June 26, 2012

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)		
	)	Docket Nos.	52-029-COL
Progress Energy Florida, Inc.	)		52-030-COL
	)		
(Combined License Application for	)		
Levy County Nuclear Plant, Units 1 and 2)	)	ASLBP No.	09-879-04-COL

PRE-FILED DIRECT TESTIMONY OF
JAMES O. RUMBAUGH, III, P.G.
ON THE DESIGN AND CALIBRATION OF THE REGIONAL COMPUTER MODEL USED IN PREDICTING THE EFFECTS ON LOCAL AND REGIONAL WATER RESOURCES FROM ACTIVE GROUNDWATER WITHDRAWALS DURING CONSTRUCTION AND OPERATION OF THE LEVY NUCLEAR PLANT, UNITS 1 & 2

I. BACKGROUND –WITNESS

Q1: Please state your name and business address.

A1. My name is James O. Rumbaugh, III. My business address is Environmental Simulations, Inc., 300 Mountain Top Road, Reinholds, Pennsylvania 17569.

Q2: Please state your employer and position.

A2: I am President of Environmental Simulations, Inc., a hydrogeological consulting company, engaged by Progress Energy Florida, Inc. (Progress) in support of the permitting and licensing of the Levy Nuclear Plant, Units 1 and 2 (LNP).[1] Environmental Simulations provides groundwater modeling consulting services to clients in the United States and internationally. As President of Environmental Simulations, Inc., I provide expertise on groundwater model construction and calibration, uncertainty analysis, aquifer test analysis, software development, and peer review studies. My clients include local government agencies (such as the various Florida water management districts),

[1] PEF101 defines selected acronyms used in my testimony for ease of reference.

Federal agencies (such as the U.S. Bureau of Land Management), private sector companies, and other consulting companies. I have worked on a wide variety of projects, virtually all of which have related to groundwater modeling. These projects have been located throughout the United States, as well as in Canada, Australia, New Zealand, Japan, and England.

Q3: Please describe your professional qualifications and experience.

A3: My professional and educational experience is summarized in the curriculum vitae provided in PEF102. I have a Bachelor's degree in Geology from Susquehanna University (1980) and a Master's degree in Geology from Penn State (1983). I have been working as a consulting hydrogeologist for almost 30 years since I graduated from Penn State. I am licensed as a Professional Geologist (P.G.) in Florida (No. 492) and Pennsylvania (No. 76).

I have been working with groundwater models for most of my career, particularly since 1987 when I helped to create Geraghty & Miller's Groundwater Modeling Group. At the time, Geraghty & Miller was one of the largest groundwater consulting companies in the country. For the past 25 years, virtually all of the projects I have worked on have in one way or another been related to groundwater modeling. Many of these projects have involved the entire groundwater modeling process from data analysis and model construction, through model calibration (typically the most difficult part of creating a groundwater model), and then predictive analysis.

I have been an active member of the American Society for Testing and Materials (ASTM) where I am a past chairman of Subcommittee D18.21 on Groundwater and

Vadose Zone Investigations.[2] ASTM was commissioned by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of the Navy to develop standards for groundwater modeling practice. I authored the first modeling standard (D5447) and was chairman of the section devoted to developing groundwater modeling standards for the EPA. I have received several standards development awards and three special achievement awards for my work with ASTM.

I have developed software for use in connection with groundwater modeling, called Groundwater Vistas, which is used by groundwater modelers around the world, including all of the water management districts in Florida, for creating and calibrating regional groundwater models. Each of the five Florida water management districts has broad regulatory authority over the management of water resources within its jurisdiction. The Florida water management districts employ sophisticated computer modeling techniques for evaluating the effects on local and regional water resources from groundwater withdrawals proposed in Water Use Permit (WUP) applications submitted in connection with water use development projects in their respective jurisdictions.

I designed and calibrated the District Wide Regulation Model, Version 2 (DWRM2), for use by the Southwest Florida Water Management District (SWFWMD), the water management district in which the LNP site is located. CH2M HILL used this regional groundwater model in connection with the LNP licensing. I also created a special extension to the Groundwater Vistas software called Focus Telescopic Mesh Refinement (FTMR) that the SWFWMD uses in evaluating WUPs like that for the LNP. The DWRM2 and associated software are used extensively by the SWFWMD Staff and by consultants in assessing the impacts from proposed groundwater withdrawals. The

[2] The term "vadose zone" refers to the cross section of earth between the top of the ground surface and the water table below.

SWFWMD, as a matter of policy, uses the DWRM2 and the FTMR software to review WUPs over 100,000 gallons per day (gpd). I have worked with the SWFWMD Staff in evaluating the use of the DWRM2 by consultants in connection with WUP applications. As SWFWMD policies change with respect to groundwater use, I work with the SWFWMD Staff to update the DWRM2 and the FTMR software to meet their needs. I also provide continued training to the SWFWMD Staff and outside consultants on the use of the DWRM2 and the FTMR software.

I have worked extensively in Florida, primarily for the SWFWMD, the St. Johns River Water Management District (SJRWMD), the Suwannee River Water Management District (SRWMD), and the South Florida Water Management District (SFWMD). I also regularly present seminars and webinars on a broad range of groundwater modeling topics in the United States, New Zealand, Australia, and the United Kingdom. For example, I will be presenting a seminar on groundwater modeling for the Australian National Centre for Groundwater Research and Training in Brisbane, Australia, in late July 2012.

Q4: What is the purpose of your testimony?

A4: The purpose of my testimony is to address those elements of Contention 4A, as admitted by the Nuclear Regulatory Commission's (NRC) Atomic Safety and Licensing Board in the combined licensing proceeding for the LNP, pertaining to the computer modeling predicting the effects on local and regional water resources from active groundwater withdrawals during construction and operation of the LNP. These elements include Contention 4A, Part A, Items 1-3.

Q5: Are you knowledgeable of the matters related to Contention 4A, Part A, Items 1-3?

A5: Yes. I am particularly knowledgeable of the technical issues raised in Contention 4A, Part A, Items 1-3 relating to the computer modeling predicting the effects on groundwater resources from active groundwater withdrawals during construction and operation of the LNP. I have the benefit of nearly three decades of practical experience in hydrogeology and water resource evaluation and planning, during which time most of my work has involved designing, calibrating, applying, or interpreting groundwater models.[3]

Q6: What is your understanding of the technical issues raised by Contention 4A, Part A, Items 1-3?

A6: I understand that Contention 4A, Part A, Items 1-3 raise the following issues with respect to active groundwater withdrawals during construction and operation of the LNP: (i) whether groundwater modeling of active groundwater withdrawals conducted by CH2M HILL supports the conclusions within the Environmental Report (ER) prepared by Progress that the direct, indirect, and cumulative environmental impacts associated with construction and operation of the LNP will be SMALL, and (ii) whether groundwater modeling of active groundwater withdrawals conducted by CH2M HILL supports the conclusions within the Final Environmental Impact Statement (FEIS) prepared by the NRC Staff that the direct, indirect, and cumulative environmental impacts associated with construction and operation of the LNP will be SMALL-MODERATE.[4] Intervenors claim in Contention 4A that LARGE environmental impacts will result from active groundwater withdrawals during construction and operation of the LNP.[5]

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3 Hydrogeology is the study of the occurrence and movement of groundwater, both within the complex subsurface environment, as well as to and from hydrologically-connected surface waters.

4 "SMALL" is defined by the NRC as meaning: "Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource." "MODERATE" is defined by the NRC as meaning: "Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource." NRC001 at p. 1-3.

5 "LARGE" is defined by the NRC as meaning: "Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource." NRC001 at p. 1-4.

Q7: What work have you done on the LNP project that relates to Contention 4A?

A7: I was contacted by Progress to review the CH2M HILL technical memoranda describing the groundwater modeling conducted in support of both the ER prepared by Progress and the FEIS prepared by the NRC Staff. This review was in preparation for a meeting with the U.S. Army Corps of Engineers (USACE) in Jacksonville, Florida, in July 2011. I attended the meeting and participated in the meeting's discussion of groundwater modeling. I was contacted again by Progress in January 2012 to provide testimony in this proceeding on the design, calibration, and application of the DWRM2 used in connection with the groundwater modeling for the LNP.

II. OVERVIEW

Q8: What will your testimony address specifically?

A8: I will describe how hydrogeologists generally design, calibrate, and use groundwater modeling in their evaluation of the effects of proposed groundwater withdrawals on local and regional water resources. I will also discuss the design, calibration, and use of the particular regional groundwater model — the DWRM2 — employed by WUP applicants and water resource planning officials in the water management district (the SWFWMD) within which the LNP site is located. Finally, I will discuss how the different approaches taken in applying the DWRM2 in connection with the ER and FEIS, respectively, resulted in differences in these documents' aquifer drawdown level and regional aquifer flow rate predictions. Notwithstanding these differences in the values obtained from groundwater modeling, my testimony will demonstrate that the groundwater modeling performed by CH2M HILL supports the conclusions in the ER and FEIS that the direct, indirect, and cumulative environmental impacts resulting from active groundwater

withdrawals during construction and operation of the LNP will be SMALL, and in one case SMALL-MODERATE .

III. GROUNDWATER MODELING

Q9: Please describe how hydrogeologists use computer models simulating the effects on local and regional water resources from proposed groundwater withdrawals.

A9: Hydrogeologists use groundwater models to solve a variety of problems, such as determining where contaminants may migrate, predicting impacts from pumping, and determining the safe yield of an aquifer system. A groundwater model is useful because it integrates available knowledge about an aquifer system into a coherent picture and provides a framework for evaluating the effect of changes introduced into the system. In Florida, groundwater models are used by the water management districts and by local consultants for groundwater resource evaluation and planning activities.

There are many different types of groundwater models, but they can generally be categorized as either analytical or numerical. An analytical model is an exact solution to the groundwater flow equation. A numerical model is an approximation of the groundwater flow equation. While an analytical model is in principle more accurate, use of this type of groundwater model is limited to ideal situations that rarely occur in nature. Thus, numerical models are used for most applications.

Q10: What are the sources of uncertainty in the groundwater modeling process, and how do hydrogeologists address these uncertainties?

A10: Although the process of building, calibrating, and analyzing a groundwater model provides hydrogeologists with valuable insights into the process of groundwater flow, groundwater models are not perfect because our knowledge of subsurface conditions will always be incomplete.

The primary cause of uncertainty in groundwater modeling is the lack of complete subsurface data. Drilling wells is expensive; thus, few wells are drilled in any given area. Another source of uncertainty is the fact that some important parameters of the model cannot be measured directly. A good example is recharge (the amount of precipitation that infiltrates the aquifer). Although hydrogeologists can obtain a good approximation of rainfall quantities from gauging and from weather radar data, they cannot measure precisely how much of that rainfall actually makes it to the water table and recharges the aquifer.

Because of the inherent uncertainty in groundwater modeling, hydrogeologists will often use one of several techniques to address potential variability in model predictions. The first technique is the process of calibration. The philosophy in calibration is that, by replicating past behavior in the groundwater system, the model should therefore be a better predictor of future behavior under different conditions. Sensitivity analysis — in which model parameters are adjusted to determine the magnitude of the resulting change in model results — is also often used after calibration to determine how changes to model parameters affect model results. In other cases, hydrogeologists will use alternative conceptual models, comparing the results of those alternative models to the results of the original model.

Q11: Please provide an overview of the groundwater modeling process.

A11: The groundwater modeling process starts with the development of a conceptual model, which is based on available data, including water-level measurements, lithologic logs (descriptions of the sediments and rocks encountered during drilling), aquifer test results, surface water gauging, climate information, and local water use. Insights gained from the

conceptual model are then used to guide the construction of a numerical groundwater model.

A numerical model consists of rectangular blocks (or cells) that are arranged in layers. Typically, each layer represents a different aquifer. Each block represents a small area of the aquifer where water-levels (or drawdown, a change in water-levels) will be computed. Each block is assigned a set of properties, such as hydraulic conductivity (a measure of the ability of water generally to move horizontally through rock and soil), transmissivity (the product of hydraulic conductivity and the thickness of the aquifer), specific yield (a measure of how quickly water-levels rise and fall in response to pumping), and a leakance coefficient (the ability of water to move vertically from one aquifer to another).

Blocks representing areas where water either enters or leaves the model are assigned boundary conditions. There are several types of boundary conditions:

- A constant head boundary condition is one in which water-level is held constant. If the water-level in a block next to a constant head boundary condition is higher than the water-level assigned to the constant head boundary condition, then water will exit through the constant head boundary condition. Constant head boundary conditions are typically used on the edges of models or to represent very large surface water features (*e.g.*, the Gulf of Mexico).
- A constant flux boundary condition is one in which the flow of water is held constant. The most common type of constant flux boundary condition is a well. Another type of constant flux boundary condition is recharge.
- Head-dependent flux boundary conditions. Head-dependent flux boundary conditions are similar in concept to constant head boundary conditions, except that

the ability of the aquifer to provide water to (or receive water from) a head-dependent boundary condition is restricted by a conductance term (relating the volume of water added or removed from an aquifer to aquifer water-level). Common types of head-dependent boundary conditions include rivers and drains.

Typically, the first model that is constructed does not match some data very well (for example, the water-level elevations computed by the model may not match water-levels measured in wells). The model is then subjected to the process of calibration whereby the model parameters (*e.g.*, hydraulic conductivity, storage, and leakance) are adjusted so that the model better reflects the observed conditions of the aquifer (*e.g.*, water-level data). The philosophy behind calibration is that, if we can show that a groundwater model adequately simulates past measured conditions, then it should be a reasonable predictor of future changes to the system. Once the model has been calibrated, the hydrogeologist then queries the system to reflect some postulated future condition. The model then simulates that future condition to illustrate the effects of that change in the aquifer system. In the case of water use permitting, that change is the additional pumping from one or more wells.

Q12: Is there a particular groundwater flow model generally used by hydrogeologists for simulating the effects on local and regional water resources from proposed groundwater withdrawals?

A12: Yes. The U.S. Geological Survey (USGS) has developed a groundwater flow model software code, known as MODFLOW, which is used throughout the United States as well as in other countries to evaluate groundwater flow processes. The USGS supports the model code with periodic updates, documentation, and educational resources. A widely-used version of the MODFLOW code (the MODFLOW-2000) is capable of simulating steady-state (computing average conditions over a given time period) or

transient (computing the changes in water-level over time) groundwater flow in one, two, or three dimensions.

Q13: What groundwater model is generally used by hydrogeologists for simulating the effects on local and regional water resources from proposed groundwater withdrawals in the vicinity of the LNP site?

A13: The water management district for the area in which the LNP site is located (the SWFWMD) employs a particular application of the MODFLOW-2000 model code created using Groundwater Vistas software — the DWRM2 groundwater model — to evaluate the effects on local and regional water resources from proposed groundwater withdrawals.

The SWFWMD engaged my company to design and calibrate both the DWRM2 as well as its predecessor groundwater model, the DWRM. The SWFWMD developed the DWRM so that the SWFWMD would have one model covering its entire district, with some overlap to adjacent water management districts (*e.g.*, the SRWMD, the SJRWMD, and the SFWMD). The DWRM was designed to predict both incremental and cumulative impacts arising from a new or modified existing water use permit. The SWFWMD released the DWRM in 2004. The SWFWMD released the DWRM2 in 2007. This updated model includes WUPs issued through 2006, with newer permits being added on a case-by-case basis as determined by the SWFWMD.

The SWFWMD has made the DWRM2 and its associated reports available to the public and encourages the use of this model in support of WUP applications submitted to the SWFWMD. The SWFWMD's confidence in the calibration of the DWRM2 to local conditions and the proven reliability of the predictions of the DWRM2 and its predecessor DWRM has made the DWRM2 the primary regional model used by the

SWFWMD Staff in their review of groundwater use permit applications. While the SWFWMD does not prohibit consultants from creating a new regional groundwater model in connection with a particular WUP application, in those cases the SWFWMD Staff will still use the DWRM2 in its own evaluation of the effects of the WUP application on local and regional water resources. Any changes made to the DWRM2 by a consultant for a permit application must be fully documented and reviewed by the SWFWMD Staff.

Q14: Please describe the design and calibration of the DWRM2.

A14: I built the DWRM2 in my Groundwater Vistas software according to specifications provided by the SWFWMD and in a manner consistent with ASTM standards. The design and calibration of the DWRM2 is described in greater detail within the SWFWMD's "Refinement of the District Wide Regulation Model for Southwest Florida Water Management District." PEF103.

The DWRM2 covers the entire area of the SWFWMD plus a 10-mile buffer around the periphery that extends into neighboring water management districts. The DWRM2 consists of 59,840 cells arranged in five layers representing (from top to bottom) the surficial aquifer system (SAS), two layers of the Intermediate Aquifer System, the Upper Floridan Aquifer (UFA), and the Lower Floridan Aquifer. Each grid cell in the DWRM2 measures 5,000 ft. on each side. The elevations of each layer were obtained from a study conducted by the Florida Geological Survey (FGS) of the hydrostratigraphy (the delineation of a body of rock into relatively more or less permeable units to aid in the understanding of a flow system) of the SWFWMD, including the area in the vicinity of the LNP site.

In developing the DWRM2 for the SWFWMD, I calibrated the DWRM2 in two stages. First, I calibrated the DWRM2 to steady-state water-levels and spring discharges in 1995. This time period was chosen by the SWFWMD (as well as by the USGS and the neighboring SJRWMD in connection with their own groundwater modeling) as the basis for the steady-state calibration of the DWRM2 because the data from this year were plentiful, pumping records were more accurate than previous years, and rainfall was approximately equal to the long-term average for the area. Drawing from a number of sources (including the SWFWMD's own databases, as well as the Tampa Bay Water database and USGS potentiometric surface reports), steady-state modeling was targeted against a total of 1,039 wells (including 14 wells located within 10 miles of the LNP) and 54 springs located throughout the SWFWMD. This steady-state calibration determined the hydraulic conductivity, transmissivity, and leakance coefficients for the model.

I conducted a second, transient calibration against water-level data obtained over 84 one-month time intervals from 1996 through 2002 in order to estimate the specific yield and storage coefficients in the model. Pumping rates assumed in connection with this stage of the model calibration were obtained from the SWFWMD, and accounted for wells in the SWFWMD, as well as the wells in the SJRWMD, the SFWMD, and the SRWMD within the DWRM2 domain. Recharge rates assigned in connection with this stage of the model calibration were based on USGS estimates for calendar year 1995 for the northern part of the SWFWMD (which includes the area in the vicinity of the LNP site), adjusted against continuous rainfall records from 1995-2002 supplied by the SWFWMD. The transient modeling was targeted against a total of 125 UFA wells from the SWFWMD's databases.

Q15: How does the SWFWMD use the DWRM2?

A15: The SWFWMD uses the DWRM2 to evaluate the impact of proposed withdrawals in WUP applications on local and regional water resources. However, because the model is so large, it cannot be used in its original configuration for the evaluation of a particular WUP. A process called telescopic mesh refinement (TMR) is used to extract a subregional model from the larger DWRM2. This new subregional model is then used to predict the incremental and cumulative effects on local and regional water resources caused by the withdrawal associated with a particular WUP.

I was contracted by the SWFWMD to create a special version of this TMR process in my Groundwater Vistas software product. The special version of the TMR process is the FTMR software. Using the FTMR software, the grid is refined around the wells proposed in a WUP application and then expanded out to the regional scale. The surficial boundary conditions (*e.g.*, wetlands and rivers) are then revised using a geographic information system (GIS) so they are more accurate at the refined grid scale. The new FTMR model is then used by the applicant and the SWFWMD to evaluate both the cumulative and incremental effects on local and regional water resources from the proposed withdrawal. The FTMR model includes the effects of withdrawals by local groundwater users near the proposed permit. The process of creating the FTMR model also creates a report which identifies these local permits, any local aquifer tests that have been conducted in the area, along with aquifer properties at the permit wells.

The SWFWMD does not recommend recalibrating the FTMR models created from the DWRM2. It views this as unnecessary because the existing calibration of the DWRM2 represents the SWFWMD's conceptual model of the aquifer systems in its jurisdiction, incorporates an exhaustive data set that was thoroughly reviewed by the SWFWMD Staff for data quality, and has resulted in reliable predictions since the

model's introduction in 2007. Consultants can adjust parameters within the FTMR models, but they must thoroughly document the need for these parameter changes. The SWFWMD reviews any changes to the DWRM2 introduced by a consultant and runs an unaltered FTMR model for comparison in its own evaluation of the WUP application. In my experience working with the SWFWMD, FTMR models are rarely recalibrated.

IV. GROUNDWATER MODELING CONDUCTED IN CONNECTION WITH THE LNP PROJECT

Q16: Was the DWRM2 used in evaluating the effects on local and regional water resources from active groundwater withdrawal during the construction and operation of the LNP?

A16: Yes. The DWRM2 was used in evaluating incremental and cumulative effects on local and regional water resources in connection with the LNP's water use permitting, ER, and FEIS. The groundwater models used in those evaluations were subregional models extracted from the larger DWRM2 regional model by the FTMR software.

Q17: Are you familiar with the use of the DWRM2 in connection with the LNP's water use permitting and the ER prepared by Progress?

A17: Yes, I have reviewed the technical memorandum (TMEM-074, PEF212) prepared by CH2M HILL as part of the groundwater modeling conducted in support of the LNP's water use permitting and the ER prepared by Progress. CH2M HILL's modeling efforts in support of LNP's water use permitting and the ER are described in greater detail in the Pre-Filed Direct Testimony of Jeffrey D. Lehnen. PEF200. I have also discussed CH2M HILL's modeling efforts with Mr. Lehnen.

Q18: In your professional opinion, are the drawdown values and regional aquifer flow rates obtained from the groundwater modeling conducted in connection with the LNP's water use permitting and the ER realistic?

A18: Yes, based on my review of PEF212, the drawdown values and regional aquifer flow rates from the groundwater modeling conducted in connection with LNP's water use permitting and the ER (the ER Model) are realistic. CH2M HILL used the FTMR software that I developed for the SWFWMD in extracting the ER Model from the regional DWRM2 that was in turn based on the USGS MODFLOW-2000 code used throughout the United States and the world for groundwater modeling. I designed and calibrated the DWRM2 in my Groundwater Vistas software according to the SWFWMD's specifications, in a manner consistent with ASTM standards related to groundwater modeling. The layers of the DWRM2 were based on data obtained from a FGS hydrostratigraphical survey throughout the SWFWMD — including in the vicinity of the LNP site. I calibrated the DWRM2 in two stages (both a steady-state stage and a transient stage) against an exhaustive set of data collected from across the SWFWMD over the course of eight years. The SWFWMD has found the DWRM2's calibration to result in realistic predictions of the effects on local and regional water resources from groundwater withdrawals such that the DWRM2 is the primary model used by the SWFWMD itself in evaluating WUP applications.

By relying on this existing calibration within the DWRM2, the ER Model was based on an exhaustive characterization of local conditions, and was employed in a manner consistent with the SWFWMD's recommended practice for WUP applicants within its jurisdiction. For these reasons, it is my professional opinion that the drawdown values and regional aquifer flow rates predicted by the ER Model are realistic.

Q19: Are you familiar with the recalibration of the ER Model performed by CH2M HILL at the request of the NRC Staff?

A19: Yes, I have reviewed the technical memorandum (TMEM-123, PEF210) prepared by CH2M HILL describing the recalibration of the ER Model performed at the request of the NRC Staff. CH2M HILL's recalibration of the ER Model at the request of the NRC Staff is described in greater detail in the Pre-Filed Direct Testimony of Jeffrey D. Lehnen. PEF200. I have also discussed the recalibration of the ER Model with Mr. Lehnen.

Q20: What is your opinion of the recalibration of the ER Model performed by CH2M HILL at the request of the NRC Staff?

A20: In my professional opinion, the recalibration of the ER Model by CH2M HILL at the request of the NRC Staff was unnecessary. As explained earlier, the DWRM2's calibration to local conditions was both exhaustive and proven to be realistic. For those reasons, the SWFWMD Staff discourages the use of alternative calibrations in connection with WUP applications in the SWFWMD.

Additionally, the recalibration methodology employed by CH2M HILL at the request of the NRC Staff was noteworthy in several respects. First, the recalibration was performed in the extracted FTMR model, rather than in the DWRM2 regional groundwater model. Ordinarily, if recalibration is performed at all, it is performed within a larger model domain (such as a regional model like the DWRM2) to better account for the interrelation of aquifer properties and boundary conditions at the regional scale. In contrast, calibration performed within a smaller model domain (such as a subregional FTMR model extracted from the regional DWRM2) tends to account for fewer of these interrelations because the constant head boundary conditions around the perimeter of the FTMR model isolate the model from regional effects.

Second, the ER Model was recalibrated against some unusual calibration targets obtained from 2007 USGS potentiometric data. One of those targets — the T&J Ranch

Well — I had considered and rejected as a calibration target in the original calibration of the DWRM2 because the water-level measured at this well was so high that it may not be representative of the regional UFA flow system. Elsewhere, the NRC Staff-requested recalibration employed a significant number of synthetic calibration targets based on water-levels estimated using the USGS potentiometric surface maps, rather than taken from actual measured water-levels. These synthetic calibration targets were essentially second-order interpretations of aquifer water-levels from 2007 USGS data.

Third, the recalibration of the ER Model to the high water-levels at these particular targets required CH2M HILL to introduce a large recharge source in an area where the presence of such a source is unrealistic.

Q21: What is your opinion of the results of the Recalibrated Model generated by CH2M HILL at the request of the NRC Staff?

A21: In my professional opinion, the drawdown values and regional aquifer flow rates obtained from the model resulting from the recalibration of the ER Model (the Recalibrated Model) are not as realistic as those obtained from the ER Model.

The principal difficulty with the Recalibrated Model is that the calibration targets chosen — in particular, the T&J Ranch Well — exhibited potentially anomalously high water-levels that forced other changes throughout the Recalibrated Model. Unusually high water-levels or mounds in a water table can be the result of either hydraulic conductivity at the mound being much lower than the surrounding area, or significantly greater recharge at the mound. Here, the T&J Ranch Well's observed water-level was so high that CH2M HILL had to incorporate both of these effects, despite the absence of local recharge and aquifer performance testing data supporting these changes. These modifications in turn resulted in higher drawdown predictions and lower regional aquifer

flow rates than those obtained from the ER Model. With these considerations in mind, the results of the Recalibrated Model are not as realistic as the values for drawdown and regional aquifer flow obtained from the ER Model.

However, simply because Recalibrated Model results are not as realistic as the values obtained from the ER Model does not mean that they are without predictive value. The results obtained from the Recalibrated Model were not much different from those of the more realistic ER Model, as the two models yielded similar drawdown values and regional aquifer flow rates within an order of magnitude of one another. Given the significant uncertainty involved in groundwater modeling in general, the fact that both the ER Model and the Recalibrated Model produced largely similar predictions speaks, in my opinion, to the Recalibrated Model results having predictive value.

Q22: In your experience, how would the groundwater withdrawals associated with the construction and operation of the LNP compare with other permitted groundwater withdrawals in the SWFWMD?

A22: In my experience working with the SWFWMD, the groundwater withdrawals associated with the construction and operation of the LNP are relatively small in comparison with other permitted groundwater withdrawals within the SWFWMD listed in the SWFWMD's Water Management Information System Database.[6] Additionally, the area in the vicinity of the LNP site has a modest number of permitted groundwater withdrawals, making its groundwater resources relatively undeveloped.

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[6] For example, permitting records maintained on the SWFWMD's Water Management Information System Database indicate that the C.D. McIntosh Power Plant and the Fort Meade Chemical Plant alone have been permitted to withdraw a combined 8.8 mgd.

V. CONCLUSION

Q23: In your professional opinion, does the groundwater modeling conducted in connection with the ER and the FEIS support the conclusions in these documents regarding the direct, indirect, and cumulative impacts resulting from active groundwater withdrawal during construction and operation of the LNP?

A23: In my professional opinion, the groundwater modeling performed in connection with the ER and FEIS supports those documents' respective conclusions regarding the direct, indirect, and cumulative impacts resulting from active groundwater withdrawal during construction and operation of the LNP. The groundwater models used in connection with both documents were extracted from the DWRM2 regional model that I designed and calibrated in accordance with SWFWMD specifications and ASTM standards. The DWRM2 was calibrated in two stages (transient and steady-state), and incorporated data compiled from over 1,000 measuring points over the course of the eight years between 1995 and 2002. The SWFWMD has found the DWRM2's calibration to result in reasonable predictions of the effects on local and regional water resources from groundwater withdrawals such that the DWRM2 is the primary model used by the SWFWMD itself in evaluating WUP applications.

Although the groundwater models used in connection with the ER and the FEIS were both extracted from the DWRM2 using the FTMR software commissioned by the SWFWMD for use with WUP applications, only the ER Model retained the DWRM2's exhaustive calibration against local conditions. For this reason, the drawdown values and regional aquifer flow levels obtained from the ER Model provide more realistic predictions of the effects on local and regional water resources from active groundwater withdrawals during construction and operation of the LNP.

In contrast, the modeling conducted at the request of the NRC Staff in support of the FEIS involved recalibration of the subregional model extracted from the DWRM2, a practice generally discouraged by the SWFWMD. The recalibration was performed against a smaller set of targets, some of whom exhibited abnormally high water-levels that caused a preference within the model for high recharge rates and lower hydraulic conductivity. These changes resulted in larger drawdown predictions and lower regional aquifer flow rates than those obtained from the ER Model. For these reasons, the results of the Recalibrated Model — although not without predictive value — are not as realistic as those of the ER Model.

I, James O. Rumbaugh, III, swear under penalties of perjury that the foregoing testimony is true and correct to the best of my knowledge and belief.

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Signature

6-26-12
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Date