March 23, 2017

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 52-040 & 52-041
	)	
(Turkey Point Units 6 and 7)	)	

NRC STAFF REBUTTAL TESTIMONY
OF ANN L. MIRACLE, DANIEL O. BARNHURST, AND PAUL D. THORNE
CONCERNING CONTENTION 2.1
(Impacts of Deep Well Injection of Four Constituents in Cooling-Tower Blowdown)

Q1. Please state your names, occupations, by whom you are employed, and your current responsibilities.

A1(a). My name is Ann L. Miracle (ALM). I am employed as a Senior Scientist, Environmental Assessment Group, in the Earth Systems Science Division at the Pacific Northwest National Laboratory (PNNL) in Richland, Washington. I am employed by the Battelle Memorial Institute (Battelle), which manages and operates the PNNL facilities for the U.S. Department of Energy. I am providing this testimony under a technical assistance contract between the staff of the U.S. Nuclear Regulatory Commission (NRC) and PNNL. My current responsibilities are set forth in A2(a) of the Revised Staff Testimony (NRC-002-R) submitted in this proceeding on March 1, 2017. A statement of my professional qualifications was previously submitted as NRC-003.

A1(b). My name is Daniel O. Barnhurst (DOB). I am a licensed Professional Geologist (P.G.) employed as a Hydrogeologist in the Environmental Technical Support Branch of the Division of Site Safety and Environmental Analysis, in the Office of New Reactors (NRO) at the NRC. My current responsibilities are set forth in A2(b) of the Revised Staff Testimony

(NRC-002-R) submitted in this proceeding on March 1, 2017. A statement of my professional qualifications was previously submitted as NRC-004.

A1(c). My name is Paul D. Thorne (PDT). I am employed as a Senior Research Scientist in the Earth Systems Science Division at PNNL. I am employed by Battelle, which manages and operates the PNNL facilities for the U.S. Department of Energy. I am providing this testimony under a technical assistance contract between the NRC Staff and PNNL. My current responsibilities are set forth in A2(c) of the Revised Staff Testimony (NRC-002-R) submitted in this proceeding on March 1, 2017. A statement of my professional qualifications was previously submitted as NRC-005.

Q2. Please explain what your duties have been in connection with the NRC Staff review of the Florida Power & Light (FPL or Applicant) application for combined licenses (COLs) for the proposed Turkey Point Units 6 and 7.

A2(a). (ALM) My duties in connection with the NRC Staff review of the Turkey Point COL application are set forth in A3(a) of the Revised Staff Testimony (NRC-002-R).

A2(b). (DOB) My duties in connection with the NRC Staff review of the Turkey Point COL application are set forth in A3(b) of the Revised Staff Testimony (NRC-002-R).

A2(c). (PDT) My duties in connection with the NRC Staff review of the Turkey Point COL application are set forth in A3(c) of the Revised Staff Testimony (NRC-002-R).

Q3. What is the purpose of this testimony?

A3(a). (ALM) The purpose of my testimony is to rebut the "Prefiled Initial Testimony of Mark A. Quarles Regarding Joint Intervenors' Contention 2.1," dated March 1, 2017, and submitted in this proceeding (Quarles Testimony) in regard to toxicology.

A3(b). (DOB) The purpose of my testimony is to rebut the Quarles Testimony on the stratigraphy and hydrogeology of the Turkey Point site and the neighboring region.

A3(c). (PDT) The purpose of my testimony is to rebut the Quarles Testimony on the stratigraphy and hydrogeology of the Turkey Point site and the neighboring region.

Q4. Are you familiar with the Quarles Testimony?

A4(a). (ALM) Yes, I have read and am familiar with the portions of the Quarles Testimony that are directed to toxicology.

A4(b). (DOB, PDT) Yes, I have read and am familiar with the portions of the Quarles Testimony that are directed to hydrogeology.

Mr. Quarles's Testimony Does Not Support the Proposition That the Constituents in the Water Injected into the Boulder Zone at the Concentrations in FEIS (NRC-008A) Table 3-5 Pose a Hazard to Human Health.

Q5. In his testimony (A19), Mr. Quarles stated that: 1) the FEIS assumes that the concentrations of the constituents would not cause adverse impacts to the Upper Floridan Aquifer based on an incorrect assumption that there are safe concentrations of the constituents; 2) that any concentration of the constituents above zero could cause adverse impacts and, 3) that "even at minute concentrations," tetrachloroethylene and heptachlor can cause adverse health effects. Quarles Testimony, A19, A21. What is your professional opinion of Mr. Quarles's testimony?

A5. (ALM) In my professional opinion Mr. Quarles is incorrect. As described in Revised Staff Testimony (NRC-002-R) at A27, the EPA sets safe water drinking standards based on the Maximum Contaminant Level Goal for a contaminant as the concentration at which there is no known or anticipated adverse effect on the health of persons. 40 C.F.R. § 141.2. None of the South District Wastewater Treatment Plant water samples had concentrations of the four constituents that exceeded the Maximum Contaminant Levels for each constituent (NRC Staff at A30, A33, A34, A35), and with additional treatment technology added in 2013, none of the constituents had any detectable concentration (NRC Staff at A29). The EPA Maximum Contaminant Levels for toluene and ethylbenzene are identical to the Maximum Contaminant Goal Levels for these chemicals, and Mr. Quarles does not identify any health effect attributable to the either of these chemicals at concentrations "above zero" but

below the Maximum Contaminant Level. The EPA set Maximum Contaminant Levels for both heptachlor and tetrachloroethylene at concentrations above zero that are considered protective of human health. Mr. Quarles disputes the EPA's determinations but does not provide a quantitative measure for the toxicity or carcinogenicity concentrations he asserts exist for the two constituents. His use of the term "minute concentrations" is subjective and he provides no quantifiable support for his opinion in his testimony. Mr. Quarles's assumption that any concentration of the four constituents in drinking water would be unsafe is unsupported.

Q6. Is Mr. Quarles correct in how he interprets constituent concentrations?

A6. (ALM) No. In A21, Mr. Quarles interprets the reported concentrations of tetrachloroethylene and heptachlor in the FEIS (NRC-008A at 3-39) as being above the EPA Maximum Contaminant Level Goal of zero for both of these constituents. Quarles testimony, A21 on page 18. The values reported in Table 3-5 of the FEIS for tetrachloroethylene and heptachlor indicate that concentrations of these two constituents were not detected in South District Wastewater Treatment Plant water samples in 2013 or 2014 when additional treatment of the wastewater was implemented (A38 of Revised Staff Testimony (NRC-002-R)).

Q7. Mr. Quarles claims that "[a]ny concentration of the constituents above zero could cause adverse health impacts[.] Quarles Testimony A19. In the same answer, Mr. Quarles refers to health effects for ethylbenzene compiled in the "ATSDR Tox FAQs" (INT-016) as apparent support for his testimony. In your professional opinion, does the reference support his statement?

A7. (ALM) The fact sheets specific to health effects for ethylbenzene (INT-016, p. 2) state that EPA has determined that an acute drinking water concentration of 30 parts per million (30 milligrams per liter), and a 10 day drinking water exposure of 3 parts per million (3.0 milligrams per liter) would not cause adverse effects in a child. The fact sheet goes on to explain that a lifetime exposure to ethylbenzene at 0.7 parts per million (0.7 milligrams per liter)

is also not expected to cause adverse effects. The 0.7 milligrams per liter is also the EPA Maximum Contaminant Level and Maximum Contaminant Level Goal. INT-016 does not support Mr. Quarles's testimony in regard to ethylbenzene that "any concentration of the constituents above zero" could cause health impacts.

Q8. Do you agree with Mr. Quarles's assertion that at minute concentrations, heptachlor impairs immune and nervous system functions?

A8. (ALM) No. Mr. Quarles states that at minute concentrations, heptachlor impairs immune and nervous system functions (A21, pg 18), and cites INT-016 as support for his assertion. However, the reference Mr. Quarles's cites does not support his testimony. INT-016 states that little is actually known about human health effects following exposure to heptachlor, and that nervous system damage may occur following exposure to high levels of heptachlor. Exposure effects via ingestion related to immune system and neurological impairment has been documented in animal studies, but not in humans. (INT-016, pages 5-6). The Food and Drug Administration sets a limit of 0.01 parts per million (0.01 milligrams per liter) for heptachlor on raw food crops, and 0.3 parts per million (0.3 milligrams per liter) on edible seafood (INT-016, page 6) for human consumption. The EPA concentrations for safe drinking water, which are protective of human health, are listed at 0.0004 milligrams per liter, which is the EPA Maximum Contaminant Level for heptachlor. The EPA Maximum Contaminant Level for heptachlor in drinking water is 750 times less than the FDA limit for heptachlor ingestion on edible seafood and twenty-five times less than the FDA limit for ingestion from raw food crops. While the term "minute" is not quantitative, it is synonymous with "minimal" or "miniscule." The FDA heptachlor limit for food sources represents a minute concentration that is considered safe for human consumption, and the more minute concentration of heptachlor set by EPA as the Maximum Contaminant Level are protective of human health and are not known to impair immune and nervous system functions.

Q9. In his testimony, Mr. Quarles. Quarles Testimony A21 refers to the First Quarles Aff. (INT-002) ¶ 31 (citing ATSDR Tox FAQ) as identifying health effects from exposure to heptachlor, tetrachloroethylene, and ethylbenzene. Does Mr. Quarles accurately summarize the effects of these three chemicals as set forth in the reference?

A9. (ALM) No. Mr. Quarles's refers to INT-002, ¶ 31, which lists heptachlor, tetrachloroethylene, and ethylbenzene, and health effects following exposure to these chemicals, but INT-002, ¶ 31 does not provide quantitative information with regard to dose or route of exposure. However, the Agency for Toxic Substances and Disease Registry (part of the Centers for Disease Control, U.S. Department of Health and Human Services) Tox FAQs (FPL-031), which INT-002 cites, does not provide quantitative information to support exposure levels and health effects for humans. Because Mr. Quarles does not identify dose or route of exposure, the health effects he asserts will result from heptachlor, tetrachloroethylene, and ethylbenzene are not supported.

Q10. In his testimony, Mr. Quarles states that the FEIS assumes that the concentrations of the constituents would not cause adverse impacts to the Upper Floridan Aquifer based on an incorrect conclusion that there are safe concentrations of the constituents. Quarles Testimony A19. How do your respond?

A10. (ALM, DOB) As discussed in the FEIS in Table 3-5 (NRC-008A at 3-38 and 3-39) and my direct testimony at A30 to A38, concentrations of ethylbenzene, heptachlor, toluene, and tetrachloroethylene were not detectable at the South District Wastewater Treatment Plant in the most recent effluent samples and are not expected at Turkey Point Units 6 & 7. The Constituents in water at concentrations that are not detectable using current detection techniques pose no threat to human health.

Mr. Quarles's Testimony is Incorrect in Claiming That the Data from EW-1 and DZMW-1 are Inadequate to Characterize the Turkey Point Site.

Q11. On page 6 (A9) Mr. Quarles asserts that the FEIS relies on a "single deep borehole test that provides very little information about the Turkey Point site characteristics." What is staff's response to this statement?

A11. (PDT, DOB) Mr. Quarles is incorrect. During characterization activities at the Turkey Point site two, not one, wells were drilled. NRC-008A at 5-26 and NRC-002 at A107. Also, contrary to Mr. Quarles's assertion, more than one test was conducted NRC-002 at A107 to A117. His testimony does not account for additional data considered by staff that are probative of the conclusions staff reached in the FEIS.

Q12. Did Mr. Quarles omit any data collected at EW-1 and considered by the Staff that supported the Staff conclusion that vertical migration of wastewater is unlikely?

A12. (PDT, DOB) Yes. A suite of geophysical logs, hydrogeological testing, and laboratory testing and data analysis was performed at the injection well (EW-1) and the dual zone monitoring well (DZMW-1). In addition, injection testing was performed at the wells to determine the receiving capability of the Boulder Zone, the impacts of injection on the Middle Confining Unit competency, and the confining nature of the Middle Confining Unit at the site. This suite of tests included every test recommended by Mr. Quarles in his 2nd Affidavit (at 6 and 7) to be performed at the Turkey Point site and included additional testing. In addition, this type of testing will be performed at each of the 12 injection and 6 monitoring wells to be installed for deep injection at the Turkey Point site. These recommended tests were initially included as recommendations in the Starr et al 2001 report for the South District Wastewater Treatment Plant. [NRC-044 at 10, 26-27 and 36] The table below shows the tests recommended by the

Starr et al study, those suggested by Quarles based on the Starr et al study and the tests actually conducted at Turkey Point.

Starr et al (2001) Recommendations from "Evaluation of Confining Layer Integrity Beneath the South District Wastewater Treatment Plant, Miami-Dade Water and Sewer Department. Dade County, Florida"		**Data Obtained during Turkey Point 6&7 Geologic and Hydrogeologic Characterization?**
Install new wells	Install three to four new wells[1]	Yes- 12 injection and 6 monitoring wells will be installed
Geophysical Logging Suite and Analysis for New Wells	Gamma-ray logs[1]	Yes
	Compensated density/neutron logs[1]	Yes- Density combined with borehole compensated sonic
	lateral logs (deep resistivity)[1]	Yes- dual induction (near and deep) obtained
	Micro-resistivity logs (near borehole resistivity)[1]	
	Borehole temperature logs[1]	Yes
	Spontaneous potential logs[1]	Yes
		Additional- caliper log
		Additional- video log
		Additional- driller lithologic log
Laboratory Analyses	Collect core[1]	Yes
	Whole-core analysis of core- porosity	Yes
	Whole-core analysis of core- permeability	Yes
	Whole-core analysis of core- mineralogy	Yes
		Additional- Vertical Hydraulic Conductivity
		Additional- unconfined compression tests
		Additional- Specific Gravity
Data Analysis and Interpretation on Geologic Data Sets	Porosity determination	Yes
	Formation fluid conductivity[1]	Yes
	Core permeability/density cross plots[1]	Yes
	Net thickness of effective confining zone	Yes

Starr et al (2001) Recommendations from "Evaluation of Confining Layer Integrity Beneath the South District Wastewater Treatment Plant, Miami-Dade Water and Sewer Department. Dade County, Florida"		Data Obtained during Turkey Point 6&7 Geologic and Hydrogeologic Characterization?
Hydraulic Head	Monitoring wells be shut in and allowed to reach steady state. Then hydraulic head should be measured at each monitoring well and injection wells to understand if a connection between the UFA and Boulder Zone exists (due to inadequately sealed wells or natural pathway)	Yes
	Fluid density in well must be considered in calculating hydraulic head from wellhead pressure measurements	Yes
	Use a cement bond log to evaluate the integrity of the annular seal between the casing and formation	Yes
Hydraulic Conductivity	Use borehole geophysical data from new wells and laboratory measurements to estimate the thickness and hydraulic conductivity of confining zones.	Yes
	Conduct flowmeter logging in wells.[1]	Yes
	Conduct a series of packer tests. [1]	Yes
	Calculate the equivalent vertical hydraulic conductivity of the Middle Confining Unit and the upper portion of the Lower Floridan Aquifer.[1]	Yes
	Calculate vertical flux and travel time calculation.[1]	Yes
	Assess whether predicted flux from the Boulder Zone to the Upper Floridan Aquifer will have a significant detrimental affect.[1]	Yes
Geochemical data	Investigate the wells that are contaminated with treated effluent and adjacent wells.	NA

[1] In Quarles 2nd Affidavit (page 6 and 7) he recommended this types of data be collected at the Turkey Point site.

Mr. Quarles now states in his testimony that the type of information he previously indicated was needed (Quarles 2nd Aff. (INT-003) ¶33) is not enough. Quarles Testimony A9 at 6.

Q13. Mr. Quarles states that the low percent recoveries of the core samples reported by McNabb suggest there are voids in the bedrock at the Turkey Point site and

that the bedrock will not be an adequate confining layer. Quarles Testimony A11. What is your professional opinion of Mr. Quarles's argument?

A13. (PDT, DOB) Staff disagree with Mr. Quarles assertion that low percent recovery of core results only from voids or open fractures in the rock that could indicate a lack of confinement. Contrary to Mr. Quarles's statement, core recovery may be low due to a number of reasons that have nothing to do with the presence of voids or open fractures in the bedrock. For example, mechanical stresses created by the drilling process can cause the core sample to break apart and fall out of the core barrel. Also, the core barrel can also become plugged during drilling, resulting in low core recovery. Accordingly, low percent recovery of core may be caused by factors other than voids or fractures in the rock being cored, contrary to Mr. Quarles's assertion. Furthermore, Staff found that the Middle Confining Unit had adequate confinement capability based on a wide source of data, and not solely on core samples. All the evidence, when taken together, support Staff's finding in the FEIS that the Middle Confining Unit is an adequate confining layer.

Q14. Mr. Quarles states that "high percent porosity found in the McNabb study indicates that the bedrock will not be an effective confinement layer." Quarles Testimony A12. What is your professional opinion of this statement?

A14. (PDT, DOB) High porosity of a core sample does not equate to lack of confinement if the pores are not connected. Porosity is the measure of void space in a sample. Effective porosity is the measure of interconnected void space capable of conducting water. For example, the pores in a sponge are connected, and the sponge is highly permeable. In contrast, closed-cell foam is a highly porous material, but the pores are not connected, and its permeability is low. The ability of porous media to transmit water is indicated by hydraulic conductivity. Testing of the recovered core samples (NRC-056, Table 5 at 19) showed that there

are layers within the confining unit with vertical hydraulic conductivity less than 10^{-5} cm/sec, which is typical for dolomite and indicates effective confining properties within the Middle Confining Unit (MCU).

Q15. Mr. Quarles argues that the failed straddle packer test results indicate that the bedrock strata below and above the packers in the confinement unit could be hydraulically connected. Quarles Testimony A13. What is your professional opinion of this argument?

A15. (PDT, DOB) The successful straddle packer flow tests performed at the EW-1 borehole (NRC-056 at 19 to 22) indicate that the tested intervals from 1930 to 1952 ft, 1970 to 1992 ft, 2058 to 2080 ft, and 2220 to 2242 ft demonstrated very low permeability. The additional seven tests that failed do not undermine or negate the successful tests. The tests that failed because the packers did not adequately isolate the test interval were likely affected by borehole conditions resulting from drilling and the use of “sleeves” on the packers for some of these tests. Natural stress within the rock formation can cause pieces of rock to break away from the borehole wall during drilling enlarging the borehole. The packer failures mean that the tests are of no use, but do not necessarily indicate that there was permeable rock in or near the tested interval.

Q16. Quarles states that pulverized drilling cuttings that are inspected on the ground surface from deep drilling depths do not provide adequate information to determine bedrock conditions such as the presence of voids, fractures, faults, hydraulic

capacity, or the confining nature of the bedrock. Quarles Testimony A14. Explain why you agree or disagree with this view of pulverized drill cuttings.

A16. (PDT, DOB) In his testimony, Mr. Quarles states that any determination based on the findings from drill cuttings "would be a qualitative, general evaluation only." (A14 at 10). The Staff agrees with Mr. Quarles in this regard, and note that this evaluation is standard industry practice and is consistent with the ways FPL used the cuttings were (NRC-056), as independently reviewed by the Staff. The EW-1 characterization strategy included collection and description of "drilling cuttings at least every 10 feet and at every formation change, with 5 foot sampling starting at a depth of 2800 feet bpl [below pad level] and continuing through the injection zone" (NRC-056 at 75). The cuttings were used by FPL to identify the "rock type, color, grain size, consolidations, porosity, and fossils" with depth and to differentiate individual geologic units with depth in the borehole (NRC-056 at 11). These samples are used for general and qualitative means and were not used "to determine the presence of voids, fractures, faults, hydraulic capacity, or the confining nature of bedrock," as Mr. Quarles claims (A14 at 10). Drill cuttings were one many lines of data and tests collected and evaluated at the exploratory well EW-1 at the Turkey Point site and are not the sole basis used to determine the geologic or hydrogeologic parameters of a formation or the formation's confining capability. The use of cuttings and others data and testing performed at EW-1 is explained throughout the FEIS (NRC-008A at 2-54 to 2-58, 4-25, 5-25, 5-26, 5-39) and in Revised Staff Testimony (NRC-002-R) A107 to A121.

Q17. Quarles states that the ten core samples taken from the bedrock only included 122 feet of the 3,230-foot well. He says that this represents only 4% of the total

depth, leaving 96% of the bedrock conditions to be "generalized." Quarles Testimony A14. What is your professional opinion of this claim?

A17. (PDT, DOB) Mr. Quarles incorrectly asserts that only ten cores totaling 122 feet were collected for the entire 3230 ft deep well and that, as a result, the remaining 96 percent of the boring was generalized. The core evaluations were targeted on the principle confining zones within the Middle Confining Unit. As a result, the cores were purposefully selected for this interval, and not for the entire well depth. Core samples were evaluated through laboratory testing to determine key attributes affecting migration, such as lithology, porosity, permeability, hydraulic conductivity, and specific gravity. This information, combined with geophysical logging, packer testing and lithology determination were adequate to characterize borehole conditions and confinement without generalizing. NRC-056 and NRC-057.

Seismic Reflection Tests are Unnecessary to Characterize the Turkey Point Site.

Q18. In his testimony, Mr. Quarles indicates that FPL should have performed seismic reflection tests to characterize the Turkey Point site. Quarles Testimony A9 at 6. What are seismic reflection tests?

A18. (PDT, DOB) Seismic reflection surveys involve producing a shockwave at the surface and recording the return time and magnitude of reflected sound waves at an array of "geophone" receivers at other locations on the surface. These data are processed to remove extraneous noise and convert the time it takes for reflections to reach the geophones into depths of the subsurface formations. The data are then interpreted to create a seismic-based visualization of the subsurface.

Q19. In his testimony, Mr. Quarles states that seismic reflection testing greatly improves upon methods that rely solely on investigations of boreholes, because it provides a much broader, three-dimensional picture of a site than a single – or even

multiple – vertical boreholes." Quarles Testimony A15 at 10. What is your professional opinion of this statement?

A19. (PDT, DOB) Although seismic reflection data from a number of intersecting reflection survey lines can be interpreted to create a three-dimensional model, there is still uncertainty in the modeled features, especially in areas between lines where seismic data have been collected. Seismic data processing and interpretation is a complex process that uses stratigraphic thickness data and sonic velocities measured in boreholes to translate the seismic reflections to information on geologic stratigraphy and subsurface features such as faults. Interpretations of seismic data are also not unique with different interpretations potentially fitting the same data set. As discussed further in the context of studies cited in Mr. Quarles's testimony, seismic interpretations should be viewed as providing an approximation of subsurface features rather than a clear picture with precise depths and locations. In addition, interpretations of seismic reflection data only show reflective subsurface structures and do not provide any information on the hydraulic flow properties of the structures.

Q20. In his testimony, Mr. Quarles states that "seismic-reflection analysis is an investigative tool favored by USGS to study the very question raised in the FEIS and Contention 2.1." Quarles Testimony A15 at 10. While Mr. Quarles seems to acknowledge that seismic reflection data by itself is not sufficient to characterize the geology of a specific location (referring to information "that includes, among other analyses, seismic-reflection tests" *id*., A9 at 6; "seismic-reflection combined with other analyses" *id*.), what is your professional opinion of the use of seismic reflection tests to characterize the geology of a site without reference to other data?

A20. (PDT, DOB) Seismic reflection surveys alone would not be sufficient to characterize the site because they do not provide information on the hydraulic flow properties of the subsurface, or the properties of subsurface fluids. In addition, data on the sonic velocities of

materials in the subsurface are required for processing and interpreting seismic reflection data. Knowledge of site geologic structure and geologic history is also required so that patterns seen in the seismic data can be interpreted. This information can only be obtained from borehole data. In one of the studies cited by Mr. Quarles, Cunningham recognizes that seismic data must be correlated to actual hydrostratigraphic units using borehole data, such as drill-cutting samples and a suite of borehole geophysical logs (NRC-050 at 2).

Q21. In his testimony, Mr. Quarles refers to U.S. Geological Survey (USGS) studies that used seismic reflection tests in south Florida (Quarles Testimony A15, A18), and indicates that "[t]he results of the Cunningham 2012 and 2015 [USGS] studies thereby strongly undermine the FEIS' conclusion that the Turkey Point area has an appropriate confining layer to prevent upward migration of injected wastewater." Quarles Testimony A15 at 13. What is your professional opinion of this statement?

A21. (PDT, DOB) Results of the referenced reports do not "undermine the FEIS' conclusion that the Turkey Point area has an appropriate confining layer to prevent upward migration of injected wastewater" because they do not identify features at the Turkey Point site that are likely to result in upward migration of injected wastewater. The USGS conducted seismic reflection surveys with an objective to "improve current understanding of the relation between seismic sequence stratigraphy, imaged tectonic and karst structures, and the potential for vertical transport of injected effluent from the Boulder Zone upward into [Underground Sources of Drinking Water] USDWs in southeastern Florida" (NRC-053 at 6). Most of the surveys were conducted from barges in canals and in Biscayne Bay, with a single ground-based seismic line. The results of these surveys are documented in the FEIS, along with the Staff evaluation of them (NRC-008A at 2-55, 2-56, and 5-25).

Results from the seismic surveys are interpreted linear sections through the subsurface showing features based on the reflection of the shockwaves. The USGS studies Mr. Quarles

cites detail the use of seismic-reflection techniques to evaluate subsurface structure and identify faults and karst collapse features. Kevin Cunningham is the primary author of these USGS studies, which were discussed in the FEIS. These studies were conducted in locations throughout southeast Florida and did identify karst collapse structures and faults. Karst terrain is created when rocks composed of soluble minerals are dissolved by surface water or groundwater and results in the formation of solution channels, caves, and sinkholes. Karst collapse structures are formed when rock or sediment collapses into open cavities as result of continued dissolution. The USGS seismic reflection interpretation shows a possible geologic fault in Biscayne Bay oriented approximately parallel to the shoreline (NRC-053 at 2). However, this fault is shown to terminate about five (5) miles north of the location of the proposed Turkey Point injection wells, and does not support Mr. Quarles's position that the study shows such a feature may exist at the Turkey Point site.

In addition, the Cunningham (USGS) studies identified a karst collapse structure from borehole data at the North District wastewater injection site and interpreted to extend about 900 feet vertically from the upper part of the Boulder Zone to a section of the Lower Floridan aquifer, which overlies the Boulder Zone and is beneath the Middle Confining Unit at that location. The karst collapse feature at the North District Plant did not extend above the Lower Floridan aquifer, which is below the Middle Floridan confining units. And the feature did not extend into any overlying Underground Source of Drinking Water (USDW) aquifer. Likewise, the existence of a karst collapse structure near the Turkey Point injection wells would not necessarily provide a pathway for injectate to migrate into the Underground Source of Drinking Water (USDW) aquifer. Moreover, the North District Plant is more than 34 miles from the Turkey Point site, and the existence of the karst collapse feature at the North District Plant does not imply that such a feature is likely to exist near the Turkey Point site.

Q22. In his testimony, Mr. Quarles states that "The Cunningham 2012 study demonstrated that widespread fractures and faults exist in the area near Turkey Point,

and those bedrock conditions render bedrock layers ineffective as confining layers." Quarles Testimony A15 at 11. What is your professional opinion of this statement?

A22. (PDT, DOB) Mr. Quarles' statement is incorrect. These studies were not conducted in the "area near Turkey Point." The Cunningham 2012 and 2015 reports did identify faults and karst collapse features in the region. However, these features are absent, or confined to the Lower Floridan aquifer in the seismic profiles nearest the Turkey Point site. Karst collapse features confined to the Lower Floridan aquifer will not provide a pathway to the Upper Floridan aquifer or any Underground Source of Drinking Water (USDW). The Cunningham 2015 report itself shows that such features are absent in profile EW-7 located two and one-half (2.5) miles northeast of the site offshore in Biscayne Bay (NRC-053 Figure 8). Similarly, Cunningham (2015) obtained similar results near the South District Wastewater Treatment Plant, as shown in the nearest onshore data profile (C1) obtained south of that plant, nine (9) miles north of Turkey Point (NRC-053 Figure 6). The only karst collapse feature identified in Cunningham (2015) is within the Lower Floridan aquifer and does not extend upward into the Middle Confining Unit. Cunningham interprets the data to show a fault, but this fault is two (2) miles offshore and does not appear to extend through the Middle Confining Unit on the profile. (NRC-053 Plate 1). A reverse fault is also located 25 miles northeast of the Turkey Point site in Biscayne Bay (NRC-053 Figure 1). As a result, Cunningham did not identify any potential pathways through the confining unit at or near the Turkey Point site. The faults and karst collapse features identified in the Cunningham studies (NRC-050, NRC-053) are shown on seismic reflection profiles that are further from the Turkey Point site than the EW-7 and C1 profiles described above, and it is not reasonable to infer that these features extend onto the Turkey Point site.

Q23. In his testimony, Mr. Quarles states that "[o]nly by conducting a comprehensive, site-specific investigation that includes, among other analyses, seismic-reflection tests, could the NRC rule out vertical transport of injected

wastewater into the drinking water aquifer." Quarles Testimony A9 at 6. What is your professional opinion of this statement?

A23. (PDT, DOB) The seismic survey interpretations conducted by the USGS in south Florida provide useful information to help understand the subsurface stratigraphy and tectonic features. However, a similar seismic survey at the proposed Turkey Point injection site is not necessary to determine the ability of the Middle Confining Unit to prevent upward migration at the site because seismic data do not indicate the probability of fluid migration through faults or karst collapse features beneath a site. The USGS has used seismic-reflection data to "provide useful evidence for the presence of faults and fractures that can plausibly function as permeable pathways" (NRC-052 at 3). However, Mr. Quarles does not identify limitations of seismic-reflection techniques that are important to this discussion. Seismic-reflection data can only identify structures that may be capable of transmitting fluid. They do not provide any indication of the hydraulic capability of the structure. A seismic survey would also not necessarily reveal the existence of a tectonic fault or karst collapse structure that could result in upward migration. For example, the karst collapse structure that was identified based on borehole data at the North District wastewater injection site was not recognized on the seismic reflection profiles acquired in the nearby C–9 Canal, Oleta River, Maule Lake, and the Intracoastal Waterway. Further, there is no evidence that tectonic faults or karst collapse structures exist within the area of the injection target zone for Turkey point. And if such features did exist, they would not necessarily result in vertical flow of injectate from the Boulder Zone because there is no evidence that such features might be hydraulically conductive.

<u>The Joint Intervenors Misconstrue the Regional Studies of Stratigraphy and Injection Impacts.</u>

Q24. Mr. Quarles states that the Middle Confining Unit "is now characterized as consisting of two "semi-confining" units because of their tendency to leak" in the vicinity of the site. Quarles Testimony A15 at 13. Does the staff agree with this characterization?

A24. (DOB, PDT) Staff disagrees that the Middle Confining Unit "is now characterized as consisting of two "semi-confining" units because of their tendency to leak" in the vicinity of the site, as asserted by Mr. Quarles in A15 at 13. To support this assertion, he cites to Cunningham 2015 (NRC-053) page 4 and Figure 4. Cunningham's designation of the MC1 and MC2 as semi-confining units in these locations is based on language used by Reese and Richardson 2008 (NRC-040). However, the Reese and Richardson report summarizes regional information for the Middle Confining Unit and Avon Park Permeable Zone (APPZ) to make this and other general statements, such as that the degree of confinement is "uncertain" as repeated by Mr. Quarles at 13. While this is true in some areas of the region, Reese and Richardson are clear that both the MC1 and MC2 are more confining in areas where these units are thicker and where the lithology is low-permeability (NRC-040 at 57). In particular, Reese and Richardson conclude that ""[g]ood confinement in MC2 and the unit below LF1 may also be provided by dense unfractured dolostone in some areas" (NRC-040 at 58). This is in total agreement with results presented in staff testimony from McNeill 2002 (NRC-064) and Maliva et al 2007 (NRC-043) which indicate that thin, unfractured dolostones with low hydraulic conductivity provide effective confinement of Boulder Zone water and injected effluent as well as site specific data from well EW-1. Revised Staff Testimony (NRC-002-R) A83 and A100.

Q25. Mr. Quarles discusses the "Cunningham studies" from 2012 to 2015 to support his assertion that seismic-reflection data should have been obtained in order to

evaluate the hydrogeology of the Turkey Point site. Quarles Testimony A15. Does Staff agree with Mr. Quarles's conclusions? If not, why not?

A25. (DOB, PDT) No, Staff does not agree with Mr. Quarles's conclusions. The Staff disagrees that the 2012 and 2015 Cunningham studies (NRC-050 and NRC-053) conclude, or could be used to conclude, that upwelling of injected wastewater from the Boulder Zone into the Middle Confining Unit at the North District Wastewater Treatment Plant and the South District Wastewater Treatment Plant resulted from subsurface features such as faults or karst collapse structures. In addition the staff also evaluated studies conducted by Cunningham in 2013 and 2014 (NRC-051 and NRC-052) as part of the FEIS. These studies were conducted only to locate features which "represent a plausible physical system for upward migration" (NRC-053 at 24) but do not measure the ability of the feature to transmit fluid. Further, no feature which could act as a potential pathway for migration into the Underground Source of Drinking Water (USDW) by cross-cutting the Middle Confining Unit was detected at the South District Wastewater Treatment Plant and no conclusion in these studies calls into question the results of McNeill 2002 (NRC-064 at 3), Maliva et al 2007 (NRC-043 at 1395), Dausman et al 2010 (NRC-047 at 147) and Walsh and Price 2010 (NRC-046 at 15), which concluded that upwelling at the South District Wastewater Treatment Plant and North District Wastewater Treatment Plant was likely the result of well related issues and had not reached the Upper Floridan aquifer.

Q26. Quarles states that the FEIS's conclusion is "contradicted by the Walsh and Price study" (Quarles Testimony A16), which he says "concluded that deep well injection into the Boulder Zone contaminated the Floridan Aquifer as a result of unintended vertical and horizontal migration of municipal wastewater into the aquifer

from wastewater injection wells." ***Id.*** **Does Staff agree with Mr. Quarles's assertion? If not, why not?**

A26. (DOB, PDT) No, the Staff does not agree with Mr. Quarles's assertion. The Walsh and Price study (NRC-046) does not contradict the Staff FEIS discussion or conclusion. Moreover, Mr. Quarles offers no specific reasons in his testimony on how this study contradicts the FEIS conclusion. As Mr. Quarles indicates, the Walsh and Price study is discussed repeatedly by the Staff in the FEIS (FEIS (NRC-008A) at 2-56 to 57, 5-23, 5-25, 5-28, 5-40), and the FEIS findings were made in part based on the findings of this study. Walsh and Price state that vertical upwelling along "rapid pathways could be the result of construction related events such as drifting boreholes, or the result of structural anomalies such as fracturing or karst features..." but further state that "no fracturing of the confining strata at either the North District Wastewater Treatment Plant or the South District Wastewater Treatment Plant has been reported" (NRC-046 unnumbered at 13).

Also, Mr. Quarles periodically states that injection into the Boulder Zone has "contaminated the Floridan Aquifer" (Quarles Testimony A16 at 14). This is repeated numerous times (Quarles Testimony A15 at 12, A15 at 13, A17 at 16, A29 at 24). However, the injection zone is within "the Floridan aquifer system" (the Boulder Zone is part of the Lower Floridan aquifer), but that the contention is focused on impact the *Upper* Floridan aquifer, which is also typically classified as the Underground Source of Drinking Water (USDW). The Walsh and Price study does not provide support for Mr. Quarles's argument, and, in fact, undermines his argument because the study states that no upwelling to the Upper Floridan aquifer was reported at the South District Wastewater Treatment Plant. Instead of supporting Mr. Quarles's claims, Walsh and Price state that the injected effluent "did not appear to extend up to the UFA" (Walsh and Price 2010 unnumbered at 15) (NRC-046).

Q27. Mr. Quarles claims in his testimony that "there are 18 documented instances where deep well injection of wastewater has unintentionally migrated upward from the injection zone" and takes exception that this should be identified as a "minority of injection sites" as the staff does in FEIS 2-56. Quarles Testimony A17. What is the Staff's response to this statement?

A27. (DOB, PDT) Mr. Quarles overstates the frequency of upwelling that has occurred as a result of injection. There are more than 180 Class I injection facilities in Florida. Mr. Quarles is correct that the EPA Relative Risk assessment states that upward migration has occurred at 18 facilities. A later study authored by Maliva et al (2007); (NRC-043) states that the upward migration has occurred at 17 sites (NRC-043 at 1388). Either way, upwelling at 17 or 18 sites out of 180 total sites means that upwelling occurred at only ten percent of the sites, which is a minority of the injection sites. Furthermore, none of the upwelling at any site has reached the Upper Floridan aquifer (NRC-008A at 5-23, Testimony A-94, NRC-046 unnumbered at 15, NRC-043 at 2.)

Q28. Mr. Quarles claims that the "…the FEIS incorrectly attributes the known instances of vertical migration of contaminated wastewater to faulty wells, rather than geologic conduits such as faults and collapsed karst structures" (Quarles Testimony at 6) and that in determining that past instances of upwelling resulted from well failure at the South District Wastewater Treatment Plant, the staff "ignor[es] the fact that the cause is just as likely to be the geological characteristics of the site." Quarles Testimony A18 at 16. What is the Staff's response to this statement?

A28. (DOB, PDT) Mr. Quarles is incorrect regarding the cause of known instances of vertical migration and the Staff's evaluation of such. Contrary to Mr. Quarles's opinion, the Staff

discussed potential for other pathways for vertical migration, such as a flow through the matrix of the Middle Confining Unit and flow through natural pathways through the Middle Confining Unit, as well as faults or fractures, extensively in the FEIS. See FEIS Section 5.2.1.3 "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" (NRC-008A at 5-23 through 5-26) and "Extent of Injected Wastewater Migration at the Turkey Point Site" (NRC-008A at 5-26 through 5-29), FEIS Section 5.2.3.2 "Groundwater-Quality Impacts" subsection "UIC Impacts" (NRC-008A at 5-39 to 5-42).

In addition, the cause of upwelling at the South District Wastewater Treatment Plant site has never been determined to be “just as likely to be the geological characteristics of the site”. While every study acknowledged that upward migration through natural features was possible, studies including McNeill 2002 (NRC-064 at 3), Maliva et al 2007 (NRC-043 at 1395), Dausman et al 2010 (NRC-047 at 147) and Walsh and Price 2010 (NRC-046 at 15) indicate that upwelling at the South District Wastewater Treatment Plant most likely resulted from well related issues and had not reached the Upper Floridan aquifer.

Q29. In his testimony, Mr. Quarles states that the Starr et al report says that “groundwater in the Upper Floridan Aquifer at the South District Plant is contaminated with treated wastewater.” Quarles Testimony A17. Mr. Quarles argues that “[t]his finding implies that contaminants are migrating through the Middle Confining Unit. Starr at 38.” *Id.* Does the Staff agree with this statement? If not, why not?

A29. As explained in the FEIS, the Starr et al study does indeed indicate that upwelling at the South District Wastewater Treatment Plant had reached the Upper Floridan aquifer. However, that conclusion, which was reached by a number of other studies conducted during the same time, was incorrect because it relied on an incorrect interpretation of the hydrostratigraphy beneath the site. The FEIS states:

> Previous reports indicated that injectate had migrated into the Upper Floridan aquifer (Starr et al. 2001-TN1251; 68 FR 23673 [TN3658]; EPA 2003-TN4759). However, more recent studies, such as Maliva et al (2007-TN1483) and Walsh and Price (2010-TN3656) have clarified that while migration has reached the USDW at some Class I injection facilities, no impact has been reported for the Upper Floridan aquifer in southeast Florida including at the SDWWTP. As discussed in Section 2.3.1.2, this is likely because the earlier studies referenced above considered the APPZ, where upwelling was detected, to be the lower part of the Upper Floridan aquifer. As a result of more recent characterization of the Floridan aquifer in south Florida (such as Reese and Richardson 2008-TN3436), it is now understood that the APPZ is separated from the Upper Floridan aquifer in south Florida by the upper confining unit of the MCU.

NRC-008A at 5-23.

This explanation is discussed several times through the FEIS including a discussion in the comment responses (FEIS Appendix E at E-112 to E-113) (NRC-008D), Revised Staff Testimony (NRC-002-R) A91 to A93. Therefore, Mr. Quarles assertion that upwelling has migrated to the Upper Floridan aquifer is outdated and incorrect.

Q30. Mr. Quarles claims in his testimony that, "The Starr study finds that the Middle Confining Unit at the South District Plant "is not a competent confining layer." Quarles Testimony A17. Does Staff agree with Mr. Quarles's statement? If not, why not?

A30. (DOB, PDT) No, Staff does not agree with Mr. Quarles's statement about the Starr report. Mr. Quarles has provided a quote from the Summary section of the Starr et al study which seems to indicate that Starr et al concluded that the Middle Confining Unit was not a competent confining layer. This quote is selective and was provided without the proper context.

The NRC staff disagrees that this study should be interpreted to indicate that the Middle Confining Unit "is not a competent confining layer". As is explained in the Summary and throughout the body of the Starr et al report, the authors expressed significant and repeated

concern regarding the quality of the data which had been provided to them for their review, and, therefore, their ability to draw meaningful results regarding the confining nature of the Middle Confining Unit at the South District Wastewater Treatment Plant from this data. As is stated in the FEIS at E-113 (NRC-008D):

> "According to the Starr et al. (2001-TN1251) report, a few of the shortcomings of the data set include;
> - "The review of the available geologic data set resulted in the conclusion that it is insufficient for performing this analysis..", NRC-044 at 9]
> - "it is not possible to perform an evaluation of the stratigraphy or physical attributes of the confining units without sonic and density logs", [NRC-044 at 8]
> - "…the validity of these hydrographs is suspect…", [NRC-044 at 11]
> - "the hydraulic head data available for review are inadequate to provide a useful understanding of head relationships…", [NRC-044 at 38] and
> - "the hydraulic conductivity data reviewed may not reflect the effective vertical hydraulic conductivity of the confining units above the Boulder Zone." [NRC-044 at 38]

Rather than indicating a lack of confinement by the Middle Confining Unit as Mr. Quarles asserts, the Starr et al. report concludes that "the Middle Confining Unit and/or upper portion of the Lower Floridan Aquifer is a better confining unit than indicated" by the data that was provided for review. NRC-044 at 25.

Q31. Mr. Quarles testifies that "[a] report from Starr, et al. (cited at pages 2-53, 2-54, 2-56, and 5-23 of the FEIS) also contradicts the FEIS' conclusion that the MCU is generally impermeable." Quarles Testimony A16. He quotes from FEIS, which he says uses the Starr report to conclude that "the geologic data provided for review are not sufficient to demonstrate that the Middle Confining Unit is a competent, low hydraulic conductivity layer that is capable of preventing upward migrations of fluids from the Boulder Zone into the overlying underground source of drinking water." What is the Staff's response to this statement?

A31. (DOB, PDT) The Staff does not agree with Mr. Quarles's characterization of the FEIS discussion of the Starr report. First, Mr. Quarles selectively quotes the FEIS.

The full quote from the FEIS states that the Starr et al. study found the data which the EPA Region 4 provided to them for their review were inadequate:

> The Starr study expressed concern over the adequacy of the data set being evaluated and concluded that "the geologic data provided for review are not sufficient to demonstrate that the Middle Confining Unit is a competent, low hydraulic conductivity layer that is capable of preventing upward migrations of fluids from the Boulder Zone into the overlying underground source of drinking water" or USDW. According to the report:
>
> - "Although the confining layer above the Boulder Zone may in fact be competent, these data sets are not adequate to draw this conclusion."
> - "A caveat to this interpretation is that the hydraulic characterization test methods employed may not adequately represent the less permeable hydrostratigraphic units, and hence the hydraulic data set may not adequately describe the actual site conditions."
> - "…the geochemical data do not show a spatial pattern of contamination that is consistent with widespread upward migration of contaminated water through a highly permeable confining layer."
>
> Rather than indicating a lack of confinement by the MCU, the study concludes that "the Middle Confining Unit and/or upper portion of the Lower Floridan Aquifer is a better confining unit than indicated" by the data that was provided for review. The study concluded that overall the spatial distribution of contaminants "suggests that isolated conduits, such as inadequately sealed wells or natural features, provide pathways for contaminated water to migrate upward from the Boulder Zone, but contaminants are not migrating upward through the Middle Confining Unit across a broad area.

NRC-044 at 39 to 40; NRC-008A at 5-23 and 5-24. There is no support for Mr. Quarles's characterization of the Middle Confining Unit. The Starr study did not find that the confining capability of the Middle Confining Unit was inadequate. This is further explained in Revised Staff Testimony (NRC-002-R) A99 and A102.

Q32. In his testimony, Mr. Quarles states that the risk assessments performed by the EPA 2003 and Bloetscher et al. (2005) do not support the Staff's impact

determination because they fail to address "the potentially high rate of vertical migration of wastewater into the drinking water aquifer." Quarles Testimony A23. What is Staff's response to this argument?

A32. (DOB, PDT) Mr. Quarles's statement is incorrect. As explained in the FEIS, the EPA risk assessment evaluated the impact to human health of "rapid flow through preferential flowpaths (such as a failed well or natural conduit)" (NRC-008A at 5-40; NRC-010 at 4-44). The Bloetscher et al study also evaluated the impact of rapid vertical migration on human health by including scenarios of: 1) rapid migration of wastewater from Boulder Zone to drinking water well in Upper Floridan aquifer, 2) direct release of wastewater into the Upper Floridan aquifer and flow to drinking water wells (NRC-011 at 484). These scenarios are conservative in that they do not reflect the confinement expected to be provided by the Middle Confining Unit, and they assume that water within the Upper Floridan aquifer is used for drinking within the area of the injection well, which is not true at the Turkey Point site. As a result, the results of these risk assessments are bounding and may also be used to determine expected impacts at the Turkey Point site. The conclusions of these risk assessments were used by the Staff to reach the SMALL impact finding.

In his testimony, Mr. Quarles repeats several of the limitations identified by the EPA regarding the 2003 relative risk assessment, such as the fact that the "presence and extent of preferential flow paths" through the Middle Confining Unit and "accurate values for some model input parameters" are not well known. Quarles Testimony A23, at 20.

However, Mr. Quarles does not discuss why these uncertainties prevent the study from being used to support the Staff's SMALL impact determination in the FEIS. As part of the risk assessment, EPA performed an analysis to evaluate the impact of this uncertainty in transport parameters on the results of fate and transport modeling. The fate and transport modeling also managed uncertainty through the use of a bounding scenario which assumed that rapid

migration from the Boulder Zone to the Underground Source of Drinking Water (USDW) or to drinking water wells in the Upper Floridan aquifer would occur. The risk assessment determined that rapid migration of treated wastewater to drinking water wells in the Upper Floridan aquifer posed a low risk to human health and that this risk was “significantly” reduced when wastewater was treated to high-level disinfection standards (EPA 2003 at ES-24). The Staff used the results of this risk assessment to understand how concentrations of constituents within wastewater might be diluted along flowpaths and what impact to human health might occur if constituents within wastewater reached drinking water at concentrations below the EPA MCLs. This is discussed in the Revised Staff’s Testimony at A38 to A58 (NRC-002-R).

In his testimony, Mr. Quarles indicates that the Bloetscher et al. (2005) risk assessment was “not designed or performed specific to the Turkey Point (or even the South District Plant)” and that it “evaluated, generalized, and compared wastewater disposal alternatives in the southeast Florida region.” Quarles Testimony A23, at 19. However, Mr. Quarles offers no reason why this precludes it from being used to draw general conclusions related to the risk to human health from deep well injection, as was done in the FEIS. The purpose of this type of generalized assessment was to enable a broad understanding of basic relationships that could be expected at all sites. Mr. Quarles identifies one such relationship when he states that, “The Bloetscher study concluded that risks to human health were the greatest nearest the wastewater injection site and that risks were reduced as the distance away from the site increases”. This relationship is one reason why injection at the Turkey Point site would not impact human health, even if rapid migration to the Upper Floridan aquifer occurred. Bloetscher et al indicate that risk at distances greater than 5 miles is negligible. There are no users of water from the Upper Floridan within this distance. In addition, this distance is greater than the expected migration distance of the injected plume based on FPL and independent Staff evaluations discussed in the FEIS at 5-27 (NRC-008A).

These items prove that, contrary to Mr. Quarles's assertion, the risk assessments performed by the EPA 2003 (NRC-010) and Bloetscher et al. (2005); (NRC-011) do address "the potentially high rate of vertical migration of wastewater into the drinking water aquifer[,]" (Quarles Testimony A23) and that the Staff use of these models in determining the impact of deep well injection was reasonable.

Q33. In his testimony, Mr. Quarles states that the 2008 Dausman et al study concluded that a rise in water levels and ammonia concentrations in the drinking water aquifer indicates "connectivity of the drinking water aquifer with wastewater injection into the much deeper Boulder Zone due to the absence of a geologic confining layer". Quarles Testimony A23 at 19. What is the Staff's response to this statement?

A33. (DOB, PDT) In his testimony, Mr. Quarles states that elevated water levels and ammonia concentrations in the "drinking water aquifer" demonstrates "connectivity of the drinking water aquifer with wastewater injection into the much deeper Boulder Zone due to the absence of a geologic confining layer." (Quarles Testimony A23 at 19.) A similar statement is repeated in his testimony in Quarles Testimony A25 at 21. Mr. Quarles cites the 2008 Dausman et al. (NRC-012) study as a basis for his arguments.

Dausman and others have completed two modeling studies at the South District Wastewater Treatment Plant site. The 2008 study (NRC-012) referred to by Quarles as well as a study published in 2010 (NRC-047). The increase in ammonia in the formation above the injection zone that Quarles noted was further evaluated in more recent modeling performed by Dausman et al. (2010); (NRC-047) and by geochemical evaluations of the South District Wastewater Treatment Plant site performed by Walsh and Price (2010); (NRC-046).

Since ammonia is a component of injected wastewater, the presence of ammonia, and not elevated water levels, indicate that upwelling has occurred. Both of the more recent studies (NRC-046 and NRC-047) used ammonia concentrations measured above ambient (or background) conditions to indicate the presence of migrated effluent. Both conclude that ammonia has not been detected above the Avon Park Permeable Zone (APPZ) of the Middle Confining Unit. This unit is beneath the Upper Floridan aquifer and is referred to by Dausman et al as the Middle Floridan Aquifer, or MFA, in both the 2008 (NRC-012) and 2010 (NRC-047) studies. In the 2010 study, Dausman et al used a variable-density groundwater model which was calibrated to match observed salinity and ammonia concentrations in monitoring wells at the South District Wastewater Treatment Plant site to test two hypotheses regarding upward migration. These were 1) effluent migration due to a well construction issue or leak, and 2) effluent migration due to a leaky Middle Confining Unit or a naturally occurring pathways (such as fractures). Based on the modeling results, Dausman et al concluded that upwelling to the higher monitored zone within the MFA/APPZ of the Middle Confining Unit was due to "flow through a channelized pathway caused by well construction" (NRC-047 at 147).

In summary, neither the Dausman et al 2008 study (NRC-012) nor the Dausman et al 2010 study (NRC-047) studies support Mr. Quarles's assertions that upwelling at the South District Wastewater Treatment Plant occurred because the Middle Confining Unit was absent at the South District Wastewater Treatment Plant site.

Q34. Mr. Quarles indicates that, due to findings of Starr, et al., and the studies by Cunningham, "The FEIS lacks a sound basis to rely on Maliva" because "Maliva's study fails to consider the more likely vertical transport mechanisms associated with vertical leakage - bedrock vertical fractures and faults that can extend hundreds and thousands of feet, and well failures recognized by the Starr, Walsh and Price, and

Cunningham studies." Quarles Testimony A26. Does Staff agree with Mr. Quarles's argument? If not, why not?

A34. (DOB, PDT) The Staff does not agree with Mr. Quarles's claim, which is incorrect and unsupported. The Maliva, Starr, Walsh and Price, and Cunningham studies, when properly understood, do not undermine each other or the FEIS. Mr. Quarles finds fault with the study by Maliva et al. 2007 (NRC-043) by claiming that the study does not consider fractures, faults and well failure which may lead to upwelling. The Maliva et al. 2007 (NRC-043) study indicated that while unfractured units with sufficiently low hydraulic conductivity could provide confinement, this would not be true for units that are fractured. As a result, and contrary to Mr. Quarles's assertion, Maliva stated that the "distribution and cause of the development of fractures, and possibly other flow conduits, in the Floridan Aquifer System, is important for understanding vertical fluid migration" (NRC-043 at 1395) and that "[c]onfinement analyses should, therefore, focus on characterizing the distribution and properties of fracture systems, which may have been caused by regional tectonism." NRC-043 at 1395. Delineation of structures that could cause fracturing of confining units was the purpose of the Cunningham studies. As a result, the Maliva 2007 (NRC-043) study is appropriate and reasonable for use as one line of evidence to support the evaluation of impacts in the FEIS.

<u>The Joint Intervenors' Testimony on the Fate of the Injectate is Erroneous.</u>

Q35. In his testimony Mr. Quarles states that "[a]ccording to the Starr study, up to 40 percent of FPL's injected fluids could contaminate the Upper Floridan Aquifer." Quarles Testimony A20 at 17. What is your professional opinion of Mr. Quarles's testimony?

A35. (DOB, PDT) This estimate provided by Mr. Quarles is incorrect. The estimate is calculated using data from the South District Wastewater Treatment Plant site that Starr et al. recognized were inaccurate.

Specifically, Starr et al. explain that the vertical flux calculation used to determine the amount of potential upwelling at the South District Wastewater Treatment Plant conservatively used the lowest values for hydraulic conductivity measured for each unit beneath the site. NRC-044 at 25. However, Starr et al determined that this hydraulic conductivity dataset was not accurate. Starr et al. stated that the hydraulic conductivity dataset used in the calculation "does not adequately describe the vertical hydraulic conductivity of the Middle Confining Unit" because the calculated amount of upwelling did not match what was observed at the South District Wastewater Treatment Plant site (NRC-044 at 25). Starr also stated that:

> "[i]f the true value of vertical hydraulic conductivity for the Middle Confining Unit is less than the measured value used in the calculations presented here, then the flux would be lower and the travel time would be longer than the values calculated here. Therefore, in order to build a better case that the Middle Confining Unit acts as an effective barrier to upward migration of fluids from the Boulder Zone, it must be shown that the effective vertical hydraulic conductivity of the Middle Confining Unit is less than the value used here."

Starr et al at 26. The hydraulic conductivity used in the Starr et al study and which Mr. Quarles used to estimate that 40 percent of FPL's injected fluids could contaminate the Upper Floridan Aquifer was 2×10^{-4} cm/sec. Starr et all explained that this value was "representative of the measured values of the Lower Floridan Aquifer and is at the low end of the reange measured in the Middle Confining Unit." NRC-044 at 22. However, vertical hydraulic conductivities of 16 core samples from the Middle Confining Unit obtained from exploratory well EW-1 at the Turkey Point site were measured and showed that the hydraulic conductivities were as low as 1.6×10^{-6} cm/sec, with a harmonic mean of 5.54×10^{-6} cm/sec. FEIS at G-50 (NRC-008C). This harmonic mean hydraulic conductivity for the Middle Confining Unit at the Turkey Point site is 36 times lower than the hydraulic conductivity value used in the Starr et al. calculation for potential flux through the Middle Confining Unit at the South District Wastewater Treatment Plant.

Accordingly, the estimate provided by Quarles that "40 percent of FPL fluid could contaminate the Upper Floridan Aquifer" is not correct.

Q36. If, hypothetically, Mr. Quarles were correct in his assertion that "up to 40 percent of FPL's injected fluids could contaminate the Upper Floridan Aquifer," would there be any adverse impact to the Upper Floridan aquifer? Quarles Testimony A20.

A36. (DOB, PDT) No. In his testimony, Mr. Quarles indicates that rapid transport along "'isolated conduits' results in less dilution because the flow is concentrated along discrete vertical pathways" (Quarles Testimony, A25 at 21) and that if this occurred, "up to 40 percent of FPL's injected fluids could contaminate the Upper Floridan Aquifer"(*id*., A20 at 17). As discussed in A42, Mr. Quarles's assertions regarding the potential amount of upwelling that may occur are incorrect because the calculation relied on data that was recognized to be inaccurate. The Staff nonetheless performed a more conservative analysis and determined that no impact would occur to the Upper Floridan aquifer even if more than 90 percent of the injected wastewater rapidly migrated from the Boulder Zone through the Middle Confining Unit to the Upper Floridan aquifer.

The Staff's conclusion is supported by risk assessments that determined that rapid migration and even direct release of treated wastewater to the Upper Floridan aquifer posed a low risk to human health which further decreased when wastewater was treated to high-level disinfection standards (NRC-010 at ES-24) and as distance to receptors increased (NRC-011 at 489). This is discussed in Revised Staff Testimony (NRC-002-R) at A38 to A58.

Q37. Is Mr. Quarles' testimony on the effectiveness of treatment on contaminant concentrations within reclaimed wastewater correct? Why?

A37. (DOB, PDT) No. In A24 at 20 Mr. Quarles states that, "[t]he mere presence" of the Constituents in the "municipal wastewater effluent reported by FPL in [Table 3-5 of] the FEIS

after treatment demonstrates that the municipal wastewater treatment plant is ineffective at removing all such constituents from the wastewater." Mr. Quarles's assertions are incorrect. It is not the "mere presence" of constituents in wastewater but rather the concentration of these constituents after treatment which is important.

Despite Mr. Quarles's assertions, the requirement that contaminants within wastewater be totally eliminated by the treatment process is not supported by enforceable limits that apply to each stage of the treatment process including pretreatment before release to the wastewater plant by industrial users, and secondary treatment and advanced filtration and high-level disinfection at the wastewater treatment plant. Revised Staff Testimony A55 to A57 (NRC-002-R). Even though the treatment process may not totally eliminate all contaminants from the wastewater, the fact that concentrations of the four Constituents measured at the South District Wastewater Treatment Plant after implementation of high-level disinfection are below detectable levels indicates that, contrary to Mr. Quarles assertion, the South District Wastewater Treatment Plant's wastewater treatment methods are effective. In addition, any remaining concentrations of four Constituents would be further reduced in the cooling process at the Turkey Point site, as discussed in the Revised Staff Testimony A61 to A64 (NRC-002-R).

Q38. Do you agree with Mr. Quarles's assertion that groundwater contamination may migrate far beyond the point of injection?

A38. (DOB, PDT) No. In Quarles Testimony A26 at 22 Mr. Quarles correctly indicates that injected wastewater can migrate beyond the point of injection and that Dausman et al. 2008 (NRC-012) indicated that injection at the South District Wastewater Treatment Plant could migrate as much as 13 miles. Mr. Quarles uses this conclusion to indicate that groundwater contamination can migrate "far from the point of injection."

However, as discussed in the FEIS, migration of injected wastewater within the Boulder Zone due to injection at the Turkey Point site is expected to be less than that predicted for the South District Wastewater Treatment Plant by Dausman et al. Modeling performed by FPL and the NRC's independent confirmatory analysis indicated that "[i]njected wastewater was not predicted to extend more than around 4 mi beyond the point of injection over the modeled timeframe. This is bounded by the transport distance of 13 mi predicted by Dausman et al. (2008-TN4757) [for injection at the South District Wastewater Treatment Plant. The extent of migration resulting from injection at Turkey Point would be expected to be less because injection rates would be around 20 percent of those at the South District Wastewater Treatment Plant and the injection period would be less than half that which was modeled by Dausman et al. (60 years vs 148 years)." (NRC-008A at 5-26)

Q39. Are there any users of groundwater within the Boulder Zone or users of the Upper Floridan aquifer within the expected 4 mile migration distance?

A39. (DOB, PDT) No. There are no users of groundwater within the Boulder Zone and there are no users of the Upper Floridan aquifer within the expected 4 mile migration distance. In addition, upwelling of injected effluent is not expected to occur and concentrations of constituents would be so low at the point of injection as to be undetectable or absent prior to injection. For these reasons, the Staffs conclusion that the impacts of injection at the Turkey Point site would be SMALL is reasonable.

Q40. Do you agree with Mr. Quarles's assertion in Quarles Testimony A25 at 21 that the FPL model of vertical migration discussed in the FEIS did not include "well

developed pathways" and that "such conduit-like flow conditions exist just to the north at the South District Plant"?

A40. (DOB, PDT) Yes, the purpose of the FPL model mentioned by Mr. Quarles in Quarles Testimony A25 was to determine that potential extent of vertical migration through an unfractured or intact Middle Confining Unit. The calculated 300 ft of expected vertical migration was confirmed by the Staff in a separate independent analysis. However, FPL performed modeling that included "well-developed pathways," and the NRC independently verified the results. As documented in the FEIS, FPL performed (and NRC staff independently verified) a number of modeling scenarios. One scenario evaluated the impact that would occur to the Upper Floridan if rapid migration occurred along a connected pathway through the entire Middle Confining Unit. This is documented in FEIS Appendix G.3.3.2 (NRC-008C). Because the analysis assumes a 1,500 ft conduit occurs through the Middle Confining Unit, it is extremely conservative. Despite Mr. Quarles's assertion, this scenario is not representative of conditions at the South District Wastewater Treatment Plant site where upwelling has been attributed to well-related issues and did not extend out of the Middle Confining Unit. This is discussed in the FEIS Section 5.2.1.3 "Boulder Zone" subsection "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" (NRC-008A) as well as McNeill 2002 (NRC-064 at 3), Maliva et al 2007 (NRC-043 at 1395), Dausman et al 2010 (NRC-047 at 147) and Walsh and Price 2010 (NRC-046 at 15).

Q41. In Quarles Testimony A28 at 23 Mr. Quarles states that "FPL's groundwater monitoring system is likely unable to detect upward migration in time because (1) sampling will not be frequent enough due to possibility of a rapid rate of

migration and (2) the constituents may migrate horizontally before they migrate upward." Does staff agree?

A41. (PDT, DOB) No. As explained in the FEIS at 4-25 (NRC-008A), each injection well would be located within 75 feet of a dual zone monitoring well. Each monitoring well would monitor zones completed above and below the Underground Source of Drinking Water (USWD). As such, migration that occurs in the vicinity of the well would be detected in these adjacent monitoring wells before reaching the Underground Source of Drinking Water (USDW). Studies of instances of upwelling at deep-injection sites indicate that monitoring wells are capable of detecting potential upward movement of fluid. These studies generally conclude that instances of upward migration are likely due to well-related issues. This decreases the likelihood that injected wastewater will flow far enough horizontally to be beyond the monitoring zone before any potential upward movement occurs. In addition, well-related issues which could lead to upward migration would be detected immediately, due to continuous pressure monitoring at the injection well (NRC-008A at 3-10).

Q42. Hypothetically speaking, if a layer is a competent to confine injectate, can deep well injection itself impair that layer's ability to confine the injectate?

A42. (PDT, DOB) If a layer is a competent to confine injectate, deep well injection of fluid could only cause the development of fractures if the increase in fluid pressure is higher than the fracture pressure at that depth (NRC-008A at 5-22).

Q43. What is your professional opinion on whether impairment of a competent confining layer could occur at the Turkey Point site as a result of deep well injection?

A43. (PDT, DOB) The minimum fracture pressure calculated for the injection zone was 1,910 psig (Short-Term Injection Testing of Deep Injection Well DIW-1 at Florida Power & Light Company Turkey Point Units 6 & 7 at 10). The pressure increase while injecting at over

7,000 gpm during the injection test at well DIW-1 was less than 10 psig during the injection test. This shows that the high permeability of the Boulder Zone negates any chance of injection pressure fracturing the confining layers (NRC-008A at 5-22)

Q44. Please describe what indication would be available to FPL should well failure occur during operation.

A44. (DOB, PDT) As discussed in FEIS Section 3.2.2.2 "Cooling System" subsection "Deep-Injection Wells", "[e]ach injection well would be a 24 in. diameter steel well casing extending up to 3,500 ft below grade. A typical injection well steel casing would be lined with 18 in. diameter glass-fiber-reinforced plastic, with a nonhazardous corrosion inhibitor in the annulus between the two. The annulus would be pressurized using a positive-seal packer located at the base of the casing and the pressure would be continuously monitored for leaks during operation." (NRC-008A at 3-10). If leaking is detected by continuous pressure monitoring, the well could be shut down and repaired before significant upwelling occurred.

<u>Mr. Quarles's testimony includes other errors.</u>

Q45. Mr. Quarles calls the Upper Floridan aquifer the "drinking water aquifer" Quarles Testimony at A23. What is your view of this statement?

A45. (DOB, PDT) Mr. Quarles repeatedly calls the Upper Floridan aquifer the "drinking water aquifer" (Quarles Testimony A9 at 6, A20 at 17, A23 at 19, and A25 at 21 and 22). While the Upper Floridan aquifer is an Underground Source of Drinking Water (USDW), it is not used for drinking near the site and cannot be used for drinking water without further treatment. The closest user of water from the Upper Floridan aquifer for irrigation is the Ocean Reef Club, 7.7 miles southeast of Turkey Point, and the upper Floridan aquifer is mixed and freshened before being used for irrigation. The nearest user of the Upper Floridan aquifer for drinking water is the Florida Keys Aqueduct Authority at a location 11 miles west of the Turkey

Point site, and it must desalinate the water to make it potable. (NRC-008A at 2-61). Neither location is within the expected migration distance of the injected effluent from the Turkey Point site (NRC-008A at 5-27).

Q46. Mr. Quarles repeatedly states that "the NRC has failed to provide a reasonable amount of technical support for the conclusions in the FEIS that . . . upward migration is "extremely unlikely" to occur from the underground injection of wastewater at the Turkey Point site." Quarles Testimony, A6, 7, 9, 10, 11, 12, 13, 14, 17, and 32 at 4, 5, 7, 8, 9, 10, 16, 25. What is your view of these statements?

A46. (DOB, PDT) Mr. Quarles endeavors to show that the Staff conclusion is unsupported by studies cited by him and cited within the FEIS. However, Mr. Quarles incorrectly paraphrases and selectively quotes portions of this Staff conclusion. As a result, Mr. Quarles spends a significant portion of his testimony proving something with which the Staff agrees, namely, that upwelling into the Middle Confining Unit is possible. The Staff acknowledges repeatedly that upward migration into the MCU is possible and even gives a maximum expected extent of upward migration in FEIS Appendix G.3.3 (NRC-008C). Rather, the Staff position in the FEIS is that upward migration through the Middle Confining Unit and into the *Upper Floridan aquifer*, which is an Underground Source of Drinking Water (USDW), is "extremely unlikely." The full quote from the Staff conclusion in the FEIS is:

> The review team believes that enhanced vertical flow through the confining units to the Upper Floridan aquifer is extremely unlikely, and if leakage associated with an injection well did occur it could be detected and mitigated as required by the FDEP UIC program.

FEIS (NRC-008A) at 5-26.

Further, the studies cited by both Mr. Quarles and by the Staff fully support this conclusion in that none have correctly indicated that upwelling has occurred through the Middle Confining Unit to the Upper Floridan aquifer. These studies are only part of the support provided

by the staff to support the impact conclusion that the impacts of deep well injection at the Turkey Point site would be SMALL.

Q47. In his testimony, Mr. Quarles states that staff did not incorporate "lessons learned" from previous reports of upwelling into the FEIS. Quarles Testimony A15 at 11, A17 at 15. How do you respond to this statement?

A47. (DOB, PDT) The Staff disagrees with these statements. While Mr. Quarles provides no specifics as to how the FEIS could have been improved, the Staff discusses the incidents of upwelling in great detail in the FEIS and describes how improved well construction and completion techniques will help to avoid future instances of upwelling associated with deep well injection. The Staff discusses these issues and others in the FEIS (NRC-008A) § 5.2.1.3 "Boulder Zone," including subsections entitled "Composition of Injected Wastewater" (FEIS at 5-20 to 5-21) (NRC-008A), "Evaluation of Confinement of Injected Wastewater in the Saline Lower Floridan Aquifer" (FEIS pages 5-21 to 5-23), "Extent of Upwelling at Deep Well Injection Facilities" (page 5-23), "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" (FEIS pages 5-23 through 5-26) and "Extent of Injected Wastewater Migration at the Turkey Point Site" (FEIS pages 5-26 through 5-29). The Staff further discussed this topic in FEIS Section 5.2.3.2 "Groundwater-Quality Impacts" subsections "UIC Impacts" (pages 5-39 to 5-42). Background information is provided in Section 2.3.1.2 "Groundwater Hydrology subsection "Floridan Aquifer System" (FEIS pages 2-53 to 2-54), "Groundwater Flow Directions within the Floridan Aquifer" (FEIS pages 2-55 to 2-57), "Hydraulic Properties of the Floridan Aquifer System at the Turkey Point Site" (FEIS pages 2-57 to 2-58). Cumulative impacts are discussed in FEIS Section 7.2.2.2 "Groundwater-Quality Impacts" (FEIS pages 7-17 to 7-18). FPL and staff modeling of the behavior of injected effluent is presented in Appendix G.3.3 "Confirmatory Calculations of Potential Upward Migration of Injectate from the Boulder Zone of the Lower Floridan Aquifer" (FEIS pages G-48 to G-52). Finally, staff responded to numerous comments regarding the potential effects of deep well injection

including this specific contention in FEIS Appendix E pages E-109 to E-115, E-190 to E-192, E-202 to E-203, E-210 to E-213. Mr. Quarles acknowledges none of this information.

Q48. In his testimony, Mr. Quarles cites his Third Affidavit in concluding that, "[i]n making any determination on the environmental impact of upward migration of constituents into the Upper Floridan Aquifer, the FEIS should have evaluated the nature and extent of a potential contamination; the impact of such a contamination to the wastewater treatment plant; the cost and economic impact of the contamination; and the cost to modify treatment and effluent distribution methods." Quarles Testimony, A31 at 25, citing Third Quarles Aff. ¶ 46. How do you respond?

A48. (DOB, ALM) Economic considerations related to modification of treatment and effluent distribution methods are out of scope of Contention 2.1. In 2013, the South District Wastewater Treatment Plant implemented high-level disinfection independent of proposed Turkey Point Units 6 & 7. As a result, concentrations of the Constituents named in Contention 2.1 in the reclaimed wastewater proposed for use at Turkey Point Units 6 & 7, which were already below EPA MCLs for drinking water, are now below detectable limits. Accordingly, there is no need to evaluate the economic impact of contamination of an Underground Source of Drinking Water (USDW) or any asserted need for remediation, since wastewater is treated to below applicable standards and does not pose a risk to human health even if migration were to occur (*see* Revised Staff Testimony (NRC-002-R) at A52).

To the extent Mr. Quarles believes that "the FEIS should have evaluated the nature and extent of a potential contamination," as he asserted in his testimony (at A31), the Staff did indeed evaluate "the nature and extent of a potential contamination" in the Upper Floridan aquifer. Specifically, the Staff discussed the incidents of upwelling in great detail in the FEIS, including the following Sections: FEIS § 5.2.1.3 (NRC-008A), "Boulder Zone," including subsections entitled "Composition of Injected Wastewater" (FEIS at 5-20 to 5-21 (NRC-008A)), "Evaluation of Confinement of Injected Wastewater in the Saline Lower Floridan Aquifer" (FEIS

(NRC-008A) at 5-21 to 5-23), "Extent of Upwelling at Deep Well Injection Facilities" (FEIS (NRC-008A) at 5-23), "Potential Causes of Upwelling of Injected Wastewater through the Middle Confining Unit" (FEIS (NRC-008A) at 5-23 through 5-26) and "Extent of Injected Wastewater Migration at the Turkey Point Site" (FEIS (NRC-008A) at 5-26 through 5-29). The Staff further discussed “the nature and extent of a potential contamination” in FEIS (NRC-008A) § 5.2.3.2 "Groundwater-Quality Impacts," in subsection "UIC Impacts" (FEIS (NRC-008A) at 5-39 to 5-42). The FEIS provides background information in Section 2.3.1.2 "Groundwater Hydrology,” in subsections "Floridan Aquifer System" (FEIS (NRC-008A) at 2-53 to 2-54), "Groundwater Flow Directions within the Floridan Aquifer" (FEIS (NRC-008A) at 2-55 to 2-57), and "Hydraulic Properties of the Floridan Aquifer System at the Turkey Point Site" (FEIS (NRC-008A) at 2-57 to 2-58). The FEIS also discusses cumulative impacts in FEIS § 7.2.2.2 “Groundwater-Quality Impacts" (FEIS NRC-008A) at 7-17 to 7-18). FPL and NRC Staff modeling of the behavior of injected effluent is presented in Appendix G.3.3 "Confirmatory Calculations of Potential Upward Migration of Injectate from the Boulder Zone of the Lower Floridan Aquifer" (FEIS (NRC-008A) at G-48 to G-52). Finally, the Staff responded to numerous comments regarding the potential effects of deep well injection, including comments on the same subject as Contention 2.1, in FEIS Appendix E (NRC-008D) at E-109 to E-115, E-190 to E-192, E-202 to E-203, and E-210 to E-213.

Q49. Does this complete your testimony?

A49. A63**.** (ALM, DOB, PDT) Yes.

March 23, 2017

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 52-040 & 52-041
	)	
(Turkey Point Units 6 and 7)	)	

AFFIDAVIT OF ANN L. MIRACLE

I, Ann L. Miracle, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

/Executed in Accord with 10 CFR 2.304(d)/

Ann L. Miracle
Senior Scientist
Pacific Northwest National Laboratory
Mail Stop: J2-25
Richland, Washington 99352
Telephone: 509-372-4327
E-Mail: ann.miracle@pnnl.gov

March 23, 2017

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 52-040 & 52-041
	)	
(Turkey Point Units 6 and 7)	)	

AFFIDAVIT OF DANIEL O. BARNHURST

I, Daniel O. Barnhurst, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

/Executed in Accord with 10 CFR 2.304(d)/

Daniel O. Barnhurst
Hydrologist
U.S. Nuclear Regulatory Commission
Mail Stop: T-7 E18
Washington, DC 20555
Telephone: 301-415-6653
E-Mail: daniel.barnhurst@nrc.gov

March 23, 2017

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
	)	
FLORIDA POWER & LIGHT COMPANY	)	Docket Nos. 52-040 & 52-041
	)	
(Turkey Point Units 6 and 7)	)	

AFFIDAVIT OF PAUL D. THORNE

I, Paul D. Thorne, do hereby declare under penalty of perjury that my statements in the foregoing testimony and my statement of professional qualifications are true and correct to the best of my knowledge and belief.

/Executed in Accord with 10 CFR 2.304(d)/

Paul D. Thorne
Senior Research Scientist
Pacific Northwest National Laboratory
Mail Stop: K7-73
Richland, Washington 99354
Telephone: 509-371-7220
E-Mail: paul.thorne@pnnl.gov