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 VAN KELLEY

TABLE OF CONTENTS

LIST OF EXHIBITS

LCRA Exhibit No. 19	Prefiled Direct Testimony of Van Kelley
LCRA Exhibit No. 20	Resume of Van Kelley
LCRA Exhibit No. 21	Map of Area around Griffith League Ranch
LCRA Exhibit No. 22	Generalized Stratigraphic Section for the Wilcox and Claiborne Groups with Major and Minor Aquifers in Central Texas
LCRA Exhibit No. 23	Schematic Illustrating Concepts of Depth to Water, Hydraulic Head and Drawdown in a Hypothetical Aquifer
LCRA Exhibit No. 24	Workflow to GM Calculation under the GM Draft Operating Permit for Authorization from Phase II to Phase III or Phase III to Phase IV
LCRA Exhibit No. 25	Excel Spreadsheet of Calculation in Permit for Authorization from Phase II to Phase III
LCRA Exhibit No. 26	Workflow to LCRA Calculation under the LCRA Draft Operating Permit for Authorization from Phase II to Phase III or Phase III to Phase IV
LCRA Exhibit No. 27	Graph of the Proposed Special Condition Calculation of Estimated DFC Year Drawdown from Phase II to Phase III

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	Univ. 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

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 VAN A. KELLEY

I. INTRODUCTION AND EXPERIENCE

Q: Please state your name.

A: My name is Van Alan Kelley.

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) in support of its applications filed with the Lost Pines Groundwater Conservation District (District).

Q: With whom are you currently employed?

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

Q: Please summarize your education and experience.

A: My education and experience are summarized in my current resume, which is LCRA Exhibit No. 20.

Q: Did you prepare LCRA Exhibit No. 20?

A: Yes.

Q: Does LCRA Exhibit No. 20 accurately reflect your education and experience?

A: Yes, it does.

Q: Please describe your experience with groundwater modeling, the development of desired future conditions, and modeled available groundwater.

A: I was the project manager on behalf of the Texas Water Development Board (TWDB) in the development of the Southern Carrizo-Wilcox Groundwater Availability Model (GAM), the Queen City and Sparta aquifers GAM (which includes the Carrizo-Wilcox Aquifers), the Yegua-Jackson Aquifer GAM, the Rustler Aquifer GAM, and the Northern Ogallala GAM (superseded by the current High Plains Aquifers GAM). I was also the Project Manager for the revision of the Northern Trinity Aquifer GAM. In addition to these TWDB GAMs, I have performed hydrogeologic modeling across the country and internationally for 34 years. I have supported several Texas groundwater conservation districts (GCDs) in the joint planning process, helping them assess Desired Future Conditions (DFC) and Modeled Available Groundwater (MAG) (terms I discuss later in my testimony). I have managed modeling supporting two regional groundwater planning groups, Groundwater Management Area (GMA) 1 and GMA-8, in prior rounds of joint planning.

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

A: My most significant contribution in the Central Carrizo-Wilcox aquifer was leading the development of the Queen City and Sparta aquifers GAM (which includes the Carrizo-Wilcox Aquifers in Texas).

Q: What is a GAM?

A: A GAM is a computer model of an aquifer that is a scientific tool used to support groundwater management. A modern groundwater model is a mathematical representation of an aquifer. Groundwater models calculate groundwater levels and aquifer flow components based on a specific set of conditions defined for the aquifer, such as pumping. GAMs are used in joint planning (including calculation of MAGs and DFCs) and are regularly used by GCDs in their permitting process. From a regional planning perspective, Texas GAMs developed and accepted by the TWDB are generally considered the best available tool describing the aquifers and are used to support GCD management plans, GCD permit evaluations, and the joint planning process through determination of the MAG. The TWDB generally requires that GAMs be publicly available and that they be developed in a public process with stakeholder involvement.

Q: Please describe your experience in groundwater management in Texas.

A: I have been District Hydrogeologist for the Upper Trinity GCD and the Northern Trinity GCD supporting activities from development of rules, development of spacing rules, hydrogeologic assessments, evaluation of variance requests and joint planning. For the Upper Trinity GCD, I also led an INTERA team tasked with

developing a monitoring well network strategy and implementation plan for six aquifers across four counties adequate to support the GCD's effort to assess DFC compliance. I have also supported many other districts in Texas including Panhandle GCD, High Plains GCD, Lone Star GCD and most recently the Harris and Galveston and Fort Bend Subsidence Districts. Most of my experience in the review of variance requests was performed with the Upper Trinity GCD. Because two of the GCDs that I have worked with most are just establishing permanent rules, my permit review work has generally been on behalf prospective purchasers of groundwater or groundwater rights. I also have supported joint planning in GMA-1 and GMA-8. And, as previously mentioned, I was the project manager in the development of several GAMs for Texas aquifers. I have also performed hydrogeologic assessments in the majority of Texas aquifers, including the Carrizo-Wilcox Aquifer. Hydrogeologic assessments entail review of aquifer structure, aquifer properties, groundwater levels and flow characteristics, groundwater quality and issues related to groundwater availability.

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

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

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

A: The following is a list of the information upon which I have relied:

- My own experience as a hydrogeologist working in Texas for over 30 years;
- Much of my prior work and reports, which are either identified in my resume or specifically identified here;
- Documents produced to LCRA in this proceeding by the Lost Pines Groundwater Conservation District (District) and others and responses to discovery and depositions questions;
- Rules of the District (District Rules) as amended April 20, 2016;
- The District Management Plan, Revised September 20, 2017;
- General Manager's Draft Operating Permit (GM Draft Operating Permit) (LCRA Exhibit No. 5);
- Prefiled Testimony and Exhibits of other LCRA witnesses in this case;
- LCRA Draft Operating Permit (LCRA Exhibit Nos. 8-A & 8-B);
- LCRA Draft Transport Permit (LCRA Exhibit Nos. 9-A & 9-B);
- LCRA Well Drilling Applications (Form 100) and Operating/Transport Permit Applications (Form 200) for eight wells LCRA proposes to drill at the Boy Scouts of America Capitol Area Council's (BSA) Griffith League Ranch (GLR) property, (February 20, 2018) (collectively, Applications) (LCRA Exhibit No. 3);

- Letter of Administrative Completeness from Jim Totten (General Manager, Lost Pines Groundwater Conservation District) to Karen Bondy (LCRA Senior Vice President, Water Resources), dated August 20, 2018;
- 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.;
- Young, S., J. Jigmond, T. Jones, T. Ewing, 2018. Groundwater Availability Model for Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifer, Report to the Texas Water Development Board, September 2018.
- Wade, S.C. and N. Ballew, 2017. GAM RUN 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, 45 p.;
- Donnelly, A., 2018. Technical Memorandum – Review of LCRA Permit Application Package, April 6, 2018, 6 p.;
- George, P.G., R.E. Mace and R. Petrossian, Aquifers of Texas, Texas Water Development Board Report 380, 172 p.;
- Bureau of Economic Geology (BEG), 1974. Geologic Atlas of Texas, Austin Sheet;
- LBG-Guyton and Associates, 2010. The Boy Scout Ranch Well, 34 p.; and

- Thornhill Group, Inc., 2003. Ground-Water Availability Assessment and Preliminary Well-Siting Investigations – Boy Scouts of America Property Near Bastrop, Texas, 49 p.

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

A: I will initially provide an overview of the aquifers present at the Griffith League Ranch. My discussion of the hydrogeology will be introductory in detail, while the testimony of Steve Young provides the local details of the hydrogeology in the vicinity of the Griffith League Ranch as well as local aquifer dynamics. Next, I will discuss the GM Draft Operating Permit (LCRA Exhibit No. 5) and technical changes to that permit I have proposed. Because the discussion of the GM Draft Operating Permit necessarily involves technical terms unique to hydrogeology, I will explain those terms as they are encountered.

II. GEOLOGIC OVERVIEW

Q: Please identify and describe LCRA Exhibit No. 21.

A: LCRA Exhibit No. 21 was prepared by INTERA staff under my direction and control. It is a map showing a portion of the District as well as the Griffith League Ranch (GLR). The basemap for this exhibit is the Bureau of Economic Geology (BEG), 1974. Geologic Atlas of Texas, Austin Sheet. LCRA Exhibit No. 21 also provides the locations of the proposed LCRA wells at the GLR as numbered in the GM Draft Operating Permit with the property boundaries of GLR. The map

identifies the geologic formations present at ground surface in the region local to the GLR. Many of these formations are classified as aquifers. The purpose of the map is to provide context for the location of LCRA's proposed wells relative to the underlying aquifers and formations.

Q: Please identify and describe LCRA Exhibit No. 22.

A: LCRA Exhibit No. 22 is a generalized stratigraphic section for Central Texas for the Claiborne and Wilcox Groups. This document was prepared by INTERA staff under my direction and control using information from the Queen City and Sparta Aquifers GAM Report (Kelley and others, 2004).

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

A: The formations depicted in LCRA Exhibit No. 22 and beneath the GLR that are the most important for groundwater development are within the Wilcox Group. These formations are collectively defined as the Carrizo-Wilcox Aquifer by the TWDB, which considers this aquifer to be a major aquifer system in Texas. The Carrizo-Wilcox Aquifer is composed of four formations in the area of GLR: the Carrizo; the Calvert Bluff; the Simsboro; and the Hooper formations. They are in order from youngest (shallowest) to oldest (deepest). The Simsboro is the most prolific aquifer in terms of groundwater production of the four formations comprising the Carrizo-Wilcox Aquifer in the region.

Q: In what aquifer is LCRA seeking operating permits from the District?

A: LCRA is seeking operating permits for eight wells that would be completed in the Simsboro Formation of the Carrizo-Wilcox Aquifer.

Q: Please describe the Simsboro Formation and its relationship with the other aquifers depicted on LCRA Exhibit No. 22.

A: As can be seen in LCRA Exhibit No. 22, the Simsboro Formation is the middle formation of the Wilcox Group with the Hooper Formation below it and the Calvert Bluff Formation above it. The Wilcox Group overlies the Midway Formation, which is a regional aquitard. An ***aquitard*** is a geologic unit that cannot transmit significant quantities of groundwater. In contrast, an ***aquifer*** is a water-saturated geologic unit that can transmit significant quantities of water. Hydrogeologists also often use the term "confining unit" synonymously with the term "aquitard." While aquitards generally cannot transmit sufficient groundwater to a well for economic purposes, they are still important to the regional study of groundwater flow. The Simsboro Formation is a sand-dominant formation in comparison to the overlying Calvert Bluff and the underlying Hooper formations. Both the Calvert Bluff and the Hooper formations have alternating sequences of fine sand, mudstone, siltstone, and lignite. They tend to have thinner sand beds as compared to the Simsboro. As a result, wells completed in either of these two formations typically produce less water than Simsboro Formation wells in the area. Because of the stratified nature of these deposits, along with the dominance of fine-grained sediments, the Calvert

Bluff and Hooper formations are regionally considered semi-confining units to the Simsboro Formation. The stratification of lower hydraulic conductivity interbeds acts to restrict vertical groundwater flow relative to horizontal directions of flow.

III. DESIRED FUTURE CONDITIONS AND RELATED TERMINOLOGY

Q: What is a Desired Future Condition (DFC) and how is it determined?

A: The DFC of an aquifer is defined in 31 Texas Administrative Code § 356.10(6) as the desired, quantified condition of groundwater resources within a management area at one or more specified times in the future. The DFC is determined by GCDs within a common management area through the joint planning process in a public process. The process to develop DFCs is described in Texas Water Code § 36.108. The DFCs determined by the GCDs within a GMA must be approved by 2/3rds of the GCDs within the GMA. The proposed DFC goes through a 90-day public comment period before final GMA adoption.

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

A: Yes.

Q: Please explain the District's adopted DFC for the Simsboro?

A: The District's current DFC for the Simsboro is 240 feet of aquifer average drawdown within the District measured from January 2000 through December of 2069.

Q: What is drawdown?

A: Drawdown is the difference between two water levels measured at the same well at different times and is generally measured in feet.

Q: Please identify LCRA Exhibit No. 23.

A: LCRA Exhibit No. 23, which was prepared by INTERA staff under my direction and control, is a schematic of a hypothetical aquifer similar in nature to the Simsboro. This schematic highlights several common concepts and terms used by hydrogeologists and that I use frequently in my testimony. Two hypothetical wells are shown in the exhibit, all screened in the aquifer depicted as light blue. The hatched blue line represents a hypothetical water level in the aquifer as it is measured within the wells in year 2000. The hatched black line represents a hypothetical water level in the aquifer as it is measured within the wells in year 2069. The blue arrow at Well 1 in the exhibit represents a depth to water measurement in Well 1.

The depth to water is generally measured from ground surface, or some common measuring point at the well, down to the water in the well. It is a distance measurement between two points and is generally reported in feet below ground surface (bgs). The depth to water has practical importance when it comes to understanding well performance and energy cost. However, it does not provide information required by hydrogeologists to understand groundwater flow, but if the

elevation of top measurement point is known, it can be used to calculate a hydraulic head.

Hydraulic head (or ***head***) is the elevation of the groundwater level in an aquifer above mean sea level (amsl). Hydraulic head is the measurement of depth to water converted to an elevation above mean sea level. The term "water level" can be confusing because people routinely refer to depth to water measurements and hydraulic heads as a water level, but these are two different measurements.

LCRA Exhibit No. 23 shows the calculated hydraulic heads corresponding to water levels measured in Well 2: one in the year 2000 and another in 2069. In this example, for Well 2, the hydraulic head in year 2000 is 500 feet amsl and the hydraulic head in year 2069 is 400 feet amsl. The difference between these two heads is the drawdown. Thus, the drawdown in Well 2 between years 2000 and 2069 is 100 feet (500 feet amsl – 400 feet amsl). This example highlights that a single hydraulic head is a different measurement than a drawdown. Drawdown can be calculated from two hydraulic heads.

IV. LCRA'S APPLICATIONS

Q: What does the District require for Operating Permit Applications?

A: District Rules 5.1 & 5.2(D)(1) require following for Operating Permit Applications:

- the submittal of an application for an Operating Permit on a form obtained from the District. The form must be signed and sworn to by the applicant. A separate application is required for each well;

- the submittal of a completed registration form for the well(s);
- a location map that adequately details the proposed well site by latitude and longitude or by GPS coordinates, and the location of other registered or permitted wells within 5,000 feet of the location of the proposed well;
- the maximum instantaneous production rate requested (gpm);
- the maximum annual production amount requested for each purpose;
- if the application requests a total maximum annual production amount of 200 acre-feet or greater, the results of a 36-hour pump test of a test well, unless the General Manager waives this requirement;
- specification of the location of the use of the water;
- information describing how the amount of water requested addresses an existing or projected water supply need;
- information regarding the End User, as that term is defined in the District Rules;
- applicant's water conservation plan and the plans of each End User, if available;
- applicant's drought contingency plan and the plans of each End User, if available;
- a water well closure plan or a declaration that the applicant will comply with well plugging guidelines and report closure to the TCEQ;
- an Operating Permit application fee; and

- any other information deemed necessary by the District to comply with the requirements of Texas Water Code Chapter 36, its enabling statutes, and general law.

Q: Do LCRA's Applications include those items listed in District Rules 5.1 & 5.2(D)(1)?

A: Yes. In my opinion, the applications conform to those requirements and the District found the applications administratively complete on August 20, 2018.

Q: What does the District require as part of a Transport Permit Application?

A: Rule 6.2.B states that the application form for a Transport Permit shall require the applicant to provide the following information:

- A copy of the completed registration form for the well;
- The maximum amount of water proposed to be transferred outside the District's boundaries annually (in gallons per minute or acre-feet per year);
- The location of the use of water;
- Information describing how this application addresses a water supply need in the receiving area, including information on when that water supply need is projected to occur;
- If the applicant is not the End User of the water, then (a) if the applicant has identified an End User, the identity of the End User and a description of the applicant's regulatory, statutory, contractual or other legal obligation to

address the End User's water supply need, or (b) if the applicant has not identified; and

- A Transport Permit application fee if one has been established under Rule 2.3.

Q: Do LCRA's Applications include those items listed in District Rule 6.2.B.?

A: Yes, I have reviewed the Applications and they have all the items required consistent with District Rule 6.2.B.

V. ELEMENTS OF OPERATING AND TRANSPORT PERMITS

Q: Please generally describe what must be included in an Operating Permit.

A: District Rule 5.3 sets forth what must be included in an operating permit. These include:

- An Operating Permit must include well-specific permit provisions, including:
  - (1) the name and address of the person to whom the permit is issued;
  - (2) the location of the well;
  - (3) the date the permit is to expire if the permitted well is not drilled and completed;
  - (4) a statement of the purpose(s) for which water from the well is to be used;
  - (5) the location of the use of the water from the well;
  - (6) the total depth of the well and the aquifer unit from which the well will produce water;

(7) the maximum amount of water that may be withdrawn from the well in a calendar year;

(8) the maximum instantaneous rate at which water may be withdrawn from the well; and

(9) the term of the permit;

- An Operating Permit must include a set of Standard Permit provisions as defined in Rule 5.3(B);
- An Operating Permit may include special conditions related to aggregation of withdrawals; and
- An Operating Permit may include other special conditions related to requested waivers or other considerations set forth in the District Rules.

Q: Please generally describe what must be included in a Transport Permit.

A: District Rule 6.4 sets forth what must be included in an operating permit. These include:

- A Transport Permit must include a set of Standard Permit provisions as defined in Rule 6.4(A); and
- A Transport Permit may include other special conditions required or authorized by the District Rules or other applicable law for Operating Permits.

Q: Do the GM Draft Operating Permit and GM Draft Transport Permit contain the required elements set forth in your testimony and listed in District Rules 5.3 & 6.4?

A: Yes, based on my review, I have concluded that both the GM Draft Operating Permit and GM Draft Transport Permit include all the required elements under the District Rules.

VI. LCRA PROPOSED CHANGES TO OPERATING PERMIT

Q: LCRA has proposed changes to the GM Draft Operating Permit. Those changes are shown in an edited version of the LCRA Draft Operating Permit, which are marked as LCRA Exhibit No. 8-A. Are you familiar with those changes?

A: Yes, I am familiar with the changes related to technical language clarifications or corrections and the changes related to the conditions allowing LCRA to increase their authorized withdrawal under Special Conditions (3), (4), and (5) of the GM Draft Operating Permit.

Q: Describe your involvement with the preparation of the proposed changes to the GM Draft Operating Permit that are included in the LCRA Draft Operating Permit.

A: In preparation for my testimony, I was asked to review the GM Draft Operating Permit prepared by the District GM and the redlined edits provided by LCRA to the District counsel on August 29, 2018. In the review of the GM Draft Operating Permit

and through consultation with LCRA and their counsel, I participated in the further development of proposed changes to the GM Draft Operating Permit.

Q: Could you please provide an overview of LCRA's proposed changes to the GM Draft Operating Permits, as shown in LCRA Exhibit Nos. 8-A & 8-B?

A: The changes can be broadly characterized as:

(1) non-substantive language clarifications or corrections;

(2) changes specifically sought by LCRA that are described in more detail in John Hofmann's testimony;

(3) changes related to the conditions under which LCRA is allowed to change its pumping total under Special Conditions (3), (4), and (5) of the GM Draft Operating Permit; and

(4) changes related to the pump test and design requirements in the GM Draft Operating Permit.

My testimony will address changes related to the conditions allowing LCRA to increase its authorized withdrawal under Special Conditions (3), (4), and (5) of the GM Draft Operating Permit and other technical clarifications to the permit.

A. GM CALCULATION

Q: Please describe the conditions under which LCRA can increase pumping under the GM Draft Operating Permit.

A: Special Conditions (3)(c) and (d) of the GM Draft Operating Permit set forth criteria that LCRA must meet before it can move to the next phase of pumping for any

phase greater than Phase II. In addition to criteria related to LCRA's contractual commitments, actual annual pumping rates, and time limits, LCRA's ability to increase pumping to levels provided under Phase III or Phase IV require LCRA to submit documentation that the "Estimated DFC Year Water Level" (defined in Special Condition (4)(j)) is less than the current DFC for the Simsboro. The GM Draft Operating Permit Special Conditions (3)(c)(iii) and (3)(d)(ii) define the test for comparing the calculated "Estimated DFC Year Water Level" to the Simsboro DFC. I will refer to the host of manipulations required to calculate the "Estimated DFC Year Water Level" as the "GM Calculation" in my testimony.

Q: Could you please describe the GM Calculation?

A: The GM Calculation provides a method to estimate potential future impacts of the next phase of authorized pumping under the permit using both historical observations of water level decline and pumping to project future drawdown based upon future pumping. As the GM Calculation is defined in the GM Draft Operating Permit, it is my opinion that it is flawed.

Q: What is your understanding of the purpose of the GM Draft Operating Permit Special Conditions (3)(c)(iii) and (3)(d)(ii)?

A: My understanding of the intent of these special conditions is to allow the GM to estimate projected average drawdown based upon future pumping and to compare that drawdown to the DFC as a means to limit, if necessary, LCRA's ability to increase pumping based on projected drawdown. As stated in the GM Draft

Operating Permit, the calculation is not meant to be used by the District to determine DFC compliance (GM Draft Operating Permit Special Condition (4)(j)).

Q: Has the District performed the GM Calculation?

A: Not to my knowledge. In responses to discovery, the District has told LCRA that it has not performed the GM Calculation.

Q: Please step through the GM Calculation as contained in the GM Draft Operating Permit.

A: I have simplified the GM Calculation from a conceptual perspective into four steps which is included in **LCRA Exhibit No. 24**, which was prepared by INTERA staff under my direction and control. Each step of the calculation may have multiple calculations within it, but these four steps conceptually describe the calculation.

- **Step 1** uses the available District Simsboro water level monitoring data to estimate an "Average Annual Static Water Level" for each year prior to the year LCRA requests to move to another pumping phase. Step 1 simply characterizes the condition of the aquifer, in terms of average water level, prior to the request for the next phase pumping. In written deposition, the District General Manager, Jim Totten, indicated that the "Average Annual Static Water Level" is a hydraulic head, which is commonly expressed as feet above mean sea level (feet amsl) just as land surface elevation is.
- **Step 2** seeks to project future drawdown in the aquifer from the year that LCRA requests to increase pumping through 2069. Step 2 calculates the "Estimated

Future Drawdown" by using a relationship between reported pumping and observed drawdown to project future drawdown that could occur with "Estimated Existing Production" plus the then-current LCRA production and the next phase of authorized LCRA production. The "Estimated Future Drawdown" is an average amount of drawdown that is projected to occur.

- **Step 3** calculates the "Estimated DFC Year Water Level" by subtracting the "Estimated Future Drawdown" (calculated in Step 2) from the "Average Annual Static Water Level" (calculated in Step 1). The result of the calculation is the "Estimated DFC Year Water Level."
- **Step 4** compares the "Estimated DFC Year Water Level" to the DFC for the Simsboro in effect when LCRA submits the information to the GM. If the "Estimated DFC Year Water Level" is less than the DFC, LCRA meets that condition and, assuming all other applicable conditions are met, LCRA may move to the next phase in the permit and increase its pumping.

Q: Could you work through an example of the GM Calculation as set forth in the GM Draft Operating Permit?

A: Yes, an Excel spreadsheet of the GM Calculation was prepared using available information provided by the District in discovery. **LCRA Exhibit No. 25** is the Excel spreadsheet that was prepared by INTERA staff under my direction and control. LCRA Exhibit No. 25 has five worksheets within it. These worksheets include the data needed to make the "Estimated DFC Year Water Level" calculation and the

GM Calculation itself. The worksheet "Permit Calculation P3 — GM" contains an example of the calculation of the "Estimated DFC Year Water Level" for moving from Phase II pumping to Phase III pumping and uses the data in the other worksheets to make those calculations. For reference, I have included at the top of the worksheet the number of the GM Draft Operating Permit Special Condition that is relevant to each of the steps in the GM Calculation.

- **Step 1**: As previously explained, Step 1 of the GM Calculation is the determination of the "Average Annual Static Water Level" from the "Annual Static Water Level" in each well for the years for which the average can be determined.
    - Determine Hydraulic Head: The worksheet named "Raw Measurements" is the Simsboro monitoring well data as provided by the District to LCRA in discovery (LPGM_XLSX_000009). For this calculation example I assume this data represents the "Monitoring Well System" described in Special Condition (4)(a) of the GM Draft Operating Permit. The data as received from the District is a combination of hydraulic head data and depth to water data. Recall, from LCRA Exhibit No. 23, the depth to water is a distance measured, from the ground surface or a common measuring point, to the level water rises within the well. For the calculation, the data must all be represented as a hydraulic head. To convert the depth to water measurements into hydraulic heads, I had to determine the elevation above

mean sea level from which the top measurement point was made. Where available, I used information from the District and augmented that information with the TWDB Water Information, Integration, and Dissemination System to determine the elevation of the top measurement point from which the depth to water was made. If no information was available, I assumed the ground surface elevation was the depth to water measurement point. The elevation of the top measurement point for each monitoring well is found in Column E of the worksheet "Datum Info." For well 58-46-501, I could not find information on the well. For well 58-405-407, I had no location or information regarding the top measurement point, but I assumed that the measurements received from the District are hydraulic heads. Having determined the elevation of the top measurement point for the monitoring data, I was able to convert depth to water measurements to hydraulic heads. This converted data is the "Annual Static Water Level" for each well in the years with data. The worksheet "Monitor Wells," columns B through M, has the "Annual Static Water Level" as calculated from the Districts monitoring well data.

- Calculate Average Annual Static Water Level: With the Annual Static Water Level determined, I was able to work through the calculation of the "Estimated DFC Year Water Level," as demonstrated on worksheet "Permit Calculation P3 — GM." The Step 1 calculation is the calculation of the

"Average Annual Static Water Level." The calculation of the "Average Annual Static Water Level" as defined in Special Condition (4)(c) is simply the arithmetic average of the "Annual Static Water Level." From a review of the monitoring well data available, one can see that monitoring data is not available for every well in every year and, in 2016 and 2017, there is no data. The GM Draft Operating Permit is silent on how to address this issue. So, for years where there are no measurements, I did not include those years in the calculation of the "Average Annual Static Water Level." The calculation of the "Average Annual Static Water Level" can be found in worksheet "Permit Calculation P3 - GM" under Step 1 (column B).

- For purposes of demonstration and in order to complete the calculation on worksheet "Permit Calculation P3 — GM," I have assumed that Phase II pumping starts in 2021 and that LCRA requests Phase III authorization in 2024. To fill in the future years, I assumed an annual average rate of drawdown in order to assign a hypothetical "Annual Static Water Level" for each well for each of the future years (2020 through 2023 in this example). Column C of Worksheet "Permit Calculation P3 — GM" calculates the "Average Annual Drawdown" as defined in Special Condition (4)(e). Based on the average "Annual Average Drawdown" from 2011 through 2019, I calculated an average annual drawdown that I applied to 2020 to calculate the "Average Annual Static Water Level" in Column B. For years 2021

through 2023, I calculated an increased "Average Annual Drawdown" to account for the increase in LCRA pumping in Phase III to calculate the "Average Annual Static Water Level" in Column B.

- **Step 2**: Step 2 of the GM Calculation uses the "Average Annual Drawdown" in Column C with an estimate of Total Production in the Simsboro to estimate an annual "Average Rate of Change" as defined in GM Draft Operating Permit Special Condition (4)(f). The "Average Rate of Change" is used with an estimate of future pumping to calculate the "Estimated Future Drawdown."
  - The GM Draft Operating Permit states in Special Condition (4)(g) that "Total Production" is equal to actual reported withdrawals in the Simsboro added to the "Estimated Simsboro Exempt Production" defined in GM Draft Operating Permit Special Condition (4)(h).
  - Reported Withdrawals: I used data on reported permitted production provided by the District to estimate "Reported Withdrawals" (Column D). The data was provided by the District in discovery in file "LPGM_XLSX_000001." For years 2018 through 2020, I assumed the reported production was equal to the 2017 reported number. For years 2020 through 2023, I increased the "Reported Withdrawals" to account for Phase II LCRA pumping. Column F has the calculated "Total Production" consistent with GM Draft Operating Permit Special Condition (4)(g) for years 2010 through 2023.

- Average Rate of Change: The next calculation in Step 2 is the estimate of the average annual "Rate of Change" defined in GM Draft Operating Permit Special Condition (4)(f). "Rate of Change" is calculated by dividing the "Average Annual Drawdown" by the "Total Production." Column G has "Rate of Change" calculated. GM Draft Operating Permit Special Condition (4)(i) specifies the calculation of the "Average Rate of Change" as equal to the arithmetic average of "Rate of Change" beginning in year 2011 (calculated in Column H, Row 19). The "Average Rate of Change" is used with projected pumping estimates to estimate future drawdown.
- Estimated Existing Well Production: GM Draft Operating Permit Special Condition (4)(m) defines the calculation of "Estimated Existing Well Production," which is tabulated in Column I. The calculation combines "Estimated Existing Well Production" with Current Phase Authorized Withdrawal plus the Next Phase Authorized Withdrawal (being requested in Phase III, an increase of 7,000 acre-feet per year, for a total of 15,000 acre-feet per year). These can be found in Columns I through K.
- Estimated Annual Drawdown: Next, the calculation estimates the "Estimated Annual Drawdown" for each year from the year of increased authorization request (2024 in this example) through 2069 (GM Draft Operating Permit Special Condition (4)(l)). Column L calculates the "Estimated Annual Drawdown" for each year from 2024 through 2069.

- Estimated Future Drawdown: The last calculation in Step 2 is the calculation of the "Estimated Future Drawdown" (GM Draft Operating Permit Special Condition (4)(k)) which is just an summation of each years "Estimated Annual Drawdown" from the year the permittee seeks to move to the next phase under the permit (2024 in this example). Column M calculates the "Estimated Future Drawdown" for year end 2069 (Column M: Row 65) and this is reproduced in Column M: Row 5. This calculation marks the end of Step 2 in LCRA Exhibit No. 24.

- **Step 3**: Step 3 of the GM Calculation is the estimation of the "Estimated DFC Year Water Level" consistent with GM Draft Operating Permit Special Condition (4)(j). The calculation is equal to the "Average Annual Static Water Level" for the year prior to authorization request (Column B: Row 19) minus the "Estimated Future Drawdown" (Column M: Row 5). This equates to a hydraulic head of 240 feet amsl (Column N: Row 5).
- **Step 4**: Finally, Step 4 of the GM Calculation is a comparison of the "Estimated DFC Year Water Level" to the DFC for the Simsboro. Specifically, GM Draft Operating Permit Special Conditions (3)(c)(iii) and (3)(d)(ii) include a test that must be satisfied before moving to the next phase of authorized withdrawal. This test requires that the "Estimated DFC Year Water Level" is less than the DFC for the Simsboro in effect when the Permittee submits the information to the General Manager.

Q: What is your opinion of the GM Calculation in the GM Draft Operating Permit?

A: The GM Calculation is logical until you get to Step 4 when GM Draft Operating Permit Special Conditions (3)(c)(iii) and (3)(d)(ii) require a comparison between two numbers that cannot be compared as defined in the GM Calculation. This is because "Estimated DFC Year Water Level" is a hydraulic head and the current DFC of the Simsboro is an average drawdown from year 2000 to 2069. As shown in LCRA Exhibit No. 23, a drawdown is the difference between two water levels measured at two different times in the same point in the aquifer and has units of feet (length). A hydraulic head is simply a water level expressed as an elevation with units of feet amsl (distance above sea level).

Q: What should the comparison be?

A: A valid comparison is one that is between to like items, either a comparison of drawdowns, or a comparison of hydraulic heads. Because the District's current Simsboro DFC is a drawdown, I recommend the calculation be amended so that the Step 4 calculations is a comparison of drawdowns.

B. LCRA CALCULATION

Q: Have you prepared changes to fix the GM Calculation?

A: Yes. The redline changes in LCRA Exhibit No. 8-A incorporate modifications to implement LCRA's proposed modifications to the calculation, and are specifically included in LCRA Draft Operating Permit Special Conditions (3)(c)(iii), (3)(d)(ii), (4)(a), (4)(d), (4)(j), (4)(k), (4)(q), (4)(r) and (5). These changes are in blue text in

LCRA Exhibit No. 8-A. I refer to these modifications collectively as the "LCRA Calculation."

Q: Please explain the LCRA Calculation.

A: The changes are relatively straightforward and maintain the core calculation. The changes have been designed to compare two comparable drawdowns at Step 4 and are relatively simple. The proposed changes have been made to maintain the GM's original intent of the GM Calculation. **LCRA Exhibit No. 26**, which was prepared by INTERA staff under my direction and control, generally describes the steps in LCRA's proposed calculation.

- **Step 1** is modified, compared to LCRA Exhibit No. 24, to use the available District monitoring well data (assumed for this example to be the "Monitoring Well System") to calculate the "Current Drawdown Since 2000." "Current Drawdown Since 2000" is defined in Special Condition (4)(r) of the LCRA Draft Operating Permit. It is my opinion that this satisfies the original intent of the GM Calculation, while allowing the calculation to add the "Current Drawdown Since 2000" (LCRA Draft Operating Permit Special Condition (4)(r)) to the "Estimated Future Drawdown" from the calculation in the GM Draft Operating Permit. This results in an average drawdown from the year 2000 to 2069. This is consistent in form with the current DFC, which is a drawdown.

- **Step 2** in LCRA Exhibit No. 26 is identical to the GM Draft Operating Permit Special Condition (4)(k), which is the core of the calculations performed in the permit.
- **Step 3** of LCRA Exhibit No. 26, similar to the calculation under the GM Draft Operating Permit of the "Estimated DFC Year Water Level," calculates "Estimated DFC Year Drawdown." Because the LCRA Calculation is now working with drawdown, "Estimated DFC Year Drawdown" is equal to "Current Drawdown Since 2000" plus "Estimated Future Drawdown." I also propose changing the term "Estimated DFC Year Water Level" to "Estimated DFC Year Drawdown" for clarity.
- **Step 4** of LCRA Exhibit No. 26, compares the "Estimated DFC Year Drawdown" to the current DFC, which is expressed as a drawdown. This is comparable to the GM Draft Operating Permit Special Condition (3)(c) and (3)(d) but compares two measurements of the same kind, unlike the GM Draft Operating Permit.

Q: Have you performed the LCRA Calculation?

A: Yes. I will work through the changes in the LCRA Calculation again using LCRA Exhibit No. 25. The LCRA Calculation can be found on the worksheet named "Permit Calculation P3 – LCRA." This worksheet is directly comparable to "Permit Calculation P3 – GM," except it has a few changes consistent with the changes to the calculation as described above. Worksheet "Permit Calculation P3 – LCRA"

links to the same data source worksheets to which “Permit Calculation P3 – GM” links. This worksheet includes references at the top to the LCRA Draft Operating Permit Special Condition that is relevant to each step in the calculation.

My proposed changes are be described below.

- **Step 1:** In Step 1, the “Annual Static Water Levels” are used to calculate “Average Annual Drawdown,” which in turn are used to calculate the “Average Rate of Change.”
    - o Calculate Annual Static Water Levels: Because there are many monitoring wells with missing waters levels for certain years, I propose that missing monitor well data be estimated by linear interpolation between two “Annual Static Water Levels” at two different years in a given monitoring well. The suggested modification to this calculation is in Special Condition (4)(d) of the LCRA Draft Operating Permit. In the worksheet “Monitor Wells,” one can see where I have interpolated Annual Static Water Levels (highlighted in yellow, Columns N through Y).
    - o Estimate Current Drawdown Since 2000: The objective of the Step 1 in the LCRA Calculation is to estimate the “Current Drawdown Since 2000.” “Current Drawdown Since 2000” is the sum of the “Average Annual Drawdown” from 2011 to the year prior to the year in which Permittee submits the documentation described in Special

Conditions (3)(c) or (d) of the LCRA Draft Operating Permits plus the estimated drawdown from 2000 to 2010. I propose using the newest Central Carrizo-Wilcox GAM (Young and others, 2018), which is calibrated from 1930 to 2010, to estimate the average drawdown in the Simsboro in the District from 2000 to 2010, consistent with the TWDB's acceptance of the new GAM. I also propose the estimate of average drawdown in the Simsboro from 2000 to 2010 be defined as 11 feet which we have calculated with the new GAM. The "Current Drawdown Since 2000" is calculated in worksheet "Permit Calculation P3 – LCRA" in Column D, Row 19 and is estimated to be 31 feet.

- **Step 2:** Step 2 (Columns E through N) calculations are identical to the GM Calculation's "Permit Calculation P3 – GM."
- **Step 3** calculates the "Estimated DFC Year Drawdown," which is calculated in Column O, Row 5 and is equal to 154 feet of drawdown.
- **Step 4** is just a simple comparison between the "Estimated DFC Year Drawdown" and the "Desired Future Condition Drawdown." In this example, "Estimated DFC Year Drawdown" of 154 feet of average drawdown is less than the "Desired Future Condition Drawdown" of 240 feet of average drawdown by 86 feet.

Q: Please identify LCRA Exhibit No. 27.

A: Exhibit LCRA Exhibit No. 27, which was prepared by INTERA staff under my direction and control, graphically plots the LCRA Calculation of the "Estimated DFC Year Drawdown" in the example I just worked through above.

- In Step 1, the first available actual "Average Annual Static Water Level" is calculated to be 406 feet amsl in year 2010. The current Central Carrizo-Wilcox GAM (Young and others, 2018 estimate of drawdown from 2000 to 2011 is 11 feet. The sum of "Average Annual Drawdown" from 2011 to the year prior to the year LCRA submits information needed to move to Phase III (2023) is equal to 20 feet of drawdown. In my example of the LCRA Calculation, the "Current Drawdown Since 2000" is equal to 31 feet (11 feet plus 20 feet).
- Step 2 of the LCRA Calculation for estimating "Estimated Future Drawdown" hasn't changed from the GM Calculation and is equal to 123 feet of drawdown. Because I interpolated static water levels in Step 1 (which slightly changes the estimates of Average Annual Drawdown), the estimate is approximately 2 feet less than in the GM Calculation.
- In Step 3, I calculate the "Estimated DFC Year Drawdown as the sum of "Current Drawdown Since 2000" (31 feet) plus "Estimated Future Drawdown" (123 feet). The "Estimated DFC Year Drawdown is equal to 154 feet of average drawdown. From LCRA Exhibit No. 27, one can see that the LCRA Calculation is simply summing estimated average drawdown from 2000 to 2069 for direct

comparison to the DFC at the end of 2069, which is 240 feet of average drawdown.

Q: In your opinion, do you think the LCRA Calculation used to determine when LCRA may move beyond Phase II of the Operating Permits achieves the intent of the GM's Special Conditions (3)(c)(iii) and (3)(d)(ii)?

A: Yes. The LCRA Calculation allows the GM to estimate projected average drawdown based upon future pumping and to compare that drawdown to the DFC as a way to limit LCRA's ability to increase pumping based on projected drawdown.

Q: Have you made other changes related to the GM Calculation?

A: Yes, one change I would like to highlight in my testimony is one related to the comparison to the current Simsboro DFC required in Step 4 and defined in Special Conditions (3)(c)(iii) and (3)(d)(ii). The GM Draft Operating Permit's special conditions allow the DFC to change. This is problematic to the formulation of the draft permit because the DFC may change significantly over time. It could be defined as a hydraulic head in a future round of joint planning or it could be split into multiple management zones. There could also be different DFCs by decade. Any of these changes would likely render the GM Calculation inoperable. To correct the issue of how the future DFC could be defined, we propose that the current DFC be the DFC used in Step 4 of the calculation for the life of the permit. This change to the permit is consistent with the GM Draft Operating Permit Condition (4)(j), which explicitly states that Step 4 (GM Draft Operating Permit

Special Conditions (3)(c)(iii) and (3)(d)(ii)) of the calculation is not relevant to demonstrating compliance with the DFC. This is also consistent with the notion that DFC compliance should not borne solely by a single permittee. If the District determines in the future that its DFC is being exceeded, no matter what the DFC is, the District can curtail LCRA along with all other permit holders, pursuant to the District Rule 9.1 and Standard Condition (1) of the GM Draft Operating Permit (which is unchanged in the LCRA Draft Operating Permit). Another change is in the LCRA Draft Operating Permit Special Condition (5), which provides LCRA the option to use a weighted average method without further action of the GM. This change recognizes the challenges of using monitoring data when a monitoring well network is not uniformly distributed or if data is missing.

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.