UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

Before the Licensing Board:

E. Roy Hawkens, Chair
Dr. Michael F. Kennedy
Dr. William C. Burnett

In the Matter of	)	
	)	Docket Nos. 52-040 and 52-041
Florida Power & Light Company	)	
	)	ASLBP No. 10-903-02-COL-BD01
Turkey Point, Units 6 and 7	)	

)

PRE-FILED REBUTTAL TESTIMONY OF MARK A. QUARLES REGARDING JOINT INTERVENORS' CONTENTION 2.1

Q1: Please state your name and qualifications to give this rebuttal testimony.

A1: My name is Mark A. Quarles. On March 1, 2017, I submitted Pre-Filed Initial Testimony regarding Contention 2.1. My professional qualifications are described in A2 of my Initial Testimony.

Q2: What is the purpose of your rebuttal testimony?

A2: The purpose of my rebuttal testimony is to respond to statements made in pre-filed testimony regarding Joint Intervenors' Contention 2.1 by witnesses for Florida Power & Light Co. (FPL) and the U.S. Nuclear Regulatory Commission (NRC) Staff. These include the following pieces of testimony submitted by FPL: Pre-Filed Testimony of Mr. Paul Jacobs (**Exhibit FPL-001**) (hereinafter "Jacobs Testimony"), Pre-filed Direct Testimony of Mr. David McNabb (**Exhibit FPL-002**) (hereinafter "McNabb Testimony"), Pre-Filed Direct Testimony of Dr. Robert G. Maliva (**Exhibit FPL-003**) (hereinafter "Maliva Testimony"), and Pre-Filed Direct Testimony of Dr. Christopher M. Teaf (**Exhibit FPL-004**) (hereinafter "Teaf Testimony"). They also include NRC Staff Testimony of Ann L. Miracle, Daniel O. Barnhurst, Paul D. Thorne, and Alicia Williamson-Dickerson Concerning Contention 2.1 (Impacts of Deep Well Injection of Four Constituents in Cooling-Tower Blowdown) (**Exhibit NRC-002**) (hereinafter "NRC Staff Testimony").

Q3: Has your expert opinion, as summarized in A7 of your Pre-Filed Initial Testimony, changed as a result of reviewing the testimony of FPL's and the NRC Staff's witnesses?

A3: No. I continue to hold the opinion that the NRC has failed to provide a reasonable amount of technical support for the conclusions in the Final Environmental Impact Statement (FEIS) for Turkey Point Units 6 and 7 that (1) upward migration is "extremely unlikely" to occur from the underground injection of wastewater at the Turkey Point site, and that (2) the environmental impacts of the upward migration of injected wastewater containing tetrachloroethylene, ethylbenzene, heptachlor, and toluene (constituents) will be "SMALL." As I stated previously, these conclusions are not supported by the necessary data, and they are also contradicted by some of the documents on which the NRC relies.

My rebuttal testimony below will address my key disputes with FPL's and the NRC Staff's witnesses. The fact that I do not respond to a particular point should not be interpreted to signify my agreement.

(1) UPWARD MIGRATION OF WASTEWATER CONTAINING CONTAMINANTS

Q4: In A9 of your Initial Testimony, you concluded that the NRC's analytical approach and conclusions pose four "key problems." Your first conclusion is as follows:

> **[W]hile the FEIS claims it can draw conclusions about the Turkey Point site by comparing it to "hydrogeological conditions and parameters at the sites at which upwelling occurred" (FEIS 5-21), the NRC did not obtain nearly enough information about the specific characteristics of the Turkey Point site to make such comparisons. The FEIS relies on a single deep borehole test that provides very little information about the Turkey Point site characteristics. What little information *is* provided by the borehole test indicates that the layers of bedrock that were believed to be confining layers were actually quite permeable. Only 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. However, no seismic study was performed for the Turkey Point site.**

Please explain why the testimony submitted by the NRC Staff and FPL has not changed your first conclusion.

A4: The NRC Staff and FPL continue to rely on testing of a single borehole for their deep bedrock characterization of the Turkey Point site: Exploratory Well 1 (EW-1). They refer to no additional data about the geological characteristics of the Turkey Point site. For instance, the "confirmatory calculations" referred to by the NRC Staff in A18 and A82 use the borehole data from EW-1. *See* FEIS at G-48 – G-50. For all the reasons stated in my Initial Testimony at A10 – A15, a single borehole does not provide an adequate basis to confirm or deny the presence of an adequate bedrock confining layer or layers. I disagree with Dr. Maliva about the significance of the data yielded by EW-1 (*See* Maliva Testimony, ¶¶ 18-24); but even if he were correct, that

single well does not provide enough information to adequately characterize the entire Turkey Point site.

In my expert opinion, FPL should have used the reasonable and feasible technique of seismic stratigraphy (*i.e.*, seismic-reflection investigations) to investigate the potential for vertical flow through geologic pathways on the Turkey Point site. Four reports by the U.S. Geological Survey (USGS) regarding such studies are attached to my testimony as exhibits.[1]

Q5: According to FPL witness Dr. Maliva's testimony (¶ 72), the Cunningham 2012 report and the Cunningham 2015 report provide no evidence that the structural features identified by seismic-reflection studies are "hydraulically" active, provide no data with respect to the hydraulic properties, and provide only speculation that the features can be water migration pathways. Do you agree?

A5: No. In my expert opinion, the Cunningham reports show that seismic-reflection reports are useful in determining site conditions that might explain leakage of wastewater into underground sources of drinking water (USDW) and can be used to evaluate whether leakage could occur at specific sites like Turkey Point. Cunningham has performed a series of investigations since at least 2012 due to the "immediate need for a subsurface assessment" because wastewater injected at some wastewater treatment plants has migrated upwards into USDW. Cunningham 2012 at 1. His work includes seismic analyses "for detailed mapping of permeable zones and semi-confining units of the Floridan aquifer system at a level of resolution never before accomplished using well data alone." Cunningham 2015 at 1.

[1] These USGS studies are as follows:

- Cunningham et al 2012-TN4576: Kevin J. Cunningham, Cameron Walker, & Richard L. Westcott, *Near-Surface, Marine Seismic-Reflection Data Define Potential Hydrogeologic Confinement Bypass in the Carbonate Floridan Aquifer System, Southeastern Florida*, SEG Technical Program Expanded Abstracts 2012, (2012) (hereinafter "Cunningham 2012", attached to my Pre-Filed Initial Testimony as **Exhibit INT-006**).
- Cunningham 2013-TN4573: Kevin J. Cunningham, *Integrating Seismic-Reflection and Sequence-Stratigraphic Methods to Characterize the Hydrogeology of the Floridan Aquifer System in Southeast Florida*, U.S. Geological Survey Open File Report 2013-1181, (2013) (hereinafter "Cunningham 2013", attached to my Pre-Filed Initial Testimony as **Exhibit INT-007**).
- Cunningham 2014-TN4051: Kevin J. Cunningham, *Integration of Seismic-Reflection and Well Data to Assess the Potential Impact of Stratigraphic and Structural Features on Sustainable Water Supply from the Floridan Aquifer System, Broward County, Florida*, U.S. Geological Survey Open-File Report 2014–1136 (2014) (hereinafter "Cunningham 2014", attached to my Pre-Filed Initial Testimony as **Exhibit INT-008**).
- Cunningham 2015-TN-4574: Kevin J. Cunningham, *Seismic-Sequence Stratigraphy and Geologic Structure of the Floridan Aquifer System Near "Boulder Zone" Deep Wells in Miami-Dade County, Florida*, U.S. Geological Survey Scientific Investigations Report 2015-5013 (2015) (hereinafter "Cunningham 2015", attached to my Pre-Filed Initial Testimony as **Exhibit INT-009**).

Cunningham's use of seismic technologies, coupled with traditional down-hole drilling and sampling methods (e.g. drill cutting, core samples, porosity tests, and packer tests), provides the most comprehensive data set available to attempt to explain how and why wastewater has migrated through layers of bedrock that previously were thought to be "confining layers" that prevented upward migration. Cunningham 2015 concluded, for example, that "a *plausible hydraulic connection* between faults and stratiform permeability zones may contribute to the upward transport of effluent" at the Miami-Dade North District Wastewater Treatment Plant. *Id*. (emphasis added).

Cunningham's investigative work was not designed as a comprehensive site-specific investigation to determine the root cause of leakage at a specific injection site. His work does, however, support the usefulness of seismic technology to provide subsurface details that far exceed the level of resolution that can be achieved by using borings and wells alone. His work certainly supports the usefulness of performing such a detailed investigation at the Miami-Dade South District and North District Wastewater Treatment Plants. And, by the same token, it supports the usefulness of seismic technologies at Turkey Point.

Q6: Dr. Maliva testifies that a single exploratory well is the norm for investigating the geology of injection well sites in Florida. Maliva Testimony, ¶10. Do you agree; and if so, why isn't that acceptable?

A6: Dr. Maliva may be correct about the past; but the Cunningham reports show that the methods used in the past are outdated and perhaps not cost-effective. As I mentioned previously, Cunningham observed an "immediate need" for more accurate characterization of the hydrogeology of Florida, and seismic-reflection technology does much better at meeting that need than an exploration that includes a single well or even multiple borings and wells.

It is also important to bear in mind that mistakes in the underground injection control (UIC) business are costly. According to Mr. Jacobs, FPL plans to install 12 deep injection wells and 6 monitoring wells located along the east and south side of the Turkey Point plant site. Jacobs Testimony, ¶ 16. Dr. Maliva observed that each exploratory well "costs millions of dollars to drill and test;" that "drilling multiple dedicated exploratory wells is not practical;" that even drilling 10 or 100 exploratory wells "would be just as likely to miss a hypothetical fault that is only a few inches to a few feet wide;" and that exploratory wells "could never identify every geological feature of the site." Maliva Testimony, ¶¶ 19 and 20. He also testified that FPL plans to use the subsurface data collected from each of its injection wells to determine whether or not adequate confining conditions exist. *Id.*, ¶ 21. Thus, FPL would spend upwards of $12 million defining subsurface conditions that Dr. Maliva acknowledges will not locate migration pathways that Cunningham determined to be plausible.

If, before installing injection wells, FPL instead conducts a Turkey Point-specific seismic investigation, in conjunction with a limited drilling program, it may save itself a great deal of money by avoiding the drilling of wells that may need to be relocated because the geologic conditions are unsuitable for injection. The seismic analysis would provide useful information about the existence of natural features that can allow upward migration of wastewater. That information could be used by FPL to pre-locate specific boring and well locations in order to

confirm or deny the presence of the natural features identified by the seismic analysis. A seismic analysis would also help FPL to optimize the placement of dual-zone monitoring wells and injection wells.

Q7: Dr. Maliva asserts that other studies indicate that tectonic faults and karst collapse structural features have no impact on groundwater flow. Maliva Testimony, ¶ 73. Do those studies demonstrate that such features will not have any effect on the upward transport of effluent at Turkey Point?

A7: No. The studies relied on by Dr. Maliva – Miller (1986) and Duncan et al. (1994) – are dated. There is no substitute for collecting site-specific data using the combined best technologies available to make informed decisions prior to injecting wastewater.

In any event, the referenced reports did not rule out faults as a conduit for groundwater flow, either locally or regionally. The Miller report merely observed that "small faults do not appear to have any effect on ground-water flow in the Floridan aquifer system." Maliva Testimony, ¶ 73. A site-specific investigation would be needed to determine whether local bedrock confining conditions sufficiently exist. The Duncan report, even as described by Dr. Maliva, also does not rule out the possibility of bedrock fracturing and leakage at Turkey Point. Rather, according to Dr. Maliva, Duncan concluded that a single injection well drilled in an unspecified "subsurface structural feature" below an injection site in Palm Beach County was not "hydraulically active." *Id*. The Duncan report illustrates the value in drilling a well in a pre-specified suspect area, at, for example, Turkey Point, in order to be more confident in the confining nature of the bedrock.

Q8: Dr. Maliva states that at the Turkey Point site, a seismic-reflection study would be "useless" because "[a] seismic reflection survey that can penetrate through to the Boulder Zone, comparable to the marine surveys performed by Cunningham, would provide no data on the confining properties of the bedrock." Maliva Testimony, ¶ 74. He also asserts that "seismic reflection surveys can identify subsurface structures, but they provide no information on their hydraulic properties for use in a confinement analysis." *Id.* Do you agree with Dr. Maliva about the limitations on seismic reflection studies? Do you agree they would be useless in these circumstances?

A8: No. As discussed above, Cunningham described the "immediate need" for seismic technologies because they provide an understanding of subsurface features that was not previously available. In stating that a seismic study would "provide no data on the confining properties of the bedrock" and would provide "no information on their hydraulic properties for use in a confinement analysis," Dr. Maliva fails to acknowledge Cunningham's conclusions that (a) the technology is capable of determining if leakage of a confining layer is plausible, (b) seismic technologies are capable of detecting vertical migration pathways such as faults and karst collapse structures that create small, discrete migration pathways, and (c) the technology "should be useful to other hydrogeological investigations in southeastern Florida." Cunningham 2015 at 1, 6, and 24, and Cunningham 2012 at 1 and 2. Dr. Maliva himself admits that exploratory wells are unlikely to detect vertical migration pathways such as faults. Maliva Testimony, ¶20.

Q9: Dr. Maliva states that he "did not ignore the bedrock structures identified by Cunningham." Maliva Testimony, ¶ 75. He testifies that he performed a confinement analysis using data produced from the single EW-1 injection well that focused on "identification of fractured and unfractured intervals." ***Id.*** **Based on his confinement analysis, he testifies that the FEIS correctly concluded that these "natural features" are "not evident" at the Turkey Point site.** ***Id.*** **Do you agree that Dr. Maliva's confinement analysis rules out the possible existence of natural features such as faults and fractures that provide vertical migration pathways?**

A9: No, Dr. Maliva's confinement analysis relied on geologic data produced from the single well EW-1 and his interpretation of what the EW-1 data shows about the bedrock conditions in the immediate area of that borehole. As Dr. Maliva concluded in his testimony, even 100 exploratory wells would be incapable of locating discrete natural pathways such as faults. Maliva Testimony, ¶20. Faults and fractures are the very geologic features that Cunningham has concluded are plausible migration pathways for injected wastewater effluent.

Q10: FPL witness Mr. McNabb asserts that FPL will do further investigations of the site hydrogeology at Turkey Point when it drills the injection wells. McNabb Testimony, ¶ 34. Would that provide adequate information?

A10: No, for three reasons. First, a promise to gather data in the future is no substitute for having adequate data when it is needed, *i.e.*, for the environmental analysis in the FEIS. Second, as discussed above in A4 and A6, boreholes by themselves provide inadequate geologic information. A seismic-reflection study should also be conducted. And, third, if FPL waits until the installation of injectate wells to gather the necessary data, it may find those wells will not be useable if confining conditions do not exist. Further, the wells themselves, if not properly constructed and maintained, can be vertical migration pathways. As the EPA has recognized:

> [T]here is a potential that monitoring wells installed for this purpose could themselves create artificial conduits for fluid movement. Additional deep monitoring wells would have to perforate all shallow confining layers as they are installed, posing the risk of contamination along the well borehole to more shallow aquifers.

Notice of Final Rule, Underground Injection Control Programs – Revision to the Federal Underground Injection Control Requirements for Class I Municipal Disposal Wells in Florida, 70 Fed. Reg. 70,513, 70,526 (Nov. 22, 2005) (**Exhibit NRC-021**) (hereinafter "UIC Rulemaking Notice").

Q11: Your second conclusion in A9 is that:

> **[T]he FEIS incorrectly relies on broad generalizations about the "low-permeability" of the "confining units" that supposedly will contain the injected contaminants.** ***See, e.g.,*** **FEIS at 2-47. Time and again, unexpected vertical intrusions of contaminated water into the drinking water supply in South Florida have proved that generalization to be dead wrong. In fact, these recurring excursions impelled the USGS to begin conducting the seismic-reflection studies that now show the presence**

of faults and collapsed karst structures that may provide pathways for rapid upward migration of contaminated wastewater. The NRC has no reasonable basis to make such sweeping claims, having failed to support them with a seismic-reflection combined with other analyses of the Turkey Point site.

Please explain why the testimony submitted by the NRC Staff and FPL has not changed your second conclusion.

A11: As I have explained above, the generalizations in the FEIS regarding the low-permeability of the confining unit in South Florida are contradicted by numerous instances of vertical intrusions of contaminated wastewater.

A 2007 report authored by Dr. Maliva himself, which discussed injectate movement at 17 deep well injection sites, demonstrated that bedrock and aquifer data beneath deep well injection sites may not be determinative on the questions of whether a confining layer actually exists; and, that if leakage does occur, how quickly that leakage can migrate. Specifically, Dr. Maliva concluded that "the upward migration of reclaimed water at the 17 sites occurred at a much more rapid rate than expected at the times of both the design and construction of the injection wells." Robert G. Maliva *et al., Vertical Migration of Municipal Wastewater in Deep Injection Well Systems, South Florida, USA*, at 2 (2007) (**Exhibit INT-014**) (hereinafter "Maliva 2007").

Additionally, the EPA itself has recognized that bedrock conditions in South Florida have allowed unintended vertical migration of injected wastewater. As the EPA stated, "monitoring of injection operations over the past several years has indicated that some deep geologic zones provide less confinement between formations than was originally thought." UIC Rulemaking Notice, 70 Fed Reg. at 70,516.

The EPA also recognizes that bedrock conditions in South Florida are complex and the bedrock conditions that define confining capabilities can vary greatly, "even within the same horizon or geological deposit of a particular time." *Id*. Dr. Maliva also recognized this bedrock heterogeneity when he concluded in his 2007 study (which was specific to deep well injection) that "fracture zones may have a limited horizontal extent, creating chimneys that were conduits for vertical fluid migration." Maliva 2007 at 7-8. Dr. Maliva concluded that "[t]he focus of confinement analyses should, therefore, be on the extent and distribution of fracturing rather than analyses of the properties of the rock matrix." *Id.* at 9. Given the discrete nature of these "chimneys," any investigation at Turkey Point should focus on identifying these discrete pathways and not rely on generalizations collected from randomly located borings.

In fact, the EPA decided that in South Florida, a UIC permit can no longer be completely justified based on the rationale that injected wastewater will not migrate from its intended geologic formation, *i.e.,* the "no-fluid-movement" rationale. UIC Rulemaking Notice, 70 Fed. Reg. at 70,515. To address the risk of vertical migration of pathogens in wastewater injected underground in South Florida, EPA now requires high-level disinfection of the municipal wastewater prior to injection. *Id.* In establishing the new UIC rule, EPA was responding to "results from ground water monitoring around some Class I municipal disposal wells in Florida" that "confirm that fluids have migrated out of the permitted injection zone." *Id.* at 70,519. The

EPA also observed that "the full areal extent of USDW contamination is not known." *Id.* According to EPA, "[t]he unknown degree of migration is not only because of limited availability of monitoring data, but *also because the location and connectivity of natural conduits for fluid flow (fractures and solution cavities in underground formations) are difficult to predict*." *Id.* (emphasis added). The underlying rationale for EPA's rule is consistent with my own view.

Q12: Your third conclusion in A9 is that:

> **[T]he FEIS incorrectly minimizes the significance of known instances of upward migration of contaminated wastewater in the area of the Turkey Point site. There can be no doubt that contamination of drinking water sources with injected wastewater is a significant problem in South Florida, warranting a three-and-a-half year investigation. Cunningham 2013 at 2. The FEIS should have acknowledged that the number of occurrences of upward migration of wastewater through "confining layers" in the vicinity of the Turkey Point site is the appropriate indicator of its significance, not a general statewide survey.**

Please explain why the testimony submitted by the NRC Staff and FPL has not changed your third conclusion.

A12: First, both the EPA and NRC have acknowledged instances of unintended upward migration of injected wastewater into USDWs. *See* U.S. EPA Office of Water, *Relative Risk Assessment for Management Options for Treated Wastewater in South Florida*, 4-12 (2003) (**Exhibit INT-015)**; UIC Rulemaking Notice, 70 Fed. Reg. at 70,519, 70,522; NRC Staff Testimony, A42; FEIS at 5-23 (observing that 17 UIC sites have experienced migration, including upwelling into the USDW at 8 of those sites).

Additionally, Dr. Maliva asserts that in my previous affidavits, I failed to distinguish between unintended migration of wastewater into protected "USDWs" versus migration into a "potable water supply." Maliva Testimony, ¶ 57. He claims that "there has been no suggestion that *any* water injected into the Boulder Zone has ever migrated upward and actually entered a potable water supply." Maliva Testimony, ¶ 15. However, Dr. Maliva fails to take into account that a USDW is a potential water supply that must be protected under the Safe Drinking Water Act. Documented leakage into the Upper Floridan Aquifer is as noteworthy as leakage into a current potable water supply because that aquifer must be protected with the assumption that it may be used in the future as a potable water supply.

Q13: Your fourth conclusion in A9 is that:

> **[T]he 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. The studies on which the FEIS relies do not support this proposition. Instead, these studies acknowledge that geologic characteristics of a given site are just as likely to be the cause of vertical migration.**

Please explain why the testimony submitted by the NRC Staff and FPL has not changed your fourth conclusion.

A13: Dr. Maliva asserts in his testimony that the "upwards movement of wastewater that has occurred at the Miami-Dade South District Wastewater Treatment Plant (South District Plant) is likely not due to migration through the confining unit" but instead "likely due to well construction issues rather than hydrogeological issues (e.g., breaches in the confining layer)." Maliva Testimony, ¶ 57. But Dr. Maliva provides no proof for his opinion, other than to blame upward movement on previous well installation procedures used at that Plant.

Dr. Maliva's exclusive attribution of vertical migration to well failure is also contradicted by his own research. In 2007, Dr. Maliva published a paper regarding the results of an investigation in which he concluded that geologic conditions at deep well injection sites are, in fact, a contributing factor to "rapid vertical migration" due to "enhanced vertical hydraulic conductivity" and "fracturing, which is evident in the geophysical logs of wells that experienced rapid vertical fluid migration." Maliva 2007 at 7. Dr. Maliva also concluded that fracture zones that produce that high conductivity "may have a limited horizontal extent, creating *chimneys that were conduits* for vertical fluid migration." *Id.* at 7-8 (emphasis added). With respect to the contribution of wells, Dr. Maliva observed that "well construction problems as a cause for vertical fluid migration *have not yet been conclusively confirmed at any injection well site*." *Id.* at 9. Dr. Maliva has not identified any subsequent research results conclusively tying upward migration to well construction problems.

In his testimony, Dr. Maliva also asserts that the "prevailing opinion" about the cause of upward movement of wastewater at the South District Plant is that it was due to the use of obsolete procedures for well construction. Maliva Testimony, ¶¶ 57-58. But his assertion is undermined by Cunningham's conclusion that faults and karst collapse structures "represent a plausible physical system for the upward migration of effluent into the boulder zone to overlying U.S. Environmental Protection Agency designated underground sources of drinking water in the upper part of the Floridan aquifer system." *See* my Pre-Filed Initial Testimony, A18, and Cunningham 2015 at 24. Dr. Maliva's opinion that the past cause of upward movement of injectate was a leaky well rather than a leaking confining layer amounts to mere speculation, because he has not provided proof that bedrock fractures, like those he evaluated in 2007, are not the main cause of the water movement.

Q14: Mr. McNabb relies on a dual zone groundwater monitoring system to assert that any wastewater leaks or migration into the USDW will be identified and resolved. Does this monitoring system ensure early detection and mitigation of contaminants? If not, please explain why the testimony submitted by Mr. McNabb has not changed your previous testimony conclusions.

A14: No. The dual-zone monitoring system may not ensure an early detection of vertical migration of wastewater through bedrock. The EPA has reached a conclusion that is consistent with my own. The EPA believes that "existing compliance monitoring programs are not sufficient to protect against movement of contaminants into USDWs, nor do they provide

sufficient early warning of contamination." UIC Rulemaking Notice, 70 Fed. Reg. 70,526. Further, EPA concluded that

> groundwater monitoring wells at most deep well injection facilities in Florida are only intended to provide some initial indication of fluid movement and are not capable of characterizing the full areal extent of fluid movement, especially where natural conduits for flow are present. Moreover, once any contamination is detected, it may be too late to prevent endangerment.

Id.

Q15: Dr. Maliva performed a groundwater model to support his opinion that sufficient confinement exists beneath Turkey Point to prevent upward migration of injected wastewater to protect the USDW. Do you agree that his model demonstrates that no future leakage to a USDW will occur at the Turkey Point site? If not, why?

A15: No. Dr. Maliva's model "is based largely on data collected from well EW-1." Maliva Testimony, ¶ 40. Dr. Maliva asserts that "[p]ervasive fracturing of the type associated with vertical fluid migration is not evident in the Turkey Point exploratory well (EW-1)." *Id.*, ¶ 64. As Dr. Maliva concluded in his 2007 study, however, bedrock in South Florida is heterogeneous and conditions can dramatically vary within short distances. Maliva 2007 at 4. As such, a bedrock boring and samples collected from it might miss faults and fracture systems. Failing to account for such complex and variable geology undermines the reliability of any model. The EPA recognized this in its 2005 rulemaking, where it announced that it "does not believe that that modeling can provide an adequate demonstration in the complex geology of Florida." UIC Rulemaking Notice, 70 Fed. Reg. at 70,526.

The EPA concluded that if a groundwater model is developed to make a confinement determination, that model should include extensive input parameters. *Id*. Specifically, the EPA concluded that a more in-depth model "would require[] information on the location and extent of fissures, cracks, voids, and channels which is impossible, using current technologies, to obtain with any certainty." UIC Rulemaking Notice, 70 Fed. Reg. 70,526. Of course, the single exploratory well EW-1 would fall far short of providing that fundamentally important information. The best opportunity to collect the needed information and to have a higher degree of confinement certainty is to perform a seismic reflection investigation at the Turkey Point site. As I have previously discussed, Cunningham has amply demonstrated the feasibility and effectiveness of this investigative technique.

(2) ADVERSE IMPACTS TO USDWS

Q16: According to the NRC Staff witnesses, the recent addition of high-level disinfection in the treatment of the wastewater at the South District Plant, instituted in compliance with state and federal UIC requirements, would "provide an effluent quality that would not endanger Underground Sources of Drinking Water." NRC Staff Testimony, A20 (quoting UIC Rulemaking Notice, 70 Fed. Reg. at 70,523). This issue is also discussed in the NRC Staff's testimony at A42 and A67. Is high-level disinfection designed to treat volatile and semi-volatile organic compounds such as heptachlor, ethylbenzene, toluene, and tetrachloroethylene?

A16: No. According to the EPA, the high-level disinfection process installed at the South District Plant in 2013 is designed to remove pathogens, such as Cryptosporidium and Giardia. UIC Rulemaking Notice, 70 Fed. Reg. at 70,518. The process is not designed to remove other contaminants, and EPA does not vouch for it for any purpose other than removal of pathogens. As EPA stated in the preamble to the rule:

> Although pretreatment, secondary treatment, and high-level disinfection will remove many contaminants that may be present in municipal wastewater, EPA agrees with commenters who said that a large variety of contaminants, such as pharmaceutical products and disinfection byproducts, that may be present in treated municipal wastewater, may not be removed.

UIC Rulemaking Notice, 70 Fed. Reg. at 70,525.

Q17: Did the EPA reach any conclusions about risks posed by other contaminants such as volatile and semi-volatile organic compounds?

A17: Yes. EPA recognized that other contaminants may be present in wastewater, and those contaminants may not be removed by the high-level disinfection process. EPA did not require that these other contaminants be removed by advanced treatment because EPA found that those other contaminants would be addressed because:

> (1) The Relative Risk Assessment found that the only contaminants that posed a potential threat were pathogenic microorganisms; (2) Class I municipal disposal wells are precluded from injecting listed or characteristically hazardous waste streams; (3) Class I municipal disposal wells are allowed to inject only wastewater that has received a level of treatment, specified in individual permits, deemed necessary by the Director to prevent endangerment; and (4) many other contaminants are addressed through EPA's existing pretreatment regulations . . . If the Director finds that any other contaminants pose a threat to USDWs, that threat can be addressed on a site-specific basis under existing authorities.

UIC Rulemaking Notice, 70 Fed. Reg. at 70,525-26. Thus, EPA found that for Class I municipal wastewater, such as the water to be injected at Turkey Point, advanced high-level disinfection treatment processes are not adequate to remove all contaminants. The presence of volatile and

semi-volatile organic constituents in the South District Plant's wastewater discharge in the past shows that the traditional wastewater treatment processes and industrial pre-treatment programs are not always effective in eliminating such contaminants from the treated wastewater effluent that would be discharged to Turkey Point.

Q18: The NRC Staff witnesses point out that measurements of heptachlor, ethylbenzene, toluene, and tetrachloroethylene, taken since the high-level disinfection equipment was installed at the South District Plant, are now below detection limits. NRC Staff Testimony, A38 and A59. Doesn't this show that the new high level disinfection equipment is reducing levels of the constituents in the wastewater from the South District Plant?

A18: No, not necessarily. As discussed above, the high-level disinfection process is designed to remove only pathogens, not other compounds such as volatile (VOC) and semi-volatile organic compounds (SVOC) that are commonly associated with industrial wastes, as examples. EPA recognized that high-level disinfection "may not" remove such contaminants and relies on other mechanism as discussed above. *See* UIC Rulemaking Notice, 70 Fed. Reg. at 70,525-26.

With respect to industrial wastes, EPA relies on an effective pretreatment program to prevent harmful amounts of such wastewater from entering into the sanitary sewerage collection system that then flows to the wastewater treatment plant. *Id.* Given that the constituents have been present in the wastewater in the past, however, the pretreatment programs do not eliminate the probability that such constituents will continue to be present in the future.

Also, the NRC Staff and FPL should not rely upon the results of four VOC samples as their demonstration that the VOC constituents are effectively being treated and removed by the high-level disinfection process, and these results certainly should not be relied upon as a definitive long-term conclusion on the effectiveness of the treatment system. The NRC Staff and FPL rely on results from four samples collected between 2013 and 2014, after the South District Plant implemented the high level disinfection process, to assert that the VOC constituents are also being effectively treated by the disinfection process. NRC Staff Testimony, A38 and A59; Teaf Testimony, ¶17, citing **Exhibits FPL-041 – FPL-046** (laboratory results for sampling done in 2013 and 2014). However, these VOC samples were collected as 40 milliliter grab samples that are only a reflection of water quality of that minute volume at the mere few seconds that it took for FPL to fill the sample vials. **Exhibits FPL-041 – FPL-046**. As such, the samples may not reflect the actual maximum concentration during any given day.

Furthermore, the fact that the high-level disinfection process may work by happenstance on occasion to remove VOCs and SVOCs does not establish its consistent effectiveness. For instance, the effectiveness of the process may be affected by the quantity of the compounds in the wastewater at any given time. A treatment system that happens to remove some of a compound, when that compound is at low levels in the wastewater, may be ineffective in removing it at higher levels.

In addition, as stated in my Initial Testimony at A24, tetrachloroethylene, heptachlor, ethylbenzene, and toluene are indicator constituents of chemicals commonly associated with industrial or agricultural wastewater streams that are discharged into the sewerage system prior

to reaching the treatment plant. The mere presence of these and other similar indicator constituents in the municipal wastewater effluent reported in the FEIS after primary and secondary treatment demonstrates that the municipal wastewater treatment plant is ineffective at removing all such constituents from the wastewater.

The current wastewater permit for the South District Plant does not include any specific sampling to monitor or otherwise verify whether the high-level disinfection process will be successful over time in reducing or removing contaminants that the system is not designed to treat. Specifically, the NPDES permit for the South District Plant, issued in 2012, contains no monitoring requirements for any of the VOC and SVOC constituents listed in Contention 2.1. A copy of the permit is attached as **Exhibit INT-019.**

Q19: FPL witness Dr. Maliva testifies that the nearest existing or planned Floridan Aquifer public supply wells are located over 10 miles west of the Turkey Point site, in the up-gradient direction, opposite from the direction of groundwater flow. Maliva Testimony, ¶ 14. *See also* NRC Staff Testimony, A64. The NRC Staff also testifies that the Upper Floridan aquifer at Turkey Point is too saline to be used for drinking water without treatment. NRC Staff Testimony, A24. Do you agree that it is appropriate to judge the significance of impacts based on the current location of drinking water supplies?

A19: No. These statements related to drinking water wells are short sighted and inconsistent with the federal Safe Drinking Water Act. The purpose of designating aquifers as Underground Sources of Drinking Water (USDW) is to ensure that they are protected for both present *and* future uses. As defined in federal Safe Drinking Water Act regulations, a USDW includes not just current sources of drinking water, but aquifers containing "a sufficient quantity of ground water to supply a public water system," if they contain fewer than 10,000 mg/l total dissolved solids. 40 C.F.R. § 144.3(a)(2)(ii). Given the high and expanding population of Florida, and given the limited supply of fresh water (and particularly the shallowness of the Biscayne Aquifer used in Southeast Florida), any aquifer with the potential to provide drinking water should be protected.

The Florida Department of Environmental Protection (FDEP) has acknowledged that demand for water will continue to increase in Florida, and that additional and diversified water sources are needed to maintain a reliable supply of water for the expected increase in demand. FDEP, Regional Water Supply Planning, 2015 Annual Report. A copy is attached as **Exhibit INT-020**. The fact that an aquifer may require desalinization at some point in the future does not provide valid grounds for failing to protect it like any other USDW, because desalinization is likely to become necessary in the future to support the population in the state.

In addition, the license term for the proposed Turkey Point Units 6 and 7 reactors is limited to 40 years. It is my understanding that after the license terminates, the goal of the NRC is that the site will be in a condition that it can be released for any type of public use. If that is the goal, it should include use of the groundwater beneath the site as a drinking water source.

Q20: The NRC Staff testifies that EPA drinking water standards are a "good benchmark for determining that the wastewater injections will not adversely affect groundwater." NRC Staff Testimony, A28. Do you agree?

A20: I agree that the Maximum Contaminant Level (MCL) is a good benchmark, as the NRC Staff testifies. In that context, it is important to note that the tetrachloroethylene level reported in Table 3-5 of the FEIS (0.00359 mg/L) exceeds the Florida Department of Environmental Protection's (FDEP's) MCL of 0.003 mg/L. Teaf Testimony, ¶ 29. Although Dr. Teaf states that the measured value of 0.00359 mg/L is "well below the federal safe drinking water standard" and "only a few ten thousandths of a mg/L above the state drinking water concentration" (*id.*), this exceedance of the Florida MCL indicates potentially significant impacts, because it exceeds the FDEP drinking water standard.

In any event, the MCL is not the only standard that should be used, because it is not based purely on public health. As EPA explains, MCLs are derived from Maximum Contaminant Level Goals (MCLGs), "the level at which no known or anticipated adverse effect on the health of persons occur and which allow an adequate margin of safety." Notice of Final Rule, National Primary Drinking Water Regulations; Synthetic Organic Chemicals; Monitoring for Unregulated Contaminants, 52 Fed. Reg. 25,690-91 (July 8, 1987). A copy is attached as **Exhibit INT0021.** MCLs, in contrast, are "enforceable standard which the [Safe Drinking Water] Act directs EPA to set as close to the MCLGs as feasible." *Id.* The EPA explains that the term "feasible" means: "feasible with the use of the best technology, treatment techniques, or other means which the Administrator finds available (taking costs into consideration) after examination for efficacy under field conditions and not solely under laboratory conditions." *Id.*

As discussed in A21 of my Initial Testimony, EPA has determined that any concentration of tetrachloroethylene and heptachlor above zero could cause adverse impacts. That is why EPA has set a MCLG of zero for tetrachloroethylene and heptachlor. The fact that measurable concentrations of these chemicals have been found in the proposed injectate is cause for concern about their impacts on public health.

Therefore, in the context of determining whether environmental impacts of a groundwater contaminant are significant or not, it is my expert opinion that the key consideration should be the concentration at which the EPA has determined the contaminant may cause adverse health effects, *i.e.*, the MCLG. Considerations of feasibility and cost, which may be relevant to the establishment of an MCL, are not relevant to the issue of whether the contaminant has significant public health, *i.e.*, environmental, effects.

In my opinion, to determine whether an environmental impact is "significant," the NRC should have also used the MCLGs, which are based only on public health considerations. The fact that tetrachloroethylene is above FDEP drinking water standard is even greater cause for concern.

Q21: Noting that the levels of ethylbenzene, heptachlor, tetrachloroethylene, and toluene set forth in Table 3-5 are "all below federal drinking water standards," FPL witness Dr. Teaf also states that "[t]his means that, with regard to these four chemicals, the injectate would not be harmful to public health." Teaf Testimony, ¶ 15. Do you agree?

A21: No. Dr Teaf's testimony uses the "federal" drinking water standard rather than the lower concentration MCL established by FDEP. As discussed above, the value for tetrachloroethylene in the FEIS exceeds the FDEP's MCL, which is the standard that is applicable to FPL's UIC permit. To the extent that an MCL establishes safe levels for a chemical constituent in drinking water, the FDEP has established a level that is not satisfied for tetrachloroethylene in this case. Dr. Teaf stated that the EPA - in addition to the Agency for Toxic Substances and Disease Registry (ATSDR) - has serious concerns regarding tetrachloroethylene because it is "likely to be carcinogenic in humans." Teaf Testimony, ¶ 53. Dr. Teaf also stated that this carcinogenic factor is "addressed in establishment of the state and federal MCLs." *Id.* As discussed above in A20, the tetrachloroethylene level reported in Table 3-5 of the FEIS (0.00359 mg/L) exceeds what FDEP determines to be protective of public health and that carcinogenic factor. In any event, as I have discussed above, MCLs are not the only relevant standard for public health effects of chemicals in drinking water; the MCLG of zero for heptachlor and tetrachloroethylene must also be considered.

Dr. Teaf also makes a number of other statements disputing my views regarding the toxicity of ethylbenzene, heptachlor, tetrachloroethylene, and toluene. But my opinions are based on documents published by the EPA, which has set MCLs and MCLGs for these compounds, and on the ATSDR. Dr. Teaf does not present any reasons why the MCLGs established by EPA should be disregarded.

Q22: FPL witness Mr. McNabb testifies that groundwater monitoring "will detect upward fluid movement or leaks, before any drinking water is impacted." McNabb Testimony, ¶ 44. Do you agree?

A22: No. First, FPL does not identify, nor am I aware of, any provision in FPL's groundwater monitoring program or the State's UIC program for testing of FPL's wastewater discharge for the four VOC and SVOC constituents of concern in Contention 2.1. As discussed above in A18, the NPDES Permit for the South District Plant contains no monitoring requirements for ethylbenzene, heptachlor, tetrachloroethylene, and toluene. While Mr. McNabb describes the general process for obtaining the UIC permit (McNabb Testimony, ¶¶ 9, 10), he does not represent that the constituents will be tested for under the UIC permit prior to injection at Turkey Point. Nor does FPL make any other commitment to test for these constituents. Mr. McNabb does not go further than to generally say that leaks of the injectate will be monitored for and detected. McNabb Testimony, ¶¶ 44-47.

Second, as discussed in my Initial Testimony at A28, FPL's own groundwater monitoring system is likely unable to detect upward migration in time because (1) sampling will not be frequent enough due to the possibility of a rapid rate of migration and (2) the constituents may migrate horizontally before they migrate upward. Upward migration of wastewater along vertical pathways can occur in a matter of days, much more quickly than could be detected by FPL's

sampling frequencies. Discrete vertical migration of wastewater can also bypass shallower monitoring wells through discrete vertical fractures in the upper-lying bedrock.

My opinion is supported by the EPA, which stated in its 2005 UIC rule that "existing monitoring programs are not sufficient to protect against movement of contaminants into USDWs, nor do they provide sufficient early warning of contamination." UIC Rulemaking Notice, 70 Fed. Reg. at 70,526. As EPA further explained:

> [G]roundwater monitoring wells at most deep well facilities in Florida are only intended to provide some initial indication of fluid movement and are not capable of characterizing the full areal extent of fluid movement, especially where natural conduits for flow are present. Moreover, once any contamination is detected, it may be too late to prevent endangerment.

Id. Thus, FPL has no basis for asserting that the environmental impacts of heptachlor, ethylbenzene, toluene, or tetrachloroethylene will be insignificant because they will be detected and mitigated in a timely and effective way.

Q23: Does this conclude your rebuttal testimony?

A23: Yes.