SECOND AFFIDAVIT OF MARK A. QUARLES

BEFORE ME, the undersigned authority, personally came and appeared, Mark A. Quarles, who, after being duly sworn, did depose and say:

Qualifications

1. My name is Mark A. Quarles. I am an expert in the field of investigating planned and accidental releases of environmental pollutants to the environment and evaluating the risks associated with those releases.

2. I have specific education and experience performing environmental investigations in fractured sedimentary bedrock such as limestone and have specific education and experience in karst geologic bedrock conditions.

3. I have reviewed and assessed the Florida Power & Light Company's Response to Joint Intervenor's Motion to Amend Contention 2.1, February 10, 2012 prepared by Florida Power & Light Company (FP&L) relative to the potential for wastewater injection operations to contaminate the groundwater and drinking water aquifers.

4. I have also reviewed and assessed the NRC Staff's Answer to Joint Intervenors' Motion to Amend Contention NEPA 2.1, February 10, 2012 prepared by the Nuclear Regulatory Commission (NRC) relative to Miami-Dade County wastewater discharges and its characteristics and the potential for that wastewater to contaminate drinking water aquifers.

5. This Affidavit contains my expert opinions, which I hold to a reasonable degree of scientific certainty. My opinions are based on my application of professional judgment and expertise to sufficient facts or data, consisting specifically of documents related to this matter. These are facts and data typically and reasonably relied upon by experts in my field.

6. In my expert opinion, FP&L has still not adequately analyzed and discussed the site conditions, the risks associated with wastewater injection activities, and the potential of certain constituents – including heptachlor, ethylbenzene, toluene, and tetrachloroethylene – to contaminate underground aquifers. FP&L concluded in their ER that the potential impact to the groundwater quality in both the underground source of drinking water (USDW) and the Boulder Zone injection formation beneath the Turkey Point plant is "SMALL". ER, Section 5.2.3.2.4 at 5.2-25. This determination relied upon incomplete, inaccurate, and unsupported data.

Summary of Opinions

FP&L has failed to provide any information regarding the sources of its data and methods of data collection used to produce the list of chemical concentrations presented in Table 3.6-2. The data presented is likely to be inaccurate given the variability of these chemical concentrations.

7. FP&L has not provided any documentation of the data set forth in Table 3.6-2 relative to the date of sample(s), which plant(s) were used to develop the list, whether or not the concentrations were based on a single sampling event, when the sample(s) were collected, if the values represent arithmetic or geometric means, or the maximum/minimum concentrations of the constituents. FP&L failed to respond to the Intervenors' request for that information. FP&L, Motion to Amend.

8. The constituents and their concentrations can vary seasonally during the year and can depend on such variables as age of the collection system, the degree of infiltration and inflow into the collection system, the treatment methods used, the compliance history of the treatment plant, the compliance history of commercial and industrial dischargers to the plant, the presence of agricultural operations that use herbicides and pesticides, and the types of industrial and commercial users connected to the wastewater collection system for each plant, as examples. Wastewater treatment plants that have more commercial and industrial fruit and vegetable washing operations, as an example, would be expected to have more herbicides and pesticides in the wastewater. Further, if one geographic area has more mosquito spraying operations where those chemicals could enter the collection system, that variable would also be relevant for wastewater constituents. Lastly, industrial users that discharge organic chemicals, such as degreasers, and their pre-treatment compliance history all would play a role in what chemicals might be present and require treatment at the treatment plant. Not all wastewater treatment operations can remove or effectively treat recalcitrant chemicals such as tetrachloroethylene and heptachlor.

9. This seasonal variability necessitates the use of long-term sampling to achieve an accurate indication of actual chemical concentrations in wastewater.

10. For these reasons, FP&L cannot accurately estimate chemical concentrations, and the risks associated with aquifer contamination, without a long-term study of constituents from the South District Wastewater Treatment Plant site.

FP&L disputes that deep well injection of South District wastewater that is planned for injection at the Turkey Point site has already contaminated the Upper Floridan Aquifer. That argument is not supported by the ER prepared by FP&L or actual data collected from the South District site.

11. FPL&L disputes the previous assertion that the upper portions of the Floridan Aquifer have already been contaminated by the Miami-Dade Water and Sewer Department (MDWASD) South District Wastewater Treatment Plant site – located just 9 miles away

from the Turkey Point site. FP&L Response at 10. Their dispute against the assertion was based on the Walsh and Price report and their definition of what geologic formations are actually included as the "Upper Floridan Aquifer".

12. According to the United States Geologic Survey (USGS), the Avon Park Formation (also known as the Avon Park Permeable Zone, APPZ) is considered to be an aquifer within the Upper Floridan Aquifer system. USGS at G7. According to the Walsh and Price investigation, 10 of 12 wells drilled in the APPZ at the South District plant site are contaminated with wastewater that was injected into the Boulder Zone approximately 1,250 feet deeper than the APPZ. Walsh and Price at 4 and 7.

13. The Idaho National Engineering and Environmental Laboratory (INEEL) has also concluded that the Avon Park Permeable Zone is within the Upper Floridan Aquifer. INEEL at 4.

14. The ER prepared by FP&L described the "Upper Floridan Aquifer" as including the Avon Park Formation / APPZ. ER, Revision 3 at 2.3-18.

15. The ER prepared by FP&L, the INEEL, and the Walsh and Price review of data support the assertion that the Upper Floridan Aquifer has already been contaminated by wastewater. That same wastewater (90 million gallons per day according to the ER) is planned for deep well injection at the Turkey Point site.

No detailed, extensive investigation has ever been completed at the Turkey Point site to determine the presence or absence of geologic confining layers or horizontal and vertical bedrock fractures that can be contaminant migration pathways.

16. The only information that FP&L submitted in the ER to support the suitability of the Turkey Point site is generalized data from various published reports that generalize regional, South Florida geologic conditions - as opposed to determining actual geological subsurface data from the Turkey Point site.

17. The only completed investigation of the subsurface near the Turkey Point site to evaluate the presence of key geologic and hydrogeologic conditions necessary to protect drinking water aquifers comes the Miami-Dade Water and Sewer Department (MDWASD) South District Wastewater Treatment Plant – the proposed source of 90 million gallons a day of wastewater to be injected at the Turkey Point site. Groundwater at that site has already been contaminated by deep well injection activities. Walsh and Price at 1. EPA RA at 4-13. INEEL at iv.

18. Walsh and Price concluded - based upon actual groundwater monitoring results from wells from data collected from 1991 to 2007 for the nearest deep well injection site for wastewater that will be injected at the Turkey Point plant - that wastewater has already contaminated shallower groundwater. Key conclusions include:

- Density-driven buoyant and rapid vertical migration occurred because in part, wastewater was less dense than the salty water in the Boulder Zone. As a result, wastewater has a natural tendency to rise. Walsh and Price at 14.
- Injected wastewater will rise upward through bedrock as a distinct water body, with little mixing of native waters as it migrates upwards. Walsh and Price at 15.
- Injected wastewater will migrate upwards through discrete vertical pathways. Walsh and Price at 15.
- Groundwater data illustrated that the injected water has a "direct pathway to the APPZ" – completely bypassing the lower Middle confining Unit (MCU2). Walsh and Price at 14.
- Contaminant concentrations in the more permeable, shallow APPZ over the MCU2 increased over time and correlated well with the concentrations that were injected into the Boulder Zone. Walsh and Price at 7.
- Rapid vertical migration pathways can be due to "structural anomalies such as fracturing and karst features that would vertically connect aquifers and provide high hydraulic conductivity transport pathways through confining layers". Walsh and Price at 13.
- Contaminated water that reaches the higher aquifer levels above the confining unit is then able to flow horizontally away from the site along the regional direction of groundwater flow. Walsh and Price at 15.

19. The South District Wastewater Treatment Plant is located approximately 9 miles north of the Turkey Point plant. ER at 2.3-47.

20. A report published in 2010 by Walsh and Price on behalf of the MDWASD, concluded after reviewing 16 years (from 1991 to 2007) of groundwater data that widespread groundwater contamination exists at that injection site because of unfavorable geologic conditions – conditions that are contrary to the assumptions made by FP&L in the ER. Walsh and Price at 7, 14, and 15.

21. Nine deep well injection wells were drilled at the South District plant from 1995 to 1996. Walsh and Price at 4. The Walsh and Price investigation of historical groundwater data showed that contamination of the Well 6U drilled into the Upper Floridan Aquifer, as defined by the USGS, began almost immediately after injection began in 1995. In fact, the investigation concluded "Well 6U showed an increased trend of NH_3 (ammonia nitrogen, the marker compound used by Walsh and Price to identify wastewater in groundwater) that was observed to be similar to the increasing trend of NH_3 in the injectate". Walsh and Price at 7. That trend was also seen in other Upper Floridan Aquifer wells when Walsh and Price concluded "almost all of the wells showed variation of NH_3 concentrations over time". Walsh and Price at 7 and 8.

22. An evaluation of the data reviewed by Walsh and Price indicates that the lower Middle Confining Unit (MCU2) does virtually nothing to prohibit the rapid vertical migration of the more buoyant wastewater that is injected. The study concluded that four (4) different contamination plumes already exist in the Avon Park Permeable Zone (APPZ), which is a zone of very permeable limestone bedrock of the Upper Floridan Aquifer that is

sandwiched between the lower MCU2 (deeper layer) and the upper MCU1 confining layer (more shallow). According to that study, 10 of 12 wells (83%) drilled to monitor for unintended contamination in the APPZ drinking water are already contaminated with wastewater. Walsh and Price at 7.

23. The ER prepared by FP&L relied on an assumed 1,000-foot thickness (at least) of the Middle Confining Unit to separate the Boulder Zone from the Upper Floridan Aquifer and to protect drinking water. FP&L Motion to Amend at 11.

24. According to Walsh and Price, the base of the APPZ is situated 378 meters (1,240 feet) above the top of the Boulder Zone. Walsh and Price at 4. As a result, contaminated groundwater at the South District site has migrated vertically a minimum of approximately 1,250 feet.

25. FP&L estimated in the ER that the vertical hydraulic conductivity (rate that groundwater will travel upwards) of the important middle confining unit that separates the Boulder Zone from the upper drinking water aquifer ranged between $1.3x10^{-4}$ feet per day (0.0026-inch) to no more than 0.24 feet per day (around 3 inches). ER at 2.3-33. That estimate was based upon generalized data for southern Florida published in the ER, not from the specific site in question. ER, Revision 3 at 2.3-33. This estimate is a gross underestimate for the same generalized geologic conditions at the South District plant where groundwater migrated *at least* 1,240 feet upward into the drinking water aquifer almost immediately after injection of the same wastewater planned for Turkey Point began at that plant, according to Walsh and Price.

26. Of the 32 groundwater monitoring wells installed at the South District plant, only four (4) wells monitor the "Upper Floridan Aquifer" (as defined by Walsh and Price); 12 wells monitor the Avon Park Permeable Zone (APPZ), which the USGS has defined as part of the "Upper Floridan Aquifer", and 16 wells monitor groundwater within the lower MCU2. None are installed into the upper Middle Confining Unit (MCU1) to know whether or not groundwater within that bedrock formation is also contaminated. As a result, there is no data to show whether or not the upper MCU1 is actually confining any contaminated groundwater at the South Plant.

27. The Walsh and Price conclusion that vertical pathways "did not appear to extend up to the UFA" (Upper Floridan Aquifer) seems to be based on the absence of groundwater contamination in one or more wells drilled within the UFA zone, as defined by Walsh and Price. That conclusion cannot be supported by groundwater data because no wells are even drilled into the upper MCU1 that lies just below the Upper Floridan Aquifer.

28. Further, of the four (4) wells drilled into the UFA (according to Walsh and Price) at the South Plant, only one (1) of four (4) wells is even capable of detecting a release of contaminants because only one well (Well 1U) is located hydraulically downgradient (in the regional direction of flow) from a plume (Plume 2 of 4), as illustrated by Walsh and Price. The remaining wells (2U, 3U, and BZ1) are located hydraulically *upgradient* from the nearest of three other contaminant plumes (plumes 1, 3, and 4).

29. The Walsh and Price investigation does not support the FP&L conclusions in the ER relative the effectiveness of the middle confining unit layers to prevent upward migration and contamination of more shallow drinking water aquifer zones.

30. Vertical pathways across multiple layers of fractured bedrock can be just a few (e.g. 2 to 3 feet) feet wide and be extremely difficult to identify. Without a very detailed subsurface investigation at the Turkey Point site to identify those features, an injection well program will risk rapid migration of contaminants into drinking water aquifers, based on the results at the South District plant.

The single exploratory well currently being drilled by FP&L to determine suitability of the Turkey Point site for deep well injection is grossly inadequate to characterize the site and define the risk to human health.

31. Apparently, there is only one subsurface boring or well that will be drilled by FP&L deeper than 615 feet at the Turkey Point site. FP&L, Response at 12. According FP&L's response, "from this well, FPL will be able to determine the confining characteristics of the intervals overlying the Boulder Zone" and not until and unless confinement is confirmed, will injection wells be drilled. In summary, FP&L is drilling a *single* exploratory well to define confinement conditions that 32 wells at the South District plant have been unable to define. That single well cannot possibly define subsurface geologic conditions to either determine the suitability of the confining layers to confine vertical migration of wastes into drinking water aquifers or to determine the true risks to the drinking water aquifer.

32. According to Walsh and Price, 32 groundwater monitoring wells and borings have been installed at the South District plant. According to the INEEL, the data produced from those 32 wells have proven insufficient to determine subsurface geologic conditions, requiring the installation of even three (3) to four (4) *more wells* and conducting more extensive monitoring activities. This degree of investigation required to understand the localized geology and hydrogeology makes the single well currently being drilled by FP&L at the Turkey Point site seem grossly inadequate.

33. Unless and until a thorough subsurface investigation is performed at the Turkey Point site to determine actual conditions before deep well injections begin, FP&L cannot possibly ensure protection of overlying drinking water aquifers. Without such a thorough investigation and given the shear volume of water to be injected in unknown geologic conditions, FP&L risks widespread contamination of drinking water aquifers with contamination - possibly lasting for the foreseeable future should that occur. The INEEL recommended these additional investigative measures be performed at the South District plant, at a minimum, to calculate the net thickness of the confining layer:

Recommended Additional Geologic Investigative Activities

• Install 3 to 4 new wells	• Test for borehole temperature logs
• Obtain gamma-ray log	• Test for electrical conductivity of the mud filtrate
• Obtain lateral logs	• Collect whole core samples
• Obtain compensated density / neutron logs	• Determine log-derived porosity
• Obtain deep resistivity logs	• Determine bedrock porosity
• Obtain micro resistivity logs	• Determine compatibility of waste with the bedrock
• Obtain spontaneous potential logs	• Test for electrical conductivity of the wastewater injected
• Develop core permeability / density cross plots	• Determine formation fluid conductivity

Recommended Additional Hydrogeologic Investigative Activities

• Collect geophysical data from new wells	• Calculate actual equivalent hydraulic conductivity of the Upper and Lower Floridan Aquifer formations
• Conduct flow meter logging from wells	• Calculate vertical flux and time of travel
• Conduct a series of packer tests	• Assess the vertical time of travel effects

In my expert opinion, wastewater injected via deep well injection into the Boulder Zone at the Turkey Point site may migrate into the Upper Floridan Aquifer, contaminating the groundwater with four constituents -- heptachlor, ethylbenzene, toluene, and tetrachloroethylene.

34. A report prepared by the Idaho National Engineering and Environmental Laboratory (INEEL) supports the conclusions of the Walsh and Price report that groundwater contamination exists; contamination of the Upper Floridan Aquifer has already occurred; that vertical bedrock fractures and conduits are likely migration pathway(s); and that an extensive investigation is needed to further understand the site conditions.

35. The INEEL report concluded that deep well injection activities at the South District plant have already contaminated the Upper Floridan Aquifer. INEEL at 38. Further, the INEEL concluded that "the geochemical data sets indicate that groundwater at some locations in the Upper Floridan Aquifer is contaminated with treated wastewater, which implies that contaminants are migrating through the Middle Confining Layer". INEEL at 39.

36. Calculations made by the INEEL using actual data collected from the South District plant site to determine the vertical rate between the Boulder Zone and the Upper Floridan Aquifer shows that "approximately 5 to 36 millions gallons per day could move from the Boulder Zone to the Upper Floridan Aquifer. For comparison, approximately 100 million gallons per day are injected". INEEL at 25. Simply put and assuming that 90 million gallons per day are injected (according to FP&L in the ER), the INEEL believes that up to 40 percent of the injected fluids could contaminate the Upper Floridan Aquifer.

37. The INEEL calculated that the travel time from the Boulder Zone to the Upper Floridan Aquifer would be rapid, with a conservative estimate being approximately 1 to 6 years. INEEL at 25.

38. The EPA Relative Risk Assessment that FP&L relied upon in their ER concluded "it would take between 30 and 1,100 years for wastewater injected via underground wells to migrate up to current Underground Source of Drinking Water (USDWs)". FP&L Response at 14. This estimate grossly underestimates the travel time that was actually experienced and / or calculated by both INEEL and Walsh and Price.

39. FP&L relies on that 30 to 1,100 years to decrease the concentrations of contaminants in the groundwater "to lower levels by the time the effluent water reached the drinking water receptors". FP&L Response at 14. Given the lower travel times actually seen and reported by Walsh and Price and the INEEL, this implies that there would be insufficient time for concentrations to be reduced before reaching drinking water receptors (humans) should the aquifer be used as a source of drinking water. Moreover, FPL provides no calculations of the rate to which the contaminants at issue here would actually degrade

40. The INEEL study for the South District plant concluded that a pattern of point-source contamination of the Upper Floridan aquifer exists at the South District plant; however, the available data to determine what exactly the "point sources" are "were not sufficient to differentiate between inadequately sealed wells or natural features as the point source features". INEEL at 36. The INEEL recommended an extensive investigation to determine what the exact sources are. INEEL at 9, 10, 26, 27, 36, 38, 39, and 40. As such, both leaky wells and geologic conditions are suspects for the contamination. INEEL at 40.

41. The EPA Relative Risk Assessment determined that there were 18 documented instances where injection well sites have contaminated drinking water aquifers.

42. The EPA concluded in their Relative Risk Assessment that 18 deep well injection activities in Florida have resulted in unintended contamination of underground sources of drinking water (USDW) due to fluid migration from the targeted injection zone. EA at 4-12. By design, fluid migration through an injection well is not supposed to migrate into an underground drinking water aquifer. The fact that the EPA specifically identified the South District plant as one of the confirmed sites that has in fact contaminated a drinking

water aquifer, supports the conclusions made by Walsh and Price and the INEEL. EA at 4-13.

43. Given that the EPA has determined that deep well injection at the South District plant has contaminated a drinking water aquifer and given that the USGS and the INEEL both consider the APPZ to be within the "Upper Floridan Aquifer", there is sufficient information to infer that wastewater injected into the Boulder Zone has migrated upward - resulting in contamination of the Upper Floridan Aquifer at the South District plant for the actual wastewater planned for injection at Turkey Point.

Sources:

1. Environmental Report (ER), Revision 3, Part 3, COL Application, Turkey Point Plant, Units 6 & 7, Florida Power and Light Company.
2. *Determination of vertical and horizontal pathways of injected fresh wastewater into a deep saline aquifer (Florida, USA) using natural chemical traces*, Hydrogeology Journal, by Walsh, Virginia and Price, Rene, published online February 2010.
3. *Evaluation of Confining Later Integrity Beneath the South District Wastewater Treatment Plant, Miami-Dade Water and Sewer Department, Dade County, Florida*, by the Idaho National Engineering and Environmental Laboratory, INEEL / EXT-01-00046, February 2001.
4. *Florida Power & Light Company's Response to Joint Intervenors' Motion to Amend Contention 2.1,* Florida Power & Light Company, February 10, 2012.
5. *Hydrogeology, Ground-Water Movement, and Subsurface Storage in the Floridan Aquifer System in Southern Florida, Professional Paper 1403-G,* U.S. Geological Survey, 1989.
6. *NRC Staff's Answer to Joint Intervenors' Motion to Amend Contention NEPA 2.1,* Nuclear Regulatory Commission, February 10, 2012.
7. *Relative Risk Assessment of Management Options for Treated Wastewater in South Florida,* US EPA Office of Water, EPA 816-R-03-010, April 2003.

Dated: February 17, 2012

MARK A. QUARLES

SWORN TO AND ASCRIBED BEFORE ME, THIS 17th DAY OF Feb., 2012.

NOTARY PUBLIC

MARSHALL W. BUTLER
STATE OF TENNESSEE NOTARY PUBLIC
DAVIDSON COUNTY
My Commission Expires 09-08-2013