SOAH DOCKET NO. 582-20-1895
TCEQ DOCKET NO. 2019-1156-IWD

IN THE MATTER OF THE	**§**	**BEFORE THE STATE OFFICE**
APPLICATION OF PORT OF	**§**	
CORPUS CHRISTI AUTHORITY OF	**§**	**OF**
NUECES COUNTY FOR TPDES	**§**	
PERMIT NO. WQ0005253000	**§**	**ADMINISTRATIVE HEARINGS**

EXHIBIT PAC-45R

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REMAND PREFILED TESTIMONY

OF

ANDREW J. ESBAUGH, Ph.D.

ON BEHALF OF

PORT ARANSAS CONSERVANCY

SUBMITTED ON FEBRUARY 2, 2022

SOAH DOCKET NO. 582-20-1895
TCEQ DOCKET NO. 2019-1156-IWD

APPLICATION BY PORT OF CORPUS CHRISTI AUTHORITY FOR WATER QUALITY PERMIT NO. WQ0005253000 IN NUECES COUNTY, TEXAS	**§ § § § §**	**BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS**

REMAND PREFILED TESTIMONY OF ANDREW J. ESBAUGH, Ph.D.

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REMAND PREFILED TESTIMONY OF ANDREW J. ESBAUGH, Ph.D.

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME.

A. Andrew Esbaugh.

Q. HAVE YOU REVIEWED YOUR SEPTEMBER 25, 2020 PREFILED TESTIMONY, ADMITTED AS EXHIBIT PAC-5 (INCLUDING EXHIBITS THERETO, PAC-5 AE-1 AND PAC 5 AE-2?

A. Yes.

Q. IS THE SUBSTANCE OF EXHIBIT PAC-5 (INCLUDING EXHIBITS THERETO STILL TRUE AND ACCURATE?

A. Yes.

Q. DO YOU ADOPT YOUR PREVIOUS TESTIMONY IN EXHIBIT PAC-5 AND INCORPORATE IT AS THOUGH FULLY SET FORTH HEREIN?

A. Yes.

Q. HAVE YOU REVIEWED YOUR NOVEMBER 5, 2020 LIVE TESTIMONY AT THE HEARING ON THE MERITS?

A. Yes.

Q. IS THE SUBSTANCE OF THAT LIVE TESTIMONY STILL TRUE AND ACCURATE?

A. Yes.

Q. DO YOU ADOPT YOUR PREVIOUS LIVE TESTIMONY, AS ADMITTED INTO EVIDENCE, AND INCORPORATE IT AS THOUGH FULLY SET FORTH HEREIN?

A. Yes.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY ON REMAND?

A. I have been retained by PAC to evaluate the amended application of the Port of Corpus Christi Authority of Nueces County ("POCCA") for a water quality permit for a proposed desalination facility on Harbor Island as well as the new draft permit prepared by the Texas Commission on Environmental Quality ("TCEQ"). I have been asked to review these documents and provide my opinion regarding the effects of the brine discharge from the proposed desalination plant and its effect on the marine environment and aquatic life. I have also been asked to prepare this prefiled testimony and to testify at the hearing regarding the permit application.

Q. ARE YOU FAMILIAR WITH THE PORT OF CORPUS CHRISTI AUTHORITY'S CURRENT PLANS FOR THE PROPOSED DESALINATION PLANT?

A. Yes, I have become familiar with the currently proposed desalination plant by reviewing portions of (a) the amended application, (b) the Port's prefiled testimony and exhibits, and (c) the new draft permit.

Q. WAS THIS TESTIMONY PREPARED BY YOU OR UNDER YOUR DIRECT SUPERVISION AND CONTROL?

A. Yes.

Q. HAVE YOU COMMUNICATED WITH OTHER TESTIFYING WITNESSES RETAINED BY PAC AND OFFERED AS EXPERTS IN THIS CASE ON REMAND REGARDING YOUR OPINIONS?

A. Yes.

Q. WHICH OTHER TESTIFYING WITNESSES RETAINED BY PAC AND OFFERED AS EXPERTS HAVE YOU COMMUNICATED WITH IN THIS CASE ON REMAND REGARDING YOUR OPINIONS?

A. Scott Holt, Gregory Stunz, Bruce Wiland, Scott Scolofsky, Kristin Nielsen, Larry McKinney, Daniel Schlenk, Barney Austin, and Tim Osting.

Q. HAVE YOU RELIED ON THE OPINIONS, DATA, OR INFORMATION FROM THOSE OTHER TESTIFYING WITNESSES RETAINED BY PAC AND OFFERED AS EXPERTS IN FORMING YOUR OPINIONS?

A. I reviewed their opinions and conclusions and find them to be consistent with my opinions, but I did not rely on them in forming my own opinion. To the extent they provided me with information within their area of expertise that I would not otherwise have (i.e. certain modeling results, or Dr. Nielsen's test results) I accept them as reliable and do rely on them as and where identified herein.

II. QUALIFICATIONS

Q. PLEASE BRIEFLY DESCRIBE YOUR EDUCATIONAL BACKGROUND THAT IS A BASIS FOR YOUR TESTIMONY HERE.

A. I am an Associate Professor of Marine Science at the University of Texas at Austin with a research lab located at the University of Texas Marine Science Institute in Port Aransas, Texas. My lab was established in 2012 with a particular focus on environmental physiology and toxicology of fishes, which has included research on salt and water balance, the effects of low oxygen, ocean acidification and ocean warming, as well as work exploring the impacts of the Deepwater Horizon oil spill on marine fishes. To date, I have published 95 peer reviewed papers/book chapters, which have been collectively cited over 3700 times. I am on the editorial board of Comparative Biochemistry and Physiology Parts A-D, which includes Part C Toxicology. I am the Applications section editor of the 2nd Edition of the Encyclopedia of Fish Physiology, and have been an expert peer reviewer for 33 different scientific journals and 8 different extramural funding bodies.

Q. PLEASE BRIEFLY DESCRIBE YOUR PROFESSIONAL EXPERIENCE.

A. In 2001 I obtained my Bachelor of Science with Honors from Acadia University (Nova Scotia, Canada) with a major in Biology. I obtained my PhD (Biology) in 2005 from Queen's University (Ontario, Canada), which explored the evolution of respiratory systems in fishes. I was awarded a prestigious National Science and Engineering Research Council (NSERC) Graduate Fellowship to undertake this work. I worked at the University of Ottawa (Ontario, Canada) from 2005 to 2009 in a post-doctoral position where I began studying the influence of environmental factors on physiological systems in fishes. I was awarded a prestigious NSERC post-doctoral fellowship to undertake this work. From 2009 to 2012 I worked as a post-doctoral associate at the University of Miami where I focused on the marine environment and gained training in environmental toxicology. My work on oil toxicity in fishes was funded through the National Oceanic and Atmospheric Administration Natural Resource Damage Assessment related to the Deepwater Horizon oil spill, which involved developing lethal and sub-lethal toxicity tests in non-model organisms for the purposes of damage assessment. I was also involved in a project funded by the International Lead and Zinc Research Organization (ILZRO) that was related to revision of the acute and chronic surface water quality standards for lead (Pb) in freshwater systems in the United States. This work involved performing toxicity testing on model and non-model organisms under a variety of water conditions for the purposes of developing models that could predict Pb toxicity in different freshwater environments.

III. SUMMARY OF OPINIONS

Q. HAS ANYTHING IN THE AMENDED APPLICATION AND DRAFT PERMIT CHANGED YOUR OUTLOOK ON THE POTENTIAL FOR DESALINATION EFFLUENT TO IMPACT AQUATIC LIFE IN THE AREA OF THE OUTFLOW?

A. No. All of my previous concerns remain, but I will add to my previous testimony based on new information.

Q. WHAT ARE YOUR MAJOR CONCERNS?

A. I have two main concerns. The first is that effluent released into the channel will result in salinity values with the potential to harm aquatic life, specifically red drum. Furthermore, I have one new concern based on CORMIX modeling efforts by Dr. Scott Socolofsky.

Q. HOW DID YOU FORM YOUR OPINION ABOUT THE POTENTIAL FOR EFFLUENT SALINITY TO HARM AQUATIC LIFE?

A. My opinion is grounded in the methods that are used to develop water quality standards in general. Section 307.(4)(g)(3) of the Texas Water Quality Standards do not provide a specific numeric standard upon which to judge effluent toxicity based on salinity in estuarine environments. However, they also explicitly state that the absence of numeric criteria does not preclude regulatory action based on salinity. My approach was to use the established framework upon which water quality standards are developed in the United States. These procedures are outlined in the USEPA Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses.

Q. CAN YOU BRIEFLY SUMMARIZE THE USEPA GUIDELINES FOR DERIVING WATER QUALITY CRITERIA?

A. I will first focus on the acute toxicity values because I believe it is most relevant in this situation. The procedure entails collecting all available acute toxicity data for a given toxicant, grouping the data into genus groupings, then rank ordering the data from most to least sensitive. These are called genus sensitivity distributions. The four values closest to the 5th percentile of sensitivity are generally the four most sensitive species, unless particularly large data sets are available. A formula is used to derive a final acute toxicity value that is used as the numerical criteria. Note that the intent behind this procedure is to offer protection based on the cumulative 5th percentile probability for sensitive genera. One important caveat to this procedure, which is outlined in Section 4 P of the USEPA Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, is that if a commercially or recreationally important species has demonstrated sensitivity below the calculated final value, then the data for that species will be used as the final numeric value. An example of this being implemented can be seen in the Ambient Water Quality Criteria – Copper Saltwater Addendum (1995). In that case the acute toxicity of blue mussels was below the calculated final acute value based on the genus sensitivity distribution, and thus the blue mussel acute toxicity value was implemented as the numeric water quality standard.

Q. WHAT IS THE DEFINITION OF ACUTE TOXICITY IN THE PROCEDURES DESCRIBED ABOVE?

A. The exact durations and test endpoints for acute toxicity vary based on the species and can be found in Section 4e of the USEPA Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. Acute tests that qualify for use in the acute genus species distribution range from 48 h to 96 h in duration, and the defined toxicity threshold is the effective concentration 50 based on lethality. Chronic testing is longer in duration, which can include full life cycling testing.

A. What was your final conclusion in the context of the current Amended Application and Draft Permit?

A. I found four different data sets that were used when forming my opinion. Three of these were included in my original testimony, which are: 1) a study on the effects of hypersalinity published by the Water Development Board, 2) a published study in Archives of Environmental Contamination and Toxicology titled Hypersalinity Toxicity Thresholds for Nine California Ocean Plan Toxicity Test Protocols (Voorhees et al. 2013. 65:665-670), and 3) a study published in Environmental Toxicology and Chemistry titled Response of Mysid shrimp, Sheepshead Minnow and Inland Silverside Minnow to Changes in Artificial Seawater Salinity (Pillard et al. 1999. 18(3): 430-435). The fourth data set was generated by Dr. Kristin Nielsen and provides further lethality data for red drum.

What is clear from this data is that the most sensitive species found in proximity to the planned desalination discharge have salinity tolerances between 36 and 38 ppt. In particular, Dr. Nielsen's data confirm the prior work published by the Water Development Board that demonstrated a 72 h LC50 of 37.7 ppt. This value is noteworthy because red drum are an important species of incredible recreational and economic value in the region. The Port Aransas ship channel is a very important habitat in the context of their life cycle, and it is very likely that embryos and larvae of this species would be present in the area of the effluent outflow. As such, this data supports an acute water quality standard for salinity of 37.7 ppt for the zone of initial dilution.

CORMIX modelling performed, and data provided by Dr. Scott Socolofsky suggests that the salinity at the outer boundary of the zone of initial dilution will range from 46 to 56 ppt when ambient salinity is 40.6 ppt and the flow velocity in the channel is 0.8 m/s. Note that the provided range is dependent on the distance between the diffuser and the sloping channel bank. However, it appears likely that salinities may exceed 44 ppt in the zone of initial dilution. The ambient salinity used in these models would occur in concert with the 95th confidence interval for ambient salinities provided by the Port in the Amended Application. Based on the procedures for water quality standards outlined by the USEPA, this discharge would be considered not protective of aquatic life.

It is important to note that my opinion is not based solely on the finding that red drum have a 72 h LC50 of 37.7 ppt. It is a combination of the salinity sensitivity of the species, the importance of the channel area to the red drum lifecycle, and the high background salinity found in the region. The Port Aransas ship channel is found within almost 200 miles of barrier island. The only areas for water exchange and animal movement between the open Gulf of Mexico and inner estuary are found at the shipping channels in Port Aransas and Port Mansfield, as well as a small waterway at Packery Channel. The limited exchange, high summer temperatures and shallow depths result in high rates of evaporation and high ambient salinities in the late summer. This coincides with the spawning season for red drum. The available data suggests that the success of this species in the local area is already challenged by natural factors, and adding hypersaline effluent to the channel will represent an additional stress compromising survivorship of embryos and larvae. Again, it is important to note that standard procedures take background toxicants concentrations into account when considering the toxic effects of effluent and the acceptable total maximum daily loads. The background salinity in the channel should be treated the same way.

Q. WHY ARE YOU CONFIDENT IN YOUR CONCLUSIONS DESPITE THE FACT THAT YOU CANNOT SAY WITH CONFIDENCE HOW LONG FISH WILL BE EXPOSED TO THE EFFLUENT?

A. This is because I am working with an agreed upon procedure used in the U.S. for the development of water quality standards. The draft permit has toxicological assessments for a number of metals and chemicals, and these assessments are all done without a thorough understanding of the exposure duration. The reason that these fundamental toxicological assessments can be performed is because exposure duration is not part of the decision making equation. The basis of a mixing zone approach for water quality related to the discharge of effluents, which was developed specifically to prevent environmental degradation and to protect aquatic life and human health, is to remove the complexities of trying to define every possible exposure scenario. For example, it is my understanding that CORMIX is not well suited to replicate the tidal influences in the channel, nor can it fully incorporate the channel bathymetry into the models. While I am not a specialist in CORMIX modeling, it is clear to me that the tools at our disposal cannot accurately assess exposure scenarios. As such, theories and estimates related to exposure duration should not be included in the decision making process.

Q. SO THE RED DRUM ARE STILL YOUR BIGGEST CONCERN WITH REGARD TO THE ACUTE EFFECTS OF DESALINATION EFFLUENT?

A. Yes. The red drum is an iconic species that was discussed a lot in the last hearing. There are good reasons for that. It is sensitive to changes in salinity. Its larvae rely on the Port Aransas Pass and the Ship Channel to get to the estuary. It is also a species of great economic value to the State of Texas and the Texas Parks and Wildlife Department has been spending millions of dollars annually for many years to stock the Texas coast with red drum. It is a very recognizable species, even to those who do not live in this region. The coastal communities near the Ship Channel, particularly Port Aransas, are tourism-based economies and the red drum is an important part of the tourism that draws people to the region.

Q. HAVE YOU CONSIDERED THE CHRONIC TOXICITY OF THE EFFLUENT TO AQUATIC LIFE?

Yes. The methods for determining chronic toxicity are more variable across species, and include tests that assess growth, development, or reproduction. The general procedure is similar to that described for acute toxicity – with the obvious exception that chronic data is used to populate the genus sensitivity distribution – or alternatively can be based on acute to chronic ratios. The latter procedure simply divides the acute toxicity value by an empirically determined acute to chronic ratio, which results in a chronic toxicity value. The majority of chronic toxicity data that I examined can be found in the published study in Archives of Environmental Contamination and Toxicology titled Hypersalinity Toxicity Thresholds for Nine California Ocean Plan Toxicity Test Protocols (Voorhees et al. 2013. 65:665-670). This study includes 9 different chronic toxicity tests ranging across 4 invertebrates and 1 plant. This data set is somewhat limiting when attempting to derive a chronic toxicity value. This is simply because I would not classify any of the species in question as economically or recreationally important, and there are not enough data to develop a species sensitivity distribution with enough resolution to accurately reflect the 5th percentile of sensitive genera.

That being said, the determined 5th percentile of the genus sensitivity distribution was equal to 36.5 ppt, and the lowest observed chronic sensitivity was 36.8 ppt. This was observed for a developmental endpoint in the red abalone, which is a marine snail species native to the Pacific coast. No data are available for Gulf marine snails, and as such this must be used as an available surrogate. Most importantly, both purple urchin and sand dollars exhibit chronic toxicity on development below 40 ppt. As such, the high natural baseline in the shipping channel again raises concern that any additional salinity effluent will impact aquatic life. Furthermore, CORMIX modeling provided by Scott Socolofsky suggests that salinity at the outer boundary of the aquatic life mixing zone could exceed 44 ppt, and reach as high as 52 ppt. This model utilized an ambient salinity of 40.6 ppt and a 0.8 m/s/ flow velocity in the channel, and the final effluent concentration in the array was dependent on the distance of the diffuser to the channel bank. This data would suggest that chronic toxicity to desalination effluent is a likely concern.

Q. LANCE FONTENOT PROVIDED TESTIMONY THAT THE USEPA ESTABLISHED A LIMIT OF 4 PPT OR 10% ABOVE AMBIENT FOR SALINITY IN SEAWATER. DOES THAT CONFLICT WITH THE APPROACH YOU HAVE DESCRIBE ABOVE?

A. I have read Mr. Fontenot's opinion and disagree for several reasons. First and foremost, the USEPA did not establish a limit in the cited Quality Criteria for Water 1986 document. It simply relayed the opinion of a 1968 statement by the National Technical Advisory Committee (NTAC) to the Secretary of the Interior. As clearly stated in the TCEQ surface water quality standards, Texas does not have a set water quality criteria for salinity in estuarine systems. A second important point is that the USEPA Quality Criteria for Water 1986 document specifically points out that the prior recommendation by the NTAC of 4 ppt above ambient was limited to scenarios where ambient is between 13.5 and 35 ppt (as shown on page 264). As such, this recommendation does not apply to the Corpus Christi Shipping Channel. Finally, and most importantly, the data utilized by NTAC to make their recommendation in 1968 do not include numerous relevant studies that would supersede any prior recommendation. In short, this recommendation for 1968 is not relevant to the current scenario in 2022.

Q. YOU MENTIONED YOU HAD TWO MAJOR CONCERNS ABOUT THE EFFLUENT BEING RELEASED INTO THE CHANNEL. WHAT IS YOUR SECOND MAJOR CONCERN?

A. Scott Socolofsky raised another issue that I had not previously been aware of, which is that the hypersaline plume is likely to be more persistent over time than what had previously been described. From my discussions with Scott, the Port had used SUNTANS modeling to suggest no bottom plume would be generated. Scott's analysis using CORMIX suggested that an effluent plume would be created along the channel floor and extend for at least 1.5 km. This plume was evident at 150 m from the discharge point as a 24 m wide bottom plume that was approximately 4 meters thick. At 400 m from the discharge site the plume will have expanded to 130 m in width, but reduced in thickness to approximately 2 m. At 1.5 km from the discharge site the plume would be approximately 284 m wide and 1.7 m thick. Importantly, the CORMIX model does not suggest that the plume will disappear at 1.5 km. It is my understanding, from talking with Scott, that the modelers have limited the model to only calculate as far 1.5 km from the discharge site. It is also noteworthy that Scott communicated to me that the Port's CORMIX modeling also demonstrated the possible presence of a persistent bottom layer plume. While I have no opinion on which modeling procedure is best, the presence of a persistent bottom layer plume is very concerning.

Q. CAN YOU DESCRIBE WHY A PERSISTENT HYPERSALINE PLUME OF THIS MAGNITUDE WOULD POSE A RISK TO AQUATIC LIFE?

A. The real concern with the bottom layer plume has little to do with salinity, instead my concerns are related to reduced oxygen levels (hypoxia). When persistent non-mixed layers, in this case a bottom plume, are formed along sea floors, the benthic life, which includes respiring organisms from microbes to animals, will consume the oxygen within the non-mixed layer. Eventually the oxygen in the non-mixed layer will decline below that required to sustain life. The exact risk levels of organisms to hypoxia are variable, compounded by warmer temperature, and can best be represented in animals by a measure called the critical oxygen threshold. This is the partial pressure of oxygen in the environment that is required for organisms to be able to take up enough oxygen to maintain vital physiological functions. If oxygen falls below this critical threshold then animals must use anaerobic metabolism to sustain vital functions, which is inherently unsustainable. More simply, when animals encounter hypoxic waters that are below their critical oxygen threshold, they have a limited amount of time to escape that area or die. An excellent example of the wide scale damage that persistent stratification can have on benthic life is found in the North Gulf of Mexico Dead Zone. This is a seasonal occurrence caused by strong saline-based stratification and nutrient loading.

There is already some concern about low oxygen in parts of the water column in the channel and estuary, which can be seen by the data collected by Dr. Dean. In Table 3 of file APP-KD-3-R the oxygen content across a depth gradient is provided. Note that on the incoming tide of June 8th and 9th the bottom layer had oxygen levels of 2.44 and 2.47 mg/L, respectively. This equals approximately 35% saturation, demonstrating the high capacity for oxygen depletion in the area.

The risks of a persistent stratification of the effluent plume can be assessed using three pieces of data: 1) what is the capacity for benthic oxygen consumption, 2) what are the starting oxygen levels in the plume upon discharge, and 3) what is the sensitivity of local fauna. With the regard to the first, the data provided by Dr. Dean (described above) demonstrate the high capacity for oxygen utilization in the system. This is common for estuarine systems that often see diel cycles of oxygen that include nightly hypoxic events associated with plant respiration. The starting oxygen levels in the effluent plume are harder to assess because it will be a combination of the direct effluent and the mixing that occurs in the various mixing zones. However, the most relevant conclusion is that it is unlikely that the plume will be above ambient oxygen prior to entering into the stratified bottom plume. First is that the mixing that dilutes salinity in the zone of initial dilution and mixing zone will also incorporate any low oxygen water present in the area into the plume. The second point is that the effluent itself will have a salinity around 70 ppt, which has a naturally lower oxygen solubility coefficient. Common chemicals used in RO desalination, such as sodium bisulphite, consume oxygen and further lower the dissolved oxygen in the effluent. As such, it is reasonable to assume that oxygen levels within the stratified plume could start as low or lower than 2.44 mg/L. The third criteria is organismal sensitivity, which is a dynamic metric that will change with ambient temperature. The higher the temperature the lower the hypoxia tolerance. But a reasonable starting point for this discussion can be taken from a collection of critical oxygen threshold data compiled by Siebel et al (2020). This data would suggest that declines below 35% saturation could be damaging to the local wildlife. For example: the critical oxygen thresholds for the lone bivalve species is approximately 39% saturation; the critical oxygen threshold for blue crab was 38% saturation, and available data for red drum produced by my group have been as high as 35% saturation. These data alone suggest that fish, bivalves (i.e. oysters) and crabs could be severely challenged by hypoxia caused by an effluent-induced persistent stratified bottom layer.

Q. HAVE YOU REVIEWED THE PRE-FILED TESTIMONY OF DR. PALACHEK?

A. Yes.

Q. DO YOU AGREE WITH DR. PALACHEK'S ASSESSMENT OF WHETHER THE EFFLUENT WILL CAUSE IMPACTS TO LOCAL WILDLIFE?

A. No. Dr. Palachek's opinion is grounded in two assumptions: 1) that EPA surrogate model species are more informative than tests on local wildlife, and 2) that WET testing will identify any potential harmful impacts of the effluent, and thus there is no potential for environmental damage.

The first point is patently ridiculous. The EPA surrogate species are valuable tools and important components of risk assessment and the development of water quality standards. But they are not intended to take the place of properly collected data on local species, especially local species of recreational and commercial importance. This acknowledgment is specifically stated in the USEPA Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. The only criteria when considering non-model species inclusion in the development of water quality standards is whether the data are of high quality and collected in the context of an appropriate experimental design. Dr. Nielsen's experiment on red drum utilized procedures I developed for the toxicological assessment of pelagic fish embryos, which was used by the National Oceanic and Atmospheric Administration Natural Resource Damage Assessment group. This assay is modelled on USEPA procedures for acute toxicity in other fish species. The quality of Dr. Nielsen's data is clear from the high replication, the repeatability of the results as demonstrated by multiple tests and prior data, as well as the high control group survivability. The data evaluated by Dr. Palachek that shows no observable effect concentrations for mysids and silverside minnows is irrelevant because they are not the most sensitive species in the ecosystem.

The second point is that the Port contends that WET testing will identify any toxicity that may be caused by the effluent. This is a misrepresentation of the role of WET testing in environmental protection. The value of WET testing is that it may identify synergistic or additive effects of toxicants in an effluent that are not easily identifiable when toxicants are evaluated individually. While this is a valuable tool in the context of risk assessment, the limitations of WET testing are well-documented, as evidenced by the review of the subject by Chapman (2000) in Environmental Toxicology and Chemistry (19(1):3-13). The view of WET testing is best described by the following quote from the paper's abstract: "Comparisons to field conditions indicate that WET tests are not reliable predictors of effects or lack of effects in the receiving environment."

There are many reasons that WET tests are not reliable, and these include both over-protection and under-protection errors. But one that is particularly relevant to Dr. Palachek's interpretation of the data is that WET tests often do not test the most sensitive species, life stage or endpoints. Dr. Nielsen's data clearly show that red drum are more sensitive than mysids and silverside minnows. It is also noteworthy that WET testing protocols are developed for sea urchin and oysters, which would have provided more useful and novel information related to the potential effects of effluent. In short, the WET testing described in the amended application and new draft permit is not comprehensive enough to ensure protection of the environment.

Q. HAVE YOU REVIEWED THE PRE-FILED TESTIMONY OF DR. KNOTT?

A. Yes.

Q. DO YOU AGREE WITH DR. KNOTT'S ASSESSMENT OF WHETHER THE EFFLUENT WILL CAUSE IMPACTS TO LOCAL WILDLIFE?

A. No. My concern with Dr. Knott's opinion is simply that his experience and viewpoint are grounded in his work in Australia, which is a very different ecosystem. As stated in his pre-filed testimony, he is not making any considerations based on the local ecosystem in Port Aransas. It is also clear that his focus is on whether the mixing is sufficient to keep salinity increases at or below 2 ppt above ambient, or 37 ppt. But as plainly stated by POCC witnesses, the 95th confidence interval for ambient salinity in the area exceeds 40 ppt and modelling by Scott Socolofsky suggests that salinity could exceed 44 ppt at the zone of initial dilution boundary. While I agree with Dr. Knott that desalination plants can be operated in many places with minimal environmental disturbance, the specifics of the local environment and sensitivity of local wildlife make the release of desalination effluent into the Port Aransas shipping channel a serious environmental concern.

IV. CONCLUSION

Q. WHAT ARE YOUR CONCLUSIONS REGARDING THE IMPACT OF THE DISCHARGE ON THIS MARINE ENVIRONMENT?

A. Overall I have found nothing presented in the Amended Application and Draft Permit to change my opinion on the potential effects of desalination effluent on aquatic life in the shipping channel. As described in my previous testimony, red drum are a particularly sensitive species with respect to salinity exposure in early life. This fact has again been verified by Dr. Nielsen. The early life sensitivity combined with the high natural salinity baselines found in the shipping channel region make red drum particularly vulnerable to potential effects caused by the desalination effluent. There is further risk on this species due to the well-known importance of the shipping channel as a conduit for larval red drum recruitment from the coastal oceans to the inner estuaries. In addition to my previously held concerns about the effects of desalination brine on red drum early life stages, new CORMIX modeling suggests that there may also be broader concerns related to persistent bottom layer effluent plumes that have the potential to increase the risk for bottom layer hypoxia in the region, which would have adverse impacts to a number of species.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.