NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD
Before Administrative Judges:
Alex S. Karlin, Chairman
Dr. Anthony J. Baratta
Dr. Randall J. Charbeneau

In the Matter of: PROGRESS ENERGY FLORIDA, INC. (Levy County Nuclear Power Plant, Units 1 and 2)	Docket Nos. 52-029-COL, 52-030-COL June 26, 2012

INITIAL PRE-FILED TESTIMONY OF TIM HAZLETT IN SUPPORT OF CONTENTION C-4 REGARDING ENVIRONMENTAL IMPACTS OF LEVY UNITS 1 AND 2 ON WATER RESOURCES AND ECOLOGY

Q1. What is your name and your employment?

A.1. My name is Tim Hazlett and I work for DHI Water & Environment, Inc. as the President & CEO of the consulting services business in the US and Canada.

Q.2. In what capacity are you providing testimony today?

A.2. I am providing testimony as an expert in hydrogeology, integrated groundwater-surface water modeling, and the use of numerical models for the quantitative assessment of groundwater and groundwater-surface water systems. My CV showing my experience in the field is provided as **Exhibit INT102**. A glossary of terms used in my testimony is provided as **Exhibit INT103.**

Q.3. What is your understanding of the proposal to construct the Levy nuclear plant ("LNP") and how the FEIS predicts the potential impacts on the local ground and surface water?

A.3. LNP is proposed to be constructed on the coastal plain of Florida in carbonate rock. The CH2MHill Tech Memo Number: 338884-TMEM-123, Revision: 0; Project: 338884 Review Date: 12/07/09 **(Exhibit INT104).** The FEIS delineated two aquifers, the surficial aquifer system ("SAS") which directly interfaces with the surface water in the area, and the Floridan Aquifer System ("FAS") that is commonly used for supply of freshwater and overlays an often poorer quality lower aquifer. During construction the LNP site will be dewatered, excavated and filled. During operation, LNP will withdraw up to 1.58 million gallons per day from the FAS and up to 5.8 Mgd for a week. To predict the effects of this withdrawal Progress Energy Florida ("PEF") used a model called the District-Wide Regulation Model, Version 2 ("DWRM2") which is the model used by the local water district, the Southwest Florida Water Management District ("SWFWMD"). This model is a steady state media model that makes no attempt to predict the interaction of the freshwater in the FAS with saline water from the Gulf. The first attempt at using this model failed because it did not meet the required calibration criteria. PEF subsequently recalibrated the model and the FEIS relies upon the recalibrated model.

Even after recalibration, this model has serious shortcomings because it cannot predict how changes will occur over time, it omitted salinity interactions with the nearby barge canal from the model, it is not well-suited to predict how pumping of the FAS will affect levels or salinity in the SAS, in and it assumes that the aquifers themselves are uniform, which they are not. As a result of these shortcomings, the model is not a suitable tool to predict how the local wetlands, which are sensitive to short term changes in SAS levels and salinity, will be affected by the proposed pumping at LNP.

Q4. Does the model recalibration have serious shortcomings?

A.4. Yes. I evaluated both the final DWRM2 variant 73 and the recalibrated variant of the DWRM2 number 124. These two models represent the baseline used for analysis of groundwater withdrawal impacts in the FEIS. The FEIS shows that the ranges in measured aquifer parameters were large and those ranges do not match well with the values used in the final model:

> Site-specific hydraulic properties for the surficial and Upper Floridan aquifers were characterized using both slug test and pumping test methods. ER Section 2.3.1.5.5 (PEF 2009a) describes slug tests that were performed in all 23 wells. Results from these tests were analyzed using the Bouwer and Rice (1976) method. Hydraulic conductivity estimates ranged from 0.9 to 28.6 ft/d (feet/day) in the surficial aquifer and from 2.4 to 54.4 ft/d in the Upper Floridan aquifer, with average reported values of 9.2 and 13.9 ft/d for the surficial and Upper Floridan aquifers, respectively. It should be noted that the average reported slug test values for both aquifers fall below the lower end of the hydraulic property range specified in the DWRM2 groundwater flow model, indicating that test conditions may result in non-representative hydraulic property estimates.

FEIS Vol. 1, pg. 2-25.

Differences between field-measured values of hydraulic properties and those same values used to eventually calibrate the model are a strong indication that the model is unable to simulate actual field conditions. A model is only an approximation of reality, but the more that model parameter calibration values (i.e. - hydraulic conductivities) differ from measured (field) values, the less reliable predictions derived from the model become. In this case, the divergence between the calibration and the measured parameters shows that the model cannot be relied upon to predict the effects of the proposed groundwater extraction to a reasonable degree of scientific certainty.

Q.5. Was sufficient data available to allow accurate calibration of the model?

A.5. No. Data for a modeling effort should be collected over a range of both spatial and temporal scales. For this particular application, both an improved conceptualization and an improved understanding of the behavior of the simulated system would come from additional data streams such as: more wells, at varying depths, being monitored and tested over a longer period of time, monitoring of water levels in wetlands over at least one year (ideally longer), and measurement of streamflows and spring discharges during both wet and dry season conditions. In addition, if a more physically accurate model were used, as appears necessary, use of dye tracers to determine the locations of major preferential flow pathways would greatly assist to understand how pumping will affect the local groundwater.

Q6. What are the implications of the large variation in hydraulic conductivities and transmissivities used in the model(s)?

A.6. In the final groundwater model report, the calibrated hydraulic conductivities (K's) are listed in Table 3 (on page 15 of 49) as ranging from about 11 to 24 ft/d in the Surficial Aquifer System (SAS) and the transmissivities (T's) ranging from about 20,000 to nearly 5,400,000 ft^2/d for the Upper Floridan Aquifer System (FAS) in the DWRM2 telescoped model. For the final and revised model, these ranges change to calibrated values of exactly 0.75 to 135 for the K in the SAS and 7920 to 11,592,030 ft2/d in the Upper FAS. Averages are also presented, but are not physically meaningful, as the calibrated range covers several orders of magnitude: the rapid flow in the system will be dominated by the most transmissive portions. The implication of large variation in K for the SAS is that water may flow 180 times more easily through those portions of the aquifer with the largest K. The calculation for the upper FAS is somewhat different in that

the report uses T instead of K. T and K are related through a simple formula: T = Kb, which stated explicitly, indicates that one can calculate the K of the upper FAS by dividing the T by the aquifer thickness used in the model, for any given cell in the model grid.

If we assume that the upper FAS in the model is the same thickness everywhere (let's say 300 feet), then the calibrated range of K for the upper FAS becomes 26.4 ft/d up to approximately 38640 ft/d. The high end of this range, for Florida, indicates karst conduit flow. In other geologic settings, it might indicate coarse gravel or heavily fractured rock, each of which also has the ability to store and/or transmit large volumes of water. In an environment with significant conduit flow, the changes that would be induced by pumping are highly dependent on the locations of the extraction wells compared to the conduits. At present, this is not understood and so the model predictions are not remotely realistic.

Q7. Does the modeling approach adequately address impacts to surface water features due to groundwater pumping?

A.7. No. There are a number of shortcomings to the modeling approach. These are both functions of how the model was conceptualized and also direct limitations presented by the simulation capabilities of the software used. The major elements of these can be summarized as follows:

- The so-named DWRM2 model was used as the model of choice for the PEF study. The development of the DWRM2 model was sponsored by SWFWMD for use in consumptive use permit (CUP) modeling. It was designed for regional use in analyzing water use, and not for localized water modeling, and therefore has several inherent flaws. In "Technical Peer Review – District Wide Regulation Model, Version 2. Southwest

Florida Water Management District," by Hughes, et. al., 2009 (unpublished) (**Exhibit INT105)**, there are many instances where the expert peer reviewers mention these shortcomings:

- "….may be limited for evaluating SAS water-level impacts in areas with high errors and/or appreciable surface-water boundary condition exchange."
- "…is limited for evaluating changes in surface-water flows (base flow and spring flow) because of poor calibration of these water budget components."
- As a suggested improvement: "….removal of conceptual drain boundary conditions used to control water levels above surface."
- "Examples of additional functionality that could improve DWRM2 and FTMR applications include the unsaturated zone flow (UZF) package…streamflow routing…..etc."

> According to the FEIS, p.2-29, for the LNP modeling, the original DWRM2 model was recalibrated (adjusted) by the following: Calibration targets included in the recalibration process included (1) site water-level data, (2) water-level data from other USGS monitored wells within the model domain, and (3) additional measurement locations synthesized from the USGS potentiometric surface where no well coverage was available. The calibration was performed in the steady-state mode using 2007 water-level elevations and the Model-Independent Parameter Estimation (PEST) code (Doherty 2004).

This recalibration is insufficient for an accurate modeling of the area because it does not address the seasonal or long term temporal variability in the natural system. At a minimum, a transient calibration with time-varying rainfall should have been performed. In addition, a number of important features appear to be missing from the model. The site is close enough to the coast that pumping water from the canal, could cause saltwater to encroach from the Gulf. Additionally, all along the canal, unless it is lined, it is recharging the aquifer, at least part of the year. None of this can be addressed without both flow and water levels in the canal being in the model, which they are not.

Overall, the model presents an average over space and time, when the transient effects caused by the start of groundwater pumping will affect a system that is very heterogeneous and time-dynamic.

Q8. Is the modeling approach adequate for evaluation of wetland impacts?

A.8. No. On page 2-29, the FEIS directly states:

> Given the complex site hydrologic conditions, including natural annual variability in groundwater level, model parameter uncertainties, and the relatively small water-level changes that have been shown in the literature to result in wetlands impacts, the staff determined that the groundwater model alone was not sufficient for supporting a definitive assessment of the impacts on wetlands.

This means that the authors of the FEIS themselves recognize that this model cannot be used to assess how the proposed groundwater extraction would impact wetlands. This is due to the large amount of uncertainty is in this model, due to a number of factors, all contributing to its unsuitability for purpose:

1) Steady state modeling and calibration was used in a clearly transient natural system. To model effects on wetlands correctly, one would need results showing predicted (and historic) variation in groundwater levels over time.
2) Although expecting the upper FAS and SAS to be well connected and mirror drawdown impacts, there are few SAS wells in the model and therefore poor constraint on SAS impacts from upper FAS drawdowns. The wetlands sit on the surface of the SAS, so by implication, impacts there are also poorly constrained.
3) As discussed in answer 7 above, the model design is unsuitable to predict effects on the SAS.

Q9. Can the utilized modeling approach quantitatively assess impacts to wetland hydroperiods due to groundwater pumping?

A.9. No. By the simplest definition, hydroperiod is defined as the period of time during which a wetland is covered by water. As enumerated in A.7., above, there are a number of ways in

which the model does not have the capacity to address various interactions with surface water (i.e. – wetlands). These can be broken into two categories: the inability of the model to simulate the flow of water on the surface of the land (overland flow, stream flow, etc.) and the inability of the model to simulate directly water levels in surface water bodies.

With regards to the first, quantitative assessments of wetland hydroperiods or variations in hydroperiods due to groundwater pumping of course need to start with an accurate ability to assess the actual amount of water residing in or flowing into or out of the wetlands (a water budget). A typical water budget for the wetland would consist of variations in the volume of water in the wetland due to evaporation (-), evapotranspiration (-), surface runoff (+/-), rainfall (+), and seepage into the ground (-). At a minimum, disregarding surface runoff as part of the wetland water budget will change any model assessment of hydroperiod.

With regards to the second, the modeling approach cannot simulate water levels in surface water bodies (wetlands). Hydroperiods, the time during which wetlands are covered with water (or not), of course are closely tied to the elevation (stage) of the water residing in the wetland. As the water level in a wetland varies, not only does the volume change, but the area of the wetland that is saturated changes as well.

The FEIS assumes a mean average precipitation of 53 inches per year at the Levy site. (FEIS p. 2-21). A time-varying (transient) model would allow sensitivity to variation in precipitation to be investigated, especially if modeling for drought susceptible areas like wetlands, which are partially addressed in the FEIS on page 2-184.

Q.10 Should the effects of climate change be included in the model?

A.10. The effects of climate change as discussed in the FEIS on page 2-181 should have been included in the model. If sea level rises, as a climate change scenario might consider, the immediate effects are that saltwater pushes inland, both above and below ground, and the groundwater gradient would flatten. In a simple sense, this could be modeled by simply adjusting the "sea level" boundary along the Gulf to a higher mean level. Over 60 years, it is advisable to at least consider the possibility of climate variation; drought, increased precipitation, sea level changes, etc. In addition, the effects of drought should have been modeled for water availability.

Q11. Was the cumulative impact from the Tarmac mine properly addressed in the FSEIS?

A11. No. Given that the model domain (area) included the locations of the proposed mines, these should have been included in the predictive model, but they were not. The FSEIS instead relies upon the following simplistic analysis:

> Although no specific evaluation of the impacts of water use at the Tarmac mine on groundwater levels and wetland was performed for the LNP units 1 & 2 draft EIS, the review team determined that the effects of water use at the Tarmac mine site on the groundwater resource would be of the same order of magnitude as those predicted for the LNP wellfield located on the LNP site because both projects would withdrawal [sic] a comparable amount of groundwater. As discussed in section 5.2.2.2, a modeling evaluation indicated that the average LNP operational groundwater use (1.58 Mgd) represents only a small percentage (0.8 percent) of the total water flux (208 Mgd) moving through the groundwater model domain. Assuming similar geohydrologic conditions at the Tarmac site, the review team determined that the proposed water use would also be a relatively small amount of the flux moving through the groundwater system. (FEIS p. 7-14)

This analysis incorrectly assumes that extraction of less than 2% of the total estimated average water flux will have little impact. This is incorrect for at least three reasons. First, extraction of

this amount of water could have a significant impact upon the locations of freshwater/salt water interfaces. Second, if local wetlands are only inundated for a small amount of time per year, a small change in the water-balance could lead to the dewatering of large areas of wetlands. This further highlights the importance of recognizing the groundwater-surface water interactions via the wetlands as a dynamic system, the vagaries of which can't be simulated with a steady state model. As discussed above, a transient model could, in part, allow the FSEIS to predict the change in hydro-period that could occur, particularly during periods of drought. This is essential here for the impact on wetlands to be accurately determined. Third, the total flux quoted is only an average and there is currently no understanding of this flux varying seasonally or during times of drought.

Q.16. Do you swear in accordance with 28 U.S.C. § 1746, under penalty of perjury, that this testimony is true and correct?

A.16. Yes I do.

Executed in accord with 10 C.F.R. § 2.304(d)

Timothy J. Hazlett, Ph.D.

June 26, 2012