. 43 represents two predicted available drawdowns in 2070 at a well location using the old and revised GAM. The values for available drawdowns are read from the x-axis and y-axis of the plot. The values on the x-axis represent estimated available drawdowns in 2060 attributed to LCRA pumping based on simulations using the former GAM. The values on the y-axis represent estimated drawdown in 2070 attributed to LCRA pumping based on simulations using the revised GAM. For example, circled well on the x-axis produces an available drawdown of 938 feet for the former GAM simulation, whereas the location of the circled well on the y-axis produces an available drawdown of 1006 feet for the revised GAM simulation.

Q: Did the District's Hydrogeologist review available drawdown after LCRA's pumping?

A: Yes, although he does not use that term. Instead, in his assessment of the impacts of drawdown associated with the proposed LCRA wells, he compared the drawdown impact that occurred at several wells to the static water level in the wells after the drawdown impact has occurred (Donnelly, 2018). This is comparable to the analysis shown in LCRA Exhibit Nos. 41, 42 and 43. In his analysis, Mr. Donnelly concluded that nearby wells have static water levels that are approximately 550 to 600 feet above the top of the Simsboro Formation in the LCRA Lake Bastrop well field, and approximately 900 to 1000 feet above the top of the Simsboro in the three Aqua wells.

Q: Please summarize your opinion of the predictions made using the revised GAM.

A: The INTERA model simulations are more appropriate for estimating the impacts of LCRA pumping than the District hydrogeologist's simulations because they use a better groundwater model and better pumping data than did the District hydrogeologist's model simulations. In addition, the INTERA model simulation included 10-more years of drawdown. The exhibits show that the impacts of LCRA pumping on wells predicted by the INTERA simulations are less than the District hydrogeologist's prediction with respect to both drawdowns caused by LCRA

pumping and the available drawdown that exists at an impacted well at the end of the model simulation.

V. UNREASONABLE IMPACTS TO GROUNDWATER RESOURCES, EXISTING PERMIT HOLDERS, OR OTHER GROUNDWATER USERS

Q: What do you consider to be "unreasonable impact" to groundwater resources, existing permit holders and other groundwater users in the district?

A: The types of impacts that I would consider unreasonable include impacts resulting from drawdown produced by the pumping well that, by itself and without contribution from other pumping wells, causes any of the following five conditions:

1) Drawdown produces land subsidence that: a) threatens the structural integrity of existing pipelines, building, or other infrastructure; b) causes land from being used for its intended use; or c) creates a drainage problem;

2) Intrusion of surface water or groundwater from another aquifer into the pumped aquifer that degrades groundwater quality in the pumped aquifer so it would not be suitable for its intended use or its potential use;

3) Sufficient reduction (or depletion) of the saturated thickness of an aquifer that prevents the intended use of the aquifer;

4) Drawdowns in an aquifer that causes the GCD to exceed a DFC for the aquifer; or

5) Drawdown from a permitted well that does not meet the District's well spacing and property boundary set-back requirements set by the District.

Q: Will LCRA's proposed pumping cause drawdown that produces land subsidence that: a) threatens the structural integrity of existing pipelines, building, or other infrastructure; b) causes land from being used for its intended use; or c) creates a drainage problem?

A: Based on my experience and research regarding subsidence issues across east Texas, it is my opinion that the drawdown caused by LCRA's proposed pumping will not cause any appreciable land subsidence of concern. As recognized in the GMA-12 explanatory report (Daniel B. Stephens & Associates and others, 2017), the aquifers in this area are substantially older (33 to 55 million years old) than the Gulf Coast formations in the Houston-Galveston area (Dutton et al., 2003). This means that the clay and shale strata within the aquifers of GMA-12 have already experienced considerable natural compaction and are considered to have a low risk of pumping-related consolidation. Further, no subsidence has been reported anywhere within GMA-12, despite large-scale pumping and associated drawdowns near Bryan-College Station (Huang et al., 2012).

Q: Will LCRA's proposed pumping cause intrusion of surface water or groundwater from another aquifer into the pumped aquifer that degrades the groundwater in the pumped aquifer so it would not be suitable for its intended use or its potential use?

A: To evaluate this issue, it is appropriate to look at measured water quality data, the available geophysical logs, results from the revised GAM simulations, and the hydrogeology of the GLR. This information helps determine the location of the brackish groundwater and location of clay layers that may impede intrusion of brackish groundwater into the overlying aquifer. Based on my review of the available information, it is my opinion that the LCRA's proposed pumping from the Simsboro Formation at GLR will not lead to degradation of the groundwater quality of the Simsboro Formation in a way that would impair its intended or potential use.

Q: Will LCRA's proposed pumping cause sufficient reduction of the saturated thickness of an aquifer to prevent the intended use of the aquifer?

A: No, the amount of drawdown caused by LCRA's proposed pumping will not cause any significant reduction of the productivity of the Simsboro. This is highlighted by my earlier testimony regarding available drawdown. I would also note that I do not consider it to be an unreasonable impact if the water level were to drop below the pump in an existing well where the well only penetrated the shallow portion of the aquifer outcrop. I have worked with several GCDs that also hold this view. In 2015, I completed a report for the Coastal Bend GCD in Wharton County (Young, 2015) that documented that seasonal pumping from large irrigation wells had caused and were causing water levels in shallow wells to drop near or below the elevation of their well pumps. One of the solutions to the problem discussed with the District was not to reduce the pumping associated with the irrigation wells but rather for

the shallow well owners that had experienced problems with low water levels to drill deeper replacement wells.

Q: Please describe "modeled available groundwater" (MAG).

A: Modeled available groundwater (MAG) is defined as the amount of water that the TWDB's executive administrator determines may be produced on an average annual basis to achieve the DFC. The MAG is determined by the TWDB by taking the parameters defining the DFC and employing them in the relevant GAM to estimate the amount of groundwater that can be produced on average on an annual basis. The MAG is calculated using the DFC.

Q: How is the MAG determined?

A: The MAG is determined by the TWDB once the GMA completes the joint planning process and prepares and submits an Explanatory Report to the TWDB. The TWDB uses the DFC to estimate the MAG for each district using the GAM. The current Simsboro MAG varies by decade and is greater than 25,000 acre-feet per year in 2020 and beyond. (Wade and Ballew 2017).

Q: Will LCRA's proposed pumping cause drawdowns that will cause the GCD to exceed a DFC?

A: No. The pumping of 25,000 acre-feet per year at LCRA's proposed well locations will not cause the District's current DFC to be exceeded. Based on my analysis of simulations using the revised GAM, the proposed LCRA's pumping alone will result in less than 40 feet of average drawdown across the District, which is considerably

less than the District's current DFC of 240 feet of aquifer average drawdown within the District, measured from December 1999 to December 2069. So long as the total pumping by LCRA is less than the modeled available groundwater (MAG), then, by definition, it should not cause an exceedance of the DFC by itself. Therefore, because the MAG is greater than 25,000 acre-feet per year beyond 2020, LCRA's proposed pumping should not cause an exceedance of the DFC.

Q: Do LCRA's proposed wells meet the District's spacing and property boundary set-back requirements?

A: Yes. LCRA's wells will be located more than 100 feet from the nearest property line and will be spaced at least 5,000 feet from the nearest well.

Q: In summary, do you have an opinion as to whether LCRA's proposed pumping will have an unreasonable impact on groundwater resources, existing permit holders, and other groundwater users in the District?

A: Based on the reasons discussed above, it is my opinion that LCRA's proposed pumping will not cause any unreasonable impacts on groundwater resources, existing permit holders, and other groundwater users in the District. My conclusion is consistent with the District's conclusion quoted earlier my testimony that the predicted drawdowns may not unreasonably impact existing wells or other groundwater users in the District.

VI. IMPACTS TO SURFACE WATER RESOURCES

Q: What do you consider an unreasonable impact to surface water resources?

A: I would consider the effects to be unreasonable if the amount of drawdown produced by the pumping is sufficient by itself and without contribution from other pumping wells, to cause any of the following:

1) Capture and withdrawal of water associated with stream underflow; or
2) A substantial change in the direction of the hydraulic gradient between the water level in a stream and the water level in an adjacent shallow groundwater flow such that a "gaining" stream reach becomes a "losing" stream reach.

Q: Based on these factors, will LCRA's proposed pumping cause an unreasonable impact to surface water resources?

A: No. LCRA's proposed pumping will not capture underflow nor do I expect LCRA's proposed pumping to create substantial change in the hydraulic gradient between the water level in a stream and the water level in an adjacent shallow groundwater flow to create an unreasonable effect on surface water resources.

Q: Please elaborate.

A: In my opinion, for a well to capture a stream's underflow, the well would need to be located in the stream alluvium adjacent to the stream. LCRA's proposed wells are not located in any stream alluvium and therefore are not able to directly withdraw stream underflow, as that term is defined by state law.

Further, based on my interpretation of the revised GAM simulations using the PS-12 modeling scenario and the revised GAM simulations, it is my opinion that LCRA's proposed pumping will not create sufficient change in the magnitude and direction of the hydraulic gradient between the water level in a stream and the water level in an adjacent shallow groundwater flow to create an unreasonable effect on surface water resources. Also, any water losses from the stream to the Colorado alluvium that may result from LCRA's proposed pumping at the full authorized amount are minimal and average less than 2,000 acre-feet per year, or less than 0.2% of the average annual flow measured at the USGS gage 08159200 on the Colorado River at Bastrop Texas, which is about 1.4 million acre-feet per year.

VII. CONSISTENCY WITH DISTRICT MANAGEMENT PLAN AND LONG-TERM MANAGEMENT TO ACHIEVE DFC

Q: Have you ever assisted a GCD with the development of a management plan?

A: Yes. I have supported several GCDs with development of their management plans.

Q: Are you familiar with the District's Management Plan?

A: Yes

Q: What is the purpose of the District's Management Plan?

A: GCDs are required to develop management plans and submit those to the TWDB for review within 3 years of GCD's creation or after the confirmation election. The requirements of a management plan are defined in Texas Water Code § 36.1071.

The purpose of the management plan is to establish a GCD's performance standards and management objectives to achieve the GCD's management goals. The management plan also includes information about the district, such as the DFC and a flow balance for the relevant and managed aquifers.

Q: Please describe the District's Management Plan.

A: The District's Management Plan is comprised of nine sections consistent with the statutory requirements in Texas Water Code § 36.1071. These include: a description of the District; District mission statement and guiding principles; plan date of approval; a discussion of District governance; the relevant aquifer DFCs and MAGs; a discussion on the District's water resources, regional water resource demands, needs and strategies to meet those needs; and management goals, objectives and performance standards and District certifications.

Q: How does the District implement its Management Plan?

A: The District implements its Management Plan through the District Rules (which address permitting) and through the participation in joint planning and the establishment of DFCs for relevant aquifers.

Q: Are you familiar with the District's DFC?

A: Yes. Section 5 of the District's Management Plan reports the current DFCs for the District. The District's current DFC for the Simsboro Formation is 240 feet of aquifer average drawdown within the District measured from January 2000 through December 2069.

Q: How is the DFC used in the groundwater permitting process?

A: The DFC is one of several items that a GCD must consider when reviewing a groundwater permit. District Rule 5.2(D)(8) states that the District shall consider whether granting the permit application is consistent with the District's duty to manage total groundwater production on a long-term basis to achieve an applicable DFC. The District Management Plan also contains Policy 2, which states that the District will endeavor to manage aquifers on a sustainable basis that is consistent with the DFCs, to the extent possible.

Q: How is the MAG used in the groundwater permitting process?

A: Texas Water Code § 36.1132(b) and District Rule 5.2(D)(8) require the District to manage total groundwater production on a long-term basis to achieve a DFC and consider the MAG, among other factors, in the issuance of permits. However, the MAG is not a cap on the amount of groundwater that a GCD can permit, as evidenced by the fact that the District has already issued permits in excess of its MAG.

Q: Based on your review of the Applications, the draft operating permits (including the GM Draft Operating Permit and LCRA Draft Operating Permit), and the District's DFC and MAG, are the Applications and draft operating permits consistent with the District's duty to manage total groundwater production on a long-term basis to achieve the DFC?

A: In my opinion, the draft permits' standard and special conditions are consistent with the District's duty to manage total groundwater production on a long-term basis to achieve the DFC. The draft permits accomplish this by using monitoring and production data to assess impacts of LCRA's pumping on aquifer conditions. Further, by the terms of the permits, LCRA is subject to the District's Rules, which could include future production limits adopted by the District to apply to all permitted wells within the District to ensure DFC compliance.

Q: In considering whether the proposed use of the water is consistent with the District's Management Plan, what information did you consider?

A: I considered: 1) Chapter 36 of the Texas Water Code, 2) the District Rules and District Management Plan; 3) the GM Draft Operating Permit and the LCRA Draft Operating Permit for management of total groundwater production on a long-term basis to achieve DFC; 4) District operating permits issued to Recharge-EndOp, and Forestar; 5) existing reports that have evaluated the impacts of pumping a well field at Griffith League Ranch on groundwater resources, inclusive of the LPGCD's review of the LCRA permit application by Mr. Andrew Donnelly dated April 6, 2018; 6) predictions of pumping impacts from the LCRA well field using both the former GAM (Kelley and others, 2004) and the revised GAM (Young and others, 2018).

Q: In your opinion, is LCRA's proposed use of the water consistent with the District's Management Plan?

A: In my opinion, LCRA's proposed use of water is consistent with the District's Management Plan and the reasons for the creation of GCDs. The District's mission is to conserve, preserve and protect interests in groundwater in Bastrop and Lee counties, while addressing statutory goals and requirements. In fulfilling its mission, the District's Management Plan states that the District will endeavor to manage groundwater to meet demands on a sustainable basis, by which the District means development, use, and reasonable long-term management of groundwater resources so that those resources can continue to be used by future generations. In my opinion, the permits further the District's management of the groundwater. Specifically, LCRA's pumping under the permits would be subject to a number of standard and special permit conditions that achieve the District's groundwater management goals by restricting production over time. Further, as with all permit holders in the District, LCRA is subject to any production limits that might be adopted by the District in the future that it determines are necessary to comply with the DFC.

VIII. WASTE & WATER CONSERVATION

Q: Do the conditions and limitations in the draft permits prevent waste and achieve water conservation?

A: Yes. The conditions and limitations in the draft permits prevent waste and achieve water conservation. This requirement is met by Special Condition (9) in the GM

Draft Operating Permit, which is identical to Special Condition (7) in the LCRA Draft Operating Permit. That condition provides:

> "Before providing water withdrawn from the Aggregated Wells to any End User, Permittee shall submit to the District: (a) each End User's water conservation plan and drought contingency plan, if the Texas Water Code or Texas Commission on Environmental Quality rules require the End User to prepare a water conservation plan and drought contingency plan; or (b) if the Texas Water Code or Texas Commission on Environmental Quality rules do not require the End User to prepare a water conservation plan and drought contingency plan, a certification from the End User that the End User agrees to avoid waste and achieve water conservation. Any End User water conservation plans and drought contingency plans that are submitted must comply with the relevant provisions of the Texas Water Code and rules of the Texas Commission on Environmental Quality or successor agency.

LCRA's witness, John B. Hofmann, also provides testimony on this issue regarding LCRA's practices and procedures. In my opinion, this provision, along with LCRA's commitment to conservation as discussed by Mr. Hofmann, demonstrate LCRA's agreement to avoid waste and achieve water conservation.

IX. ARTESIAN PRESSURE, WATER TABLE, WELL INTERFERENCE

Q: Do the conditions and limitations in the draft permits minimize as far as practicable the drawdown of the water table or reduction of artesian pressure?

A: Section 8 of the District's rules defines the purpose of spacing rules as to minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure, to prevent interference between wells, to prevent degradation of water quality, and to prevent waste. LCRA's proposed wells comply with the spacing rules for Simsboro wells and far exceeds the minimum spacing requirements for setback from the property boundary.

Further, LCRA has considerable freedom to adjust the pumping rates among its active wells to accommodate the different performance characteristics of the wells. The latitude to adjust pumping rates allows for the well owners to minimize as far as practicable the reduction of artesian pressure across the well field. Further, as discussed above, the drawdown caused by LCRA's proposed pumping does not cause unreasonable impacts to the aquifer.

Q: Do the conditions and limitations in the draft permits lessen interference between wells?

A: The Permits themselves do not contain special conditions related to interference between wells. Instead, as stated above, the District's spacing rules for non-

exempt wells are designed to address this issue. And LCRA's proposed wells meet the spacing requirements in the District's rules.

X. LCRA DRAFT OPERATING PERMIT

Q: Are you familiar with the LCRA Draft Operating Permit?

A: Yes.

Q: Did you provide LCRA with guidance on changes to the LCRA Draft Operating Permit?

A: Yes.

Q: Please describe the changes that you helped develop for the LCRA Draft Operating Permit.

A: My testimony addresses the changes in LCRA Exhibit No. 8-A that are in green text and are discussed below.

- **Concern #1 - Changes to the Definition of Monitoring Well System in GM Draft Operating Permit Special Condition (4)(a).** The GM Draft Operating Permit defines the Monitoring Well System very broadly such that the GM appears to have sole authority to select, change, or add wells to the system without any opportunity for LCRA to provide input or challenge these decisions. In working with Van Kelley to evaluate the calculations used to determine whether LCRA can advance to the next phase of pumping under the GM Draft Operating Permit, it is apparent that random or arbitrary selection of monitoring well locations or improper averaging methods could prevent the special conditions of the GM Draft Operating Permit

from accomplishing what I understand as their intended purpose. Based on deposition testimony provide by Jim Totten and Andy Donnelly, it is my opinion that the District has not developed ample safeguards or appropriate criteria for selecting monitoring sites, for calculating the Annual Static Water Level, and for calculating the Average Rate of Change used in the GM Draft Operating Permit that would help to minimize and quantify potential bias. Among the possible sources of bias in any monitoring well program is an insufficient number of wells, improperly placed wells, and inappropriate data analysis. In my opinion, the District should investigate the potential bias associated with its current monitoring well locations and how it affects the proposed calculations in the draft operating permits before those wells are added to the Monitoring Well System that is used to make the calculations required under the permit. Among the options that the District could use to guide the expansion of its monitoring well network are statistical evaluations and cross validation tests on measured water levels. In addition, the GAM's simulated hydraulic heads for the Simsboro Formation could be used to investigate whether the average of the hydraulic heads at the location of the monitoring wells accurately reflects the true average hydraulic head or rate of drawdown for any of the simulated years.

Recommended Change to Address Concern #1. I recommend changing the definition of "Monitoring Well System" to provide that LCRA and the GM jointly agree on monitoring wells that would be included in the Monitoring

Well System that meet specific criteria as set forth in the redline LCRA Draft Operating Permit, and that are used to calculate Annual Static Water Level and Average Rate of Change in the draft operating permits. The purpose of the proposed criteria is to promote continued improvement with how well the data collected from the wells in the Monitoring Well System and the associated permit calculations that rely on the data, and to achieve the intent of the special conditions in the draft operating permits.

Concern #2 – Measurement of Static Water Level in the monitoring wells (GM Draft Operating Permit Special Condition (4)(b)). Based my experience working with GCDs and reviewing discovery in this case, it is my opinion that the District needs to develop protocols to ensure transparency and consistency in measuring water levels in its monitoring wells. These protocols would address issues such as how to document and account for recent pumping activity prior to measuring water levels in a well.

Recommend change to address Concern #2. For purposes of this permit, I have proposed changes to the definition of "Annual Static Water Level" to require that the measurement procedures be based on methods mutually agreed upon by the GM and Permittee.

Concern #3 – Changes to GM Draft Permit Special Condition (14) related to the pump test requirements. It appears that at least some of the language in Special Condition (14)(a) was copied directly from a permit issued by the District

that involved a single well, whereas LCRA's permit includes 8 wells and well testing will occur for each individual well as they are installed. Special Condition (14)(b) in the GM Draft Operating Permit, appears to require LCRA to supply the specific date of the 36-hour pump test to the District 75 days in advance. Based on other permits that I have reviewed and my experience with pumping test procedures, this condition is highly burdensome for the permittee and provides the District with an unnecessarily long time to prepare to monitor the pumping test. Further, I have concerns related to Special Condition (14)(e) in the GM Draft Operating Permit, which states: "If the pump test results indicate aquifer parameters that result in unanticipated impacts on water levels in nearby wells that are material different than the model predictions, then the General Manager may reduce the authorized maximum rate of withdrawal under the permit." My understanding of the objective of the special condition is that the aquifer test data will be used to calculate aquifer parameters, such as aquifer transmissivity and storativity, and that these parameters would be used to calculate drawdowns for the closest wells. However, as written, this special condition introduces unnecessary uncertainty as to what criteria the District could use to determine unanticipated impacts and provides unilateral authority to the General Manager to determine if the pumping rate will be cut back.

Recommended Changes to Address Concern #3. As shown in LCRA Draft Operating Permit Special Condition (12) in LCRA Exhibit No. 8-A:

- I recommend changes to reflect that the authorized maximum rate of withdrawal in LCRA's permit is an aggregated amount for all 8 wells and not specific to a single well. (LCRA Draft Operating Permit Special Condition (12)(a))
- I recommend reducing the required notice to 30 days and to allow LCRA to notify the District of the scheduled date of the pump test at least 3 business days prior to the test and via a call or email. (LCRA Draft Operating Permit Special Condition (12)(b))
- I recommend that the permits include specific parameters for transmissivity that would be used to determine whether a change in the pumping rate is required. This parameter has the most impact on the long-term drawdown caused by pumping and can typically be calculated with relatively high confidence from an aquifer pumping test. My proposed change to the Special Condition (14)(e) of the GM Draft Operating Permit is to establish a threshold value for the minimum transmissivity of 2,000 $feet^2$/day at which no changes in permitted pumping would occur. The value of 2,000 $feet^2$/day represents the median value of transmissivity for the Simsboro Formation for Bastrop County in both the former GAM and the revised GAM and is therefore a reasonable threshold. (LCRA Draft Operating Permit Special Condition (12)(e))

- In addition, I recommend changes to the procedure set forth in subsection (f) related to the LCRA's right to appeal a decision by the General Manager to limit pumping from the tested well that mirror similar language proposed by the General Manager elsewhere in the GM Draft Operating Permit. (LCRA Draft Operating Permit Special Condition (12)(f))

Concern #4 - Changes to GM Draft Operating Permit Special Condition (15) related to submittal of design information. The special condition states that Permittee must provide the General Manager with the design specifications, including the total depth of the well, the depth of the screened interval, and the pump size, for the completed well within thirty (30) days of completion of the well. The provision then expressly allows the General Manager to administratively approve the design specifications so long as the specifications are in accordance with those provided in the permit application without notice or a hearing if the design amendments do not trigger notice or a hearing under District Rules 7.2 or 7.3. My concern is the timing of the review and the General Manager's apparent sole authority to disapprove the well design after the well has been drilled even if the well specifications are in accordance with those provided in the permit application. As far as I'm aware, this condition is not in other permits issued by the District nor in other permits issued by any other GCDs.

Recommended Change to Address Concern #4. As shown in the redline LCRA Draft Operating Permit Special Condition (13) in LCRA Exhibit No. 8-A, I recommend that the special condition related to well design and construction be modified to require LCRA to provide the General Manager, within thirty (30) days of completion of the well and prior to operation of the well, the design specifications for the well, consistent with the requirements for registering a well within the District. This information provides the District with the necessary information to ensure the wells are completed as anticipated and required by the District Rules regarding well construction and design.

XI. CONSIDERATIONS OF TRANSPORT PERMITS

Q: Please summarize what the District must consider when deciding to grant an application for a transport permit.

A: District Rule 6.3.B describes what the District must consider when deciding to grant a transport permit, which are: the availability of water in the District and the proposed receiving area during the period the water is requested; the projected effect of the proposed transfer on aquifer conditions, depletion, subsidence, or to other existing users within the District; and the approved regional water plan and the District Management Plan.

Q: Have you evaluated LCRA's Applications and the draft transport permits to assess the effects they may have on those items listed in District Rule 6.3.B.?

A: Yes.

Q: What are the effects of LCRA's proposed transport of the water to Travis County on aquifer conditions and depletion within the District?

A: I understand the concern to be whether the transport of water out of the district will result in any additional desaturation of the saturated portion of the aquifer or cause additional impacts to aquifer conditions beyond what would occur if the water was used in the district. I would not expect the proposed transfer of water to Travis County to have any distinguishable impact on the aquifer conditions or depletion in the District as compared to the use of the water within the District. Any water exported to Travis County would have a very small impact on the amount of water returned to the aquifer in the aquifer outcrop through leaky distribution systems, septic systems, and irrigation use from in-District use.

Q: Based on this review, in your opinion, will LCRA's proposed transport of the water to Travis County cause subsidence? Why?

A: No. As I have previously explained in my testimony above, land subsidence in the Simsboro Formation is not a concern. Transport of the water does not affect my opinion.

Q: Do the draft transport permits unreasonably affect existing permit holders and groundwater users within the District?

A: No. My analysis of this issue as it relates to the operating permits, which is set forth in detail above, supports this conclusion.

Q: The District's Rule 6.3.B(1) requires the District to consider the availability of water in the District and in the proposed receiving area during the period of time for which the water supply is requested. Have you reviewed the availability of water in the District and in Travis County during the period of time for which the water supply is requested?

A: Yes.

Q: Based on this review, what is your opinion about the availability of water in the District to meet the water supply needs in the District during the period of time for which the water supply is requested?

A: The Simsboro Formation in the area of GMA-12 is a vast resource that contains 229 million acre-feet of stored water. Within the District, the Simsboro Formation contains approximately 46 million acre-feet of stored water. In my opinion, this vast resource can provide the necessary water supply needs in the District while allowing LCRA to transport some or all of the water under its proposed permits to Travis County.

Q: District Rule 6.3.B(3) requires the District to consider the approved regional water plan and the District Management Plan. Have you reviewed the Applications in light of these considerations?

A: Yes. In terms of the transport permits, the District Management Plan does not require that transport permit contain any special conditions other than what may

be required by the District Rules. LCRA witness, John Hofmann, discusses the regional water plan and the demands for water in Travis County.

Q: Does this conclude your testimony?

A: Yes. However, I reserve the right to supplement and amend my testimony at the time of the hearing.