BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

ON BEHALF OF FLORIDA POWER & LIGHT COMPANY

REBUTTAL TESTIMONY OF PETER ANDERSEN

DOCKET NO. 20170007

SEPTEMBER 25, 2017

BACKGROUND/QUALIFICATIONS

Q. Please state your name and business address.

A. My name is Peter Andersen and my business address is: 1165 Sanctuary Parkway, #270, Alpharetta, Georgia 30009.

Q. Who is your current employer and what position do you hold?

A. I am employed by Tetra Tech, Inc., an environmental consulting firm, where I am a Principal Engineer and Operations Manager at the Alpharetta Georgia office.

Q. Please describe your educational background beginning with your undergraduate degrees.

A. I obtained my Bachelor’s of Civil Engineering (“BCE”) in 1977 from Auburn University and a Master of Science Degree in Civil Engineering from Auburn University in 1980.

Q. Please describe your professional work experience since obtaining your last academic degree.

A. Following graduation with my BCE, I was employed by the Alabama Water Resources Research Institute as a field engineer. I aided in the design, construction, operation, and data analysis for an aquifer thermal energy storage and recovery project near Mobile, Alabama. Field work included operating production and injection wells and a hot water boiler as well as collecting temperature, water level, and flow rate data in a coastal aquifer.

Following graduation with my Master's Degree, I was employed as an instructor in the Civil Engineering Department at Auburn University. I taught undergraduate courses, including computer programming, hydraulics, and hydrology.

I then worked for the South Florida Water Management District in the Water Use Department. There, I was involved with permitting of water use for agricultural and municipal entities and establishment of saltwater intrusion monitoring programs.

Later, in 1982, I accepted a position with GeoTrans, Inc in Reston, Virginia. I have worked for GeoTrans since that time in positions of progressively greater responsibility. GeoTrans was acquired by Tetra Tech and is now fully integrated into Tetra Tech and goes by that name. My duties included development and testing of groundwater and solute transport models, application of these models to characterize natural systems and evaluate conceptual designs of engineered systems, report preparation and presentation to clients, and teaching. An example project included evaluation of the causes of and potential mitigation measures for saltwater intrusion at a public supply wellfield in south Florida. The analysis was performed using a sophisticated numerical model of density dependent groundwater flow and solute transport. The analysis was of significant complexity, enabling publication in a professional journal. Also during this period, I worked with other GeoTrans engineers and scientists to prepare conceptual designs of groundwater remediation systems, involving low-permeability covers, slurry cut-off walls, drains, and extraction wells. In 1994, I moved to Atlanta Georgia to open a branch office. As a Principal Engineer and Operations Manager, my duties include project management, technical analysis and design, as well as administrative tasks such as business development and office management. My technical duties include project management, conceptual designs of remedial engineering systems for hazardous waste sites, analysis of subsurface systems using numerical models, evaluation of water supply potential and prediction of impacts of water supply development, and teaching of short courses.

I have been involved with water resource problems in Florida throughout my career and have provided services to a broad range of clients, including the water management districts, counties, agricultural interests, utilities, and industry.

I have taught approximately 65 short-courses to working professionals at the International Ground Water Modeling Center, the U.S. Army Corps of Engineers Hydrologic Engineering Center, Florida Water Management Districts, and other commercial entities.

Q. Please describe any professional registrations or certifications that you hold in your field of expertise.

A. I am a Professional Engineer in the State of Florida, as well as in Georgia, Alabama, and Virginia.

Q. Please describe any professional or technical publications you have published.

A. I have authored or co-authored over 50 technical papers, either as peer reviewed journal articles or conference proceedings. Nearly all of these deal with groundwater hydrology and modeling. Two notable peer-reviewed publications involved modeling of saltwater intrusion in the Biscayne Aquifer near Hallandale Florida and a post-audit of a groundwater model I used to design a contaminant extraction/injection system. I authored "A Manual of Instructional Problems for the USGS MODFLOW Model," a training manual sponsored by the USEPA.

Q. Have you had prior experience in evaluating the impacts of the movement of contaminants from a facility or water body, and if so could you describe that experience?

A. Much of the work I do involves assessment of the migration in groundwater of constituents from source areas that are either natural or industrial in nature.

These source areas include basins, sumps, ditches, pits, landfills, injection wells, etc. The evaluation usually involves determination of the water and mass being added to the natural system and computing the impact of this addition. Although the evaluations are all different in complexity, hydrogeological setting, and analysis objectives, they share similar analysis methods, which include a combination of data processing and some form of modeling.

Q. Have you had prior experience in designing methods of abatement and remediation of contaminants in groundwater, and if so could you describe that experience?

A. Yes. Like the evaluation of impact I described in my previous answer, the design of methods for abatement and remediation of contamination in groundwater is something I have done for my entire career. My experience in this type of work began in 1982 with developing the conceptual designs of remedial alternatives for prevention of contamination from the Lipari Landfill, which was at the time the number one site on the Superfund National Priorities List ("NPL"), and has extended to the present. I have been involved with the design of remedial systems in over 10 states and a variety of hydrogeological environments including the fractured and karst system of the Anniston Army Depot.

Q. What role have you had with assessment of the operation of and environmental effects of FPL's Turkey Point Plant cooling canal system ("CCS")?

A. I have been involved with assessment of the operation of the Turkey Point Plant from a water use perspective since 2004, when I was involved with the permitting and site certification of Unit 5. During the past 10 years, I have worked on a number of projects at the Turkey Point Plant that have dealt directly or indirectly with the cooling canal system. Starting in 2008, I assessed the feasibility and permitting of the Units 6 and 7 125 million gallons per day (mgd) backup water supply that consisted of radial collector wells extending beneath Biscayne Bay. Although this system is intended to be independent of the CCS, the design and analysis nevertheless had to consider and avoid impacts to the CCS. I testified at the Site Certification hearing for Units 6 and 7 in 2013.

In 2009, I served as an advisor to FPL on the development of a monitoring plan for the Extended Power Uprate ("EPU"). This plan involved locating water level and salinity monitoring points to understand and evaluate the effect of increasing temperature in the CCS by a maximum of 2.5 degrees Fahrenheit. In 2010, I was involved with a feasibility study regarding methods of lowering the salinity of the cooling canal system and preventing further saltwater intrusion west of the CCS. These alternatives included a means of lowering the salinity of the CCS and others that involved stopping or reversing the landward migration (intrusion) of saltwater. Analysis of these alternatives included the development of a cross-sectional groundwater flow and solute transport model and a water and salt balance. This analysis was refined with additional data that was collected from the CCS Uprate Monitoring Program. FPL chose to address the source of contamination, the CCS, by lowering its salinity through addition of fresher water from the Upper Floridan Aquifer ("UFA"). In 2015 I was involved with further "proof of concept" of what became known as "the freshening alternative." The analysis further evolved to include the "Fukushima well," which is intended to be a reliable emergency backup supply of water, and is a recent requirement by the Nuclear Regulatory Commission. Following the conceptual design, I was involved with more detailed well layout. I was involved with documenting our work and presenting it as a part of the Request for Modification of the Site Certification.

As a part of the Site Certification, I was involved with a series of Florida Department of Administrative Hearings ("DOAH") hearings that have shaped the agenda for future work at the CCS. In the aftermath of those hearings, FPL entered into a consent agreement Miami-Dade County (the "MDC CA"). Part of that agreement included a requirement to develop a three-dimensional density dependent groundwater flow and transport model to design a recovery well system ("RWS") to retract the hypersaline part of the groundwater to FPL boundaries. I, along with my team of modelers, developed the model and evaluated alternative designs for the RWS subject to the constraints set forth in the agreement. We used a decision matrix approach to determine the best design. Since selection of Alternative 3D, we have modified the model in an attempt to improve its accuracy and certainty. Most recently, we also used the model as a tool to provide FPL a basis to apportion costs for the RWS between remediation (retraction of the plume) and maintenance (containment).

Q Have you ever testified as an expert witness before and if so, please describe those proceedings and the nature of your testimony.

A. Yes. I have testified as an expert in 13 proceedings, in the fields of groundwater hydrology, groundwater modeling, and water resource engineering.

Q. Are you sponsoring an exhibit in this proceeding?

A. Yes, I am sponsoring the following exhibits:

- Exhibit PFA-1 -- Resume of Peter F. Andersen
- Exhibit PFA-2 -- Simulated Relative Salt Concentrations in Model Layer 8 after 10 years for Alternatives 1, 2, and 3D
- Exhibit PFA-3 -- Revision of OPC Witness Panday’s Demonstrative 23
- Exhibit PFA–4 -- Comparison of 2015 Modeled Freshwater-Saltwater Interface with CSEM data
- Exhibit PFA-5 -- Location of CCS Monitoring Stations Relative to Plant Cooling Water Intake and Biscayne Bay
- Exhibit PFA-6 -- Saltwater Intrusion as Mapped by the USGS, 1984 and 1995

REBUTTAL OF OFFICE OF PUBLIC COUNSEL ("OPC") WITNESS PANDAY'S TESTIMONY

Q. Could you please describe the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to focus on and rebut two faulty conclusions offered by OPC witness Panday: 1) that the RWS is ineffective at retracting the hypersaline plume, and 2) that the apportionment of costs proposed by FPL is incorrect. In addition, I will respond briefly to his erroneous assertion that FPL should have known since 1992 that the CCS was causing salinity intrusion. My opinion regarding this assertion is based on my own historical involvement with the CCS starting in 2004.

1. The RWS is an Effective, Necessary Component of FPL's Agency-Approved Corrective Actions

Q. On Page 33, OPC witness Panday states that Tetra Tech's methodology involving simulating the combined impact of both the project components (freshening and remediation wells) hinders the ability to establish the impact of one project component versus that of the other. Why were the two projects simulated simultaneously?

A. The approved alternative for corrective action incorporates the requirements of both the MDC CA and the Florida Department of Environmental Protection consent order (the “FDEP CO”) (i.e., freshening, remedial wells pumping, underground injection of pumped water, interceptor ditch operation) by design to address cumulative impacts of the components of the CA and CO. All elements of the approved alternative are intended together; none of them is intended to be sufficient by itself. However, OPC witness Panday is wrong in his assertion that we have not evaluated the impact of one project component isolated from the others. On pages 16 and 17 of our initial modeling documentation (referred to as Tetra Tech, 2016c in the Office of Public Counsel’s Notice of Substitution of Exhibit SP-2 to the testimony of OPC witness Panday, filed September 14, 2017) we describe Alternative 1, which is a No Action case; Alternative 2, which is the Salinity Abatement case (or freshening case); as well as five other alternatives that include recovery wells. This documentation is my Exhibit PFA-2. In it, I show map views of simulated salinity distributions for three alternatives. The impact of both elements of Alternative 3D (recovery wells and freshening) can be seen by comparing it to Alternative 1, the No Action Case. In contrast, the impact of only the recovery wells can be seen by comparing the impact of Alternative 3D to that of Alternative 2, the Salinity Abatement case (or freshening case). As designed, the freshening primarily addresses the source while the recovery wells contain and retract the hypersaline plume.

Q. In the next paragraph of page 33, OPC witness Panday says he ran Alternative 3D without the retraction well component and compared these results to Alternative 3D with the retraction wells. Is his a valid

comparison?

A. Generally, yes, but not for evaluating the retraction wells in the context of the overall regulatory requirements for the CCS. OPC witness Panday's comparison is intended to show the net effect of the recovery wells. He does this by comparing a simulation with a background condition of a hypersaline CCS without recovery wells pumping to one with the same background condition with recovery wells pumping. This is one way of approximating the independent effect of the recovery wells. However, OPC witness Panday's case is unrealistic based on the performance objectives for the freshening of the CCS, which includes a requirement to reduce CCS concentrations to 34 PSU within 2 years of commencement of freshening. Another unrealistic aspect of his comparison is that it does not account for the additional seepage that will occur as a result of adding 14 mgd to the CCS as a part of the freshening. Thus, OPC witness Panday's method of approximating the effect of the recovery wells is flawed in two ways: (1) it represents a case that will not occur if the elements of the CA are followed because (2) his method underestimates the flow that must be handled by the recovery wells.

Q. OPC witness Panday goes on to say (lines 11-15) that "[t]he simulation results in layer 8 after 1 year for this case without pumping the retraction wells versus the case of with pumping the retraction wells…showed that the simulated concentrations are not materially different between the two cases." Does this show that the recovery wells are ineffective?

A. No. The ten recovery wells pumping along the interceptor ditch ("ID") are not slated to pump until *after* year 1. Therefore, the only difference in this comparison *at* 1 year is whether the recovery well beneath the CCS, which operates as a requirement to test the Underground Injection Control ("UIC") well, is operating or not. The recovery well beneath the CCS merely supplies water to the UIC well, and there is no expectation that it will contribute to plume retraction.

Q. Further on in this discussion, OPC witness Panday makes a similar comparison in layer 8 after 10 years and says that the impact of the retraction wells is minor. Do you agree with that conclusion?

A. No. To support his conclusion, OPC witness Panday uses his Demonstrative 23, which shows map views of the simulated distribution of salinity in the vicinity of the CCS for conditions of a) no RWS pumping and b) RWS pumping. In reviewing Demonstrative 23, one should focus on the unlabeled contour between contour lines 1.2 and 0.8. This unlabeled contour line corresponds to a 1.0 concentration, which is the dividing line between saline and hypersaline water. Retraction of this line, which is the boundary between saline and hypersaline water, is the objective of the RWS. To clearly illustrate the difference in salinity distributions resulting from no pumping and pumping conditions, I have modified OPC witness Panday's Demonstrative 23 by highlighting in red the 1.0 concentration unit lines, representing the boundary between hypersaline and saline water. The modified Demonstrative 23 is my Exhibit PFA-3. It shows that without pumping of retraction wells, the 1.0 contour line is located approximately 1.5 miles west of the CCS after 10 years. In contrast, Exhibit PFA-3 shows that with pumping of the retraction wells, the 1.0 contour line is located within the FPL property, as represented by the ID, for most of the 5 mile length of the CCS after 10 years. Thus, OPC witness Panday's own demonstrative exhibit illustrates clearly that the RWS makes a significant contribution to achieving the intended purpose of retracting the hypersaline plume.

Q. If the 1.0 concentration contour is so important to this demonstration, why has OPC witness Panday chosen not to label it?

A. I cannot tell, but certainly it is an important contour line to feature, considering that it defines the extent of the plume that FPL is required to retract.

Q. OPC witness Panday then concludes that the impact of the retraction (recovery) well system is minor in layer 11, the lowest layer in the model. Do you agree with this conclusion?

A. FPL has acknowledged that the effectiveness of the RWS in the deepest layers of the Biscayne Aquifer is not as great as in the other layers. However, it should be noted that the modeled hydrogeologic characteristics were based on best available data and optimized as described in model documentation. It is possible that aquifer characteristics could vary from those estimated using standard modeling practices. This could also explain why the model overstates the extent of the hypersaline water in the deepest layers by approximately 1 mile as compared with groundwater quality data produced by the CSEM geophysical survey, as illustrated in my Exhibit PFA-4. Because the modeled hypersaline water in layer 11 is further from the recovery wells than supported by the CSEM data, the model shows the effect of pumping on hypersaline plume retraction to be less than it would be based on the data-supported location of the hypersaline plume edge. The MDC CA requires FPL to revisit and revise the model (as necessary) after the RWS wells are constructed and operated for a year, to incorporate new hydrogeologic data produced from construction and operation of the system.

Q. OPC witness Panday presents two plots (Demonstrative 25) that show the difference in simulated salinity between the recovery wells pumping and not pumping after 10 years. Is this a useful way of looking at the effectiveness of the recovery wells?

A. No. These plots are developed by subtracting (1) salinities under a simulation with RWS pumping from (2) salinities under a simulation with RWS wells not pumping. The subtraction, or difference, indicates the net change in salinity between pumping and non-pumping conditions. I do not believe that the difference plots are particularly useful. This is because FPL is required to reduce salinity in the hypersaline plume north and west of the CCS to that of seawater (35 PSU) or less. The required reduction in salinity is not a constant number—in some areas lowering salinity by 1 PSU is all that is required; in other areas lowering salinity by 10 PSU or more may be required. In addition, the hypersaline volume outside the CCS is all that needs to be addressed by the RWS; not the entire area that is shown in Demonstrative 25. Showing the effect on the entire layer, without indicating the area that FPL has a regulatory requirement to address, invites a visual conclusion that is misleading. For these reasons, the concentration difference plots are not useful in assessing the effectiveness of the RWS.

Q. Do you believe that the RWS is an effective component of the Alternative 3D measure?

A. Yes. OPC witness Panday appears to have misinterpreted his own figure in Demonstrative 23, which clearly shows retraction of the hypersaline plume (depicted by the 1.0 contour line) to the FPL boundary. The impact of pumping versus no pumping is highlighted by the fact that the pumping is shown in Figure 22 of our modeling documentation (Tetra Tech, 2016c) to remove 24 x 10^9 (24 billion) lbs of salt mass over 10 years of operation.

Q. On page 35 of his testimony, OPC witness Panday describes the use of a steady-state spreadsheet-based water and salt balance to evaluate the impacts of adding 14 MGD to the CCS. Is this an appropriate way to evaluate those impacts?

A. No. FPL initially used a steady-state water and salt balance in the feasibility analysis conducted in 2010. That model was based on limited data and simplifying assumptions. One of these assumptions was that the CCS water balance could be simplified into an "average" number for the components of precipitation, water level, salinity, inflow, outflow, evaporation, and temperature. Since 2010, however, FPL has collected information on these parameters on an hourly basis and developed a transient water and salt balance that is much more sophisticated than the original steady state model. The new model is closely calibrated to monitoring data and has been demonstrated to match historical long- and short-term trends in salinity and water level. It has also been reviewed and accepted by the South Florida Water Management District. The steady-state water balance model is now obsolete and should not be used.

Q. Did FPL provide OPC witness Panday with the transient water and salt balance?

A. Yes.

Q. Did the CCS freshening analysis, as OPC witness Panday asserts on page 36, line 2 and 3, "[d]epend on (and assumes) groundwater salinity being at 35 PSU's to simulate total added water of about 14 MGD"?

A. The steady state balance, for the reasons described below, does assume the groundwater inflow salinity is 35 PSU—however, we no longer use this model. The groundwater inflow component of the steady-state water balance is made up of water flowing into the CCS from the east (Biscayne Bay, via the Biscayne Aquifer) and smaller amounts from the west, south, north, and beneath the CCS. At the time the steady state water balance was formulated, the groundwater inflow was a single lumped parameter that included the Biscayne Bay and smaller flows. Also, it was generally assumed that the CCS water seeped to the groundwater system, not vice versa. Thus the groundwater input term in the steady-state balance was assumed to be predominantly Biscayne Bay water at 35 PSU.

The more sophisticated transient water and salt balance, upon which FPL now relies, splits the directional components (east, west, north, south, and beneath CCS) into individual inputs that have salinities that are representative of their respective water sources. Inflow from the east, from Biscayne Bay, at 15.37 MGD, is assigned a salinity of 35 PSU, equivalent to Biscayne Bay water. Inflow from beneath the CCS is 11.47 MGD and is assigned temporally and spatially (specific areas of the CCS) varying salinities of based on time series data from the shallow screens of nearby monitoring wells Turkey Point Ground Water (TPGW)-1, -10, -12, and -13. The measured salinities from these wells are conservatively not adjusted downward for simulations involving freshening.

Q. Is OPC witness Panday's assertion that freshening the CCS will require 31 MGD of Floridan Aquifer water reasonable?

A. No. OPC witness Panday assumes that *all* groundwater seepage comes from beneath the CCS and therefore has a salinity of 55 PSU. This is clearly not valid. The largest component of groundwater seepage to the CCS comes from Biscayne Bay at a salinity of 35 PSU. The inflow of Biscayne Bay water to the CCS is a fundamental component of the CCS water balance: it is the "makeup water" that replaces water that is lost to evaporation as a part of the cooling process. The fact that a large volume of groundwater seepage comes from Biscayne Bay is confirmed by water levels in the most easterly canals of the CCS being less than the water level in Biscayne Bay. My Exhibit PFA-5 shows the locations of three key measuring points along the CCS: the plant intake, CCS-6 and CCS-5. The plant intake has, on average, the lowest water level in the system, indicating surface and groundwater flow towards the intake. The water level at CCS-6 is, on average[1], 0.3 feet less than that of Biscayne Bay. The water level at CCS-5 is, on average[1], 0.1 feet less than that of Biscayne Bay. Thus, the data show that there is a large component of groundwater seepage from Biscyane Bay to the CCS. Moreover, erroneously assuming that makeup water comes from beneath the CCS at a high salinity of 55 PSU, as OPC witness Panday has done, will lead to computation of an erroneously high amount of water required for freshening.

Q. Does FPL have data on actual CCS conditions that suggest that 31 MGD will not be required to freshen the CCS to 35 PSU?

A. Yes. In late September and early October 2014, FPL discharged into the CCS over a three week period an average of 43.5 MGD of water from Canal L31-E, with salinity similar to that of the Floridan Aquifer. The addition had an immediate effect on CCS salinity, reducing salinity from 90 to 62 PSU, a 28-PSU reduction. The freshening design is to reduce the CCS salinity from 60 to 34 PSU, a 26 PSU reduction. The observation that an influx of 43.5 MGD over a 3 week period reduced the CCS salinity by more than the design amount and that this occurred immediately, rather than over the 2 year design period, suggests that 31 MGD will not be required to freshen the CCS to 35 PSU.

[1] Based on 2010 through 2016 Uprate Monitoring data from these CCS stations.

In addition, the water level and salinity response of the CCS to the addition of a known quantity and quality of water was used to further calibrate the model. Based on the model calibration and data from the water addition, we believe that 31 MGD will not be required to freshen the CCS.

Q. OPC witness Panday states on line 13 of Page 41 that "[t]he retraction well component of FPL's proposal is not reasonably effective at retracting the hypersaline plume." Do you agree with this summation?

A. No. OPC witness Panday's summation is based on his prior statement that "[t]he retraction wells do not meet their stated objective of retracting the hypersaline plume west of the CCS footprint, as I have shown in my analysis above." As I have just explained, OPC witness Panday has misinterpreted his own results and erroneously concluded that the wells did not retract the plume. Because his summation is based on an erroneous conclusion, it too is erroneous.

Q. OPC witness Panday states on Page 40, line 19 that he is not aware of any system where this combination of corrective actions (i.e., freshening of the CCS and pumping from extraction wells) has been deployed. Does Alternative 3D rely on an unusual or unproven corrective action strategy?

A. No. Alternative 3D relies on a basic concept that has been demonstrated time and again at all manner of environmental cleanup sites: 1) source control/removal, followed by 2) plume containment or remediation. The fact that source removal is accomplished by "freshening" should not be misunderstood to indicate that this technique is novel or outside the mainstream of conventional groundwater cleanups. Freshening has been demonstrated by FPL to be effective in their transient water and salt balance as well as measured CCS response to the addition of L31E water. Pumping of recovery wells is perhaps the most basic and understood method of plume containment and plume removal.

2. FPL Has Properly Allocated RWS Costs between Containment and Retraction

Q. Regarding the cost allocation in the FPL proposal, OPC witness Panday states that the proposed remedial alternative does not consider retraction of the saline water further west of the hypersaline plume. Is this a valid criticism?

A. No. The MDC CA only requires retraction of the hypersaline part of the plume. Addressing a larger and less concentrated plume would be considerably more costly than the proposed remedy. FPL's cost allocation is appropriately based on the actions FPL is required to take, not on ones it is not required to take.

Q. OPC witness Panday also takes issue with the suggestion that the lower two layers of the model may not actually be a part of the Biscayne Aquifer. Is this a valid criticism?

A. No. OPC witness Panday claims that he has "noted that the lower two layers have hydraulic conductivities in excess of 500 ft/d in the model" and that this "does not reflect confining or aquitard-like conditions." However, aquifers are not defined by an absolute value of hydraulic conductivity for a particular layer. Rather, they are defined by their ability to transmit water, which is a function of the *relative* conductivity of adjacent layers. In the most recent update to the Tetra Tech model, the lower two layers have a hydraulic conductivity of 389 ft/d and are adjacent to a high flow zone, which has a hydraulic conductivity of 35,980 ft/d, or nearly two orders of magnitude greater than the lower layers. This sharp contrast in hydraulic conductivity causes the lower two layers to not behave as part of the aquifer above them. Instead, the extraction wells, despite being screened within the lower two layers, obtain most of their water from the preferred high flow zone. Hydraulically, the lower two layers do not behave as part of the Biscayne Aquifer.

Q. OPC witness Panday takes issue with using an analysis period of 20 years when the hypersaline plume west of the CCS is removed by 11 years. Is this a valid criticism?

A. No. The RWS is a remediation *and* containment system. If the system were turned off at year 11 when the hypersaline water to the west of the ID has been removed, the containment aspect of the system would be lost. Containment of the area east of the ID is important because there are areas beneath the CCS that are projected to remain hypersaline even after 11 years of pumping and freshening.

Q. OPC witness Panday suggests that the extraction rates and hence the cost apportionment should be adjusted over time as remediation goals are accomplished. FPL witness Ferguson addresses this proposal from an accounting perspective. What is your reaction to the proposal from a scientific perspective?

A. I do not believe that it is reasonable. As I noted previously, the RWS is both a remediation and containment system. Containment depends on capturing the *volume* of water moving westward, not the mass of salt contained in that water. Therefore, a decline over time in the salt mass removed does not affect the volume of water that must be captured. The extraction rates to contain the westward moving water remain relatively constant.

3. FPL Could Not Reasonably Have Been Expected to Know in 1992 That the CCS Was Causing Salinity Intrusion.

Q. You described your involvement in a 2010 feasibility study for stopping westward migration of saline water and decreasing Cooling Canal System concentrations. What was your understanding of FPL's reasons for performing this study?

A. FPL had just renegotiated the site certification for Turkey Point to include the EPU. Among the conditions for the renegotiated site certification was a requirement to develop a monitoring plan to assess the extent of salt water intrusion and in particular hypersaline water, west of the plant. My understanding was that the purpose of the study was to assess options for addressing the hypersaline conditions in the CCS and to stop westward migration of saline water should the monitoring indicate that this would be required.

Q. Did you, at the time of the study, know the extent of hypersaline water to the west of the CCS?

A. No. One of the key limitations in 2010 was the lack of monitoring points to the west of the CCS. There were two wells, L-03 and L-05, that were located on the L-31E levee (and hence the "L" designations) just outside the FPL property. These wells were monitored for salinity at two depths, shallow (approximately 20 ft) and deep (approximately 60 ft). The next sets of monitoring wells (G-21 and G-28) were located along Tallahassee Road, three miles west of the CCS. These wells were also monitored for salinity at two depths, shallow (approximately 20 ft) and deep (approximately 60 ft). The deep L-wells, just outside the FPL property, indicated hypersaline water to be present. The deep G-wells, on the other hand were showing a rise in salinity, but had not reached the salinity of seawater. Another limitation was that the L and G wells did not have discrete screened intervals from which a sample could be collected or measurement made. Instead, the measuring device was simply lowered into the well to a certain depth and a measurement taken. It was then lowered further to another depth and a measurement taken. The quality and accuracy of this data was questionable. So, in summary, the extent of the hypersaline water was not known in 2010 due to data limitations.

In addition, the data that did exist were of questionable quality.

Q. Did the United States Geological Survey ("USGS") publish maps that showed the extent of saline water intrusion in Southeast Florida at different points in time before and after the CCS went into service?

A. Yes. The USGS published regional maps that showed interpretations of the extent of the 1000 mg/L TDS isocontour line at the base of the Biscayne Aquifer. The interpretations were based on regional monitoring well data that were collected by the USGS. Isocontours were published for 1970, 1984, 1995, and 2008. A comparison of the 1984 and 1995 maps is shown in Exhibit PFA-6.

Q. And what did these maps show?

A. The maps showed the 1000 mg/L TDS isocontour line extending from north to south, essentially following the coastline, shifting slightly westward with the coastal bend in south Florida. This line was approximately 5 miles inland from the coast in all the maps. Besides showing the extent of saltwater intrusion, the maps were interesting because they indicated relative stability of the saltwater interface with time, over a period covering 1970 to 2008. In fact, as shown in Exhibit PFA-6, the saltwater interface was mapped further west in 1984 than it was in 1995, suggesting that the saltwater interface had retracted toward the coast during this time period.

Q. Why was the relative stability of the saline water interface of interest to you?

A. One of the theories that have been advanced is that the hypersaline water "pushes" the saline water interface. Conversely under that theory, if the saline water interface was stable and not being "pushed," then it would suggest that the hypersaline plume must also be stable.

Q. How accurate were these maps?

A. The USGS struggled with the same data limitations as did FPL. With the benefit of hindsight, it now appears that these maps may not have accurately mapped saltwater intrusion near Turkey Point. However, reliance upon these maps by FPL, regulators, and the general public was reasonable at the time and may have given a false sense of security that salt water intrusion, and hence hypersaline water movement, was not occurring.

Q. OPC witness Panday concludes that it was clearly demonstrated in 2009 that the CCS had increased the Biscayne aquifer's salinity. Do you agree?

A. No. First, saying that "the CCS increased the Biscayne aquifer's salinity" is a very imprecise statement and may not be of importance. Second, OPC witness Panday bases his conclusion on a model by Hughes, et al. (2009) that I have found both to be subject to a significant methodological limitation and to be based on errors in key input assumptions.

Q. What is the methodological limitation with the Hughes model?

A. It is not calibrated, which means that it does not compare the model response to a historical response. Comparison to a past condition provides confidence that the model is an accurate representation of the hydrogeological system. Calibration is an important step in the modeling process and provides credibility to the model. Because the Hughes model is not calibrated, four different versions of the model are presented, each with a different value of hydraulic conductivity. The hydraulic conductivities in the four versions vary over 5 orders of magnitude. Hydraulic conductivity is perhaps the most important parameter in the model and not knowing its value within 5 orders of magnitude makes the results of the model highly speculative. There are several other technical limitations that further support my conclusion.

Q. You also mentioned errors in the input assumtions for the Hughes model. What are these and how do they affect the results?

A. The model contains errors in the assumed depths of the ID and the return canal. The ID, which is 18 feet deep, is modeled to be 9 ft deep. This error allows more saltwater to move west than would occur with the more realistic deeper ditch. In addition, the 18 ft deep return canal that runs from the south to the north within the CCS is modeled as 3 ft deep. The effect of this error is less clear, although, as a return canal, it may not capture as much CCS water as it would occur with a deeper ditch. Under this circumstance, the model would overestimate the amount of mass added to the aquifer and hence the extent of saltwater intrusion.

Q. Please summarize your testimony.

A. OPC witness Panday's criticisms of the corrective actions that FPL is implementing pursuant to the MDC CA and FDEP CO are based on misunderstandings of the intended purpose of those actions as well as flawed and outdated modeling. They are invalid and should be rejected. For similar reasons, his criticism of FPL's apportionment of the RWS costs between retraction and containment is ill-founded and should be rejected. Finally, his assertion that FPL should have known by 1992 that the the CCS was causing salinity intrusion is insupportable based on information available at the time.

Q. Does this conclude your testimony?

A. Yes.

TETRA TECH

Peter F. Andersen, P.E.

Principal Engineer

37 years of experience in groundwater hydrology and civil engineering. Professional expertise with numerical methods in hydrology, groundwater hydrology, contaminant transport, surface water hydrology, computer programming, saltwater intrusion and aquifer water quality, wellfield analysis, and aquifer thermal energy storage.

Education:

M.S., Civil Engineering, Department of Civil Engineering, Auburn University, 1980

B.C.E., Civil Engineering, Department of Civil Engineering, Auburn University, 1977

Registrations/Certifications:

Professional Engineer:
VA #014511
GA #028802
AL #26482
FL #62133

Office:

Atlanta

Years of Experience:

Thirty seven

Years with Tetra Tech:

Thirty five

PROFESSIONAL WORK HISTORY

Tetra Tech / Tetra Tech GEO / GeoTrans, Inc., Atlanta, Georgia, (1994-Present), *Principal Engineer/Vice President*
GeoTrans, Inc., Sterling, Virginia, (1982-1994), *Staff* to *Principal Engineer/Vice President*
South Florida Water Management District, Water Use Division, Resource Control Department (1981), *Water Resource Engineer*
Department of Civil Engineering, Auburn University (1981), *Instructor*
Department of Civil Engineering, Auburn University (1979-1980), *Graduate Research /Teaching Assistant*
Water Resources Research Institute, Auburn, Alabama (1978-1979), *Field Engineer*

RELEVANT PROJECT EXPERIENCE

Mr. Andersen's project experience is divided into categories of: 1) Water Resource Evaluations, 2) Contaminant Transport, 3) Mining, 4) Peer/Technical Review, 5) Code Development / Testing / Other, 6) Teaching, and 7) Litigation Experience.

Water Resource Evaluation

Manson Bolves Donaldson Varn, Cape Coral, FL—Reviewed groundwater modeling performed by consultants for the Florida Governmental Utility Authority (FGUA) and Department of Environmental Protection (FDEP) supporting a Class V injection well near the City of Cape Coral's water supply. Provided questions for deposition of the opposing party's modeling expert. The case settled prior to an administrative hearing.

Florida Power and Light Company, Florida City -- Project Manager for a project to develop a variable density SEAWAT model of the groundwater and cooling canal system surrounding the Turkey Point power generation plant. Integrated a large amount of recent and historical data and calibrated the model to over 40 years of movement of saline and hypersaline water. Used the model to support the design of a Recovery Well System to remove hypersaline water from the aquifer. Presented results to stakeholders and performed modifications to the study to address concerns.

Florida Power and Light Company (through Golder Associates), Okeechobee County, Florida -- Performed an initial water supply assessment for a new power plant near Ft. Drum. Later, assisted FPL in technical discussions with the St Johns River Water Management District and Indian River County for obtaining permits for a water supply of 9 mgd. Performed groundwater modeling to determine impact on existing legal users in the area around the wellfield. Prepared for a site certification hearing, which later was not contested.

Florida Power and Light Company, Florida City – Project Manager for technical analysis for certification of a 125 mgd backup water supply for two new nuclear units at the Turkey Point electrical power plant. Conducted numerical modeling using MODFLOW and SEAWAT to assess the feasibility of infiltrating ocean water through a series of laterals extending beneath Biscayne Bay from on-shore caissons. The model was also used to design and analyze a 10,000 gpm aquifer test and to predict the environmental impact of operating the radial collector system. Provided peer review of another contractor's work related to the regional impact of the radial collector wells. Testified in the Site Certification hearing on nature of the impacts and compliance with State and County statuates and codes.

Florida Power and Light Company, Florida City – Provided support to the development of a groundwater, surface water, and ecological monitoring plan for the cooling canal system at the Turkey Point site as a part of the "Uprate Project". Developed a comprehensive water and solute balance of the cooling canal system. Evaluated the effectiveness of adding Floridan Aquifer water to the cooling canal system to reduce salinity.

Northwest Florida Water Management District – Project manager for a study of water supply development potential on St. George Island, Florida. Developed screening level models to evaluate various levels of development and their impact in terms of drawdown and saltwater upconing.

Hesperides Group, LLC, Grand Cayman Island – Constructed and calibrated cross-sectional SEAWAT variable density flow and transport model of East End, Grand Cayman Island to simulate current extent of saltwater wedge. Predicted changes to saltwater wedge extent due to construction of a mixed-use seaport. Wrote technical memorandum summarizing modeling analyses and results as a part of proposal to Cayman Islands Department of Environment.

Escambia County, Florida – Reviewed a petition for a waiver to the County's wellhead protection ordinance for an expansion to a construction debris landfill. Performed technical analyses to refute claims regarding the influence of a public water supply well on groundwater flow directions on the landfill property. Gave a deposition on the findings of the analysis.

Northwest Florida Water Management District - Prepared a data package for inclusion in a dredge and fill permit application for Bayou Chico (Pensacola, FL). The impact of a wellhead protection ordinance was evaluated, as well as the potential for saltwater migration from the dredge pond under variable climatic conditions. The SEAWAT model was applied to evaluate the potential for migration of a saltwater plume to a public water supply well. A groundwater monitoring plan was developed to set triggers for when dredging should be curtailed and for verification that saltwater was not migrating from the pond. Participated in negotiations between the regulatory agency, water management district, and a water supplier to gain issuance of the permit, which was eventually granted.

Hillsborough County, Florida – Member of the County's Water Team, which evaluated various water supply projects and their effect on the County's interests. Provided litigation and arbitration support as required. Provided review of SWFWMD proposed rule on minimum flows and levels. Gave a deposition on opinions on validity and applicability of the rule. Evaluated environmental impacts due to the proposed Cone Ranch wellfield. Reviewed a plan for optimal operation of wellfields in the Northern Tampa Bay area. Quantified expected environmental impacts from a proposed above-ground off-stream storage reservoir. Participated in an arbitration regarding the impacts due to the reservoir. Provided review of an integrated groundwater/surface water model of the Northern Tampa Bay area.

Florida Power and Light Company, Palm Beach County, Florida – Conducted groundwater flow modeling in support of site certification for the West County Energy Center. Performed initial groundwater modeling to assess impact of water use and later modified the model using site-specific hydraulic parameters derived from an aquifer test.

Smurfit-Stone Corporation, Fernandina Beach, Florida – Conducted groundwater modeling in support of the facility's consumptive use permit renewal. Developed a wellfield management plan as guidance for operation, monitoring, and reporting.

Florida Power and Light Company, Florida City – Reviewed groundwater modeling conducted in support of site certification under the State of Florida's Power Plant Siting Act of the Turkey Point Unit 5 Project. Performed independent groundwater modeling to evaluate impacts to existing legal users of groundwater (irrigation and aquifer storage and recovery ASR facilities) and presented expert testimony at the site certification hearing.

Pinellas County Utilities, Florida - Evaluated a groundwater model study developed by the state regulatory agency. Performed inverse modeling to evaluate the effect of parameter uncertainty on drawdown impact predictions. Also evaluated the technical basis for environmental protection standards developed by the state. Provided integrated groundwater/surface water modeling using a linked HSPF/MODFLOW model in support of a consumptive use permit for the Cross Bar Ranch wellfield.

Pinellas County Utilities, Florida - Technical analysis of water use permit renewals at four wellfields in the northern Tampa Bay area. Gave two depositions in anticipation of an administrative hearing.

Peace River Manasota Regional Water Supply Authority, Florida (through Carey, Whittaker, O'Malley, and Manson, P.A.) – Evaluated the effectiveness of a proposed reservoir in southwest Florida for meeting environmental goals (minimum stream flows) and water-supply demand.

Deseret Ranches/EEE Corporation/NNN Corporation, Osceola County, Florida - Evaluated hydrogeological data and their implementation into numerical flow and transport models for a proposed wellfield. Presented expert testimony regarding results of the analysis at an administrative hearing.

South Florida Water Management District, Florida - Project Manager for the development of a groundwater withdrawal optimization module for the MODFLOW model. This module allows determination of optimal pumpage rates and locations given constraints on head, drawdown, or hydraulic gradients.

St. Johns River Water Management District, Florida - Served on a panel that provided recommendations for assessment of future needs and sources of groundwater to the St. Johns River Water Management District of Florida.

St. Johns River Water Management District, Florida - Served as project manager for a project involving development of a three-dimensional flow and transport model of the Wekiva River Basin in east-central Florida. The model was used to assess the potential for salt-water intrusion into the aquifer and river system due to future pumpage increases.

Harloff Farms, Southwestern Florida - Evaluated and modified existing numerical models of drawdown impact resulting from a large agricultural concern. Provided expert witness testimony on the results of the analysis.

Southwest Florida Water Management District, Florida - Managed a project involving development of cross-sectional and three-dimensional variable density numerical models of the groundwater system on the Pinellas County, Florida peninsula. Alternative conceptual models were evaluated to assess the potential for salt-water intrusion due to pumpage and natural effects. Extensive sensitivity analysis was conducted to evaluate parameter uncertainty.

South Florida Water Management District, Florida - Managed a project involving assessment of the causes of saltwater intrusion into the Hallandale wellfield in south Florida. Cross-sectional and three-dimensional modeling of variable density groundwater flow was performed to aid in development of a comprehensive water management plan.

Long Island Water Conference, New York - Conducted an investigation on the current status of groundwater availability and potential for saltwater intrusion. The results were presented at a NYDEC regulatory hearing.

Nesbit Law Firm, Northwestern Indiana - Conducted numerical modeling to conceptualize flow in a multilayer aquifer system. Assessed the possibility that lowered water levels in the surficial aquifer were the result of pumpage in an underlying aquifer.

Bureau of Indian Affairs, New Mexico - Participated in investigation of available groundwater resources in the San Juan Basin for litigation purposes. Compiled existing data, conducted numerical modeling, and served as project manager.

U.S. Attorney's Office, Albuquerque, New Mexico – Conducted numerical modeling and provided expert witness testimony for a hearing concerning water appropriation for the Plains Electric generation facility near Gallup New Mexico.

South Florida Water Management District, Florida - Evaluated water use permit applications for withdrawals greater than 100,000 gal/day for municipal, industrial, and agricultural use, and wrote reports citing staff recommendations. Also coordinated water quality monitoring with water utilities, and assisted in establishing programs to manage saltwater intrusion.

Contaminant Transport

New York Office of the Attorney General, New York. As a consulting expert, developed a conceptual model of groundwater flow and solute transport for the OU-3 off-site groundwater of the New Cassel Industrial Area (NCIA) on Long Island. Oversaw development of an EVS/MVS visualization of chemical data. Presented results to the Office of the Attorney General and Department of Environmental Conservation. Later, as a testifying expert, developed opinions for the purpose of cost recovery regarding extent of TCE and PCE contamination resulting from three sites in the NCIA. Gave a deposition regarding these opinions. Prepared for a bench trial that was eventually settled during the trial.

Lockheed Martin Corporation, California – Task Manager for development and execution of groundwater flow and solute transport modeling of perchlorate and TCE plumes in the Bunker Hill Basin near San Bernardino. The modeling is being used to make decisions regarding implementation of water treatment at wellheads and blending to attain water quality objectives. Various basin-wide pumping scenarios have been evaluated to optimize containment and minimize costs. Successfully identified wells that would be affected by a slug release from the industrial facility based on an analytical screening model, BIOCHLOR.

U.S. Army Corps of Engineers, Mobile District - Task manager for groundwater flow and transport modeling being conducted in support of a focused feasibility study at the Anniston Army Depot, Anniston, Alabama – Challenging aspects regarding the site are the combination of its setting in a karst limestone aquifer and the presence of DNAPLs in the subsurface.

Westinghouse Savannah River Company, South Carolina - Program Manager for a task order contract for groundwater modeling services. The tasks ranged from determining the extent and risk of groundwater and soil contaminated with solvents, metals, and/or radioactive byproducts to evaluating the effectiveness of various remedial alternatives. Contaminants of concern for these analyses included solvents, metals, and radionuclides (tritium, uranium, plutonium, radium). Conducted or managed work using MODFLOW, MT3DMS, MODFLOW-T, MODPATH, HELP, FTWORK, GMS, VZCOML, GOLDSIM, ArcView/GIS, ZONEBUDGET, TRAMP.

ATK Launch Systems, Magna, Utah – Project Manager for a Corrective Measures Study at a solid-fuel rocket motor research, development, and production facility. Oversaw the development of a plan submitted to the Utah Department of Environmental Quality that identified corrective action objectives, developed various alternatives for meeting the objectives, and provided details on the selected remedy. Constituents of interest included perchlorate, TCE, and 1,1-DCE.

U.S. Army Corps of Engineers, Sacramento District– Project Manager for a solute transport modeling study at the Tooele Army Depot (TEAD) in Utah. Evaluated the development of a large TCE plume and the operation of a 5000 gpm groundwater extraction/injection system. Provided technical justification for the temporary shutdown of the system. Continue to provide annual updates to the model, advice on monitoring and management of the plume, and present results to regulators and the public.

U.S. Army Corps of Engineers, Kansas City District – Provided guidance on correcting and modifying an existing groundwater flow and contaminant transport model at the former Nebraska Ordnance Plant in Mead, Nebraska for the purposes of cost recovery. Oversaw development of programs to compute factors relevant to cost recovery, such as relative mass in place of various constituents and duration of remediation. Presented results to U.S. Army Corps technical staff, EPA, Department of Justice attorneys, and representatives of potentially responsible parties.

U.S. Army Corps of Engineers, Mobile District - Evaluated groundwater capture zone modeling for containment of an explosives (TNT, RDX, HMX) plume at the Milan Army Ammunition Plant in Milan Tennessee. Selected locations of additional extraction wells and designed the groundwater monitoring network to verify containment and restoration at the O-line facility. Performed numerical modeling to verify capture zones of the operating system and evaluated alternative operational strategies. Performed modeling in support of a base-wide risk assessment. Used numerical modeling to design a groundwater extraction system and associated monitoring network at the X-line facility. Presented results at several Restoration Advisory Board (RAB) meetings.

Westinghouse Savannah River Company, South Carolina - Performed numerical modeling in preparation of an Environmental Impact Statement (EIS) for a new production reactor at the Savannah River Site. Also developed and calibrated a regional three-dimensional groundwater flow model of the hydrogeologic system. Used parameter estimation techniques to calibrate and evaluate the model. In addition, performed numerical modeling of RCRA closure options for two seepage basins. Contaminants of concern included solvents, metals, and radionuclides (uranium, plutonium, radium, tritium).

NewFields, Inc., Muskegon, Michigan - Performed a particle tracking evaluation of proposed remedial alternatives at the Bofors-Nobel Superfund Site for a PRP group. Evaluated mechanisms for the fate and transport of benzidine contamination.

NewFields, Inc., Aberdeen, North Carolina - Performed solute transport modeling and technical analysis in support of a natural attenuation demonstration at the Aberdeen Pesticide Dump Sites for a PRP group. The modeling helped demonstrate the ineffectiveness of a proposed pump-and-treat remedy and that natural attenuation and phyto-remediation would prevent off-site migration of contamination.

Addington Environmental Services, Macon, Georgia - Performed numerical modeling to evaluate groundwater flow trajectories and solute concentrations resulting from a leak scenario for a proposed landfill expansion.

Martin Marietta Energy Systems, Paducah, Kentucky - Project Manager for the development of a three-dimensional groundwater flow model at the Paducah Gaseous Diffusion Plant. Provided recommendations for a field data collection program. Used optimization techniques to evaluate efficiency of various remedial designs.

Hudson County, New Jersey (through SCS Engineers) - Performed three-dimensional numerical modeling in support of a permit application for a new landfill.

Westinghouse Savannah River Company, South Carolina - Project Manager involving environmental performance and groundwater modeling at the Savannah River Site. Performed modeling in support of exposure assessments for baseline and remedial alternative risk assessments. Determined Alternate Concentration Limits (ACLs) from a large mixed waste facility. Used numerical modeling to design a groundwater recirculating system for containment of a tritium plume.

Prices Pit Landfill, New Jersey - Performed numerical modeling of alternative remedial measures.

BCM, Inc., Lipari Landfill, New Jersey - Performed computer modeling of alternative remedial measures, including capping, drains, cutoff walls, and groundwater extraction. The results of this study were published in a peer-reviewed journal.

Mining

Oldcastle Materials, Opelika Alabama – Developed a conceptual model to evaluate allegations of spring depletion due to dewatering of a quarry. Collected and evaluated data from sonic flow meters, water level transducers, precipitation gages, and other sources to develop the conceptual understanding. Gave a deposition on the findings in anticipation of a jury trial.

Kennecott Eagle Minerals Company, Upper Peninsula, Michigan – Reviewed groundwater modeling performed as a part of mine permit application to assess the impact of bedrock mine dewatering on a surficial aquifer and streams. Modeling performed by the client’s consultant and parties opposed to the mine were reviewed and expert testimony prepared in preparation of a contested case hearing.ndings and provided support for attorneys representing the County.

Meridian Gold, Chile – Developed a groundwater flow model to assess the impacts of mine dewatering, in particular changes to a groundwater divide upon which the proposed mine is situated. Drawdown, impacts to surface water flows, and potential contaminant pathways were also assessed.

Nicolet Minerals Company, through Foth and Van Dyke, Inc., Northern Wisconsin - Project Manager for groundwater modeling and studies in support of an Environmental Impact Report (EIR) for a proposed underground zinc mine. The study involved using numerical modeling to predict mine inflows and effects on the groundwater system and surface waters due to mining operations. Solute transport modeling to assess the magnitude and extent of metals migration from a proposed tailings management area was also performed. The results of the study were used to design water handling and water treatment facilities and to demonstrate compliance with regulatory requirements. Participated in over 50 public meetings with state and federal regulators, the U.S.G.S., Native American Tribes, and citizen groups.

Peer / Technical Review

Southwest, South, and St Johns River Water Management District, Florida – Serving as chairman of a peer review team that is reviewing and providing guidance on the development of the East Central Florida Transient Expanded (ECFTX) groundwater flow model. Fellow peer reviewers are Drs Mark Stewart and Louis Motz.

St Johns River Water Management Distict, Florida – Reviewed modifications to and application of the Northern District Model, a joint project also involving the Southwest Florida Water Management District, and resulting in Version 4 of that model.

St Johns River Water Management Distict, Florida – Participated in a peer review of tools and methods being considered by the St Johns and Southwest Florida Water Management Districts for setting a minimum flow and level (MFL) on Silver Springs. Silver is one of the largest artesian spring fomations in the world and a National Natural Landmark. Fellow peer reviewers were Drs Mark Stewart, Sam Upchurch and Shahrokh Rouhani. Commented on the basic philosophy, data, modeling, and temporal changes to the spring as a part of the review documentation.

Georgia Environmental Protection Division, Atlanta, Georgia – Reviewed groundwater modeling in support of the Georgia State Water Plan. Several groundwater models were applied, subject to various constraints, to estimate sustainable yield in various part of the state.

Mississippi Department of Environmental Quality, Jackson, Mississippi – Conducted a peer review of a groundwater flow model developed by the MDEQ of the Mississippi Delta Alluvial Aquifer. Attended meetings with the MDEQ and USGS and conducted a review of the modeling assumptions and implementations. Authored a report on the findings and made suggestions for model improvements and aquifer management strategies.

Northwest Florida Water Management District - Provided technical review and advice on the development of a groundwater flow and saltwater transport model of the coastal area of Okaloosa and Santa Rosa Counties in Florida. Considerations for the conceptual model, a pre-development model, and sensitivity/uncertainty analysis were presented to the District and later incorporated into the model.

South Florida Water Management District, Florida – Served as chairman of a peer review team, also consisting of Dr. Leonard Konikow and Dr. Bruce Jacobs, for the East Central Florida Transient (ECFT) model developed by District staff. Led weekly teleconferences and was in charge of developing a report on the findings of the peer review team.

South Florida Water Management District, Florida – Served as chairman of a peer review team, also consisting of Dr. Richard Peralta and Dr. John Shafer, for a subregional model, Lower East Coast subRegional (LECsR) developed by District staff. The model was of significant complexity and included groundwater/surface water interactions. Led weekly teleconferences and was in charge of developing a report on the findings of the peer review team.

St. Johns River Water Management District, Florida - Provided peer review of groundwater modeling projects being conducted by District staff and outside consultants. Models and studies that have been reviewed include: 1) Northeast Florida, 2) East Central Florida, 3) Volusia County, 4) Palm Coast, 5) Rationale for minimum flows and levels at Blue Spring, and 6) North Central Florida. Provided input to the District for modification to the models. Participated in the Northeast Florida Water Supply Planning Area Groundwater Modeling Subgroup meetings and discussions.

Northwest Florida Water Management District, Florida. Provided peer review of groundwater flow model of a proposed new wellfield in Bay County. Participated in meetings and discussions to refine the model. Provided testimony and assisted attorneys in cross-examination of witnesses for parties opposing the wellfield at an administrative hearing.

Coastal Bend/Coastal Plains Groundwater Conservation Districts, Texas. Technical reviewer for work related to the Lower Colorado River Authority (LCRA) and San Antonio Water System (SAWS) Water Project (LSWP). The initial focus of this support was to review for the Districts the numerical groundwater flow model that was developed as part of the LSWP by URS Corporation and others.

Hillsborough County, Florida—As a member of the County's Water Resource Team, provided technical review of an integrated groundwater/surface water model being developed by Tampa Bay Water, a regional water supply authority. Participated in meetings and provided questions and critiques to the model development team.

JIS Performing Group, New Jersey - Provided peer review of a groundwater flow and solute transport model for a PRP group. Modeling was performed to assess merits of various pump-and-treat and monitored natural attenuation scenarios. Recommendations were made for all aspects of the study, including development of the conceptual model, model calibration, and construction of scenarios.

South Florida Water Management District, Florida - Provided review of technical issues relating to development of minimum water flows and levels criteria for the Lower East Coast Planning Area as a member of the SFWMD Expert Assistance Pool.

Foth and Van Dyke, Inc., Southern Illinois - Provided technical review and oversight of flow and transport modeling performed in support of two proposed landfill expansions.

South Florida Water Management District, Florida - Technical reviewer of modeling studies prepared for the District's Water Supply Planning Initiative. Reviewed and provided comments on groundwater flow models of: Broward Co., Martin Co., Hendry Co., Lee Co., and Jensen Beach.

Code Development / Testing / Other

U. S. EPA, Kerr Labs, Oklahoma - Developed a manual of instructional problems for the MODFLOW groundwater model.

Auburn University, Alabama - Developed methodology and performed numerical simulation of solute transport in a two-well tracer test in a stratified aquifer.

Developed pre-processors to facilitate data preparation for the USGS two-dimensional model, USGS modular model, and a proprietary saltwater intrusion model.

USGS, Houston, Texas - Extensively modified the USGS two-dimensional groundwater flow model to include effects of varying principle directions of anisotropy, layered systems and barriers for modeling of the Edwards Aquifer.

Aquifer Thermal Energy Storage (ATES) Projects, Auburn University – Contributed to the design, construction, operation, and data analysis of a field experiment to demonstrate the feasibility of storing thermal energy in aquifers for the purpose of leveling the demand/availability cycle for thermal energy. The project involved pumping water from a shallow aquifer, heating it using a boiler, injection of the hot water to a deeper aquifer, storing it for a period of 2-3 months, and pumping to recover the stored water and heat. The project successfully demonstrated during two six-month cycles of operation that 65 to 74 percent of the injected heat could be recovered for later reuse. Approximately one half of the work involved data processing, and data analysis; the other half involved operating pumps and a hot water boiler, in-the-field troubleshooting and modifications, as well as collecting temperature, water level, and flow rate data from monitoring and production/recovery wells.

Teaching

Short courses GeoTrans/Tetra Tech: 1982- present

Basics of Groundwater Flow and Pollution (USGS2D, MODFLOW):
Georgia Southwestern College, July 1982
International Groundwater Modeling Center, Indianapolis Indiana, 1983, 1984, 1985, 1986, 1987(2), 1988, 1989(2), 1990(2), 1991(2)
International Groundwater Modeling Center, Golden, Colorado, 1992(3), 1993(2), 1994(2), 1995
USEPA Region IV, February 1985
Roy F. Weston, Inc., May 1985
Southwest Florida Water Management District, July 1986
Tipton and Kalmbach, Inc., May 1987
BP America, May 1988
Mississippi DEQ, June 1990
U.S. Army Corps of Engineers, August 1993

South Florida Water Management District, August 1995
Shell Oil Company, July 1997
Sonoma County Water Agency, February 2011

Advanced Groundwater Flow Modeling (MODFLOW, MODPATH, associated modules):
International Ground Water Modeling Center, July 1995, June 1998

Polishing Your Groundwater Modeling Skills (MODFLOW, MODPATH, associated modules):
International Ground Water Modeling Center, June 1999, June 2000, March 2001, May 2002, September 2003, November 2004, May 2006, May 2008, May 2009, May 2010, June 2011, March 2012, June 2013, November 2014, May 2015, May 2017

Groundwater Modeling Module of *PROSPECT Groundwater Hydrology Course*:
U.S. Army Corps of Engineers, August 1994, August 1996, September 1997, August 1999, August 2002

PROSPECT Course on *Groundwater Modeling*
U.S. Army Corps of Engineers, July 1998

Groundwater Modeling for Non-Modelers
St. Johns River Water Management District, April 2007
International Ground Water Modeling Center, May 2008
St. Johns River Water Management District, October 2014

Introduction to the U.S.G.S. Three-Dimensional Groundwater Flow Model:
St. Johns River Water Management District, October 1983

Introduction to DAFI2D, a Pre-processor for the U.S.G.S. Two-Dimensional Groundwater Flow Model:
South Florida Water Management District, October 1983

Saturated Zone Modeling (U.S.G.S. Method of Characteristics):
USEPA, Region VI, November, 1988
USEPA, Region VIII, November, 1988
USEPA, Region IX, December, 1988
USEPA, Region X, December, 1988

Introduction to Modeling Saltwater Intrusion (SWICHA):
Southwest Florida Water Management District, October 1984
South Florida Water Management District, February 1986
St. Johns River Water Management District, November 1986

Instructor, Auburn University, 1981:

Computer Methods in Civil Engineering (CE202)
Theory of Structures I (CE304)
Hydraulics (CE308)
Hydrology (CE312)

Graduate Teaching Assistant, Auburn University, 1979-80:

Computer Methods in Civil Engineering (CE202)

Litigation Experience

Expert witness in an administrative hearing, St. Johns Riverkeeper, et al. vs St Johns River Water Management District and Sleepy Creek Lands, LLC, regarding issuance of a consumptive use permit for a cattle ranch. Gave a deposition and testified on the findings of a peer review of the groundwater flow model used in the proceedings (April, 2017).

Expert witness in a hearing before the Atomic Safety and Licensing Board of the U.S. Nuclear Regulatory Commission. Provided testimony regarding the impact of a license amendment to allow a power company to operate two nuclear units at higher cooling water intake temperatures (January, 2016).

Expert witness in an administrative hearing regarding modification to conditions of certification for the Turkey Point Power Plant Units 3-5. Provided testimony and gave a deposition regarding the introduction of up to 14 mgd of brackish water into a cooling canal system (December, 2015).

Expert witness in an administrative hearing regarding an Administrative Order issued by the Florida Department of Environmental Protection to require a power company to develop a salinity management plan that included remedies for abating saltwater intrusion resulting from a cooling canal system. Provided testimony on the efficacy of a remedial alternative that involved decreasing salinity in the cooling canal system (November, 2015).

Testifying expert for the New York State Office of Attorney General concerning PCE and TCE contamination at the New Cassell Industrial Area of Long Island, New York for a cost recovery case (April 2015, 2016).

Expert witness in a comprehensive administrative hearing regarding certification of two new nuclear units at a power plant in south Florida. Testified on the expected impacts of a 125 mgd backup water supply and its compliance with state and local codes and regulations (July, 2013).

Expert witness for the Northwest Florida Water Management District in an administrative hearing regarding a proposed consumptive use permit for a new wellfield in Bay County, Florida (October 2011).

Deposition concerning compliance with and technical details of a wellhead protection ordinance in northwest Florida (February 2009, Rapid Management Company v. Board of County Commissioners, Escambia County, Florida).

Deposition concerning alleged environmental impacts of pumping to dewater a marble quarry in east-central Alabama (December 2006, Lee County Commission v. Oldcastle Materials Southeast, Inc).

Expert witness (pre-filed written testimony) in a site certification hearing for the Florida Power and Light West County Energy Center, Palm Beach County, Florida (September, 2006).

Expert witness in a site certification hearing for the Florida Power and Light Turkey Point (Unit 5) Expansion Project, Florida City, Florida (September, 2004).

Expert witness in an arbitration, Environmental Protection Commission of Hillsborough County and Hillsborough County vs. Tampa Bay Water, A Regional Water Supply Authority, regarding seepage and environmental issues related to a proposed above-ground reservoir (March, 2001).

Deposition concerning a minimum flows and levels rule challenge in southwest Florida. Hillsborough County Florida and Environmental Protection Commission of Hillsborough County vs Southwest Florida Water Management District. (February, 2000).

Depositions concerning groundwater modeling and technical analysis performed to assess propriety of proposed pumpage restrictions and environmental protection standards in southwest Florida (West Coast Regional Water Supply Authority, et al, vs. Southwest Florida Water Management District and Thomas W. Reese, et al. (March and May 1996).

Expert witness (pre-filed written testimony) in an administrative hearing, Mullis Tree Services, for an appeal to a permit for a proposed municipal landfill in Bibb County, Georgia (November 1994).

Expert witness in an administrative hearing, Osceola County/Deseret Ranches/EEE Corporation/ NNN Corporation vs. South Brevard Water Authority and the St. Johns River Water Management District (Florida), regarding a proposed municipal water use permit (September 1991).

Expert witness in an administration hearing, City of Sarasota, Florida vs. Roger Harloff and Southwest Florida Water Management District, regarding an agricultural water use permit (August 1989).

Deposition concerning groundwater modeling performed to assess drawdowns in an upper aquifer created by irrigation pumping in northwestern Indiana by Prudential Company of America (September 1983).

Expert witness for U.S. Attorney's Office, Albuquerque, New Mexico. Hearing before the New Mexico State Engineer concerning groundwater appropriations near Gallup, New Mexico for Plains Electric (September 1982 and January 1983).

PUBLICATIONS

Peer Reviewed Journals

Andersen, P.F. and G.W. Council, 2008. Practical methods and metrics for calibration of transient groundwater flow models. In *Calibration and Reliability in Groundwater Modeling: Credibility of Modeling*, IAHS Publication 320: 305-309. ISBN 978-1-901502-49-7

Andersen, P.F. and S. Lu, 2003. A post-audit of a model-designed ground water extraction system. *Ground Water* 41(2): 212-218.

Andersen, P.F., J.W. Mercer, and H.O. White, Jr., 1988. Numerical modeling of saltwater intrusion at Hallandale, Florida, *Ground Water*, 26(5): 619-630.

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TETRA TECH

A Groundwater Flow and Salt Transport Model of the Biscayne Aquifer

Introduction

This technical memorandum describes a regional, three-dimensional, density-dependent, groundwater flow and saltwater transport model of conditions in Biscayne aquifer in the vicinity of the Florida Power & Light Company (FPL) Turkey Point Cooling Canal System (CCS). This model was developed, as a requirement of a Consent Agreement between FPL and Miami Dade County Department of Environmental Resource Management (MDC DERM). The model is based on hydrologic, water quality, geologic, and meteorologic data from myriad sources, including the USGS, South Florida Water Management District, MDC DERM, and FPL.

Modeling involved simulating historical (1940s through 2015) conditions that helped to define the present configuration of saltwater and hypersaline water beneath and in the vicinity of the CCS. Once the model was calibrated within acceptable standards, it was used to simulate a 10-year predictive period (2016 through 2025) under different configurations of proposed aquifer remediation system designs. The model provided data used to evaluate the effectiveness of different remedial alternatives under a performance ranking matrix which supported the identification of the top ranked recommended remedial alternative system.

Purpose and Objectives

The objectives of the groundwater flow and saltwater transport model are two-fold: (1) to support the design of a Recovery Well System (RWS) to intercept, capture, and contain the hypersaline plume north and west of the CCS; support authorization through the appropriate regulatory processes; and demonstrate that it will not create adverse impacts to groundwater, wetland (hydroperiod or water-stage), or other environmental resources, and (2) to continue to assess the status and efficacy of the system operation in meeting the objectives of the Consent Agreement. In order to achieve these objectives, the calibrated model will be applied to quantify the ability of potential abatement and remedial alternatives in retracting the hypersaline plume west and north of FPL's property. In addition to the positive effects of reducing the salt mass and volumetric extent of hypersaline groundwater, the model will also assess ancillary impacts, such as changes to hydroperiods of wetlands and seepage from surface waters in the vicinity of the proposed alternatives. The analysis will identify a preferred alternative. In addition, the model will support the review of the current Interceptor Ditch Operation Procedures (IDOP) in relation to freshening and RWS operations to determine if revisions to the IDOP are warranted.

model not used to guide the groundwater model calibration estimated a hypersaline interface consistent with that of the groundwater model provides a validation of the model. Distinctions between the CSEM-based salt concentrations and modeled salt concentration exist and are discussed further below.

Based on the success in meeting the aforementioned calibration goals, the sequence of calibration models was deemed satisfactory to employ in the execution of the main objective of this study: to assess the relative effectiveness of different remedial scenarios with respect to reversing the inland migration of the hypersaline water front around the CCS. The model application to simulate the remedial scenarios is discussed below.

Model Application

The purpose of model construction and calibration to historical conditions is the development of an informed predictive tool that can simulate future conditions with reasonable confidence and accuracy. In this case, the groundwater flow model was calibrated to approximately 75 years of saltwater and hypersaline water interface development and subsequently reconfigured as a tool to predict the movement of these interfaces under assumed future remedial scenarios. The remedial scenarios evaluated are generally predicated on the operation of recovery well systems (RWS) for the purpose of the removal from and/or eastward movement of saline and/or hypersaline water in the Biscayne aquifer.

Aquifer Remediation Scenarios

Seven remediation scenarios were broadly designed and evaluated. Each scenario is a 10-year simulation. The hydrologic stresses and model boundary conditions employed as a surrogate for the predictive 10-yr timeframe (2016 through 2025) are gleaned from the 2011 through 2015 timeframe simulated by the calibrated model's monthly transient groundwater flow and saltwater transport model, repeated once. The 2011 through 2015 timeframe experienced reasonably wide-ranging environmental conditions (dry and wet conditions) and, as such, constitute a robust set of surrogate future conditions with which to evaluate the performance of the remedial scenarios.

The bulk of the scenarios evaluated constitute a remedial action via CCS salinity abatement and groundwater well operation. The general locations of extraction and injection wells in the different remedial alternatives are shown in Figure 18. In this figure, impacts to the saltwater and hypersaline interfaces are evaluated within the footprint identified as the Model Control Boundary. While most of the alternatives reflect a remedial action, one of these scenarios evaluated represents the "no action" case:

Alternative 1, No Action – Ten years of operation with no CCS salinity abatement, remedial actions, or sediment removal-based improvements. This scenarios is employed as a basis of comparison to evaluate the relative effectiveness of the remediation-based scenarios.

The remaining six remediation scenarios fall into two categories, based on which type of groundwater (saltwater, hypersaline water) they are designed to impact. Four of the scenarios address the provisions of the Consent Agreement by intercepting, capturing, containing, and ultimately retracting the hypersaline plume with minimal impacts to groundwater, wetland, and other environmental resources:

Alternative 2, CCS Salinity Abatement – The addition of 14 MGD of Floridan water to the CCS, the reduction of CCS salinity down to 34 PSU, and the associated increase in stage by 0.1 ft relative to historical conditions. No additional supplemental inflows to the CCS are simulated. CCS salinity abatement is simulated in all of the remaining five alternatives. The results of this simulation identify the extent of hypersaline water reduction without groundwater extraction. This alternative is representative of the Consent Agreement and Administrative Order.

Alternative 3, Northwest CCS On-Property Wellfield – One year of extraction from the base of Biscayne aquifer beneath CCS and adjacent to the Underground Injection Control well (UIC well in Figure 18), followed by 9 years of extraction from wells spaced approximately 2000 ft apart, extracting a total of 15 MGD, and screened at the base of the aquifer. Three different wellfield configurations that vary in the length of north-to-south transect were evaluated. CCS salinity abatement was also simulated.

Alternative 4, Northwest CCS Horizontal On-Property Wellfield - One year of extraction from the base of Biscayne aquifer beneath CCS and adjacent to the Underground Injection Control well (UIC well in Figure 18), followed by 9 years of extraction from horizontal wells that are screened at the base of the aquifer, extend west of L-31E by about 500 ft, and extracting a total of 15 MGD. CCS salinity abatement was also simulated.

Alternative 5, Northwest CCS Off-Property Wellfield - 1.5 years of extraction from the base of Biscayne aquifer beneath CCS and adjacent to the Underground Injection Control well (UIC well in Figure 18), followed by 8.5 years of extraction from wells parallel to the ID located approximately 2,500 ft west of L-31E in Everglades Mitigation Bank land and screened at the base of Biscayne aquifer. Three different wellfield configurations that vary in the length of north-to-south transect were evaluated. CCS salinity abatement was also simulated.

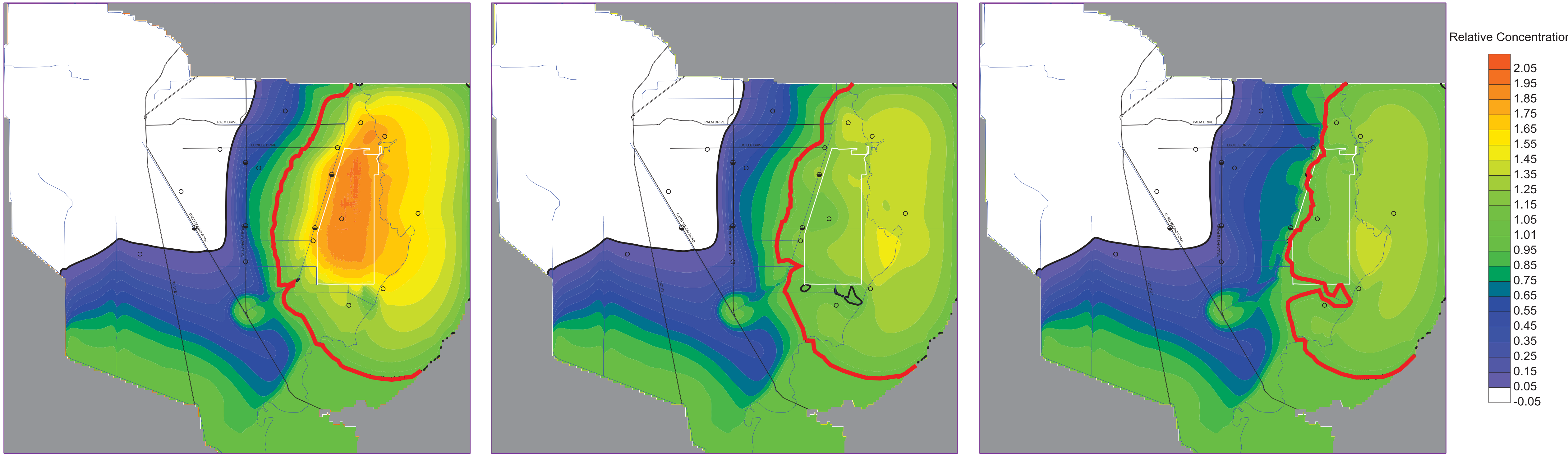
The remaining two scenarios are intended to stabilize or retract the toe of the saltwater interface in the Biscayne aquifer.

Alternative 6, Tallahassee Road Extraction – One year of extraction from the base of Biscayne aquifer beneath CCS and adjacent to the Underground Injection Control well (UIC well in Figure 18), followed by 9 years of vertical extraction wells (6 wells, 2000 feet apart, withdrawing a total of 12 MGD) along a north-to-south transect along Tallahassee Road south of Palm Drive. Two different configurations were evaluated, with varying well locations. The purpose of this remedial alternative is to retract the saltwater interface east of the Newton wellfield and the ACI property.

Alternative 7, Saltwater Toe Injection – One year of extraction from the base of Biscayne aquifer beneath CCS and adjacent to the Underground Injection Control well (UIC well in Figure 18), followed by 9 years of vertical well injection (4 to 8 wells, between 1 and 5 MGD) west of Tallahassee Road, east of Newton wellfield and ACI property, at the base of the aquifer. Three different configurations were evaluated, with varying well locations and injection volume.

Scenario Selection Criteria

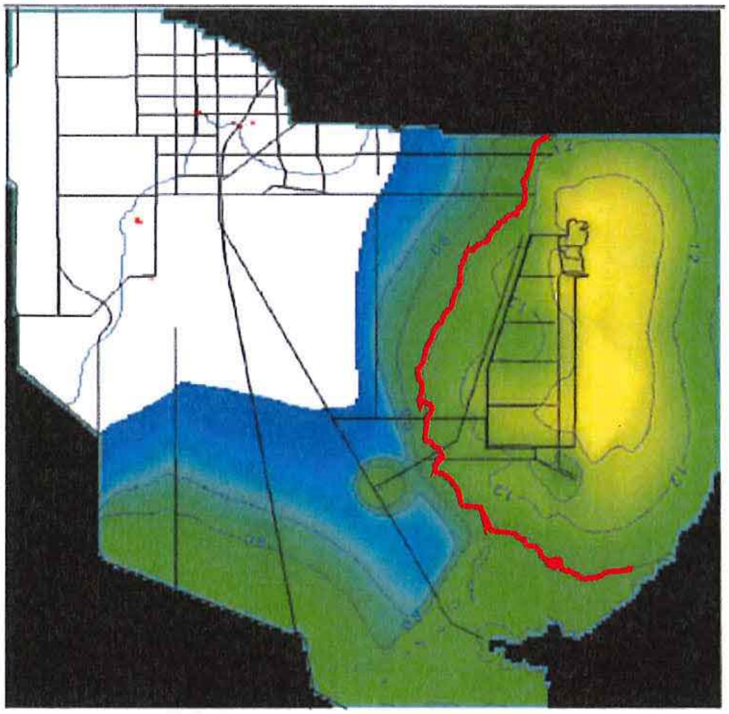
The success of each remedial scenario was evaluated relative to a specified set of criteria (Table 3). Generally, the model-based criteria serve as a basis for ranking the remedial scenarios based on their ability to ameliorate salt concentrations and the westward movement of the saltwater and hypersaline water interfaces in the Biscayne aquifer, without adversely impacting wetlands and



Alternative 1 (No Action) | Alternative 2 (Salinity Abatement) | Alternative 3D (Salinity Abatement + RWS)

Simulated relative salt concentrations (1.0 = 35 PSU) in model layer 8 after 10 years of Alternatives 1, 2, and 3D. The red contour in each figure represents the hypersaline interface.

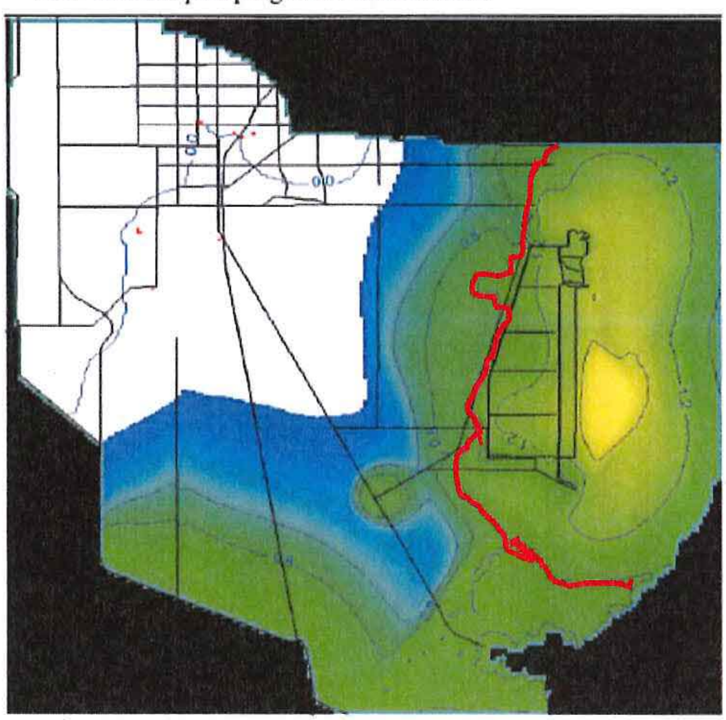
Revision of OPC Witness Panday's Demonstrative 23



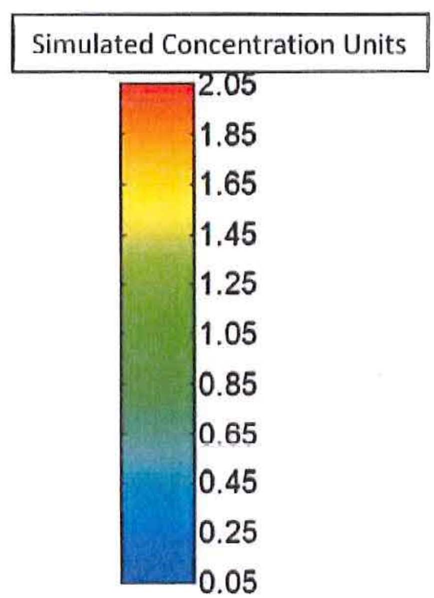
23a. Without pumping of retraction wells

1.0 Concentration Units Line (**RED**) representing boundary between hypersaline and saline water

WITHOUT pumping of RWS



23b. With pumping of retraction wells



WITH pumping of RWS

Comparison of 2015 Modeled Freshwater-Saltwater Interface with CSEM Data

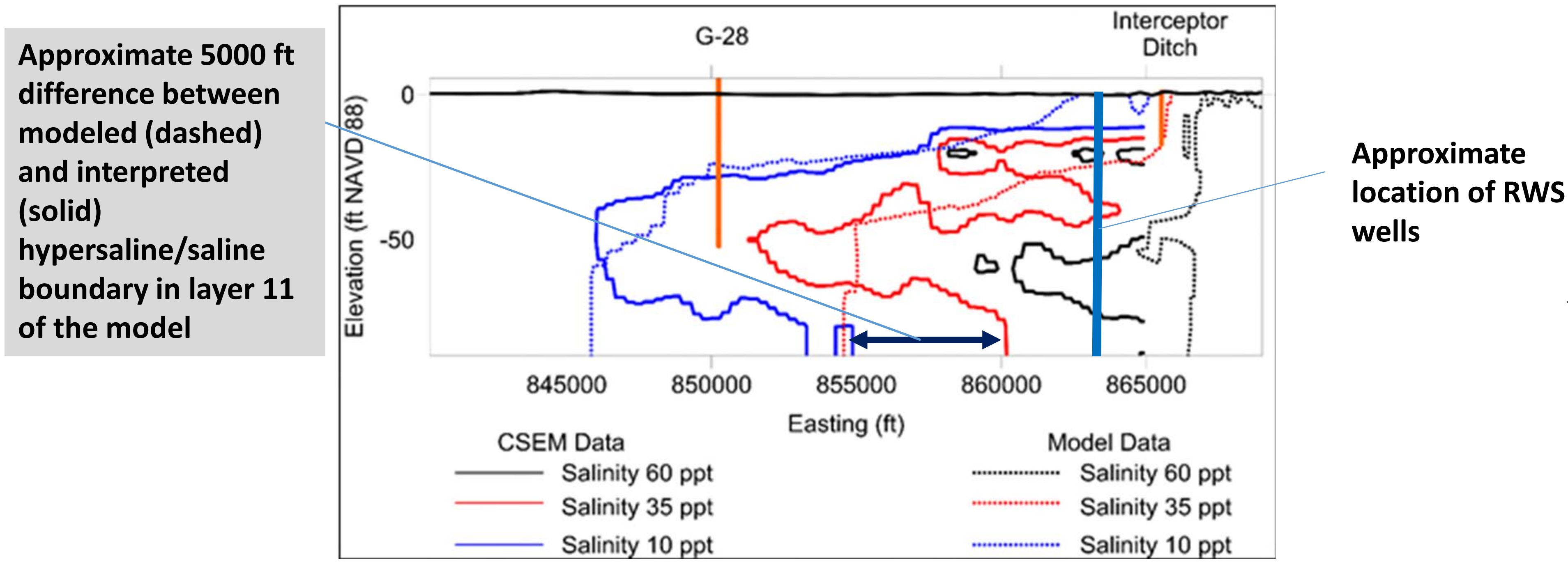
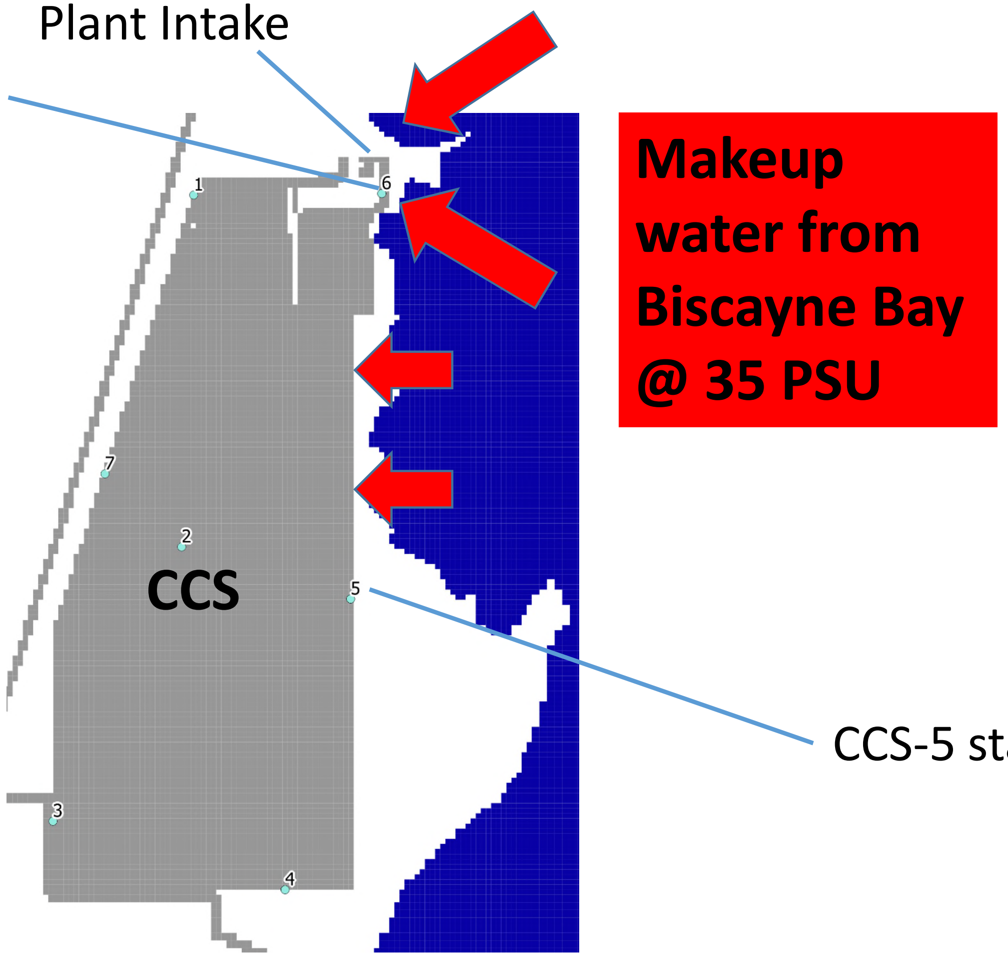
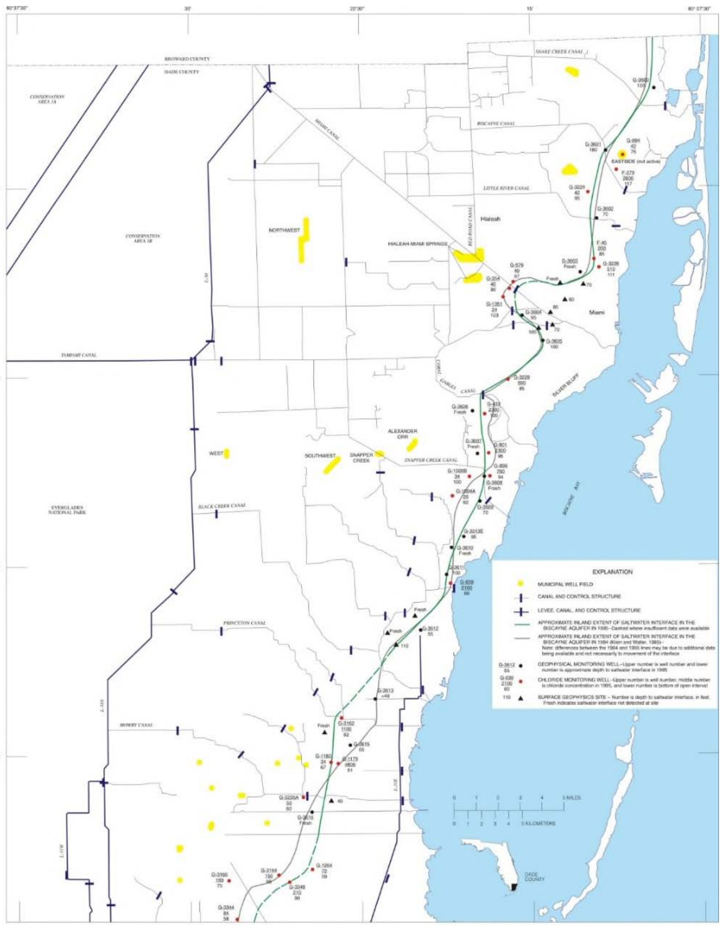


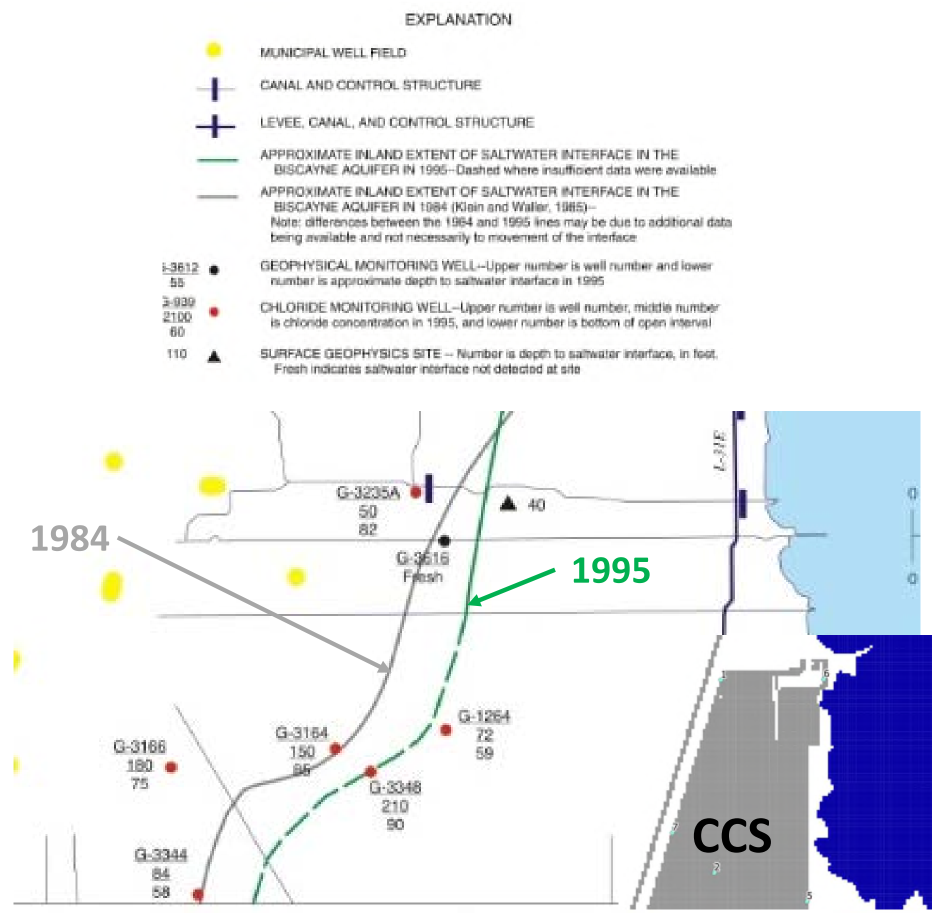
Figure 17b. (from June 2016 report)

Location of CCS Monitoring Stations Relative to Plant Cooling Water Intake and Biscayne Bay



Saltwater Intrusion as Mapped by the USGS, 1984 and 1995





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CERTIFICATE OF SERVICE
Docket No. 20170007-EI

I HEREBY CERTIFY that a true and correct copy of the rebuttal testimony and exhibits of Peter Andersen has been furnished by electronic service this 25th day of September, 2017 to the following:

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