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-48R

SOAH DOCKET NO. 582-20-1895
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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**

REMAND PREFILED TESTIMONY

OF

KRISTIN NIELSEN

ON BEHALF OF

PORT ARANSAS CONSERVANCY

SUBMITTED ON FEBRUARY 2, 2022

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

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

REMAND PREFILED TESTIMONY OF KRISTIN NIELSEN, PH.D.

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Exhibit PAC-48R KN-1	Curriculum Vitae
Exhibit PAC-48R KN-2	Proposed Harbor Island Seawater Reverse Osmosis Desalination Facility: A Prospective Evaluation of Toxicological Risk (March 2021)
Exhibit PAC-48R KN-3	Report documenting rangefinder test for the median lethal concentration (Test 1), the results of the first median lethal time test (Test 2), and all data from follow-up testing
Exhibit PAC-48R KN-4	Manuscript submitted for peer review
Exhibit PAC-48R KN-5	Referenced Literature
Exhibit PAC-48R KN-6	Historical rainfall records of Port Aransas

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME.

A. Kristin M. Nielsen.

Q. PLEASE STATE YOUR ADDRESS.

A. My address is 15345 Beaufort Court, Corpus Christi, TX 78418.

Q. WHAT HAVE YOU BEEN ASKED TO DO WITH REGARD TO THIS MATTER, SOAH DOCKET NO. 582-20-1895?

A. I have been retained by the Port Aransas Conservancy to review and evaluate the application of the Port of Corpus Christi Authority of Nueces County (the Port of Corpus Christi) for a water quality permit for a proposed seawater desalination facility on Harbor Island in Nueces County, Texas, as well as the draft permit prepared by TCEQ. I have been asked to review documents and provide my professional assessment as to the potential effects of the proposed activities, specifically, the potential effects on aquatic and aquatic-dependent life. I have also been asked to prepare this written testimony and to testify at the hearing related to the Port of Corpus Christi's permit application and the draft permit.

II. QUALIFICATIONS

Q. PLEASE BRIEFLY DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. I earned a B.A. in Biology from Texas A&M University and a Ph.D. in Aquatic Toxicology from the University of North Texas (UNT). My dissertation research examined the maternal transfer and developmental toxicity of dietary methylmercury to early life stage fish (*Pimephales promelas)*. While completing my Ph.D., I also participated in research conducted in support of the National Resource Damage Assessment (NRDA) for the *Deepwater Horizon* oil spill, which investigated the combined toxicity of oil and intense solar radiation to early life stage marine organisms in the Gulf of Mexico, including red drum *(Sciaenops ocellatus)*, speckled seatrout *(Cynoscion nebulosus),* red snapper *(Lutjanus campechanus),* mahi mahi *(Coryphaena hippurus)*, bay anchovy (*Anchoa*

mitchilli), fiddler crab *(Uca longisignalis)*, and others. After graduating with my Ph.D., I completed a two-year postdoctoral research fellowship in Aquatic Toxicology at UNT, while also teaching Aquatic Toxicology to graduate/upper division students as an adjunct faculty member. A large part of my postdoctoral research was focused on examining the photo-enhanced toxicity of oil to early life stage estuarine and marine fish in the Gulf of Mexico, including improving risk prediction models. These studies were funded by NOAA as part of a separate Damage Assessment that I worked on (Taylor Energy Site).

Q. PLEASE BRIEFLY DESCRIBE YOUR CURRENT OCCUPATION AND OTHER RELEVANT PROFESSIONAL EXPERIENCE.

A. I am currently an Assistant Professor at the University of Texas at Austin Marine Science Institute in Port Aransas, Texas, where my lab researches how chemical and physical environmental stressors (separately and in combination with one another) adversely impact the health of aquatic ecosystems. Although my work incorporates levels of biological organization through the whole ecosystem level, I primarily focus on how environmental stressors impact fish development. My teaching responsibilities at the University of Texas include Marine Environmental Science, as well as a graduate level course in Aquatic Toxicology and Risk Assessment.

I also have prior professional experience in environmental public health and risk assessment from my time in the private and government sectors. I continue my risk assessment work in a research capacity, with a focus on the human health risks of dietary contaminant exposure from subsistence fishing.

Q. PLEASE IDENTIFY WHAT HAS BEEN MARKED AS EXHIBIT PAC-48R KN-1.

A. This is a copy of my current Curriculum Vitae, which includes a list of my publications, presentations, and research grants. My CV reflects my expertise for the opinions I am providing here.

Q. IS THIS A TRUE AND CORRECT COPY OF YOUR CV?

A. Yes.

PAC offers Exhibit PAC-48R KN-1.

Q. HAVE YOU EVER TESTIFIED AS AN EXPERT WITNESS IN A TRIAL OR AN ADMINISTRATIVE HEARING PRIOR TO THIS MATTER?

A. No.

Q. HAVE YOU PREPARED ANY ANALYSIS OF THE PORT OF CORPUS CHRISTI'S APPLICATION, OTHER THAN YOUR TESTIMONY HERE?

A. Yes. Prior to being asked to serve as an expert for this case, I authored a report titled *Proposed Harbor Island Seawater Reverse Osmosis Desalination Facility: A Prospective Evaluation of Toxicological Risk* that prospectively evaluated potential ecotoxicological risks associated with the discharge of effluent from the Port of Corpus Christi's proposed desalination facility to the Corpus Christi Ship Channel and the surrounding habitat. As the report indicates, this study was requested and funded by the UTMSI Marine Science Council and was conducted as part of my responsibilities as a faculty member at the University of Texas. It was published in 2021.

Q. PLEASE IDENTIFY WHAT HAS BEEN MARKED AS EXHIBIT PAC-48R KN-2.

A. This is a copy of the report I just mentioned.

Q. IS THIS A TRUE AND CORRECT COPY OF THAT REPORT?

A. Yes.

PAC offers Exhibit PAC-48R KN-2.

Q. DID YOU RELY ON THIS REPORT TO INFORM YOUR OPINIONS ON THIS MATTER?

A. Yes.

Q. HAVE YOU CONDUCTED ANY OTHER STUDIES THAT ARE RELEVANT TO THE ISSUES ADDRESSED IN YOUR TESTIMONY IN THIS MATTER?

A. Yes. I conducted multiple studies investigating the survival and growth implications of anthropogenic-mediated salinity stress to early life stage red drum (*Sciaenops ocellatus*). While these studies are highly relevant to this issue and have informed my opinion regarding the Port of Corpus Christi's application and draft permit, it should be noted that the results have implications for estuarine-dependent fisheries beyond this matter. As with the report I prepared for the UTMSI Marine Science Advisory Council, these studies were funded entirely by UTMSI departmental funds and were conducted as part of my responsibilities as a faculty member at the University of Texas.

Q. PLEASE IDENTIFY THE DOCUMENT MARKED AS EXHIBIT PAC-48R KN-3.

A. PAC-48R KN-3 is the report documenting the methods and results of the rangefinder test for the median lethal concentration (Test 1), the results of the first median lethal time test (Test 2), and all data from follow-up testing (i.e., the final median lethal concentration test and the second median lethal time test).

Q. IS THIS A TRUE AND CORRECT COPY OF THIS REPORT?

A. Yes.

PAC offers Exhibit PAC-48R KN-3.

Q. DID YOU RELY ON THIS REPORT TO INFORM YOUR OPINION ON THIS MATTER?

A. Yes.

Q. HAS THIS STUDY BEEN PEER-REVIEWED?

A. The manuscript is currently undergoing peer review at *Estuaries & Coasts*, the Coastal and Estuarine Research Federation's scientific journal. In addition, I submitted my data to an uninvolved third-party for review as a part of my University-approved Financial Conflict of Interest (FCOI) Management Plan. My data was submitted to Dr. Matthew Alloy, with

US EPA, for preservation and review. His evaluation resulted in similar (though slightly more conservative) toxicity values to those reported in the manuscript.

Q. PLEASE IDENTIFY THE DOCUMENT MARKED AS EXHIBIT PAC-48R KN-4.

A. Exhibit PAC-48R KN-4 is the manuscript currently undergoing peer review.

PAC offers Exhibit PAC-48R KN-4.

Q. DID YOU RELY ON THIS MANUSCRIPT TO INFORM YOUR OPINION ON THIS MATTER?

A. Yes.

Q. WHAT OTHER MATERIALS HAVE YOU REVIEWED, IF ANY, IN DEVELOPING YOUR OPINIONS IN THIS MATTER?

A. I have reviewed the Port of Corpus Christi's application, draft Permit No. WQ000523000, and supplemental materials. I also have reviewed the pre-filed testimony of the Port's expert witnesses. I have reviewed prior deposition testimony from Dr. Andrew Esbaugh and Dr. Scott Holt. I have also reviewed TCEQ Chapter 307 Texas Surface Water Quality Standards, US EPA Risk Assessment guidance and toxicity testing methods, plus a range of scientific literature, the titles of which are included in Exhibit PAC-48R KN-5.

PAC offers Exhibit PAC-48R KN-5.

Q. ARE THESE THE TYPES OF RESOURCES GENERALLY RELIED ON BY EXPERTS IN YOUR FIELD?

A. Yes.

III. SUMMARY OF OPINIONS

Q. HAVE YOU DEVELOPED ANY OPINIONS REGARDING THE APPLICATION OF THE PORT OF CORPUS CHRISTI OR THE DRAFT PERMIT PREPARED BY TCEQ?

A. Yes.

Q. PLEASE SUMMARIZE THOSE OPINIONS.

A. My overarching opinion is that the proposed activities described in the draft permit pose a high degree of risk to estuarine habitats hydrologically connected to the Corpus Christi

Ship Channel. The permit application and the draft permit fail to include and consider the toxicological and environmental data necessary to perform a robust and adequate environmental impact assessment and/or ecological risk assessment. The evaluation that was submitted in support of the Port's application by Dr. Fontenot is wholly inadequate and its conclusions are misleading for several key reasons.

I am also of the opinion that discharge of effluent from the Port's proposed facility to the Corpus Christi Ship Channel will result in salinity concentrations that have a high potential to cause adverse effects on aquatic life, particularly on early life stage red drum and other aquatic species that are sensitive to salinity stress during early development.

I am also concerned that the proposed location of the outfall in the Corpus Christi Ship Channel is hydrologically connected to an enclosed bay system with high ecological value/high productivity and with low flushing/mixing/water turnover. It is my opinion that the siting of the proposal outfall in this location will lead to degradation of the critical estuarine habitats that rely on the Corpus Christi Ship Channel for water exchange, as well as the organisms that use the channel as a major migratory corridor.

Furthermore, the Port failed to consider the impacts of simultaneous exposure to multiple stressors experienced by organisms in the wild, including the important role of latent mortality. These factors are particularly critical to evaluate when predicting ecological risk, as simultaneous exposure to multiple stressors is known to cause lethal impacts to early life stage aquatic organisms at levels that may be orders of magnitude lower than laboratory toxicity tests would suggest. Estuarine-dependent species that spawn in nearshore waters in proximity to the Corpus Christi Ship Channel, especially those with planktonic offspring

that must passively drift through channel to complete development in shallow seagrass nurseries in adjacent bays, are of particular concern in this respect.

Q. HAVE YOU COMMUNICATED WITH OTHER TESTIFYING WITNESSES RETAINED BY PAC AND, IF SO, WHICH ONES?

A. Yes. I have communicated with Andrew Esbaugh, Brad Erisman, Daniel Schlenk, Greg Stunz, Scott Holt, and Scott Socolofsky.

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

A. Yes. I relied on modeling conducted by Dr. Socolofsky. I also relied on Drs. Stunz' and Holt's intimate knowledge of the ecology of the Corpus Christi Ship Channel and hydrologically connected habitats.

IV. OPINIONS REGARDING THE ECOLOGICALLY SENSITIVE NATURE OF THE AREA ADJACENT TO THE PROPOSED DISCHARGE

Q. YOU MENTIONED THAT THE AQUATIC HABITAT ADJACENT TO THE PROPOSED DISCHARGE SITE IS HIGHLY PRODUCTIVE AND OF HIGH ECOLOGICAL VALUE. PLEASE EXPLAIN WHAT YOU MEAN.

A. This area contains some of the most well-preserved and productive estuarine habitats in the nation. By productive, I mean that it generates large amounts of organic biomass to support complex coastal food webs, which maintains high biological diversity and ecosystem function. Seagrass beds serve as essential nursery grounds for early life stage aquatic organisms, including many managed and protected fish species. When the ecosystem is healthy and functions properly, humans reap the benefits through a wide range of ecosystem services, such as water filtration and detoxification, enhanced coastal resiliency, erosion prevention, and maintenance of biogeochemical cycles. The economic benefits of tourism, recreation, and fisheries to the area also cannot be overstated here. Texas has a $3.2 billion recreational fishing industry, two thirds of which comes from red drum (*Sciaenops ocellatus*) and speckled seatrout (*Cynoscion nebulosus*) fisheries, both of which

are estuarine-dependent species that thrive here. Though red drum can be found elsewhere along the Texas Coast, our immediate area supports some of the most robust populations in the nation.

Q. PLEASE EXPLAIN WHY THIS IS IMPORTANT.

A. I mentioned above that this is an area of high ecological value that (when functioning correctly) provides critical nursery and feeding grounds for early life stage fish, like red drum. This is important to consider because the sudden reduction in number of red drum larvae that successfully reach the seagrass beds in any given year would mean lower adult fish numbers are available to fisherman 3 to 5 years later. Fewer adults mean fewer successful spawns the next year, further depressing fish populations through a series of feedbacks. Because red drum are so long lived, adverse impacts to seasonal recruitment of young can impact the health of fisheries for years. In fact, red drum populations are not expected to recover from the low productivity of the 2010, 2011, 2012, and 2013 year classes (from the *Deepwater Horizon* oil spill) until the year 2053.

There is an abundance of peer-reviewed scientific literature to show that the collapse of important marine fisheries eliminates sustainable livelihoods for nearby communities.

V. OPINIONS REGARDING SALINITY CHANGES UPON DISCHARGE

Q. YOU MENTIONED SALINITY OF THE DISCHARGE. HAVE YOU DEVELOPED OPINIONS REGARDING THE POTENTIAL IMPACT OF SALINITY OF THE PROPOSED DISCHARGE ON AQUATIC LIFE?

A. Yes.

Q. WHAT ARE YOUR OPINIONS REGARDING SALINITY IN THE PROPOSED DISCHARGE?

A. Global experts explicitly recommend against discharging brine into habitats with (1) high ecological value, (2) high productivity, (3) high concentrations of sub-adult organisms, and (4) poor flushing and long water residence times. All of these characteristics describe

estuaries hydrologically connected to the Gulf of Mexico by the Corpus Christi Ship Channel. Neither the application nor the draft permit have demonstrated that the salinity or any other chemical constituents present in the discharge will not adversely impact the growth or survival of aquatic and aquatic-dependent life (particularly organisms in early life stages) Modeling has shown that the outfall may easily result in salinities that are ≥ 2 ppt above ambient, which my research and that of others have found to be the threshold above which adverse ecological effects are possible in a system of this kind. Collectively, the biological and modeling data confirm that the upper range of naturally occurring salinities within the Corpus Christi Ship Channel are already near the tolerance threshold of native red drum larvae and other estuarine dependent species. Therefore, under frequent summer drought conditions, even minimal elevations in the salinity of the channel may lead to significant adverse ecological impacts. Further, the modeling done by the Port of Corpus Christi does not demonstrate that this hypersaline effluent will not adversely impact aquatic life beyond the mixing zone. In summary, the effluent discharged from the Port's proposed facility to the Corpus Christi Ship Channel and surrounding habitat will result in salinity concentrations with a high potential to cause adverse effects on aquatic life, particularly on sensitive estuarine-dependent organisms, like early life stage red drum.

Q. WHAT IS THE BASIS FOR YOUR OPINION?

A. My opinion is based on my experience as an ecotoxicologist, in both a research and risk assessment context. I have performed a large number of studies with early life stage fisheries species in the Gulf of Mexico, including multiple stressor studies and salinity testing with red drum and other native fish and invertebrate species. I also research coupled human and natural systems in subsistence fishing communities, and I have professional

experience in environmental public health and risk assessment that also contributed to my opinions. Further, I relied on the opinions of other relevant experts (previously identified).

Q. YOU PREVIOUSLY MENTIONED TOXICITY TESTS ON EARLY LIFE STAGE RED DRUM. PLEASE EXPLAIN HOW YOU CONDUCTED THESE TOXICITY TESTS.

A. I performed two types of single stressor toxicity tests with embryonic and larval red drum. The first type was designed to find the median lethal concentration (LC50), which is the concentration that will cause 50% of larvae to die at pre-set timepoints. That test also allows us to predict two other values, called a NOEC (no observable effect concentration) and LOEC (lowest observable effect concentrations). The LOEC is the lowest treatment concentration that had a statistically significant effect, and the NOEC is the concentration just below the LOEC (in which any effects were not yet statistically significant). The second type of test was designed to find the median lethal time (LT50), which is the length of time required to kill 50% of embryo-larval red drum that drift into full strength brine (i.e., an LT50 test). Both tests counted only mortality that occurred while the test was running, so latent mortality is not accounted for (i.e., the values likely underestimate risk to a high degree).

I performed both types of tests in duplicate. The first round of testing consisted of rangefinder tests, which is standard practice in my field. To perform a rangefinder for an LC50 test, you start with a very broad range of concentrations and then you use the results of that test to refine your final study design to focus on a narrow range of concentrations at which you see effects start to occur. This second step is key to generating toxicity values with a high degree of certainty, because you can avoid extrapolating across large gaps in concentrations (e.g., 5 ppt or 10 ppt increments). The second round of testing I conducted

consisted of this type of refined test. We also doubled the number of replicates we tested in each concentration to increase our statistical power even further.

For both LC50 tests, survival was evaluated at nominal test hours 24, 48, and 72. We did not run the tests out for the standard 96 hours used by EPA, because embryo-larval red drum have used up their yolk sac by 96 hours, so mortality counts would be confounded by starvation at the last time point. This is standard practice for embryo-larval red drum tests, including those conducted for National Resource Damage Assessments. The rationale is that at test hour 72, a rapidly developing red drum will be developmentally similar to an EPA estuarine model fish at test hour 96.

Q. WHAT WERE THE RESULTS OF THE TOXICITY TESTS?

A. The results of the LC50 rangefinder studies showed that 50% of red drum would not hatch at test hour 24 as expected if the salinity is around 49 ppt. At test hour 48, a salinity of around 43.8 ppt would be lethal to 50% of larvae. At test hour 72, half of the larvae will die in water with a salinity of about 40.4 ppt.

Using this information, we repeated the test to focus on a narrower range of salinities that were close to the LC50s from the first test, with treatments that increased by only 2 ppt (instead of the 5 ppt increments used in Test 1). Results of this second round of tests agreed excellently with our first round of results, despite the fact that we used eggs from Texas Parks and Wildlife (spawned in 25 ppt tanks) for the first test, and eggs from UTMSI (spawned at 35 ppt) for the second test.

Follow-up testing showed that 50% of red drum embryos will fail to hatch in water with a salinity of 50.8 ppt. Twenty-four hours later (test hour 48), 50% of larvae are expected to die in water with a salinity of 44.8 ppt. At 48 hours post hatch (test hour 72), a salinity of 37.7 ppt is expected to kill 50% of larvae. The LOEC for all timepoints (i.e., the

concentration at which adverse effects on hatch and survival first starts to occur) was 37 ppt. This means that the only treatment that did not cause significant lethality to larvae was the 35 ppt control treatment (i.e., the NOEC for salinity is essentially the salinity they were spawned in).

During both rounds of LT50 testing, we observed significant lethality at every timepoint evaluated, including the first timepoint (4 minutes for round 1 and 10 min for round 2). This means that significant effects on the survival of larval red drum drifting through the ZID will begin sometime between 0 and 4 minutes, with 50% mortality between 47.7 and 55.4 minutes.

Q. DID YOU CONDUCT ANY MORE FOLLOW-UP TESTS THAT YOU HAVE NOT ALREADY MENTIONED?

A. I have not yet done any follow-up tests, but I did perform confirmatory statistical analyses in R using probit models and (where appropriate) post hoc comparisons via estimated marginal means. I also used a Tukey adjustment to control for the increased rate of error inherent in multiple comparisons. Using this approach produced toxicity values that were either the same, or lower than my initial values.

Q. WHAT WERE THE RESULTS OF THESE CONFIRMATORY STATISTICAL ANALYSES?

A. The new run showed that 50% of red drum embryos will fail to hatch around 46.6 ppt, as compared to my original run at 50.4 ppt. At test hour 48, the probit model predicts that 50% of larvae will be dead at a salinity of 43.3 ppt, as compared with my original value of 44.8 ppt. Finally, at test hour 72, 50% of the larvae will be dead at a salinity around 37.9 ppt, which is almost identical to my previous value of 37.7 ppt. The LOEC for all timepoints remained at 37 ppt.

Q. DO THE RESULTS FROM THESE NEW ANALYSES IMPACT YOUR OPINION IN ANY WAY?

A. They do not change my opinion. For the initial analyses, all p values were < 0.001 (anything less than 0.05 is significant, but the lower the number, the more undeniable the significance). We also performed two rounds of testing, with eggs from two different broodstock, and got nearly identical results. The second time, we used twice the replication that Parson's sub-contractor used for their testing (they used the minimum required by the EPA) and salinity increments between treatments of only 2 ppt, to avoid having to extrapolate to any meaningful extent. The one added advantage of this second approach is that it controls for the random error that is associated with multiplicity, so these results essentially eliminate any uncertainty about the values.

Q. DO LC50 AND LT50 VALUES HAVE ANY LIMITATIONS THAT YOU BELIEVE ARE IMPORTANT TO YOUR OPINION?

A. Yes.

Q. WHAT ARE THOSE LIMITATIONS?

A. It is important to note that the toxicity values from the LC50 and LT50 test do not account for latent mortality (i.e., death that occurs in the hours or days following exposure). Based on low salinity tolerance of this species during early development (as demonstrated by our tests and by others), it is likely that latent mortality will be a significant factor affecting the survival of larval red drum exposed to hypersaline conditions in the CCSC. Moreover, these tests considered only salinity stress, and do not account for additional stress from contamination, mechanical forces, intense solar radiation, hypoxia, or other co-stressors that can interact to cause lethality at much lower exposure concentrations than lab studies can predict.

Q. WHY DID YOU USE EARLY LIFE STAGE RED DRUM?

A. In the context of predicting and evaluating potential damage to local estuarine ecosystems from human-caused environmental change in the Gulf of Mexico, early life stage red drum are essentially the gold standard of study organisms.

The reason I specifically focus on early development is because organisms are known to be more sensitive to environmental stress during early development than juveniles or adults (and thus, are more important drivers of ecological risk). It is also a widely accepted principle that physical and chemical stressors that adversely impact the reproductive success and/or survival of early life stage fish have the most severe effects on populations as a whole, so evaluating risks on developing fish is key to understanding what will happen to total fish numbers in the long term.

While juvenile and adult red drum are known to be fairly tolerant of high salinity, early developmental stages are very sensitive to changes in salinity outside of their normal range. Since red drum drift through the Ship Channel during this incredibly sensitive stage, they are expected to be an important driver of risk, unlike the inland silverside (the fish species that the Port used for testing that is spawned in shallow bays and is widely known to be euryhaline at hatch).

Finally, red drum are known to be especially sensitive to multiple stressor effects, including both chemical and physical types of stress. These are also the reasons that NOAA chose to use early life stage red drum for toxicity testing (including results of multi-stressor toxicity studies) that was used to develop broader conclusions about the extent of damage caused to nearshore marine ecosystems in the Gulf of Mexico by the *Deepwater Horizon* oil spill. The reason people don't use them more commonly is merely a product of availability (very few places can successfully spawn red drum in captivity) and the sensitivity of early life

stages (which makes it hard to successfully transport them long distances). In the immediate area, we are exceptionally fortunate to have two local facilities with long and successful histories of spawning wild caught red drum in captivity (UTMSI and Texas Parks & Wildlife). Thus, my lab is able to use these organisms for regionally relevant toxicity testing while maintaining high baseline survival. This species is regionally important in many respects, including the following key points:

(1) They are critical predators that play an important role in maintaining the structure and function of our local estuarine ecosystems

(2) They are highly relevant to all of the aquatic habitats that are hydrologically connected to the Corpus Christi Ship Channel (i.e., nearshore waters, the channel itself, connected bay systems), and thus, the proposed facility.

(3) Their economic value to Port Aransas and Corpus Christi (and coastal Texas as a whole) cannot be overstated.

(4) Due to their long lifespan, the impacts of below average survival and recruitment can persist for multiple decades.

Q. DOES YOUR LAB REGULARLY USE EARLY LIFE STAGE RED DRUM FOR TOXICITY TESTS?

A. Yes. My lab uses early life stage red drum for a wide variety of toxicity testing, including studies examining the toxicity of oil, perfluorinated compounds, and physical stressors (e.g., intense ultraviolet radiation and salinity), both separately and in combination with one another.

Q. YOU MENTIONED THAT YOU USED RED DRUM BROODSTOCK FROM TWO DIFFERENT SOURCES. DOES THAT INFLUENCE YOUR OPINION?

A. The red drum broodstock at UTMSI were not being spawned the week my lab planned to perform the rangefinder tests, as the tanks were not yet up to the temperature necessary to

induce spawning (our aquaculture experts manipulate tank temperatures very gradually to avoid stressing the fish). Texas Parks & Wildlife (Flour Bluff location) spawning tanks were already up to temperature, so we used embryos from their facility to perform preliminary testing. This is a very standard practice for those of us working with red drum at UTMSI. In fact, many of the red drum eggs used for *Deepwater Horizon* toxicity testing were provided by the same Texas Parks & Wildlife facility.

By the time we were ready to perform our refined (final) tests, the spawning tanks at UTMSI were up to temperature and producing high quality spawns. To avoid the potential for transport stress to affect results, we used embryos produced at our facility for final testing. It is relevant how similar the test findings were, given that eggs from two different broodstock populations were used, especially since the Texas Parks & Wildlife tanks were at 25 ppt (Test 1) and 28 ppt (Test 2), but the UTMSI embryos were spawned at 35 ppt. Thus, the degree of alignment between the preliminary and final testing further confirms the broad applicability of the toxicity values we generated for early life stage red drum exposed to hypersaline conditions.

Q. ARE THE METHODS YOU FOLLOWED THE TYPES OF METHODS ACCEPTED BY PROFESSIONALS IN YOUR FIELD?

A. Yes.

Q. HAVE THESE SAME METHODOLOGIES BEEN THE BASIS OF PUBLISHED PEER-REVIEWED STUDIES BEFORE?

A. Yes. The underlying study design is the same or similar to most other early life stage red drum studies conducted by my lab and others, as well as many other peer-reviewed studies involving estuarine/marine species that are not typical EPA testing models but have been found to be incredibly important for evaluating risk to valuable and unique ecosystems in

the Gulf of Mexico for National Resource Damage Assessments. These include fiddler crab zoea, blue crab zoea, mahi mahi, speckled seatrout, anchovy, red snapper, cobia, and others.

Q. DO YOU KNOW WHAT TYPE OF SPECIES THE PORT RELIED ON FOR THEIR TESTING?

Yes. The Port chose two species – mysid shrimp and inland silverside.

Q. DO YOU HAVE ANY OPINIONS ABOUT THE SPECIES THE PORT RELIED ON?

A. It is a widely accepted principal in toxicology that early life stage organisms are much more sensitive to the adverse effects of environmental stress than juvenile or adult stages. The salinity tolerance demonstrated by early life stage organisms in estuaries is extremely variable. Some species have a remarkably high ability to cope with extreme salinity fluctuations from day one, like sheepshead minnow (*Cyprinodon variegatus*), mysid shrimp (*Mysidopsis bahia*), and inland silverside (*Menidia beryllina*) while others require very specific salinities during certain windows to complete development.

Still, the Port selected mysid shrimp (*Mysidopsis bahia*) and inland silverside (*Menidia beryllina*) as organisms for salinity testing. To start, mysid shrimp are known to be the most dominant Mysidacea in the Laguna Madre, which regularly reaches 70 ppt during the arid summer months. Their occurrence and survival under these conditions in the Corpus Christi area has been documented in the peer reviewed literature for at least four decades, making them an inappropriate toxicity model for this particular project.

The inland silverside is an equally poor choice for this project because of life history differences that lead to high salinity stress tolerance during the earliest stages of development. These organisms spawn in shallow estuarine waters that naturally experience a wide range of salinities, so even newly hatched animals must be highly tolerant to salinity stress in order to survive. Many organisms that spawn in tidal rivers, brackish water, or other shallow estuarine habitats demonstrate the same tolerance immediately upon hatch.

It is worth noting that the US EPA standard operating procedures for the inland silverside test contained in publication *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (EPA-821-R-02-014) explicitly states that the inland silverside can tolerate a wide range of salinities, *from 0 ppt to 58 ppt*.

In contrast to the above-mentioned and highly tolerant organisms, estuarine-dependent species that spawn in nearshore waters (e.g., red drum and speckled seatrout) experience gradual changes in salinity across a relatively narrow range during their earliest developmental stages, so their salinity tolerance in the days following hatch is very low. Along with the findings of others, testing performed in my lab shows that newly hatched red drum are very intolerant of salinity fluctuations in early development (as are speckled seatrout), regardless of spawning salinity. Additionally, larvae becoming increasingly tolerant as they proceed through subsequent developmental stages and settle in seagrass beds. In summary, the Port's species are an inappropriate and suspect choice for evaluating ecological risk from hypersaline discharge.

Q. ARE FISH THE ONLY CLASS OF ORGANISM THAT YOU ARE CONCERNED ABOUT?

A. No. Every class of organisms has members that are much less tolerant of salinity changes than others. This even includes phytoplankton, which form the base of the estuarine food web in this bay complex. Research has shown that hypersaline brine from desalination plants kills more sensitive phytoplankton species, leaving fewer species of highly tolerant phytoplankton. The decrease in phytoplankton diversity near multiple desalination facilities has been shown to trigger harmful algal blooms.

VI. OPINIONS REGARDING CONTAMINANTS OTHER THAN SALINITY UPON DISCHARGE

Q. YOU MENTIONED CONTAMINANTS OTHER THAN SALINITY. HAVE YOU DEVELOPED OPINIONS REGARDING THE POTENTIAL IMPACT OF CONTAMINANTS OTHER THAN SALINITY ON AQUATIC LIFE AS A RESULT OF THE DISCHARGE?

A. Yes.

Q. WHAT ARE YOUR OPINIONS REGARDING CONTAMINANTS OTHER THAN SALINITY?

A. My opinion is that neither the application nor the draft permit have demonstrated that there will be no contaminants in the discharge, nor has it been demonstrated that those contaminants in the discharge will not adversely impact aquatic and aquatic-dependent life.

Q. PLEASE EXPLAIN.

The Port claims that the intake water is not located near chemical source areas, yet the Corpus Christi area is a major source of both municipal and industrial contamination, including a variety of constituents from contaminant classes, such as metals, polychlorinated biphenyls (PCBs), per- and polyfluoroalkyl substances (PFAS), organochlorine pesticides (OC pesticides), and polycyclic aromatic hydrocarbons (PAHs). Many of these contaminants can be transported long distances through normal environmental processes, so they are certainly of potential concern in nearby coastal systems, especially in sediments.

Harbor Island has been regularly exposed to point source industrial pollution. It was once the largest import port for crude oil for decades. Exxon used the port to import foreign sources of crude for its Humble refinery that once operated in Ingleside. The *Deepwater Horizon* oil spill, which released millions of barrels of oil into the Gulf of Mexico and oiled thousands of miles of shoreline, is another major source of potential contamination that is highly relevant to this area.

The pollutants commonly released by industrial facilities and oil spills will preferentially partition to sediments (which have not been evaluated by the Port) due to their physico-chemical properties. Because oil contamination is widely known to remain in marine sediments for many decades, it is not reasonable to suggest that sediment pollution is not a potential concern at the intake site. In fact, the World Health Organization (WHO) explicitly states that there is "a significant potential for anthropogenic contamination of source waters, particularly seawater and estuarine waters" to be present in effluent from Reverse Osmosis facilities, resulting in "a significant potential for contamination by petroleum hydrocarbons, particularly in regions where there is substantial oil extraction activity" (e.g., the Corpus Christi area).

Data from NOAA's National Status and Trends Program's ecotoxicological database support these conclusions. The database provides sediment and tissue monitoring data for a subset of contaminants in Corpus Christi, Aransas, and Copano Bays through 2006 (before the *Deepwater Horizon* spill). I evaluated these data, which indicate that a number of contaminants are already at or near levels of potential concern in these bays, particularly those associated with crude oil. Furthermore, tissue contamination was typically higher than contamination in nearby sediments, indicating that the pollution is bioavailable and is entering the food web. The Port has made no effort to show that the proposed facility will not add to the existing level of contamination via redistribution of contamination from the intake site to the outfall (which will occur continuously).

Chemicals added during the desalination process may also react with constituents present in the aquatic environment to yield highly toxic halogenated by-products. Chronic exposure to mixtures of contaminants of concern that exert sublethal affects (e.g., reduce

reproductive capacity/biomass, developmental abnormalities) are typically expected to drive ecotoxicological risk for sensitive receptors at sites of this nature, rather than acute mortality from single contaminant exposure. Neither the application nor the draft permit provide enough information to support the Port's position that the facility will not remobilize contamination from the intake site into habitats that are hydrologically connected to the Corpus Christi Ship Channel.

Q. WHAT IS THE BASIS FOR THIS OPINION?

A. My opinion is based on my experience as an ecotoxicologist, in both a research and risk assessment context, particularly the study I conducted entitled, *Proposed Harbor Island Seawater Reserve Osmosis Desalination Facility: A Prospective Evaluation of the Ecotoxicological Risk.*

Q. WHAT ASSUMPTIONS DID YOU RELY ON IN THIS STUDY?

A. Since this proposed facility is not already permitted and operating, there are no site-specific quantitative data from any releases that have already occurred. Therefore, my evaluation of the risks posed by contaminants relied on surrogate data. For the exposure assessment, I reviewed a combination of peer-reviewed scientific journal articles, reports from various government agencies, technical reports, permitting documents, and NOAA's National Status and Trends Program's ecotoxicological database (which contains sediment and tissue monitoring data for Corpus Christi, Aransas, and Copano Bays).

Q. ARE YOU AWARE OF ANY ENVIRONMENTAL SAMPLING CONDUCTED BY THE PORT OF CORPUS OF CHRISTI TO DETERMINE CURRENT LEVELS OF CONTAMINATION AT THE INTAKE SITE?

A. Yes. In supplemental materials dated June 25, 2021, the Port of Corpus Christi released the results of two water quality samples it says Parsons collected near the location of the proposed intake. No sediment sampling was conducted.

Q. DO YOU HAVE ANY OPINIONS REGARDING THE PORT'S ENVIRONMENTAL SAMPLING?

A. Yes. The Tischler - Garza memo included in the supplemental materials references the two water samples, saying they were to be "collected over a relatively short time period (approximately one week). In fact, the samples were collected over the course of two consecutive days in early June 2021. Texas Administrative Code Rule 307.9 requires that samples used "to determine standards attainment in ambient water must be representative in terms of location, seasonal variations and hydrological conditions." Based on the sample size and collection window alone, the Port cannot meet these requirements. The code also goes on to state that "sample results that are used to assess standards attainment must not include samples that are collected during extreme hydrological conditions such as high-flows and flooding immediately after heavy rains." This is critical to the interpretation of the Port's sampling results, as the historical record shows that these samples were collected during a period of abnormally high rainfall in Port Aransas. See Exhibit PAC-48R KN-6.

PAC offers Exhibit PAC-48R KN-6.

Thus, my opinion is that the two water samples that the Port collected are in no way representative of the typical water quality or contaminant concentrations present at the intake site, so they cannot be used to evaluate standards attainment or to predict the concentration of contaminants that will be present in effluent. Nonetheless, the Port proceeded to calculate average predicted contaminant concentrations in effluent under a 40% recovery scenario using these values. It is noteworthy that in spite of their insufficient data collection, the Port still shows that concentrations of contaminants will be higher in effluent than in intake water (Tables reporting sampling results from intake location in Industrial Wastewater Application Technical Report).

You cannot confidently evaluate risk using two biased-low water sampling values collected during abnormal hydrological conditions. Nonetheless, the Port chose to perform all of its risk calculations using these values. Other standard risk assessment practices that Dr. Fontenot chose to forego in his so-called ecological risk assessment are evaluations of the role of sediment contamination in exposure and risk, and a discussion of uncertainty surrounding his conclusions.

Q. YOU SAID THE PORT DID NOT CONDUCT ANY ASSESSMENT ON SEDIMENT. IS THIS IMPORTANT TO YOUR OPINIONS?

A. Yes.

Q. IN WHAT WAY?

A. Despite the fact that the Port's Process Design Basis and Narrative states that the intake will pull in millions of gallons of sediment and other suspended matter (e.g., phytoplankton and other small organisms, organic carbon) every day, along with intake water, no sediment sampling was conducted. The Port's choice to omit this information is particularly troubling for many reasons, the first being that the vast majority of contaminants in the marine environment are typically found in the sediment. The Port attempts to justify this omission by saying that the "intake surface water from the Gulf of Mexico is not located near chemical source areas and will not contain appreciable suspended solids/sediments. This statement is patently untrue, as the Port's Process Design Basis and Narrative states that along with intake water, millions of gallons of sediment and other suspended matter (e.g., phytoplankton and other small organisms, organic carbon) will be taken up every day. In fact, in Table 2: *50 MGD Desalination Facility Design Basis Source Water and Effluent Constituent Concentrations*, the Port shows that the facility will take in such large quantities of suspended solids (including associated contaminants) that even after removing and disposing of 5.1 million gallons of solids, the effluent water will still have

twice as many suspended solids as when the process started (The Port's supplement material states that total suspended solids in source water will be 7.4 mg/L, while effluent will contain 15 mg/L of suspended solids at the outfall under a 50% recovery scenario). Consequently, the Port should understand the need to evaluate the potential risk associated with remobilization of sediment contamination from the intake to the outfall, rather than dismissing sediment as a source contribution. This is especially true given that the Port states in its own materials that suspended solids will be concentrated and discharged at the outfall, thereby continuously adding any associated pollutants to the baseline level of contamination present near the outfall.

Q. PLEASE SUMMARIZE YOUR OPINIONS REGARDING CONTAMINANTS OTHER THAN SALINITY.

A. In summary, desalination will take up and concentrate contamination from both water and sediments at the intake site, which will be continuously released at the outfall day after day, resulting in accumulation near the outfall (above and beyond any existing pollution). Therefore, organisms getting hit with hypersaline water will simultaneously have to deal with a plume of concentrated contamination, which will result in multi-stressor effects (which causes organisms to die at much lower salinity/contaminant concentrations than those predicted by laboratory toxicity studies). The Port has not provided representative or reliable samples that would show the intake water will not harm aquatic life in the area surrounding the proposed outfall, and the Port has not conducted any sediment sampling near the intake site. The Port's evaluation misrepresents and underestimates actual risk to receptors in the area.

VII. OPINIONS REGARDING THE LOCATION OF THE OUTFALL

Q. DO YOU HAVE ANY OPINION REGARDING THE LOCATION OF THE PROPOSED OUTFALL?

A. Yes.

Q. WHAT IS YOUR OPINION?

A. The shallow protected bays that are hydrologically connected to the Gulf of Mexico via the Corpus Christi Ship Channel are surrounded by a nearly continuous band of barrier islands that prevent flushing and mixing with oceanic waters. While this minimizes wave action and allows for the formation of wetlands and seagrass beds, it also results in remarkably long water turnover times (up to a year) in these bays, and predisposes them to contaminant accumulation, eutrophication, marine heat waves, hypersalinity and hypoxia. For these reasons, experts from around the globe consistently warn against discharging desalination effluents into enclosed bay systems and coastal lagoons, which typically have (1) high ecological value, (2) high productivity, (3) high concentrations of sub-adult organisms, and (4) poor flushing and long water residence times.

Q. YOU MENTIONED HYPOXIA. PLEASE EXPLAIN.

A. One of the Port's experts, Dr. Furnans, co-authored a paper that evaluated "whether additional salt loads from desalination would lead to enhanced hypoxia in Corpus Christi Bay (the result was affirmative)." In his publication, the authors warn engineers against modeling "using depth-averaged methods" for shallow bays (like those that are hydrologically connected to the Gulf of Mexico via the Ship Channel), as the "additional salt load of a desalination plant" may not vertically mix as expected. Although the Port's overly simplistic CORMIX models do not show the effect predicted in Dr. Furnans' 2011 publication, the improved modeling performed by Dr. Socolofsky confirms the likelihood of a persistent density current (a cause of hypoxia) at the outfall. From an ecological risk perspective, Dr. Furnans and his co-authors raise another important point, emphasizing that "understanding the possible development, transport and fate of thin hypersaline layers is

critical to predicting the development of hypoxia and associated ecological impacts" from desalination brine.

Simultaneous exposure to multiple stressors (such as hypoxia and hypersalinity) causes lethal impacts to early life stage aquatic organisms at exposure levels orders of magnitude below those that would normally be required to cause lethality in laboratory studies.

VIII. OPINIONS REGARDING MULTI-STRESSOR EFFECTS AND LATENT MORTALITY

Q. YOU PREVIOUSLY MENTIONED MULTI-STRESSOR EFFECTS AND THE POTENTIAL FOR LATENT MORTALITY. DO YOU HAVE OPINIONS REGARDING MULTI-STRESSOR EFFECTS RELATED TO THE PORT'S PROPOSED FACILITY?

A. Yes.

Q. DO YOU HAVE ANY OPINIONS REGARDING THE POTENTIAL FOR LATENT MORTALITY RELATED TO THE PORT'S PROPOSED FACILITY?

A. Yes.

Q. WHAT ARE YOUR OPINIONS REGARDING MULTI-STRESSOR EFFECTS AND LATENT MORTALITY?

As I previously mentioned, multi-stressor effects and the potential for latent mortality are critical to evaluate the effects that the proposed facility will have on estuarine-dependent species that spawn in nearshore waters proximal to the Corpus Christi Ship Channel, especially those with planktonic offspring that must passively drift through the channel to complete development in shallow seagrass nurseries in adjacent bays. Unfortunately, laboratory testing is not capable of completely replicating the multitude of simultaneous stressors that organisms face under "real-world" conditions, because they are focused on controlling for all but only one (or some limited number) of variables. This does not mean that laboratory tests are unreliable, obviously, it only means that those results must be considered in context of other stressors.

Essentially, for an early life stage organism passively drifting along, the laboratory is like the Four Seasons – complete luxury. There is no safer or less physiologically stressful place to be than a predator-free, food-abundant, perfectly calm, and perfectly stable laboratory environment. However, in the wild, these organisms are exposed to a cocktail of natural stressors (e.g., intense sunlight, salinity and temperature fluctuations, mechanical forces from waves and wind, predators) that are intensified by any additional man-made stressors (e.g., contamination, climate change, entrainment, mechanical forces from discharge). For this reason, even small amounts of additional manmade stress can cause widespread lethality to early life stage organisms that are already at the edge of their stress tolerance.

Another important consideration for fish in the wild that isn't captured by typical laboratory studies is the effect of latent mortality or "delayed death." Latent mortality is death that occurs in the days or weeks after exposure to stress. This can be compared to the eventual death of a plant that initially survives the stress of a cold snap or disease outbreak but is never able to fully recover. Delayed death is also not captured by traditional laboratory toxicity tests, because researchers typically stop collecting data at a pre-determined time (e.g., 96 hours).

The data I presented from my toxicity tests do not incorporate multiple stressors or latent mortality, so the toxicity values are almost certainly underestimating risk to wild organisms.

IX. CONCLUSION

Q. WHAT IS YOUR OPINION AS TO WHETHER THE APPLICATION SHOULD BE GRANTED AND THE DRAFT PERMIT ISSUED?

A. My opinion is that the Port of Corpus Christi should not proceed with its current plans to discharge saltwater reverse osmosis effluent into the Corpus Christi Ship Channel because

the proposed discharge presents a likelihood of significant adverse impacts to aquatic life and to aquatic ecosystems on which coastal communities rely.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, though I reserve my right to supplement this testimony if I learn of information that causes me to change any of my opinions stated here.