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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 AP-LF-1R

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**

PREFILED DIRECT TESIMONY

OF

DR. LANCE FONTENOT

ON BEHALF OF APPLICANT

THE PORT OF CORPUS CHRISTI AUTHORITY OF NUECES COUNTY ON REMAND

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APPENDICES

LIST OF DEFINITIONS, ABBREVIATIONS AND ACRONYMS

1. “ADCP” means Acoustic Doppler Current Profiler.
2. "ALJs” means Administrative Law Judges.
3. “Application” means the Port of Corpus Christi Authority of Nueces County’s application for TPDES Permit No. WQ0005253000.
4. “Aransas Channel” means the Aransas Channel identified on Exhibit PF 1-1 below.
5. “Aransas Pass” means the Aransas Pass identified on Exhibit PF 1-1 below.
6. “ASCE” means American Society of Civil Engineers.
7. “CCH” means the Contested Case Hearing.
8. “CCSC” means the Corpus Christi Ship Channel.
9. “CWA” means the Federal Clean Water Act.
10. “Diffuser” means the multi-port diffuser designed by Dr. Lial Tischler and described in Dr. Tischler’s memo of June 24, 2021 in the Revised Application.
11. “Effluent” means the water identified in the Draft Permit with the outflow from the Facility to be discharged into the CCSC pursuant to the terms of the Draft Permit.
12. “EPA” means Environmental Protection Agency.
13. “Executive Director” or “ED” means the Executive Director of the TCEQ.
14. “Facility” means the desalination facility proposed in the Revised Application.
15. “Harbor Island” means Harbor Island identified on Exhibit PF 1-1 below.
16. “HHMZ” means Human Health Mixing Zone.
17. “LOEC” means Lowest Observable Effects Concentration.
18. “Lydia Ann Channel” means the Lydia Ann Channel identified on Exhibit PF 1-1 below.
19. “MGD” means Million Gallons Per Day.
20. “MZ” means Mixing Zone.
21. “NOAA” means National Oceanic and Atmospheric Association.

22. “NOEC” means No Observable Effects Concentration.

23. “Outfall” or “Outfall 001” means the location of the effluent discharge identified in the Revised Application and shown on Exhibit PF 1-1 below.

24. “PAC” means Port Aransas Conservancy.

25. “Permit” or “Draft Permit” means the version of TPDES Permit No. WQ0005253000 submitted by the TCEQ Executive Director in September 2021.

26. “Port Authority” means the Port of Corpus Christi Authority of Nueces County, Texas.

27. “PPT” means Parts Per Thousand.

28. “Prior Draft Permit” means the version of TPDES Permit No. WQ0005253000 submitted by the TCEQ Executive Director in 2020 prior to the Remand Order.

29. “Protestants” means all of the individuals or organizations that are parties to the Contested Case Hearing opposing the Draft Permit.

30. “Remand Order” means the Order from the Texas Commission on Environmental Quality dated May 26, 2021.

31. “Revised Application” means the revision of June 24, 2021 to the Port of Corpus Christi Authority of Nueces County’s Application for TPDES Permit No. WQ0005253000 and associated documents.

32. “SOAH” means State Office of Administrative Hearings.

33. “SWQS” means Texas Surface Water Quality Standards.

34. “TBELs” means Technology-Based Effluent Limits.

35. “TCEQ” means Texas Commission on Environmental Quality.

36. “TPDES” means Texas Pollution Discharge Elimination System.

37. “WQBELs” means Water Quality-Based Effluent Limits.

38. “ZID” means Zone of Initial Dilution.

39. “40 C.F.R.” means Code of Federal Regulations Title 40.

40. “30 T.A.C.” means Texas Administrative Code Title 30.

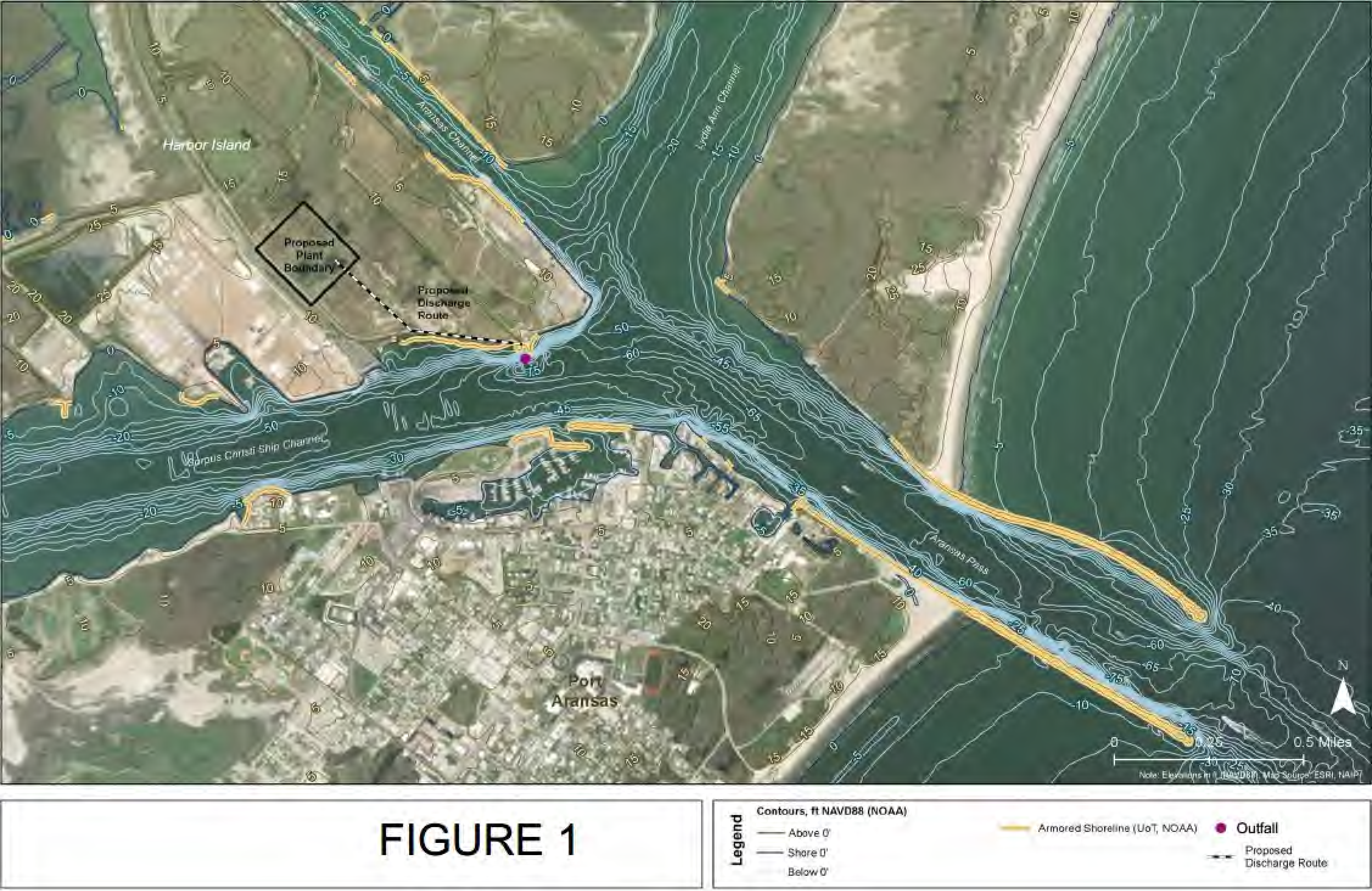

Harbor Island
Proposed Plant Boundary
Proposed Discharge Route
Aransas Channel
Lydia Ann Channel
Corpus Christi Ship Channel
Aransas Pass
Port Aransas
0 0.25 0.5 Miles
N
Legend
Contours, ft NAVD88 (NOAA)
Above 0'
Shore 0'
Below 0'
Armored Shoreline (UoT, NOAA)
Outfall
Proposed Discharge Route

FIGURE 1

DIRECT TESTIMONY

I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name and business address.

A. Lance Fontenot, Ph.D., PWS
8550 United Plaza Blvd., Suite 702, Baton Rouge, Louisiana 70809

Q. What is your occupation?

A. Environmental Toxicologist.

Q. Where are you presently employed?

A. Integral Consulting Inc. (Integral).

Q. How long have you been employed by Integral?

A. One year.

Q. What are your current position and job responsibilities?

A. I serve as a Principal. I provide technical expertise in the Toxicology, Health and Ecological Sciences practice area, with emphasis on human health and ecological risk assessment (ERA) projects in the Gulf Coast region. I also serve as a regional adviser for the Gulf Coast and Atlantic region of the company.

Q. Prior to working for Integral, where were you employed?

A. Geosyntec Consultants.

Q. What were your dates of employment with Geosyntec Consultants and what were your position[s] and job responsibilities with that company?

A. Geosyntec Consultants, Baton Rouge, Louisiana, 2016–2021 Principal Toxicologist
I provided consulting services in the risk assessment and toxicology practice area that included performing calculations, preparing consulting reports, and providing expert

litigation support services for oilfield legacy cases with salinity and hydrocarbon impacts in coastal Louisiana and cases involving aquatic ecotoxicology.

Q. Describe your professional work history prior to working for Geosyntec Consultants.

A. Louisiana State University, Department of Plant, Environmental Management, and Soil Sciences, Baton Rouge, Louisiana, Instructor (Quantitative Risk Assessment) 2022 – Present.

Instructor for Quantitative Risk Assessment (EMS 4020) which covers EPA and Louisiana guidance on human health and ecological risk assessments.

Franciscan Missionaries of Our Lady University, Baton Rouge, Louisiana, Adjunct Faculty (Principles of Toxicology), 2018–Present

Instructor for Principles of Toxicology (CHEM 4330).

ARCADIS U.S., Baton Rouge, LA, 1996–2016 Technical Expert (Scientist)/Toxicologist.

I provided consulting services in the risk assessment and associated services practice area that included performing human health and ecological risk assessments, surface water studies, and ecological investigations for contaminated sites and environmental assessments and environmental impact studies. I also provided expert litigation support services for oilfield legacy cases with salinity and hydrocarbon impacts in coastal Louisiana and for pesticide aquatic toxicology cases.

Terra Consulting Group, Baton Rouge, LA, 1995–1996 Toxicologist/Risk Assessor.

I provided consulting services for human health and ecological risk assessments and supported a natural resource damage assessment of a gasoline spill in a Louisiana marsh and swamp.

Q. What is your educational background?

A. I received a B.S. (1987) in Zoology and an M.S. (1990) in Biology from Southeastern Louisiana University, and a Ph.D. (1995) in Zoology (Ecotoxicology Emphasis) from Clemson University in South Carolina. My coursework included biochemistry, chemical fate in the environment, principles of toxicology, wildlife toxicology, advanced environmental toxicology, and ecotoxicological statistical methods. I hold adjunct faculty appointments and currently teach an undergraduate course on the principles of toxicology at Franciscan Missionaries of Our Lady University, and an undergraduate/graduate course on quantitative risk assessment at Louisiana State University.

Q. What was the subject of your doctoral dissertation/master's thesis?

A. My dissertation thesis was titled "Utilization of Amphibians and Reptiles and their Parasite Communities as Bioindicators of Environmental Contamination." My dissertation research focused on snakes and frogs and their parasite communities, and evaluated trophic level movement of polychlorinated biphenyls (PCBs) in a PCB-contaminated watershed in South Carolina. I applied elements of the U.S. Environmental Protection Agency (EPA) Framework for Ecological Risk Assessment (USEPA 1992) in my research, such as collecting site-specific PCB exposure data and conducting field and laboratory studies on the ecological effects of PCBs. My master's thesis research was conducted on the parasites of aquatic snakes in south Louisiana wetlands and integrated the knowledge of parasite life cycles with snake food habits and habitat preference. I have published peer-reviewed articles on several aspects of ecotoxicology and on other basic ecological studies in aquatic environments. This included aquatic hazard assessments of a chemical used for fisheries management, bioaccumulation studies of PCBs, and animal surveys from aquatic environments. I have served as a technical reviewer on subjects related to ecotoxicology, aquatic toxicology, and wildlife toxicology for several peer-reviewed journals, e.g., Environmental Toxicology and Chemistry; Archives of Environmental Contamination and Toxicology, American Midland Naturalist, The Journal of Parasitology. Finally, I previously served on the editorial board (1998 – 2004) for the Society of Environmental Toxicology and Chemistry's journal, Environmental Toxicology and Chemistry.

Q. Do you hold any professional certifications?

A. Yes, I am certified as a professional wetland scientist (PWS; No. 2565) which includes certification knowledge areas such as watershed dynamics, soils, hydrology, plants, fish and wildlife, protected and invasive species, ecology and function, wetland classification and function, mapping, delineation, environmental impact assessment, and wetland mitigation and restoration.

Q. Tell us about those certifications.

A. The PWS certification is managed by the Society for Wetland Scientists. The professional certification program was established in 1994 for certification of wetland science training and experience, with the aim of serving the public and governments' need to identify qualified individuals capable of assessing and managing wetland resources.

Q. What is your experience related to determining the environmental impacts of salinity?

A. I have worked on the following three major coastal restoration projects in Louisiana over the last 15 years: the Violet Freshwater Diversion project, the South Pecan Island Freshwater Diversion project, and as a participant on the Mississippi River Gulf Outlet (MRGO) salinity working group. An important aspect of these efforts was to evaluate the ecological impacts of salinity changes. I have also provided expert litigation support on more than 35 oilfield legacy site cases in Louisiana where a prime ecological impact consisted of high salinity from produced water (brine) releases. Produced water with high salinity (up to 300 parts per thousand [ppt]) is brought to the surface during oil and gas extraction and is toxic to many freshwater and estuarine organism if released to the environment. I have collected data, during my field studies of salinity impacts, pertaining to amphibian species diversity and presence of salinity-tolerant species in areas of the coastal zone characterized by salt-water intrusion. Surface water salinity data were correlated with species presence or absence. This research on the effects of saltwater intrusion on coastal amphibian populations was presented at a Louisiana Coastal Geology Symposium in 2018.

Q. Please look at the document marked as Exhibit App-LF-2-R (Appendix 1) and tell us what that is?

A. My CV.

Q. How are you familiar with Exhibit App-LF-2-R?

A. I prepared Exhibit App-LF-2-R.

Q. Does Exhibit App-LF-2-R accurately reflect a summary of your educational and professional employment history?

A. Yes.

The Port Authority offers Exhibit App-LF-2-R and asks that it be admitted into evidence.

Q. What is the specific area of your professional work?

A. Ecological and Human Health Risk Assessment and Environmental Toxicology. My specialty consists in assessing the health and ecological effects of hazardous substance releases. I have an academic background in ecology and environmental toxicology and more than 25 years of applied consulting experience in toxicology, risk assessment, and ecological studies. Representative projects include:

- **USACE New Orleans District, Inner Harbor Navigation Canal.** I conducted a risk evaluation using existing data to confirm that dredged material posed no significant risk to human health or the environment and was, therefore, exempt from solid waste regulations.
- **EPA Region 6, Refinement of Aquatic Life-Use Categories, Terrebonne Basin, Louisiana.** I served as the team leader for a project to collect physical, chemical, and biological data to establish a basis for refining aquatic life use categories and applicable water quality criteria for freshwater and estuarine water bodies in the Terrebonne Basin of Louisiana. We used basin-wide field collections of fish, benthic invertebrate, and dissolved oxygen data to develop dissolved oxygen criteria.

- **Major Railroad Company, Gautier, Mississippi.** I performed an ERA of contaminated sediments in the Pascagoula River estuary system. Major activities included site-specific biological investigations; sediment quality triad assessment; evaluation of benthic macroinvertebrate communities; and assessment of estuarine fish and crab tissue residues. I also provided input on a remediation and ecological restoration program to mitigate impacts and enhance habitats. Capped areas over contaminated sediment included the creation of sand dunes, 4 acres of tidal wetlands, 10 acres of open field habitat, 8 acres of maritime forest habitat, and 1 acre of oyster reef habitat. The Wildlife Habitat Council awarded the project a Wildlife Habitat Certification and highlighted this project in the publication, "Transforming Remediation Sites into Conservation Assets."
- **Petrochemical Plant, Port Neches, Texas.** Prepared Texas Commission on Environmental Quality (TCEQ) affected property assessment reports for an industrial client in southeast Texas. I prepared, and the TCEQ accepted, five affected property assessment reports, two response action plans, and multiple post-response action care reports. These projects included ecological exclusion criteria checklists and screening-level ERAs, and used TCEQ ecological screening benchmarks.

Q. Have you previously served as an expert witness in any other matters?

A. Yes. I have previously qualified in Louisiana courts as an expert in environmental toxicology, risk assessment, and biology.

II. WORK PERFORMED FOR PORT AUTHORITY.

Q. Have you been retained to provide professional services to the Port Authority?

A. Yes.

Q. What were you asked to do in connection with the Port's proposed Harbor Island desalination facility?

A. I was asked to review the Draft Permit and associated expert filings regarding the potential for environmental impacts that may result from the Effluent. I am providing technical expertise related to biological and ecotoxicological matters for the evaluation of potential environmental impacts from the Effluent.

Q. What did you review in getting ready to give your opinions in this case?

A. I reviewed numerous sources of data and information in support of my testimony, including:

- The Revised Permit and its supporting documentation and opinions.
- The Protestants' opinions and data pertaining to the estimated environmental impacts of the proposed desalination project on the local aquatic ecosystem, as well as the results of laboratory salinity toxicity tests performed by the Protestants using red drum early life stages.
- The CORMIX Mixing Zone Model output files generated by TCEQ, Dr. Lial Tischler, and the Protestants.
- The voluminous published literature pertaining to salinity ecotoxicity and tolerance, the general biology of key estuarine species present in the Gulf of Mexico and the estuaries associated with Aransas Pass, and studies measuring potential environmental issues at other desalination plants in the US and abroad.
- Published papers on the types of water treatment chemicals routinely used in saltwater reverse-osmosis desalination plants.
- Published papers on modeling the distribution of "passive particles" moving with incoming tides from the Gulf of Mexico through Aransas Pass and into the three adjoining channels (Aransas Pass, Lydia Ann Channel, and CCSC).
- The presence of sensitive habitats and threatened and endangered species in the general vicinity of the proposed effluent diffuser in the CCSC.
- The natural salinity fluctuations measured in surface water flowing through Aransas Pass between 2007 and 2017.
- The migration patterns of different life stages of key invertebrate and fish species moving in and out of the estuaries through Aransas Pass; and

- The quality of the surface water chemistry at the proposed intake location in the Gulf of Mexico.

Q. **What is in Exhibit REF 1?**
A. Exhibit REF 1 in **Appendix 2** identifies the documents and sources of information that I reviewed in getting ready to provide opinions. This exhibit identifies more than 180 published literature references and other materials that I reviewed in forming my opinions in this matter.

Q. **Have you reviewed information from Protestants' experts?**
A. Yes.

Q. **Please describe that information?**
A. I reviewed Dr. Kristin Nielsen's reports, toxicity tests, and production materials. I also reviewed the prefiled testimony of experts with biological expertise, such as Dr. Gregory Stunz, Dr. Scott Holt, Dr. Andrew Esbaugh, and Dr. Brad Erisman during the contested case hearing in November 2020.

Q. **What public information do you have about the proposed Desalination Facility?**
A. I have the Port Authority's Revised Permit Application and comments associated with the permit application. I also have reviewed the Draft Permit and the depositions of Lial Tischler and Randy Palachek that discuss the Facility, the Outfall, and the Draft Permit.

Q. **Have you reviewed the Draft Permit?**
A. Yes.

Q. **What other information have you reviewed about the Draft Permit?**
A. I have reviewed TCEQ correspondence related to the Port Authority's Permit Application.

Q. **Have you reviewed the modeling and other information from Lial Tischler and Randy Palachek?**

A. Yes.

Q. Have you reviewed the modeling done by Jordan Furnans?
A. Yes.

Q. In connection with your work on this matter, have others at the firm where you are employed as a Principal, Integral, assisted you?
A. Yes, I worked with multiple staff members at Integral to prepare all of the information presented in this testimony.

Q. Have you now provided a comprehensive summary of your education, experience and reviewed materials and information that is relevant to your opinion and testimony in this matter?
A. Yes.

Q. Now Dr. Fontenot, I would discuss your opinions in this matter and the methodology utilized to form those opinions.
A. Yes.

III. SUMMARY OF OPINIONS

Q. What is your opinion regarding the potential for the Effluent from the Facility to cause adverse effects on human health and the environment?
A. My opinion is that the predicted changes in salinity will not be of sufficient magnitude or duration to cause adverse effects to human health or the environment.

Q. What is your opinion, if any, about potential effects to aquatic life including early life stages such as fish eggs and larvae from the Effluent or the Facility?
A. Based on my comprehensive review of the spatial and temporal changes in salinity which results in limited spatial areas of exposure of short duration, known salinity tolerances of both fish and their larval stages, and comparison of predicted salinity changes to

published toxicity studies, I conclude that there will not be an adverse effect to aquatic life, including early life stages.

Q. **What is your opinion, if any, about potential effects to wildlife species such as birds and mammals from the Effluent or the Facility?**

A. My opinion is that adverse effects to birds and mammals will not occur.

Q. **Will the Effluent or Facility affect Threatened and Endangered Species?**

A. No, and this is based on the lack of suitable habitat (the ship channel is Estuarine and Marine Deepwater habitat) for such species and the listed species are highly mobile or transitory and, if present, could avoid the small area of elevated salinity.

IV. METHODOLOGY: EPA REVIEW PROCESS

Q. **What methodology did you use in reviewing the information and formulating your opinions?**

A. I used EPA's Ecological Risk Assessment (ERA) framework to review, organize, interpret, and present this large body of information.

Q. **Please describe the EPA ERA process?**

A. ERA is a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. As described by USEPA (1998), the process is used to systematically evaluate and organize data, information, assumptions, and uncertainties to help understand and predict the relationships between environmental stressors and ecological effects, in a manner that is useful for regulatory decision-making. Using this framework, the ERA prepared in support of the proposed desalination plant uses current knowledge of environmental conditions in the study area to evaluate the nature and spatial extent of possible ecological effects associated with the release of increased salinity to the ship channel.

Q. **What were your objectives in following the EPA ERA process?**

A. The specific objectives of my ERA were to:

- Identify compounds in environmental media (water) that may cause adverse impacts to local ecological receptors.
- Identify potentially exposed receptors and potentially complete exposure pathways to compounds in environmental media.
- Assess and quantify the potential risks associated with each complete exposure pathway for representative target species.
- Summarize the nature and spatial extent of possible risks to those target species.

Q. Why did you follow the EPA ERA process?

A. To provide an accurate assessment of the habitats and types of receptors at the Outfall and use reasonably conservative assumptions regarding the exposures of representative receptors, the chemicals of concern (COCs), and the appropriate toxicity reference values for the COCs.

Q. Is the EPA ERA process commonly accepted by professionals in your field of expertise?

A. Yes, the EPA ERA is a well-recognized and widely accepted methodology.

Q. What are the steps of the EPA ERA process?

A. The framework as applied to the current evaluation revolves around four (4) major components or as I refer to them here, "Steps", as follows:

- **Step 1: Problem Formulation** identifies target species of concern and their habitat requirements, sensitive habitats and listed species, site-specific conditions in the vicinity of the proposed effluent diffuser, and other elements needed to prepare a conceptual site model to describe the stressor (i.e., increased salinity), exposure media, exposure routes, ecological receptors, and the potential for those receptors to be exposed to the increased salinity.
- **Step 2: Exposure Assessment** estimates the overlap between a receptor and the increased salinity based on site-specific considerations, such as life histories (e.g., life stage-specific habitat requirements, seasonal movements, feeding habits), and

the presence, magnitude, duration, and extent of increased salinity from the effluent in the environment, in order to estimate the degree of exposure potentially experienced by the target species.

- **Step 3: Effects Assessment** uses site-specific or published test results to estimate how receptors may potentially respond when exposed to different levels of salinity.
- **Step 4: Risk Estimation** consists of comparing the salinity-specific exposure levels measured or anticipated in the field to a range of salinity-specific effects reported in the literature in order to estimate the potential for impact by the receptors exposed to increased salinity.

Q. How often have you used the EPA ERA process on projects?

A. I have used the EPA ERA process at more than 50 sites to prepare ERA checklists, at 12 sites to prepare screening-level ERAs, and at 8 sites to prepare baseline ERAs and perform site-specific ecological studies. Ecological studies included a northern leopard frog egg mass survey to evaluate potential reproductive effects from PCBs, an ecotoxicological tissue residue and pathology study on turtles, and benthic macroinvertebrate survey and sediment toxicity testing for the Pascagoula River estuary system.

Q. Are the EPA ERA steps published?

A. Yes, the steps for an ERA are described in EPA and TCEQ guidance publications, including:

- Framework for Ecological Risk Assessment (USEPA 1992)
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA 1997)
- Guidelines for Ecological Risk Assessment (USEPA 1998)
- Conducting Ecological Risk Assessment at Remediation Sites in Texas (TCEQ 2018).

V. SUMMARY OF EXHIBITS

Q. Have you created any exhibits that reflect your ERA for the Draft Permits?

A. Yes.

Q. Please describe the exhibits that you prepared reflecting your work in this matter.

A. The exhibits are organized around the four major components or "Steps" of the ERA - the ecological risk assessment framework--outlined earlier. **Exhibit LIST 1** in **Appendix 3** lists all of the graphs, figures, and data tables compiled in preparation for my testimony. I organized my exhibits into two distinct groups for the sake of brevity, as follows:

- The primary exhibits are embedded in the text of my testimony to emphasize key concepts or ideas in support of the ERA.
- The secondary exhibits are included in appendices and provide ancillary information or other data included in my evaluation.

Q. What exhibits did you prepare for Step 1 of the ERA--Problem Formulation?

A. The **primary exhibits** for the **Problem Formulation** (PF exhibits) consist of the following:

- **Exhibit PF 1-1** shows the aquatic habitats and land uses in the vicinity of the proposed desalination plant effluent diffuser.
- **Exhibit PF 1-2** presents a conceptual view of the desalination plant surface water intake structure in the Gulf of Mexico.
- **Exhibit PF 2-1** provides a photo of the CCSC as viewed from Port Aransas.
- **Exhibit PF 3-1** provides a figure identifying the occurrence of major listed species near the project area.
- **Exhibit PF 4-1** summarizes the general seasonal movement and preferred habitat locations of five major life stages of the red drum in the estuaries around the project area.
- **Exhibit PF 4-2** shows the vertical distribution of red drum eggs in the water column.

- **Exhibit PF 6-1** provides representative annual natural salinity variations measured in surface water from Aransas Pass in 2010, 2012, and 2015.
- **Exhibit PF 7-1** presents a conceptual site model for the saline effluent released in the CCSC by the proposed desalination plant.

Appendix 4 provides the **secondary exhibits** prepared in support of the **Problem Formulation** (note: for clarity, this appendix also includes larger versions of the primary exhibits mentioned above):

- **Exhibit PF 1-3** highlights the estuarine habitats present in the broader region around the project area.
- **Exhibit PF 1-4** shows the location of the restrictive shellfish harvest areas in the broader region around the project area.
- **Exhibits PF 2-2 and 2-3** provide additional photos of the CCSC in the vicinity of the project area.
- **Exhibit PF 3-2** lists the threatened and endangered species that may occur near the project area, their general habitat requirements, and the potential adverse effects of desalination plant effluent on those species.
- **Exhibit PF 4-3** summarizes the fecundities for six estuarine target species.
- **Exhibit PF 5-1** lists the general habitat requirements for different life stages of the six estuarine target species.

Q. What exhibits did you prepare for Step 2-Exposure Assessment of the ERA process?

A. The **primary** exhibits for **Step 2-Exposure Assessment** (EA exhibits) consist of the following:

- **Exhibit EA 1-1** summarizes published results of several simulations designed to estimate the relative distribution of passive particles, representing planktonic early life stages of estuarine species of invertebrates and fish, moving with incoming tides from the Gulf of Mexico into Aransas Pass and through the CCSC, the Aransas Channel, and the Lydia Ann Channel.

- **Exhibit EA 2-1** provides a scientific representation of the effluent plume in the CCSC emanating from the proposed desalination plant diffuser and developed based on results obtained from the CORMIX Mixing Zone Model.
- **Exhibit EA 3-1** shows a top-down screenshot of a timed animation of passive particles moving with an incoming tide in the vicinity of the proposed effluent diffuser.
- **Exhibit EA 4-1** summarizes the number of days between 2007 and 2017 when the natural background salinities in the surface water from Aransas Pass exceeded 40 ppt.
- **Exhibit EA 4-2** expands on the information presented in Exhibit EA 4-1 by focusing on the individual days between 2007 and 2017 when natural salinities in Aransas Pass exceeded 40 ppt and highlighting the duration and extent of those daily exceedances.
- **Exhibit EA 4-3** visually presents the salinity exceedances above 40 ppt as determined from the 2007–2017 background salinity data set collected from Aransas Pass.
- **Exhibit EA 5-1** presents the available 2007–2017 Aransas Pass salinity monitoring data in the form of a stacked time series.
- **Exhibit EA 6-1** summarizes the exposure potential to desalination effluent in the CCSC for four life stages of the six target aquatic species.

Appendix 5 provides the **secondary** exhibits prepared in support of **Step 2-Exposure Assessment** (note: for clarity, this appendix also includes larger versions of the primary exhibits mentioned above):

- **Exhibit EA 1-2** calculates the particle transport percent allocation into the three channels based on Dawson et al. (2021).
- **Exhibit EA 1-3** shows the emplacement of the estuarine monitoring locations evaluated by Dawson et al. (2021).
- **Exhibit EA 3-2** provides a side-view screenshot of a timed animation of passive particles moving at three tidal velocities in the vicinity of the proposed effluent diffuser.

- **Exhibit EA 3-3** provides a side-view screenshot of a timed 3D animation of passive particles moving with an incoming tide in the vicinity of the proposed effluent diffuser.
- **Exhibits EA 5-2 and EA 5-3** provide two examples of 30-day time series extracted from the Port Aransas background salinity data set to show the extent of natural daily fluctuations.

Q. What exhibits did you prepare for Step 3-Effects Assessment of the ERA process?

A. The **primary** exhibits for **Step 3-Effects Assessment** (EFA exhibits) consist of the following:

- **Exhibit EFA 1-1** presents published salinity toxicity data and published salinity tolerance ranges for the six target aquatic species evaluated in this risk assessment.
- **Exhibit EFA 1-2** summarizes published and unpublished salinity toxicity data pertaining specifically to eggs and larvae of the red drum.

Appendix 6 provides the **secondary exhibits** prepared in support of **Step 3-Effects Assessment** (note: for clarity, this appendix also includes larger versions of the primary exhibits mentioned above).

- **Exhibit EFA 1-3** summarizes the salinity toxicity data collected for this project and used to create the graphs presented in Exhibits EFA 1-1 and 1-2.
- **Exhibit EFA 1-4** provides the survival results of laboratory toxicity testing performed for the Harbor Island desalination permit application.
- **Exhibit EFA 2-1** summarizes the relative abundance and salinity tolerances for the six target aquatic species in Aransas and Corpus Christi bays, Texas.
- **Exhibit EFA 2-2** presents additional published salinity tolerance ranges in Texas estuaries for the six target aquatic species.
- **Exhibit EFA 3-1** summarizes aquatic toxicity data for bromoform.
- **Exhibit EFA 3-2** summarizes aquatic toxicity data for chloroform.
- **Exhibit EFA 3-3** provides surface water benchmarks for bromoform and chloroform published by TCEQ.

Q. What exhibits did you prepare for Step 4-Risk Estimation of the ERA process?

A. The **primary** exhibits for **Step 4-Risk Estimation** (RE exhibits) consist of the following:

- **Exhibit RE 1-1** compares CORMIX salinities (ppt) to the USEPA (1986) salinity level of 4 ppt above ambient.
- **Exhibit RE 1-2** compares CORMIX salinities (ppt) to the USEPA (1986) salinity level of 10% above ambient.
- **Exhibit RE 1-3** compares CORMIX salinities (ppt) to red drum no-observed-effect concentrations (NOECs).
- **Exhibit RE 1-4** compares CORMIX salinities (ppt) to red drum lowest observed effect concentrations (LOECs).
- **Exhibit RE 1-5** compares CORMIX salinities (ppt) to a euryhalinity upper tolerance level (UTL), chronic NOEC, and acute NOEC for salinity.
- **Exhibit RE 1-7** provides a statistical summary of the natural background salinities measured in Aransas Pass between 2007 and 2017.
- **Exhibit RE 1-8** compares the analytical data for two surface water samples collected from the general vicinity of the proposed desalination plant water intake structure in the Gulf of Mexico to permit limits and marine surface water benchmarks.
- **Exhibit RE 1-9** summarizes all the lines of evidence considered for Risk Estimation.

Appendix 7 provides the **secondary** exhibits prepared in support of **Step 4-Risk Estimation** (note: for clarity, this appendix also includes larger versions of the primary exhibits mentioned above).

- **Exhibit RE 1-6** summarizes key output values generated by the numerous CORMIX model scenarios evaluated by TCEQ for the Harbor Island desalination plant permit.

Q. Do you know how these exhibits were prepared?

A. Yes, I supervised their preparation.

Q. Do you know who prepared these Exhibits?

A. Yes, they were prepared under my direction by people working on this matter for Integral.

Q. Is the information in the Exhibits reliable?

A. Yes, it is reliable. We created these exhibits to summarize other reliable information that has been produced in this matter or that is available from public records. I worked with the professionals identified above to create these exhibits, and they summarize the voluminous records that I reviewed along with the extensive data that we gathered to perform the ERA.

Q. Are you familiar with how Integral maintains its records?

A. Yes, I am, and I am one of the custodians of records for Integral in that I am responsible for maintaining records reflecting my analysis while working for Integral and am informed about how Integral handles that process.

Q. Are these Exhibits identified above Business Records? By Business Record, I mean the following: a document that was created at or near the time of the events reflected in the document by, or from information transmitted by, a person whose job it was to create the document and who knows about the events and information contained in the document, and the document was made and kept in the course of the regularly conducted business activity of a company whose regular business practice it was to create the document and who regularly maintained the document under circumstances indicating that the document is trustworthy and accurate.

A. Yes, the Exhibits are Business Records under this definition. We created these exhibits as part of our work on this case to assist the trier of fact in understanding the work that went into my analysis. I routinely create documents reflecting my analysis like those documents identified above as exhibits to my testimony. I am familiar with how these documents were created, who created them, how they are stored, and their reliability.

Q. If I asked you whether each of the exhibits identified above met the definition of a Business Record from the preceding question, what would you say?

A. My answer would be that each of these exhibits qualifies as a Business Record using that definition.

Q. Do the Exhibits identified above also summarize information that you have gathered in connection with forming your opinions in this matter?

A. Yes, they summarize voluminous information from published literature and data that we have reviewed.

Q. What do you mean voluminous information?

A. We created the Exhibits to provide a useful summary of hundreds of pages of published literature and enormous amounts of data that would be impractical to attach as exhibits to my testimony.

Q. **Has the information that was used to create the exhibits to your direct testimony been produced in discovery?**

A. Yes, we produced that information and our exhibits as part of my expert designation and throughout discovery in this matter.

Q. Does each exhibit use information that is commonly used by an expert in your field to offer opinions?

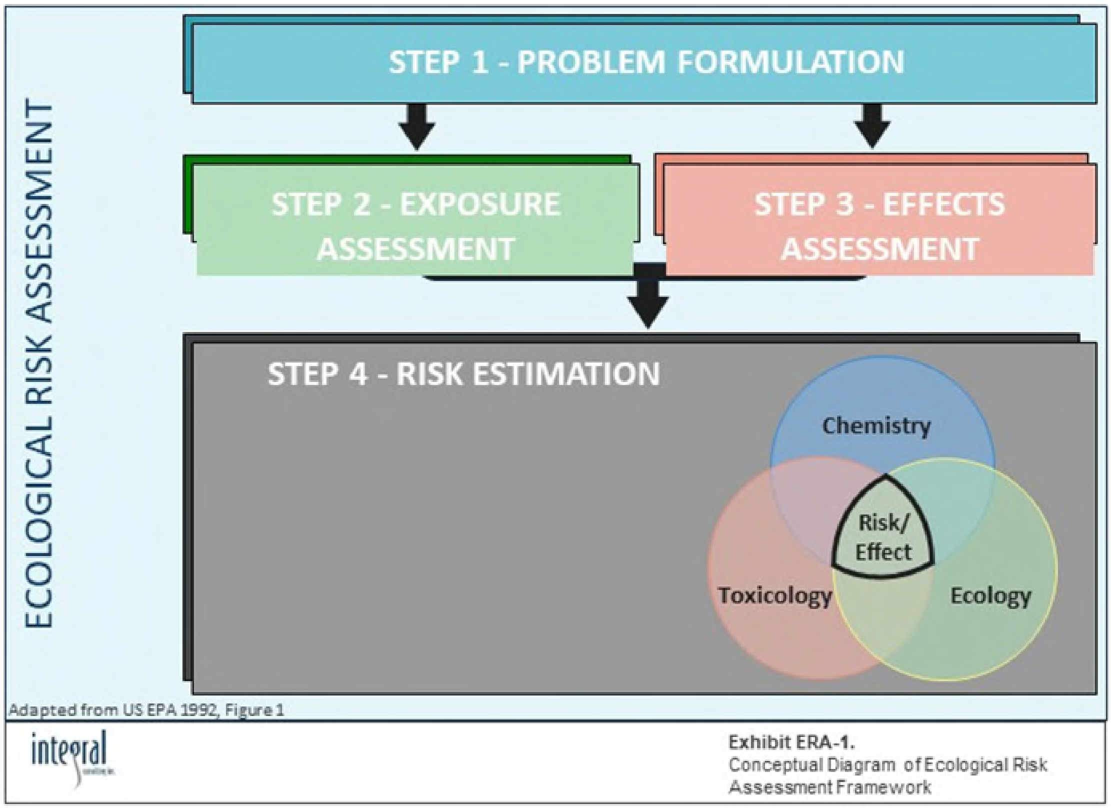
A. Yes.

The Port Authority offers the foregoing exhibits in Appendices 1-7 and asks that they be admitted into evidence.

VI. METHODOLOGY

Q. Now moving onto the application of the methodology you have described, could you please briefly remind us of the four Steps of the ERA assessment that you used in forming your opinions in this case?

A. Step 1-Problem Formulation; Step 2-Exposure Assessment; Step 3-Effects Assessment; and Step 4-Risk Estimation (Exhibit ERA-1). I have attached a demonstrative picture to illustrate the process:



STEP 1- PROBLEM FORMULATION

Q. Please describe how you went about conducting Step 1 - "Problem Formulation"?

A. For the Draft Permit, the goal of the Problem Formulation step is to develop a conceptual site model that identifies the pathways by which aquatic receptors present in the CCSC may come in contact with surface water salinities associated with the effluent plume from the proposed desalination facility. This approach requires a detailed understanding of the general habitat conditions in the CCSC and the surrounding areas.

Q. What did you do to review the general habitat conditions?

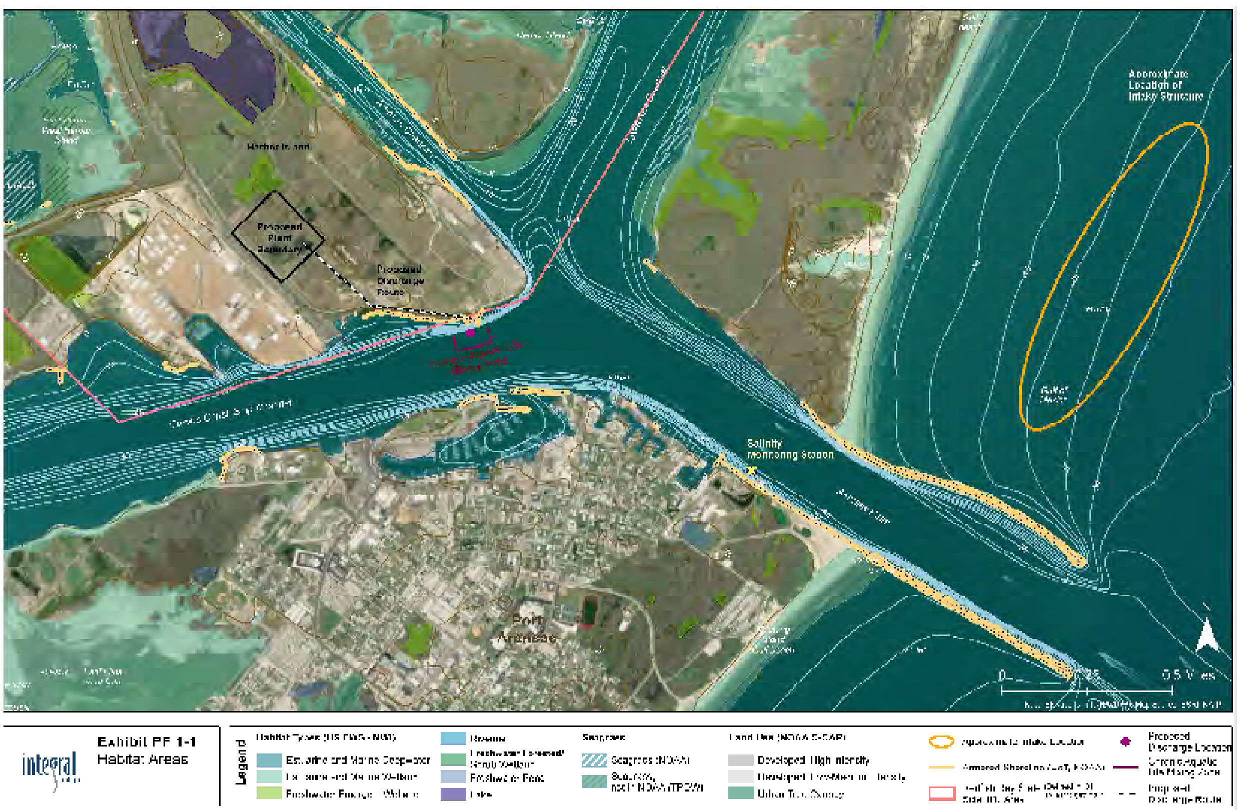
A. I used widely available computer-based resources and habitat mapping, published literature on the ecology of resident estuarine species, and natural salinity data available for Aransas Pass.

Q. Did you prepare any exhibits reflecting your review of the general habitat conditions?

A. Yes.

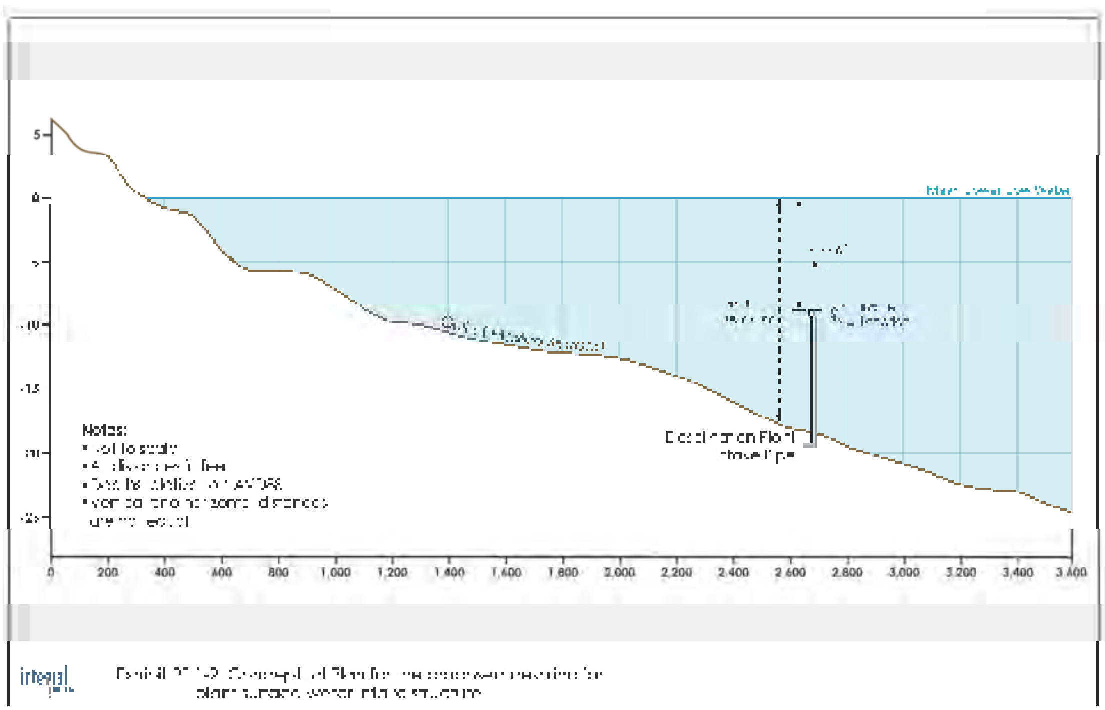
Q. Please describe those exhibits and the information that they provided to you in reviewing the general habitat conditions?

A. **Exhibit PF 1-1** shows a close-up view of the general vicinity around the Facility. The specific wetland habitat of the CCSC is Estuarine and Marine Deepwater habitat (E1UBL). The area where the Facility will discharge Effluent lacks substantial shallows or seagrass beds, contains armored shoreline, and is characterized by the substantial depth (about 60 ft) and width (about 1,200 ft) of the CCSC.



Q. What other exhibits did you create that reflect your review of the general habitat conditions?

A. **Exhibit PF 1-2** provides a schematic drawing of the desalination plant surface water intake structure to be built in the Gulf of Mexico outside of Aransas Pass. This structure is planned to be placed about halfway up into the water column at a depth of approximately 20 ft. It is not anticipated that clean seawater extracted 10 ft above the substrate will entrain significant amounts of sediment particles. This is based on the chemical analysis of surface water samples that did not identify the presence of industrial chemicals and a reasonable assumption based on the lack of industrial sources of chemicals near the intake. Hence, no sediment-related pollutants are expected to become concentrated in the effluent as a result of the desalination process prior to release into the CCSC.



Q. Did you prepare any other exhibits that reflect your review of the general habitat in the area of the Outfall?

A. Yes, I prepared the following exhibits to reflect the information that I reviewed:

Exhibit PF 1-3 (Appendix 4) provides a wider view of the types of estuarine habitats present in the region around the proposed project area. Extensive wetlands, seagrass beds, and other shallow estuarine habitats are present in the surrounding bays.

Exhibit PF 1-4 (Appendix 4) shows the location of the Redfish Bay restricted shellfish harvest area, which includes all of the CCSC in the vicinity of the project area. The shellfish harvest restrictions, which include oysters, have been implemented by the Texas

Department of State Health Services in response to excessive bacterial counts measured in the local surface water.

Q. What other exhibits reflect Step 1-Problem Formulation and what information do those other exhibits, if any, provide?

A. I prepared exhibits reflecting the project specific conditions in the CCSC.

Exhibits PF 2-1 to 2-3 (see Appendix 4 for the two latter exhibits) provide general views in the vicinity of the proposed project area. These photos show the presence of shoreline armoring, a lack of seagrass beds or wetlands, and various human activities in the area (e.g., jetties, a ferry terminal).

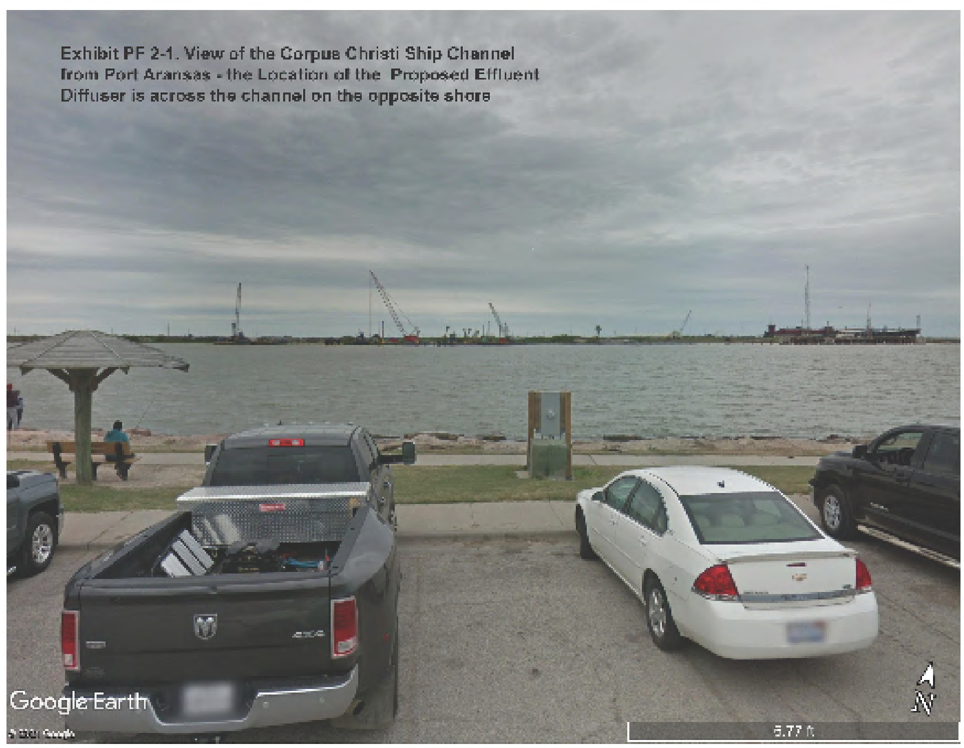


Exhibit PF 2-1. View of the Corpus Christi Ship Channel from Port Aransas - the Location of the Proposed Effluent Diffuser is across the channel on the opposite shore

Q. What other exhibits reflect Step 1-Problem Formulation and what information do those other exhibits, if any, provide?

A. I reviewed any potential threatened or endangered species in the area of the Outfall. These exhibits are as follows:

Exhibit PF 3-1 shows where threatened and endangered aquatic-dependent species have been observed in the past in the general vicinity of the proposed project area. These species include the West Indian manatee (Port Aransas Municipal Boat Harbor), the hawksbill sea turtle (mainly in Aransas Pass and the CCSC across from Port Aransas), green sea turtle (Aransas Pass and the nearby Gulf of Mexico), the piper plover (mainly Mustang Island Gulf Beach on the Gulf of Mexico), and the black rail (East Flats mud flats next to Port Aransas to the southwest).

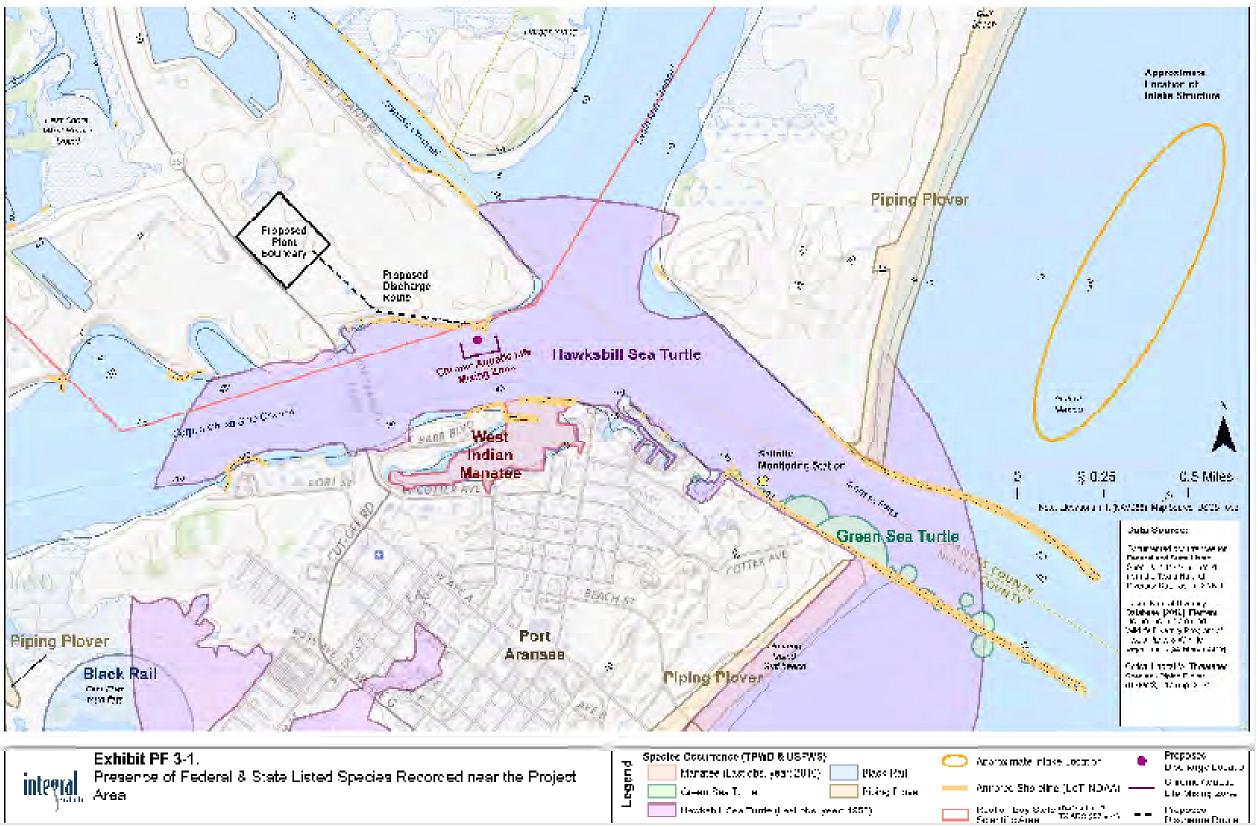


Exhibit PF 3-1.
Presence of Federal & State Listed Species Recorded near the Project Area

Q. What other exhibits did you create?

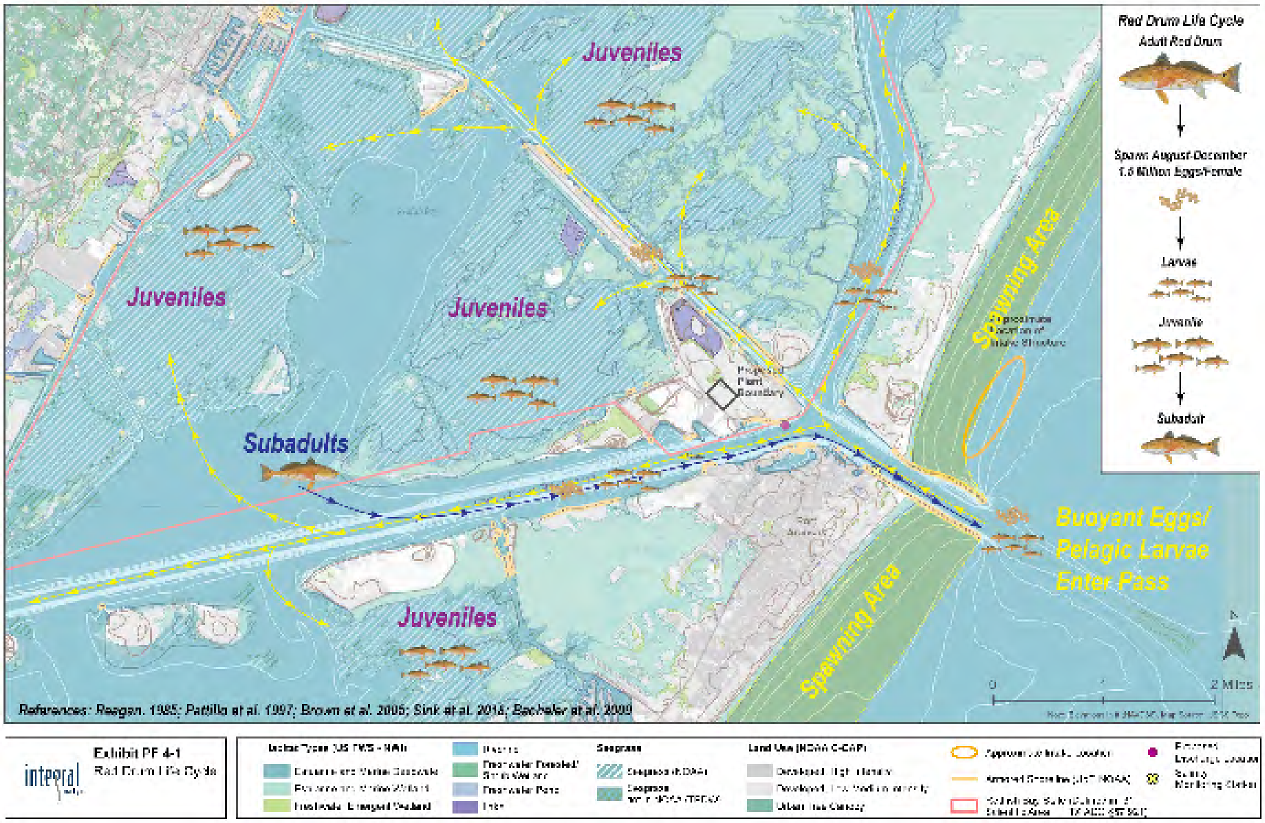
A. We prepared the following table of listed species. Exhibit PF 3-2 (Appendix 4) identifies the threatened and endangered species that have the potential to occur in the project area. This list contains birds, marine turtles, and marine mammals. An evaluation of the habitat needs of these species indicates that the CCSC in the vicinity of the Outfall either lacks suitable habitat for such species or may provide supporting habitat but the listed species are highly mobile or transitory. For example, the deep-water habitat of the ship channel would not be used by the Piping Plover which prefers shoreline habitats such as beaches, sandflats, and mudflats. Sea turtles are highly mobile, and Manatees rarely occur in Texas and are also highly mobile. Based on these considerations, listed species are not included in the evaluation.

Q. What other exhibits reflect Step 1-Problem Formulation and what information do those other exhibits, if any, provide?

A. The following exhibits also reflect Step 1-Problem Formulation, in particular:

- <u>Species and life stage distributions</u>

  Exhibit PF 4-1 provides a schematic overview of the life cycle of the red drum, which is considered a key target species of high recreational importance. This species spawns in the nearshore areas of the Gulf of Mexico in the general vicinity of Aransas Pass. The buoyant eggs hatch within 24 to 36 hours. They, or the larvae, are carried by incoming tides through Aransas Pass and the CCSC, Aransas Channel, and Lydia Ann Channel into the extensive seagrass beds of the surrounding estuaries where they settle to feed, grow, and mature. The subadults then migrate out through the channels and Aransas Pass back into the Gulf of Mexico for spawning. The key observation is that the CCSC in the vicinity of the project area does not provide high-quality habitat for the early life stages of the red drum. Instead, the ship channel serves as a conduit between the Gulf of Mexico (via Aransas Pass) and the nursery habitats located farther inland although it is not the only channel because the data reflect that over half of the eggs and larvae may move through the Lydia Ann Channel.

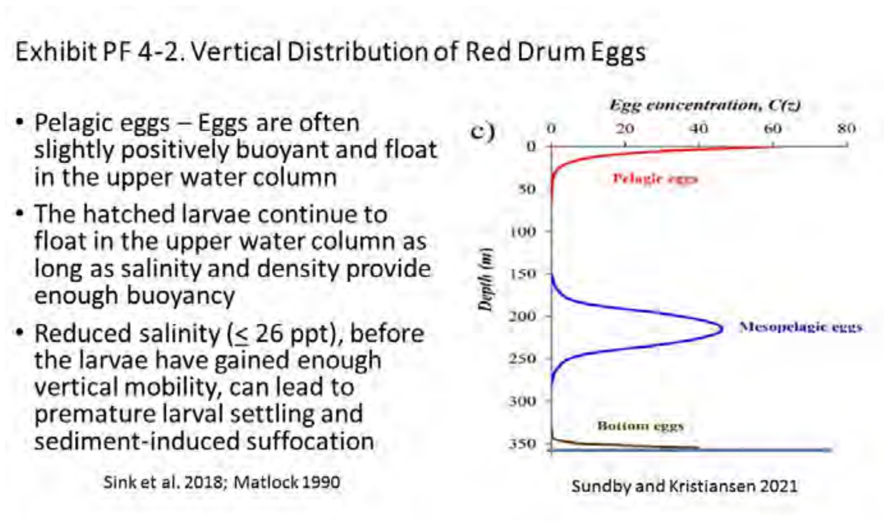


Q. Why did you examine red drum eggs and larvae in the area of the CCSC?

A. Red drum are an abundant and recreationally important species with a complex estuarine life cycle and, therefore, this was one of the target species selected for evaluation, and it was a subject of testimony in the hearing in November 2020. **Exhibit PF 4-2** emphasizes that red drum eggs and larvae that move into the estuaries via the pass and the channels tend to float in the upper water column. The buoyancy of the early life stages of red drum has important implications for this species because it would tend to limit the extent and duration of future contact with the Effluent.

Q. **Why do you say that it would limit the extent and duration of future contact with the Effluent?**

A. Because the early life stages of red drum would have a tendency to float above the portion of the Effluent with the highest salinity.



Q. What other exhibits reflect your analysis of Step 1-Problem Formation?

A. The following Exhibits:

- **Exhibit PF 4-3** (Appendix 4) lists the six target species selected for evaluation. These species are the eastern oyster, blue crab, white shrimp, red drum, Atlantic croaker, and spotted seatrout. All represent important commercial or recreational species that use the estuarine habitats (e.g., Redfish Bay, Corpus Christi Bay, Aransas Bay, and Copano Bay) during parts of their life cycle for foraging, hiding, growth, and/or reproduction. This table also summarizes their fecundities. One common theme is that all of these target species are prolific spawners that have the ability to reproduce multiple times per year, with each female releasing millions of eggs into the environment.

- <u>The following exhibit also reflects Step 1 - Problem Formulation, in particular the General habitat requirements for the six target species:</u>

  Exhibit PF 5-1 (Appendix 4) summarizes the general habitat requirements for different life stages of the six target species. A common theme is that the eggs and larvae of all six species are planktonic. In some species (e.g., blue crab, white shrimp, Atlantic croaker), the early life stages develop in the Gulf of Mexico before the older post-larvae are transported through Aransas Pass and the channels into the shallow nursery areas of the bays. In other species (e.g., red drum, spotted seatrout), the early life stages move quickly into the shallows where they develop further. Finally, eastern oysters are immobile as adults and the early life stages remain within estuaries. In all cases, tidal transport plays a major role in moving and distributing these species throughout the local estuaries.

Q. What other exhibits reflect Step 1-Problem Formulation and what information do those other exhibits, if any, provide?

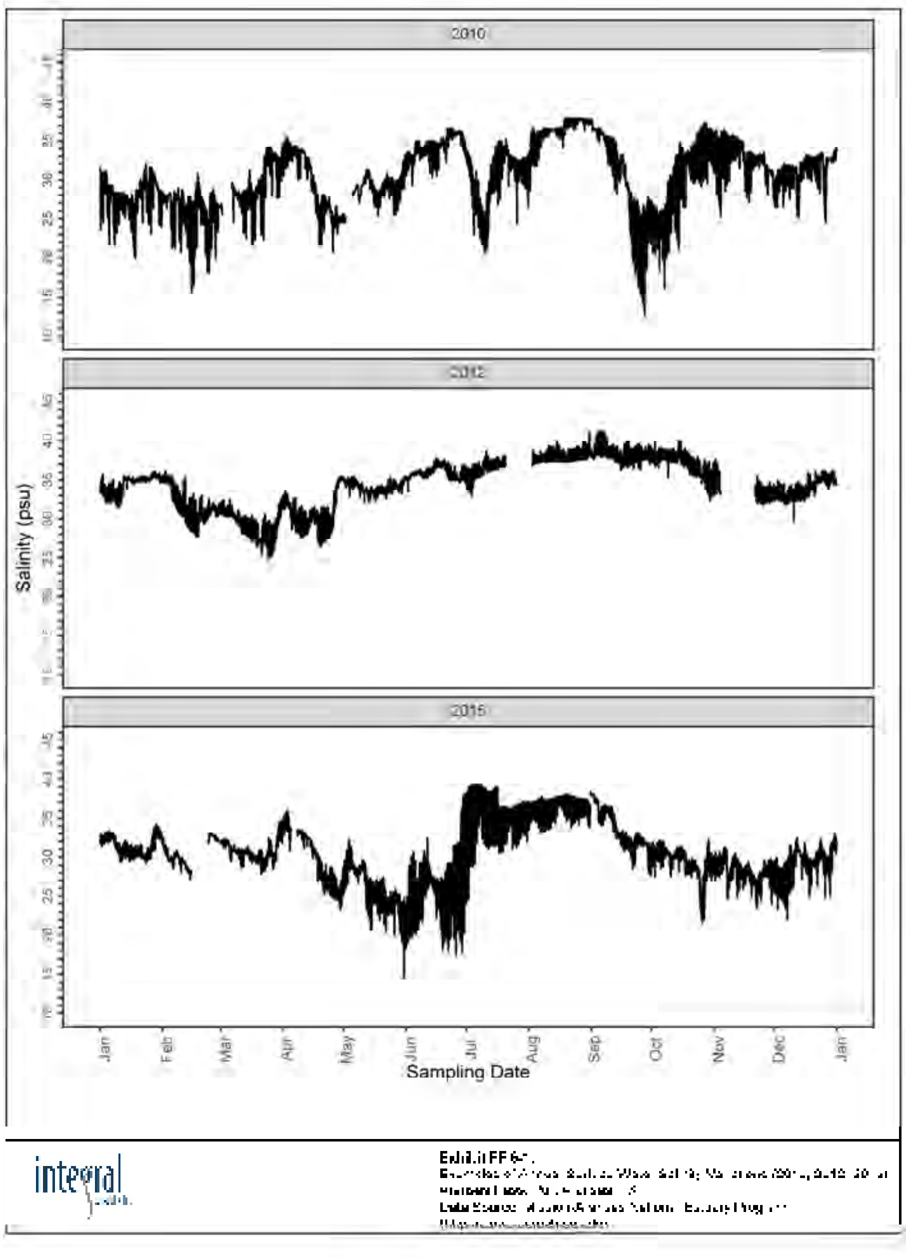
A. This exhibit also reflects Step 1-Problem Formulation, in particular:

- Natural background salinities

  Exhibit PF 6-1 summarizes three representative years (2010, 2012, and 2015) of natural background salinities measured at a long-term monitoring station in Aransas Pass.

Q. What do these data show?

A. These data show that natural background salinities in the water fluctuate greatly on a seasonal basis. The estuarine species present in this system have adapted to survive and thrive in an aquatic environment defined by constantly changing salinity levels.



Q. Are there any other exhibits relevant to Step 1 - Problem Formulation?

A. Yes, we developed the conceptual site model as follows:

Exhibit PF 7-1 provides the conceptual site model used in structuring the risk evaluation.

Q. What is a conceptual site model?

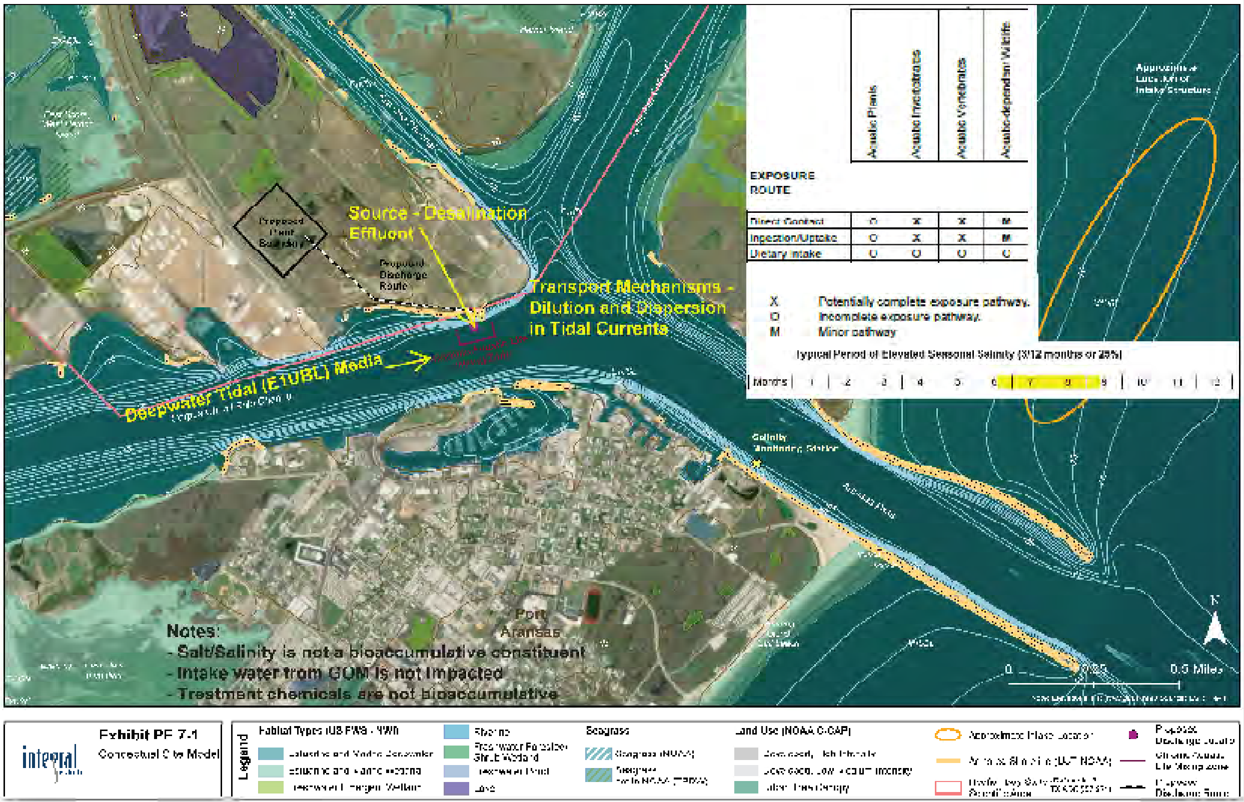
A. A conceptual site model offers a visual description of how a stressor released into the environment can move from a source, via one or more exposure pathways and transport mechanisms, to different receptor groups that may be present in the area. It also identifies the various exposure routes by which these receptor groups may come in contact with the stressor. The conceptual site model developed for this project provides the foundation to proceed with the exposure assessment, the effect assessment, and the risk estimation.

Q. How did you go about producing it in this case?

A. I assessed the habitat conditions in the CCSC and the surrounding area, the source of the increased salinity, the types of receptor groups that may be present, the pathways by which the increased salinity may reach the receptor groups, and the mechanisms by which this salinity could interact with the receptor groups.

Q. What information does the conceptual site model tell you?

A. It shows that the Effluent from the Facility represents a source of increased salinity to the local aquatic environment. The Revised Application shows that this Effluent is planned to be released about 60 ft below the surface in the deep-water tidal estuarine habitat of the CCSC. The Diffuser will be designed to cause rapid dilution and dispersion of this Effluent in the surrounding water column, thereby greatly limiting the spatial extent and duration of high-salinity conditions. A limited number of early life stages of aquatic invertebrates and fish carried into the surrounding estuaries by tidal currents from the Gulf of Mexico, or adults migrating from the estuaries into the Gulf of Mexico to spawn, may temporarily become exposed to increased salinity via direct contact with and ingestion of surface water. But, as discussed below, that limited exposure will not in reasonable scientific probability cause harm to aquatic life.



Q. Based upon the conceptual site model, will the Effluent have any adverse consequences on the aquatic plant community?

A. No.

Q. Please explain your answer.

A. The aquatic plant community (e.g., seagrass beds) will not experience increased salinities from the Effluent because aquatic plants are absent from the deep-water tidal habitat in the vicinity of the proposed Diffuser, and the seagrass beds are located in shallow areas well outside of the expected area of high Effluent salinity.

Q. Based upon the conceptual site model, will the Effluent have any adverse consequences on wildlife species?

A. No.

Q. Please explain your answer.

Potential exposure to Effluent-related increased salinity via direct contact or ingestion/uptake represents only a minor pathway to aquatic-dependent wildlife species (including threatened and endangered species); hence, birds and mammals are not included in the assessment. Aquatic-dependent wildlife species are not likely to use the deep-water habitat of the ship channel, do not forage in sediments located 60+ ft deep, and would not be exposed by direct contact or dietary intake as salt is not a bioaccumulative substance.

Q. So, based upon the conceptual site model and your other work on Step 1-Problem Formulation, do you draw any conclusions?

A. Yes.

Q. What are they?

A. Based on these considerations, estuarine species of aquatic invertebrates and fish are retained for evaluation, with direct contact and ingestion/uptake representing the major potential exposure routes to effluent salinity, in addition to the naturally occurring salinity fluctuations typical of estuarine habitats. Again, this is for the purposes of further analysis, as explained below.

Q. What other information did you look at in conducting Step 1-Problem Formulation?

A. I used the following major information sources to support the Problem Formulation:

- Computer-based resources provided by the U.S Fish and Wildlife Service National Wetland Inventory and Information for Planning and Conservation, information on seagrass beds provided by the Texas Parks and Wildlife Department Diversity and Habitat Assessment Programs and by the NOAA, NOAA's Coastal Change Analysis Program (C-CAP), and the Texas Department of State Health Services Shellfish Harvest Areas Viewer
- Published literature pertaining to species-specific fecundities, life histories, habitat requirements, and life stage-specific distributions
- The 2007–2017 database for the natural salinities measured in surface water from Aransas Pass obtained from the Mission-Aransas National Estuary Program.

Q. Do you have an opinion on whether you were able to complete Step 1-Problem Formulation in this matter?

A. Yes.

Q. What is that opinion?

A. Enough data are available on local habitats, species-specific habitat requirements, and ecological life histories of aquatic organisms that may be present in the CCSC. I also considered well-documented natural salinity levels, and available modeled salinity concentrations, to prepare a site-specific evaluation to determine if Effluent discharge has the potential to cause harm.

Q. What, if any, conclusions did you draw from the work you did pursuant to Step 1-Problem Formulation?

A. In accordance with the site-specific model I developed under Step 1-Problem Formulation, the primary assessment endpoint to be considered is survival and reproduction of aquatic invertebrates and fish, with an emphasis on early life stages. The measurement endpoints consist of comparing estimated salinity and non-salinity chemical concentrations in surface water to available water quality levels, salinity toxicity values, and background salinity levels.

Q. Once you complete Step 1-Problem Formulation in the EPA ERA Process, what do you do next?

A. Step 2-Exposure Assessment.

<u>STEP 2- EXPOSURE ASSESSMENT</u>

Q. Did you conduct Step 2-Exposure Assessment in this matter?

A. Yes.

Q. Please describe how you went about conducting Step 2-Exposure Assessment?

A. For this project, the goal of the Exposure Assessment consists of estimating the salinity levels that may occur in the CCSC within the near-field region of the Effluent plume under various environmental conditions. This assessment relies in part on output provided by the CORMIX Mixing Zone Model. Key additional elements of Step 2-Exposure Assessment include: (i) a review of the potential distribution of early life stages of aquatic species carried with incoming tides from the Gulf of Mexico through Aransas Pass into the three channels (Lydia Ann Channel, Aransas Pass, and CCSC); (ii) an understanding of the amount of time that these early life stages may be exposed to increased salinities from the Effluent plume; (iii) the spatial extent of the Effluent plume in relation to the size of the CCSC; (iv) the extent and duration of maximum background salinity concentrations, and (v) the natural variation in salinity on a daily basis and across years.

Q. What was your goal in carrying out Step 2-Exposure Assessment?

A. I combined all of these aforementioned separate lines of evidence to estimate the potential for exposure by the aquatic target species to increased salinity from the desalination effluent.

Q. Do you rely upon, or reference, any exhibits in connection with, Step 2-Exposure Assessment?

A. Yes.

Q. Please describe those exhibits and the information that they provide.

A. The following describes the exhibits I created to illustrate my analysis and to summarize voluminous data and information collected in support of the exposure assessment:

- <u>Early life stage transport considerations</u>

  Exhibit EA 1-1 summarizes the results of several published modeling efforts to estimate how passive particles, representing the embryo-larval life stages of estuarine species of invertebrates and fish, may distribute themselves into the three channels when moved by incoming tides from the Gulf of Mexico through Aransas Pass. The simulations provide mixed results but suggest that up to half or more of the organisms transported into Aransas Pass from the Gulf of Mexico may move to their nursery habitats farther inland via Lydia Ann Channel and Aransas Channel, thereby bypassing the CCSC and the desalination Effluent plume altogether.

Exhibit EA 1-1. Summary of Modeled Particle Transport Percent Allocations in the Three Channels and Aransas Pass

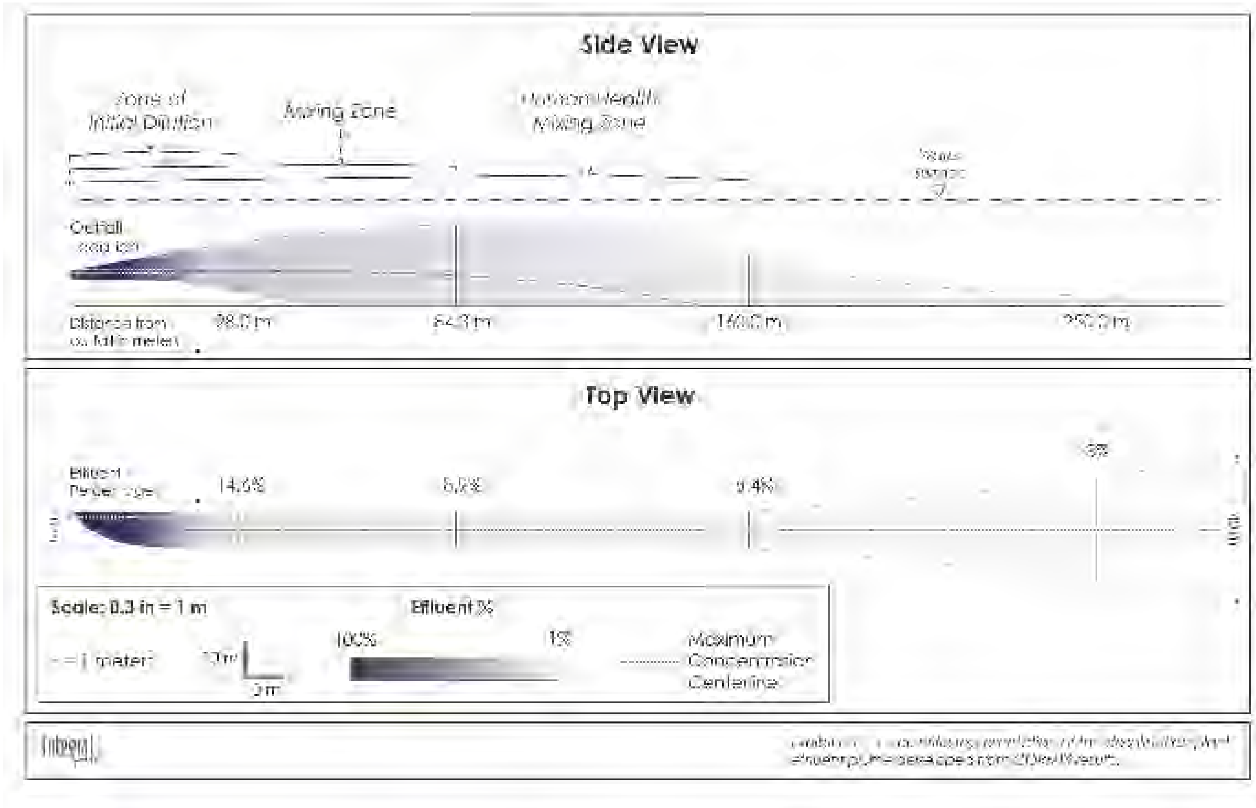
Location	Brown et al. 2000	Brown et al. 2004			Dawson et al. 2021
		All particles	Competent particles	Pulse two	
Corpus Christi Ship Channel	60	60	50	18	10.6-28.3
Lydia Ann Channel	18	30	43	80	66-81
Aransas Channel	3	10	7	NA	4.5-7.74
Aransas Pass	17	NA	NA	NA	NA
Total	98	100	100	98	NA

Exhibit EA 1-2 (Appendix 5) provides additional calculations about particle distributions based on data from Dawson et al. (2021), with **Exhibit EA 1-3** (Appendix 5) highlighting the names and locations of four nursery habitats in the estuarine habitats evaluated by Dawson et al. (2021).

Q. What other exhibits reflect Step 2-Exposure Assessment and what information do those other exhibits, if any, provide?

A. I reviewed the output of the CORMIX Mixing Zone Model and created the following exhibits:

Exhibit EA 2-1 shows a scientific representation of the effluent plume developed from CORMIX results. The plume is predicted to remain at depth (note: the permit application states that the proposed Diffuser will be located about 60 ft below the surface along the northern bank of the CCSC) and to quickly dilute out in the surrounding water column.



Q. What other exhibits reflect Step 2-Exposure Assessment and what information do those other exhibits, if any, provide?

A. I reviewed the calculations regarding the amount of time that a particle or embryo-larvae would be exposed to any increase in salinity, and we created an animation reflecting that passive particles would move through the mixing zones.

Q. How was this animation created?

A. The animation was created using QGIS software, which is a GIS platform, together with Adobe After Effects, which is an animation and motion graphics program. A base map was generated in QGIS using a 2021 aerial image from Google. Shapefiles of the mixing zone boxes and salinity plume were added to the base map to provide additional context. The base image was then imported into After Effects. Software within After Effects, known as CC Particle World, was used to generate the simulation of the flow of water in the channels. Finally, an example particle shape was added, and timed to move the length of half the ZID box at the correct speed.

Q. Have you reviewed the animation to confirm it is reliable?

A. Yes.

Q. What does it show?

Exhibit EA 3-1 provides a top-down view of a timed animation of passive particles moving with an incoming tide in the vicinity of the proposed effluent diffuser. The animation shows how long it would take for embryo-larvae to pass through the zone of initial dilution (ZID) when carried through the CCSC with an incoming tide at 1.2 m/second. Under those conditions, exposure to salinity conditions within the ZID is expected to last much less than 1 minute.

Exhibit EA 3-2 (Appendix 5) is a screen shot of an animation that further expands the Exposure Assessment by timing the movement of passive particles (representing embryo-larvae) through the ZID for three different tidal speeds, namely 1.2, 0.8, and 0.4 m/second. Under those tidal conditions, passage through the ZID by embryo-larvae is predicted to take 23, 35, and 75 seconds, respectively.

Q. What does this information tell you?

A. This information tells me that embryo-larvae moving through that portion of the CCSC encompassed by the ZID can only be expected to be exposed to increased salinity from the Effluent plume for short time periods lasting minutes or less.

Exhibit EA 3-3 (Appendix 5) is a screen shot of a 3D animation, which provides a visual contrast between the sizes of the ZID, the chronic aquatic life mixing zone, and the effluent plume versus the full depth and width of the CCSC in the vicinity of the proposed diffuser.

Q. What does this exhibit show?

A. The animation shows that the area of higher salinity around the Diffuser will only represent a small fraction of the total area available in the ship channel. This observation clearly illustrates the small spatial scale of potential exposure to aquatic life.

Q. What other exhibits reflect Step 2-Exposure Assessment and what information do those other exhibits, if any, provide?

A. I examined the maximum salinity background levels and created the following exhibits:

- Maximum background salinity levels

  Exhibit EA 4-1 uses the salinity data collected between 2007 and 2017 from a long-term monitoring station in Aransas Pass to calculate the fraction of time during each monitoring year when background salinities exceeded 40 ppt. This value was selected for further evaluation because it represents the extreme high end of the natural salinity ranges observed in Aransas Pass. Also, the long-term monitoring station was situated less than 1 mile from the proposed location of the Effluent in the nearby CCSC (Exhibit PF 1-1) and therefore provides surrogate salinity levels for that location. The data show that background salinity exceeded 40 ppt on an annual basis from 0% of the time in 2007, 2010, 2015, and 2016, to a maximum of 0.30% of the time (representing 1,575 minutes or a little over 24 hours) in 2012.

Exhibit EA 4-1. Summary of Natural Salinity Exceedances > 40 ppt in Aransas Pass

Year	Salinity > 40 ppt		Maximum Salinity (ppt)
	Minutes	% of year	
2007[a]	0	0%	35.0
2008	165	0.03%	40.1
2009	270	0.05%	41.1
2010	0	0%	37.9
2011	375	0.07%	40.7
2012	1575	0.30%	41.3
2013	960	0.18%	41.3
2014	795	0.15%	41.9
2015	0	0%	39.4
2016	0	0%	37.9
2017[b]	45	0.01%	40.3

Notes: ppt = parts per thousand
[a] Salinity data available August 24–December 31 only
[b] Salinity data available January 1–August 28 only

Q. What does Exhibit EA 4-2 show?

A. **Exhibit EA 4-2** expands on the information summarized in Exhibit EA 4-1 by identifying the number of days in the 2007–2017 monitoring data set that had one or more readings when background salinity in Aransas Pass exceeded 40 ppt. These data show that such an event occurred only during 40 days out of the approximate 3,000-day monitoring period, which represents a small fraction of time. With few exceptions, background salinities above 40 ppt occurred between late July and the end of September. During the 40 days of interest to this analysis, the consecutive time that background salinity exceeded 40 ppt was 1 hour or less in 62.5% of the cases. Of note, at no time during the 40 days when background salinity exceeded 40 ppt in Aransas Pass did the high-end exposures exceed 40 ppt. When conducting an ERA, high-end exposures, also known as reasonable maximum exposures, are represented by the 95% upper confidence limit (UCL) of the mean salinity. Those values are also presented in Exhibit EA 4-2.

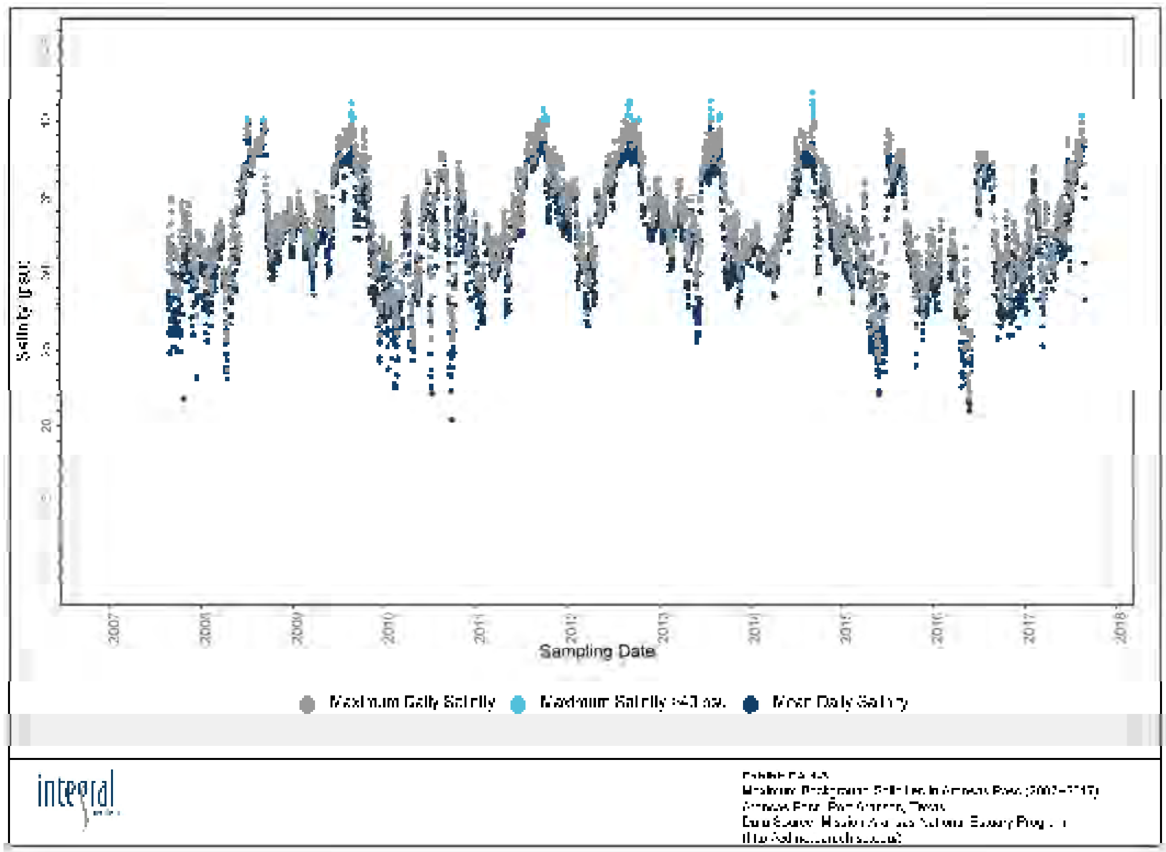
Exhibit EA 4-2. Exceedances of 40 ppt in the Historical Salinity Data Set Collected from Aransas Pass (2007–2017)

Date	No. of readings	No. of readings > 40 ppt	Consecutive readings > 40 ppt	Total hours	Total hours > 40 ppt	Consecutive hours > 40 ppt	Minimum (ppt)	Maximum (ppt)	Mean (ppt)	Mean stdev (ppt)	95% UCL
7/6/2008	96	3	1	24	0.75	0.25	38.4	40.1	39.6	0.3	39.6
9/8/2008	96	8	8	24	2	2	37.6	40.1	39.3	0.8	39.4
8/23/2009	96	4	2	24	1	0.5	37.2	40.5	38.5	0.9	38.6
8/24/2009	96	1	1	24	0.25	0.25	37.1	40.3	37.7	0.8	37.9
8/26/2009	96	5	2	24	1.25	0.5	37.2	41.1	38.0	0.9	38.2
8/28/2009	96	3	2	24	0.75	0.5	37	40.3	37.9	0.9	38.1
8/29/2009	96	3	2	24	0.75	0.5	37.1	40.5	38.0	0.9	38.1
8/30/2009	96	1	1	24	0.25	0.25	37	40.1	37.8	0.9	38.0
8/31/2009	96	1	1	24	0.25	0.25	37	40.2	37.7	0.8	37.8
9/27/2011	96	1	1	24	0.25	0.25	37.7	40.1	38.4	0.6	38.6
9/28/2011	96	6	4	24	1.5	1	37.3	40.7	38.5	0.8	38.6
9/29/2011	95	1	1	23.75	0.25	0.25	37.8	40.2	38.4	0.7	38.5
9/30/2011	96	3	3	24	0.75	0.75	37.7	40.2	38.4	0.8	38.5
10/10/2011	96	11	9	24	2.75	2.25	34.7	40.3	37.4	2.0	37.8
10/14/2011	95	3	3	23.75	0.75	0.75	28.8	40.1	35.4	2.6	35.8
8/30/2012	95	11	11	23.75	2.75	2.75	37.8	40.4	39.0	0.7	39.1
8/31/2012	96	14	14	24	3.5	3.5	38	41	38.5	0.9	38.7
9/3/2012	96	6	5	24	1.5	1.25	38.1	40.8	38.9	0.6	39.0
9/4/2012	96	19	14	24	4.75	3.5	38.1	41.2	39.1	0.9	39.3
9/5/2012	96	16	10	24	4	2.5	37.9	41.3	38.9	0.9	39.0
9/6/2012	96	22	22	24	5.5	5.5	38	41.2	38.9	1.1	39.1
9/7/2012	96	14	8	24	3.5	2	38	41	38.8	0.9	39.0
9/8/2012	96	1	1	24	0.25	0.25	37.8	40.3	38.5	0.6	38.6
9/19/2012	96	1	1	24	0.25	0.25	36.6	40.1	37.9	1.2	38.1
10/14/2012	96	1	1	24	0.25	0.25	37.5	40.1	38.2	0.6	38.3
7/24/2013	96	4	3	24	1	0.75	37	40.3	37.7	0.9	37.9
7/26/2013	96	11	8	24	2.75	2	37.5	41.2	38.4	1.0	38.6
7/27/2013	96	32	18	24	8	4.5	37.8	41.3	39.5	1.0	39.7
7/28/2013	96	9	6	24	2.25	1.5	37.6	40.7	38.8	0.9	39.0
7/29/2013	96	2	2	24	0.5	0.5	37.4	40.2	38.1	0.7	38.2
9/2/2013	96	2	2	24	0.5	0.5	37.3	40.1	38.0	0.8	38.2
9/3/2013	96	3	2	24	0.75	0.5	37.3	40.4	38.0	0.9	38.2
9/4/2013	96	1	1	24	0.25	0.25	37.3	40.3	37.9	0.7	38.0
9/5/2014	96	8	4	24	2	1	34.4	41	37.4	1.9	37.8
9/6/2014	96	23	12	24	5.75	3	35.8	41.9	38.5	1.4	38.7
9/7/2014	96	7	4	24	1.75	1	34.9	41.3	38.1	1.1	38.3
9/8/2014	96	8	5	24	2	1.25	33.9	40.9	36.4	1.9	36.7
9/9/2014	96	1	1	24	0.25	0.25	34.6	40.3	36.7	1.6	37.0
9/10/2014	96	6	5	24	1.5	1.25	34.7	40.7	37.5	1.3	37.7
8/16/2017	96	3	3	24	0.75	0.75	37.9	40.3	38.6	0.7	38.7

Notes: ppt = parts per thousand

Q. What does EA 4-3 illustrate?

A. **Exhibit EA 4-3** graphically illustrates the timing and extent of the 40 ppt exceedances in the 2007–2017 background salinity data set. The light-blue dots in the figure represent the 40 days highlighted in Exhibit EA 4-2.

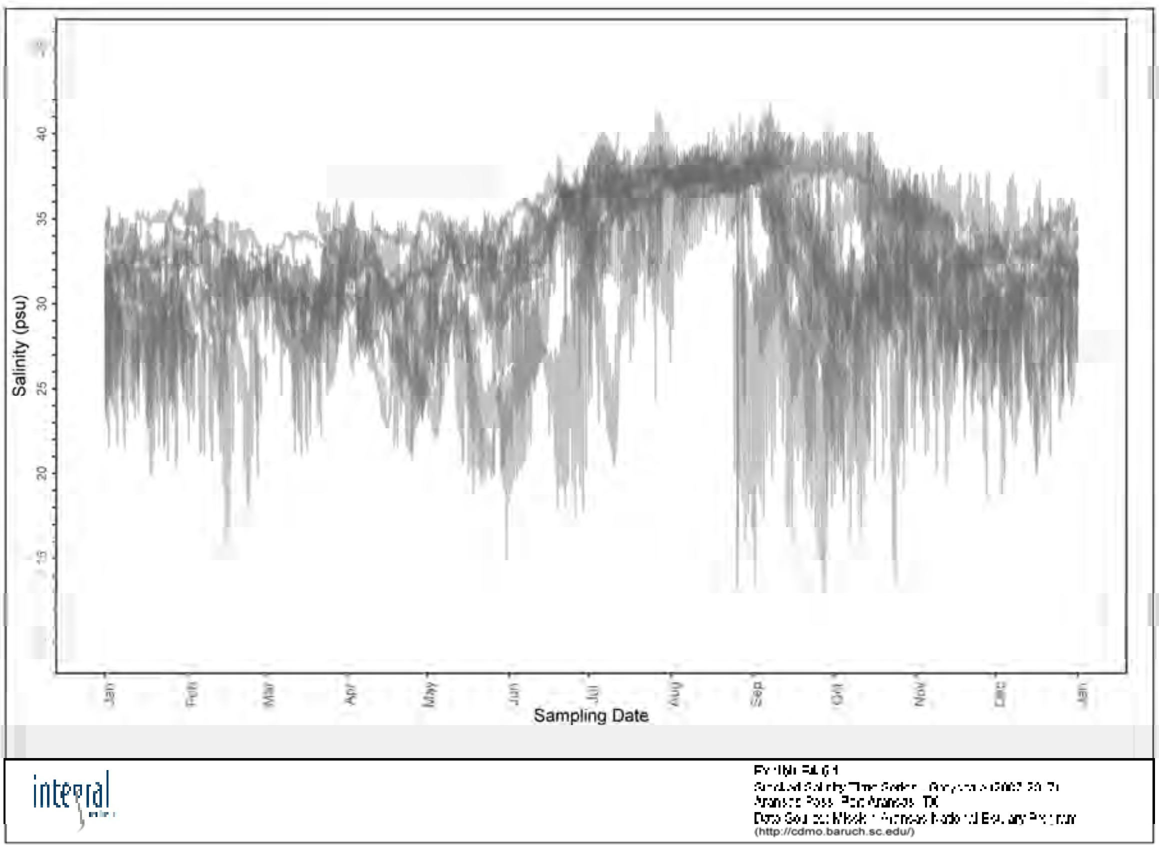


Q. What other exhibits reflect Step 2-Exposure Assessment and what information do those other exhibits, if any, provide?

A. I examined the natural variations in salinity and created the following exhibits:

- <u>Natural variations in background salinities</u>

  Exhibit EA 5-1 provides a stacked salinity time series plot of the long-term monitoring salinity data points collected from Aransas Pass between 2007 and 2017. This figure provides striking visual confirmation of the large fluctuations in salinity that occur naturally in this system on a day-to-day basis throughout the year.



Q. Did you prepare any other exhibits that reflecting salinity changes in the area of the Outfall?

A. Yes. **Exhibits EA 5-2 and 5-3** (Appendix 5) provide two examples of more detailed views of the daily salinity changes observed in the long-term monitoring data collected from Aransas Pass. Daily salinities can fluctuate from <1 ppt to >5 ppt, as well as experience large up or down changes over periods of days or weeks in response to droughts, excessive rainfall, or seasonal changes.

Q. Do these exhibits provide any information that you used in forming your opinions in this matter?

A. Yes, by implication, the aquatic estuarine species that live and thrive in such an environment have evolved physiological mechanisms to cope with the constantly changing salinity levels in their environment.

Q. **What other exhibits reflect Step 2-Exposure Assessment and what information do those other exhibits, if any, provide?**

A. I conducted the following analysis as reflected in the exhibits as part of Step 2 to examine the **exposure potential**.

Q. What does Exhibit EA 6-1 show?

A. **Exhibit EA 6-1** evaluates the potential for exposure by four life stages of the six target species to increased salinity from the Effluent. This assessment considers several variables, including the presence of life stage-specific habitat in the vicinity of the proposed Diffuser, an estimate of the potential duration of exposure to the Effluent, an estimate of the fraction of the total number of organisms moving past the diffuser that might come in contact with the Effluent plume, and a consideration of the estimated width of the Effluent plume versus the total width of the CCSC.

Q. Does Exhibit EA 6-1 provide any information that you used in forming your opinions in this matter?

A. Yes.

Q. Please explain how?

A. The CCSC in the vicinity of the Diffuser represents a deep, dredged navigational waterway under strong tidal influence that generally lacks the kinds of habitats favored by early life stages of estuarine aquatic species (e.g., extensive shallows, tidal wetlands, seagrass beds). The typical exposure durations to increased salinity over ambient in the immediate vicinity of the Diffuser by early life stages moving through the ship channel are considered to be short, on the order of a few minutes to less than 35 minutes (during slack tide). Based on the general shape and depth of the Effluent plume, and the spatial extent of the ZID and the chronic aquatic life mixing zone in front of the diffuser, it is estimated that only a small fraction (<1%) of each life stage of the target aquatic species moving through the ship channel at any one time has the potential of contacting the high salinity from the Effluent for even this limited amount of time. Finally, the width of the ZID represents a small fraction of the total width of the CCSC.

Q. What, if any, conclusions did you draw from the analysis reflected in this exhibit?

A. Taken together, I conclude that the aggregate exposure potential to increased salinity from the Effluent plume by aquatic receptors present in the CCSC in the vicinity of the Diffuser will not present a risk of harm to aquatic receptors.

Exhibit EA 6-1. Evaluation of the Exposure Potential of Estuarine Indicator Species/Life Stages in the Corpus Christi Channel in the Vicinity of the Proposed Desalination Plant Effluent Diffuser

	Egg					Larva				
	Exposure Potential to Desalination Effluent					Exposure Potential to Desalination Effluent				
	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential
Blue crab	X	NA	NA	NA	NA	•	low	low	low	low
American oyster	o	low	low	low	low	o	low	low	low	low
White shrimp	X	NA	NA	NA	NA	X	NA	NA	NA	NA
Red drum	o	low	low	low	low	o	NA	NA	NA	NA
Spotted seatrout	o	low	low	low	low	•	low	low	low	low
Atlantic croaker	X	NA	NA	NA	NA	•	low	low	low	low

	Juvenile					Adult				
	Exposure Potential to Desalination Effluent					Exposure Potential to Desalination Effluent				
	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential
Blue crab	•	low	low	low	low	•	moderate	low	low	low
American oyster	•	low	low	low	low	•	low	low	low	low
White shrimp	•	low	low	low	low	•	low	low	low	low
Red drum	•	low	low	low	low	•	low	low	low	low
Spotted seatrout	•	low	low	low	low	•	low	low	low	low
Atlantic croaker	•	low	low	low	low	•	low	low	low	low

Notes: NA = not applicable; ZID = zone of initial dilution

[a] Suitability of the habitat in the ship channel in the vicinity of the desalination effluent diffuser, modified from Table 6 (Habitat Associations) in Patillo et al. (1997). The "habitat domain" representative of the general location of the effluent diffuser is assumed to consist of both "inlet mouth" and "channel."

Habitat qualifiers:

Absent = X

Transitory = o

Present = •

[b] Exposure potential to desalination effluent

Exposure qualifiers:

Duration of continuous exposure to desalination effluent (professional judgment): low = minutes to 1 hour; moderate = 1 hour to days; high = multiple days

Fraction of available organisms in the ship channel in the vicinity of the diffuser potentially exposed to desalination effluent (professional judgment): < 1% = low; 1-10% = moderate; > 10% = high

Width of ZID (43 ft, from CORMIX model) vs. ship channel (1,200 ft): <5% = low; 5-20% = moderate; > 20% = high

Exposure potential: low | moderate | high

Q. Did you complete Step 2-Exposure Assessment?

A. Yes.

Q. What conclusions, if any, were you able to draw from your completion of Step 2-Exposure Assessment?

A. In summary, Step 2-Exposure Assessment shows that the Facility Effluent is planned to be released about 60 ft below the surface in the CCSC. This Effluent, being denser than the surrounding water, will also remain at depth. The initial Effluent salinity is expected to rapidly dilute in the surrounding water column, ranging from 0.35 to 2.5 ppt above ambient salinity at the chronic aquatic life MZ boundary. This relatively small salinity increase falls well within the natural salinity fluctuations measured in this estuarine environment.

Q. What other conclusions, if any, were you able to draw from your completion of Step 2-Exposure Assessment?

A. The results from the CORMIX Mixing Zone Model show that the anticipated width of the desalination Effluent plume during an incoming or outgoing tide is expected to take up only a small fraction of the total width of the ship channel. Based on these spatial considerations, and conservatively assuming that the early life stages of invertebrates and fish are evenly distributed throughout the entire width and depth of the water column in the ship channel, very low numbers of these organisms are expected to come in direct contact with high-salinity effluent. Those numbers would be substantially smaller for early life stages in which the organism has a preference for staying closer to the surface (e.g., buoyant red drum eggs) or travelling along the edges of the ship channel.

Q. What other conclusions, if any, were you able to draw from your completion of Step 2-Exposure Assessment?

A. My evaluation of the exposure durations for those early life stages of aquatic species that happen to move through the chronic aquatic life MZ with the tide also indicates that a small percentage of organisms would be exposed to increased salinity levels from the Outfall within the chronic aquatic life mixing zone for a period of minutes to less than 35 minutes, depending on tidal conditions. The increase in salinity exposures fall well within the naturally occurring changes in salinity of between 0.35 to 2.5 ppt above ambient salinity.

Q. Did you draw any other conclusions at this Step 2-Exposure Assessment?

A. Yes.

Q. What are they?

A. The results of particle transport modeling by Brown et al. (2000, 2004) and Dawson et al. (2021) also showed that early life stages of invertebrates and fish moving passively with incoming tides from the Gulf of Mexico, through Aransas Pass, and into the three adjoining channels (i.e., CCSC, Aransas Channel, and Lydia Ann Channel) do not pass exclusively through the CCSC. Instead, depending on the model assumptions, up to half or more of the organisms moving through Aransas Pass may be swept into the two other channels, thereby preventing these organisms from ever coming into direct contact with high levels of the Facility Effluent.

Q. What other information did you look at in reaching these opinions?

A. I used the following major information sources to support the Step 2-Exposure Assessment:

- Larval transport papers that modeled the tidal movement of passive particles from the Gulf of Mexico through Aransas Pass into the three channels
- Graphs and tables of the output generated by the CORMIX Mixing Zone Model

- Figures and tables summarizing the natural maximum salinities, as well as daily natural salinity fluctuations, measured in surface water from Aransas Pass between 2007 and 2017.
- A summary table combining the exposure potential of estuarine indicator species life stages based on several lines of evidence.

Q. Once you complete Step 2: Exposure Assessment, as part of the EPA ERA Process, what do you do next?

A. Step 3-Effects Assessment.

STEP 3-EFFECTS ASSESSMENT

Q. Did you conduct the Step 3-Effects Assessment in this matter?

A. Yes.

Q. Please describe how you went about conducting Step 3-Effects Assessment?

A. For this project, the goal of Step 3-Effects Assessment was to estimate how target species may respond toxicologically to increased salinity levels. This assessment includes reviewing the published ecotoxicological literature to assess the effects of salinity to different life stages of aquatic species and the salinity toxicity tests performed in a commercial laboratory (Stillmeadow Inc. 2021a, b, c) following EPA testing protocols. Key additional elements of Step 2-Effects Assessment consisted of obtaining information on species-specific salinity tolerance levels as measured in the field, evaluating the unpublished results of tests on early life stages of the red drum performed by Dr. Nielsen on behalf of the Protestants, and reviewing toxicity data for the trihalomethanes bromoform and chloroform that may be formed when free residual chlorine used to treat the incoming water naturally reacts with organic matter present in the sea water.

Q. What exhibits reflect Step 3-Effects Assessment and what information do those exhibits, if any, provide?

A. First, Integral created **Exhibit EFA 1-1** that summarizes toxicity data and published salinity tolerance ranges.

Q. What does Exhibit EFA 1-1 show:

A. **Exhibit EFA 1-1** presents published salinity toxicity data and published salinity tolerance ranges for four life stages (i.e., eggs, larvae, juveniles, adults) of the six target aquatic species (i.e., eastern oyster, white shrimp, blue crab, Atlantic croaker, spotted seatrout, and red drum) evaluated in this ecological risk assessment. Of the six target species, the eastern oyster appears to be the least tolerant to high salinities, but oyster reefs do not occur at the depths (60 ft) of a navigation channel bottom within the area of the Outfall.

Q. What does this information show?

A. When only examining the most relevant exposure durations (i.e., the shortest durations) the available published LOECs for the eggs (significant differences in time to hatch) and larvae (survival at 24 hours post hatch) of spotted seatrout and red drum are up to 60 ppt and LOECs of 45 to 60 ppt were reported for Atlantic croaker. As highlighted in the Exposure Assessment presented earlier in this testimony, the early life stages of the target aquatic species transported from the Gulf of Mexico in the CCSC by an incoming tide would only experience exposures to higher salinities for durations lasting from less than a minute to 35 minutes. Therefore, any toxicity results based on 24 hours, or more, of exposure to salinity are highly conservative and unrealistic within the context of the current assessment.

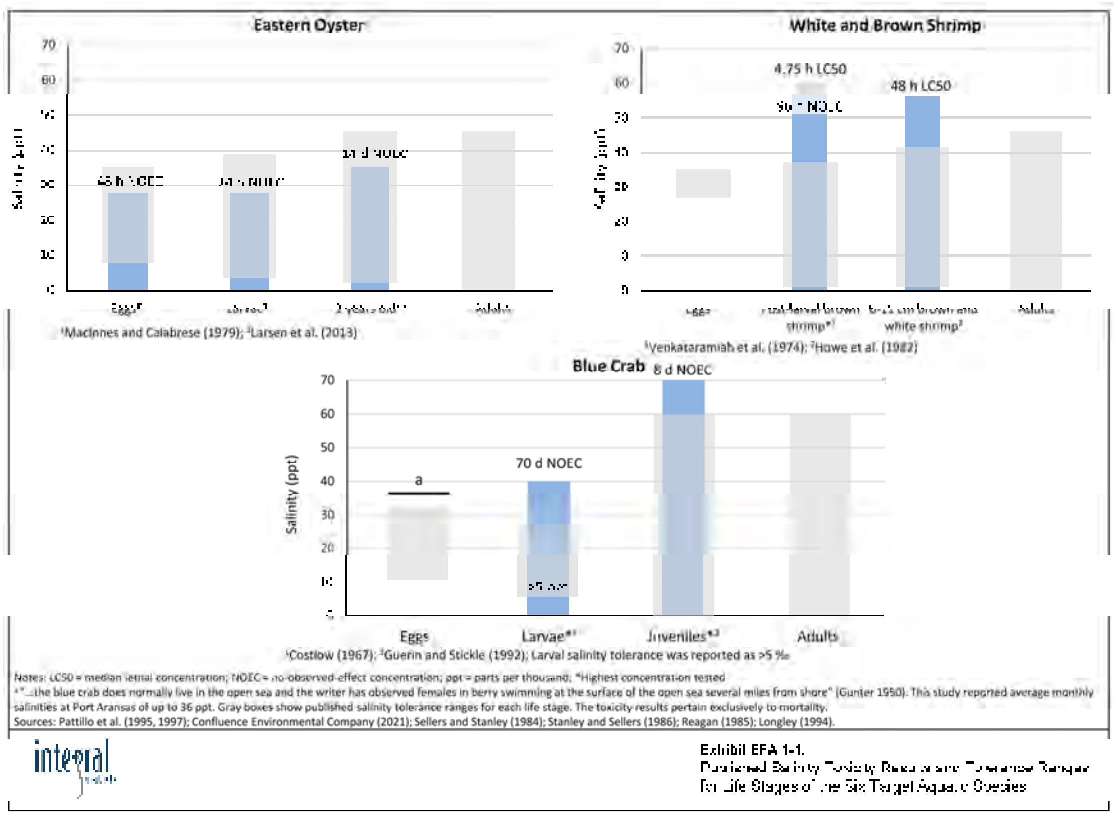


Exhibit EFA 1-1.
Published Salinity Toxicity Results and Tolerance Ranges for Life Stages of the Six Target Aquatic Species

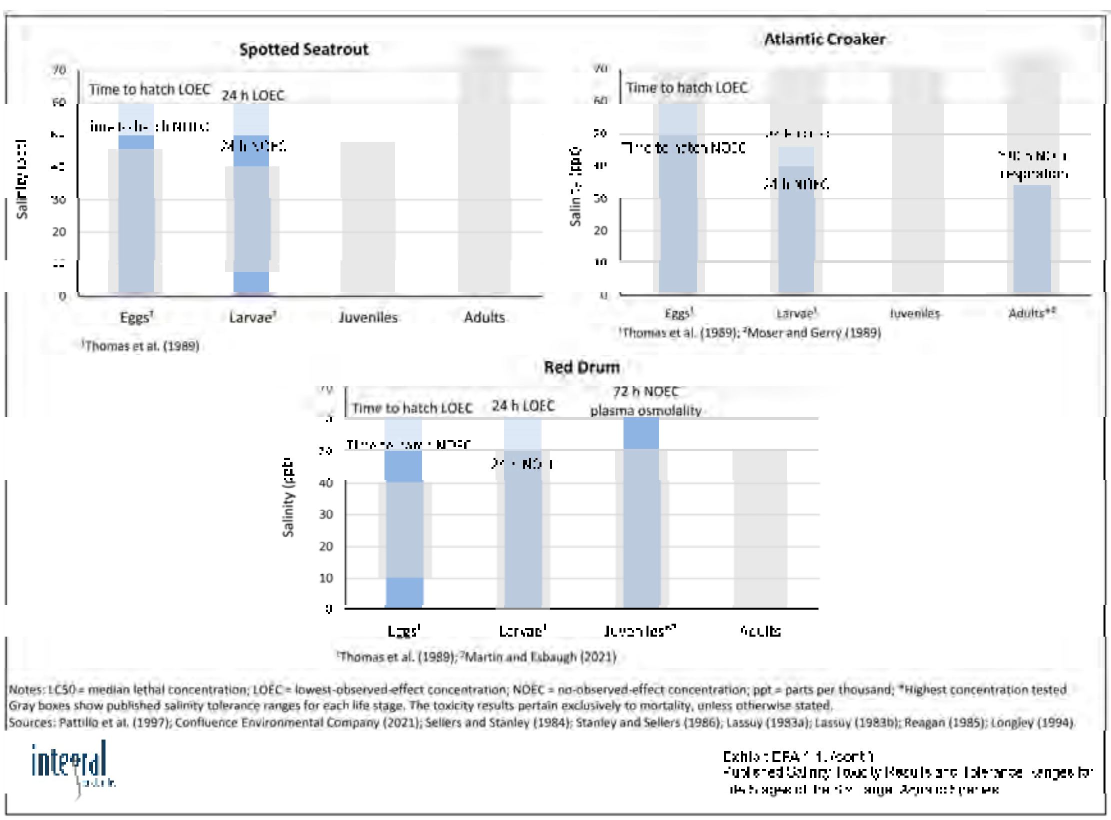


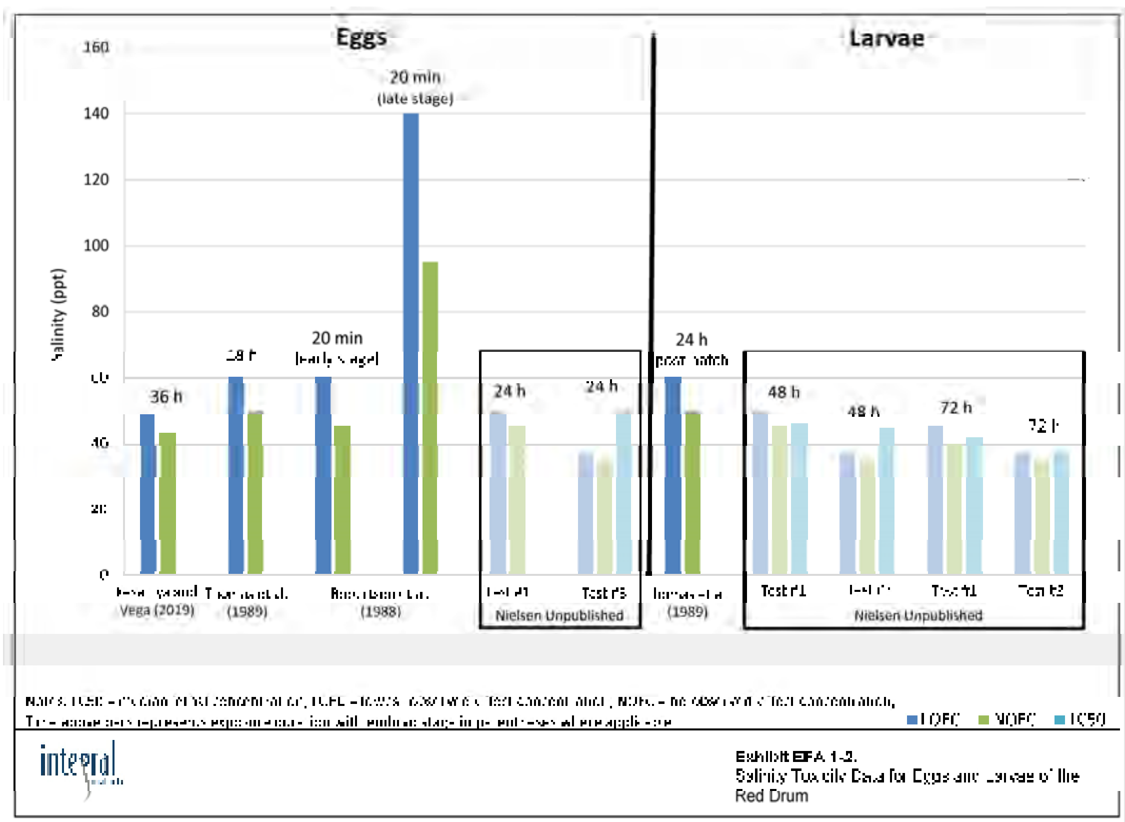
Exhibit EFA 1-1. (cont.)
Published Salinity Toxicity Results and Tolerance Ranges for Life Stages of the Six Target Aquatic Species

Q. Did you create any other exhibits to reflect your analysis in Step 3-Effects Assessment:

A. Yes, I created EFA 1-2 which looks at salinity toxicity.

Q. Please explain what EFA 1-2 shows:

A. Exhibit EFA 1-2 focuses specifically on salinity toxicity data for early life stages of the red drum. The figure includes not only data obtained from the published literature, but also unpublished toxicity data generated by Dr. Nielsen for this project in support of the Protestants (i.e., Nielsen test #1 and #3). Of note, except for the Robertson et al. (1988) study, all of the exposure durations are 18 hours or more and therefore do not reflect the much shorter exposures that would occur in the CCSC from the Outfall under consideration in the Draft Permit.



Q. What does Exhibit EFA 1-3 show?

A. **Exhibit EFA 1-3** (Appendix 6) summarizes the available toxicity data for the six target aquatic species obtained from the published literature. This information provided the basis for preparing the first two exhibits.

Q. What does Exhibit EFA 1-4 show?

A. **Exhibit EFA 1-4** (Appendix 6) summarizes survival results for salinity toxicity tests performed in a commercial laboratory based on EPA protocols and using two test species (i.e., inland silverside and mysid shrimp) commonly employed in effluent permit testing. The NOECs (mortality) after 2 minutes of exposure equals 55 ppt in both species, but represent the highest salinity tested and therefore may not represent the highest NOECs. The NOECs (mortality and growth) after 7 days of exposure equal 45 ppt in both species, but again represent the highest salinity tested and therefore may not represent highest NOECs. No LOECs (mortality) could be generated from the available data. The results show that these two estuarine species, which are surrogates representing a wider array of aquatic species, are not expected to be affected by salinities predicted to be present in the vicinity of the Outfall. As mentioned before, assuming a 7-day exposure to a constant salinity of 45 ppt is highly conservative because all of the evidence presented in my testimony shows that such conditions are not experienced by early life stages moving by tidal currents through the CCSC.

Q. What other exhibits reflect Step 3-Effects Assessment and what information do those other exhibits, if any, provide?

A. **Exhibits EFA 2-1 and 2-2** (Appendix 6) summarize the relative abundances and salinity tolerances for the six target aquatic species present in Aransas Bay and Corpus Christi Bay based on a compilation of published data.

Q. What do these exhibits show?

A. Salinity tolerances differ from toxicity data in how this information is collected and provided. Toxicity data are collected in a laboratory setting by exposing test organisms to controlled conditions and measuring responses such as behavior, mortality, or molecular markers. Tolerance data are generally derived from catch data collected in field studies and often include basic information such as presence/absence and relative abundance of particular life stages and species. Tolerance data may provide a more complete view on both the presence of certain life stages and species in the area, and actual habitat use. These two combined data sets from Exhibits 2-1 and 2-2 give a fuller picture of the ability of these species to tolerate various salinities and show that most estuarine species and life stages can survive salinities in excess of 45 ppt.

Q. What other exhibits reflect Step 3-Effects Assessment?

A. Exhibits EFA 3-1 and 3-2.

Q. What information do these exhibits provide that is relevant to Step 3-Effects Assessment?

A. EFA 3-1 and 3-2 summarize information regarding aquatic toxicity data as follows:

- Water treatment chemicals

  Exhibits EFA 3-1 and 3-2 (Appendix 6) present published aquatic toxicity data for trihalomethanes bromoform and chloroform, respectively. These two compounds may occur in the Outfall if chlorine is used in water treatment activities and reacts with organic matter present in the intake water. If present in the effluent, these compounds are not expected to affect the aquatic receptors in the CCSC because of their relatively low toxicity and the rapid dilution of the desalination plant plume in the surrounding water column. In addition, the results of the permit-required periodic aquatic toxicity testing of effluent samples will help identify any potential toxicity in the effluent. **Exhibit EFA 3-3** (Appendix 6) provides the TCEQ surface water benchmarks for bromoform and chloroform.

Q. What conclusions or other determinations, if any, were you able to make in the undertaking of Step 3-the Effects Assessment?

A. In summary, I estimated the potential effects of increased salinity on estuarine receptors by compiling data from a literature search for salinity toxicity testing on the six target aquatic species, evaluating the unpublished toxicity data for the early life stages of the red drum provided by Dr. Nielsen, and reviewing the results of three desalination permit application toxicity tests (Stillmeadow Inc. 2021a, b, c) that followed rigorous EPA testing protocols.

Q. In conducting Step 3-Effects Assessment and making any determinations, what other sources of information were relevant and what information was obtained from these other sources?

A. Key study information and reported endpoints, specifically median lethal concentrations (LC50s), LOECs, and NOECs were compiled. Results from toxicity testing on the six target species were graphed to visualize differences in sensitivity between life stages.

Q. Anything else?

A. I obtained long-term background salinity data collected from Aransas Pass and graphed the results on an annual time frame and over the duration of the data set (about 10 years) to visualize the background salinity conditions in the CCSC.

Q. What else?

A. Finally, I compiled a list of the consecutive time points that exceeded 40 ppt to show how long local organisms would encounter naturally high salinities. These data show that because this system is so variable, organisms that live in it must be able to tolerate large salinity fluctuations over short periods of time. Furthermore, the higher salinities (>40 ppt) are brief and infrequent.

Q. What conclusions, if any, were you able to draw from your examination or reference to these other sources that you have just identified?

A. Overall, this information shows the ability of local organisms to survive in a variety of salinity conditions as well as the short- and long-term natural background salinity changes they encounter without the addition of the Effluent.

Q. Have you now identified all other sources of information that you consulted in connection with Step 3-Effects Assessment, and if not, what other sources of

information were relevant, if any, and what information was obtained from these other sources, if any?

A. I also retrieved information on water treatment chemicals that may be used in reverse-osmosis saltwater desalination plants to determine their potential effects. For those compounds with information on bioaccumulation and bioconcentration, the bioconcentration potential is low and none are considered to be bioaccumulative in aquatic environments. As explained by Alex Wesner, P.E., in his testimony, many (if not all) of these compounds are expected to settle out into solid waste during the water treatment process in the desalination plant and would therefore be unlikely to be present at significant concentrations in the effluent.

Q. You have identified a fairly voluminous amount of material and other sources referenced in connection with Step 3-Effects Assessment, can you touch again on a few of the relevant sources?

A. The information sources used in support of the Step 3-**Effects Assessment** are varied and include:

- Results from toxicity testing done in support of this project, including those on Inland silverside, mysid shrimp, and red drum
- Published literature on salinity toxicity testing (e.g., Thomas et al. 1989) and tolerance (e.g., Pattillo et al. 1997; Longley 1994) for six representative Gulf of Mexico species
- Information on the identity, purpose, aquatic toxicity, bioconcentration, and bioaccumulation potentials of reverse-osmosis water treatment chemicals
- Published literature and openly available data (from databases operated by EPA and the European Chemicals Agency Registration, Evaluation, Authorization and Restriction of Chemicals program) on the bioaccumulation potential and toxicity of bromoform and chloroform
- TCEQ surface water benchmarks for chloroform and bromoform
- The 2007–2017 database for the natural salinities measured in surface water from Aransas Pass obtained from the Mission-Aransas National Estuary Program.

Q. Did you complete Step 3-Effects Assessment ?

A. Yes.

Q. What did you do next?

A. I conducted Step 4-Risk Estimation.

STEP 4-RISK ESTIMATION

Q. What did you examine to conduct Step 4-Risk Estimation?

A. I examined the potential complete exposure pathways and effects estimates.

Q. When, or under what conditions, are the exposure pathways considered to be complete?

A. The following components must be present for an exposure pathway to be complete:

- A migration pathway (e.g., surface water discharge) through which a chemical of concern ("COC") moves from its source to a receptor
- An exposure point (e.g., surface water) or point of contact between the COC and the receptor
- A receptor (e.g., fish, invertebrates)

  An exposure route (e.g., direct uptake, gill transfer) through which the receptor comes in contact with the COC.

Exposure is not possible if any one of these components is not present. By definition, risk is a function of both the potential effect of and potential exposure to a stressor, such as salinity.

Q. Can you give us an example?

A. For example, seagrass beds are not present near the proposed discharge location in the CCSC and are therefore not expected to be affected by higher-salinity Effluent.

Q. What else, if anything, is involved in Step 4-Risk Estimation?

A. Step 4-Risk Estimation compares the exposure and effect estimates. If an exposure exceeds an effect, then the magnitude and nature of the risk is discussed in light of site observations and key uncertainties or biases in the Step 2-Exposure Assessment and Step 3-Effects Assessment.

Q. Please describe how you went about conducting Step 4-Risk Estimation?

A. Step 4-Risk Estimation focuses on exposure pathways that are considered complete. The best way for me to explain my analysis under Step 4-Risk Estimation is to review the exhibits that Integral created.

Q. What exhibits reflect Step 4-Risk Estimation and what information do those exhibits, if any, provide?

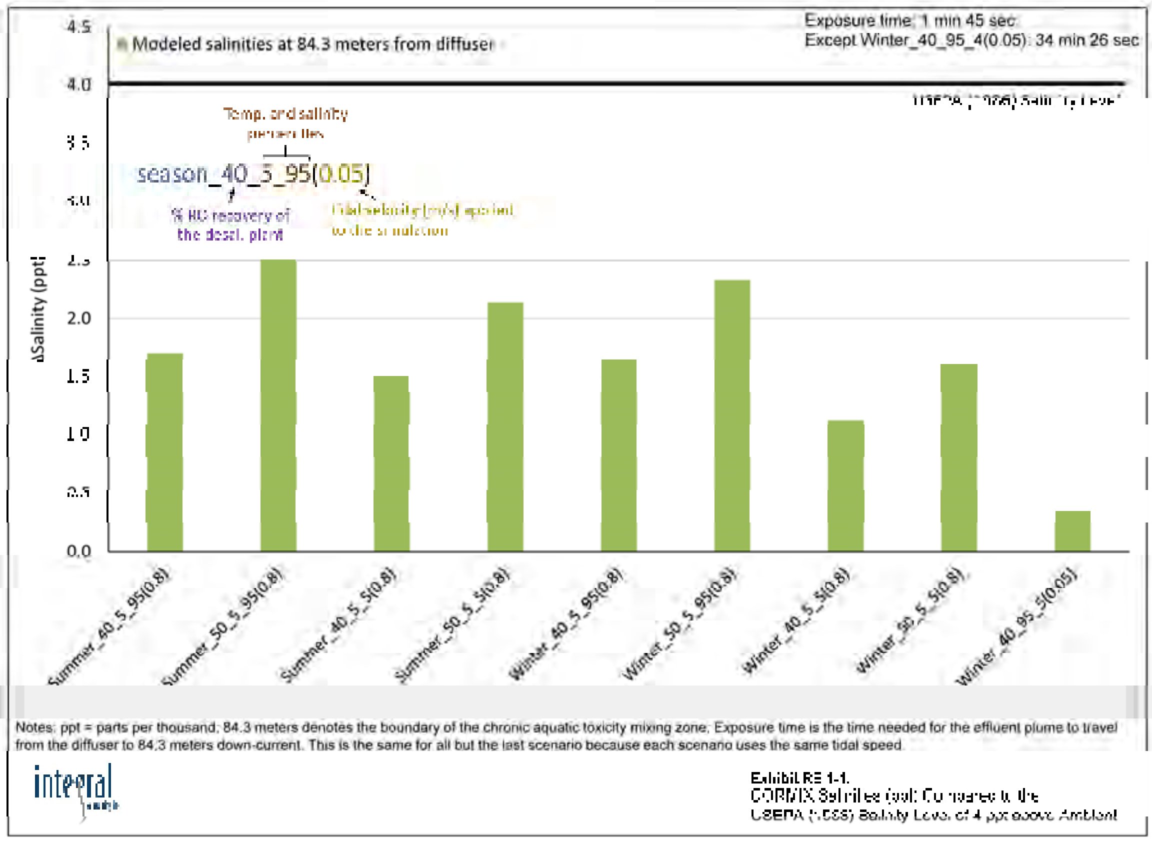
A. Let me start with discussing exhibit RE 1-1. Exhibit RE 1-1 compares the increases in CORMIX-estimated salinities (in ppt) at the boundary of the chronic aquatic toxicity mixing zone against the EPA maximum salinity increase of 4 ppt above ambient concentrations (USEPA 1986).

Q. Why did you want to look at this issue?

A. EPA has provided salinity levels that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms.

Q. What did you find?

A. This comparison shows that, even under "worst-case" conditions (i.e., highest increase in ambient salinity at the boundary with the chronic aquatic toxicity mixing zone during summer under a 50% freshwater extraction scenario), the maximum increases in salinity are not expected to exceed the EPA 4 ppt salinity level above ambient concentrations.



Q. Is that significant for your opinions?

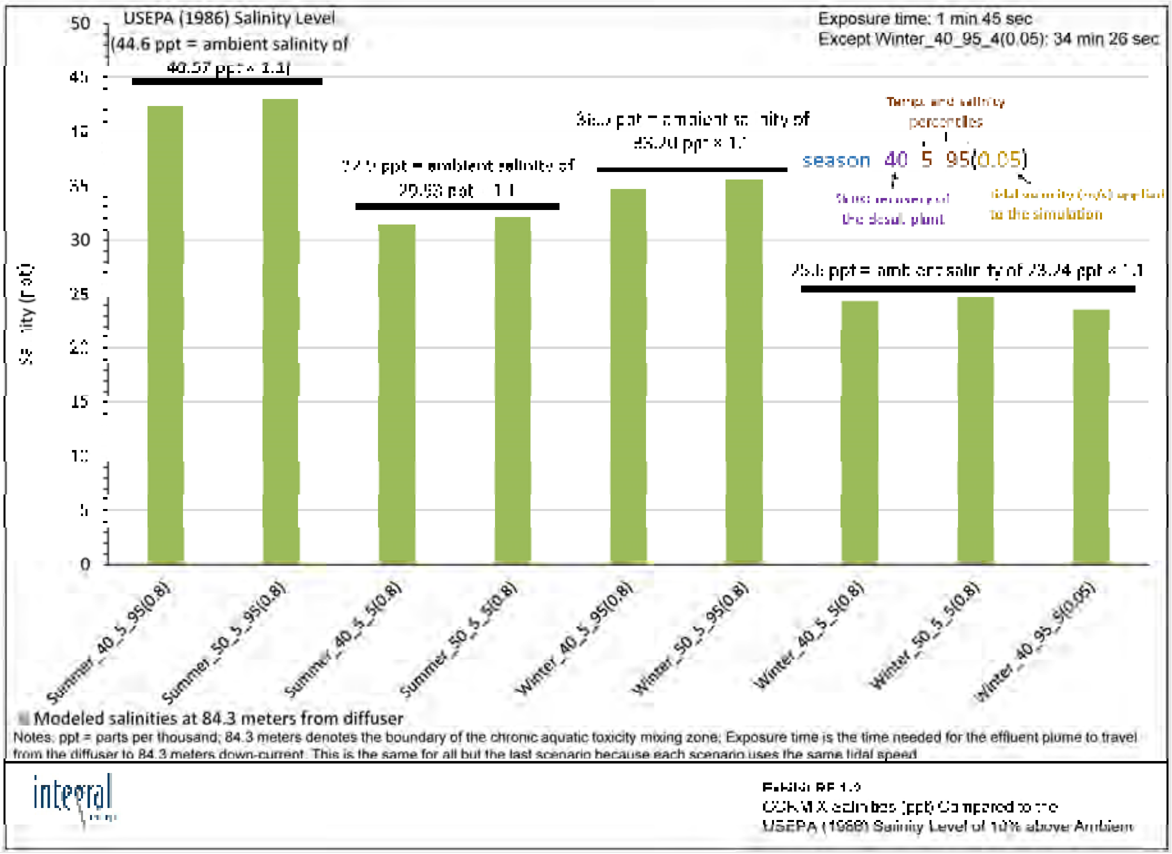
A. Yes.

Q. Why?

A. This comparison demonstrates that salinity increases at the mixing zone boundary are well within the salinity levels established by EPA.

Q. What is the next exhibit reflecting your analysis of Step 4-Risk Estimation?

A. Please refer to Exhibit RE 1-2. **Exhibit RE 1-2** compares the increases in CORMIX-estimated salinities (in ppt) at the boundary of the chronic aquatic toxicity mixing zone against the EPA maximum salinity level increase (in ppt) of 10% above ambient (USEPA 1986).



USEPA (1986) Salinity Level
(44.6 ppt = ambient salinity of
Exposure time: 1 min 45 sec
Except Winter_40_95_4(0.05): 34 min 26 sec
season 40 5 95(0.05)
percentiles
to the simulation
50
45
30
25
15
0
Summer_40_5_95(0.8)
Summer_50_5_95(0.8)
Summer_40_5_5(0.8)
Summer_50_5_5(0.8)
Winter_40_5_95(0.8)
Winter_50_5_95(0.8)
Winter_40_5_5(0.8)
Winter_50_5_5(0.8)
Winter_40_95_5(0.05)
Modeled salinities at 84.3 meters from diffuser
Notes: ppt = parts per thousand; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.
integral

Q. Why did you want to conduct this analysis?

A. EPA has provided salinity levels that reflect acceptable changes in salinity for the protection of habitats and estuarine organisms.

Q. What did it show?

A. This comparison shows that, even under "worst-case" conditions (i.e., highest increase in ambient salinity at the boundary with the chronic aquatic toxicity mixing zone during summer under a 50% freshwater extraction scenario), the maximum rises in salinity are not expected to exceed the EPA 10% salinity limit above ambient concentrations.

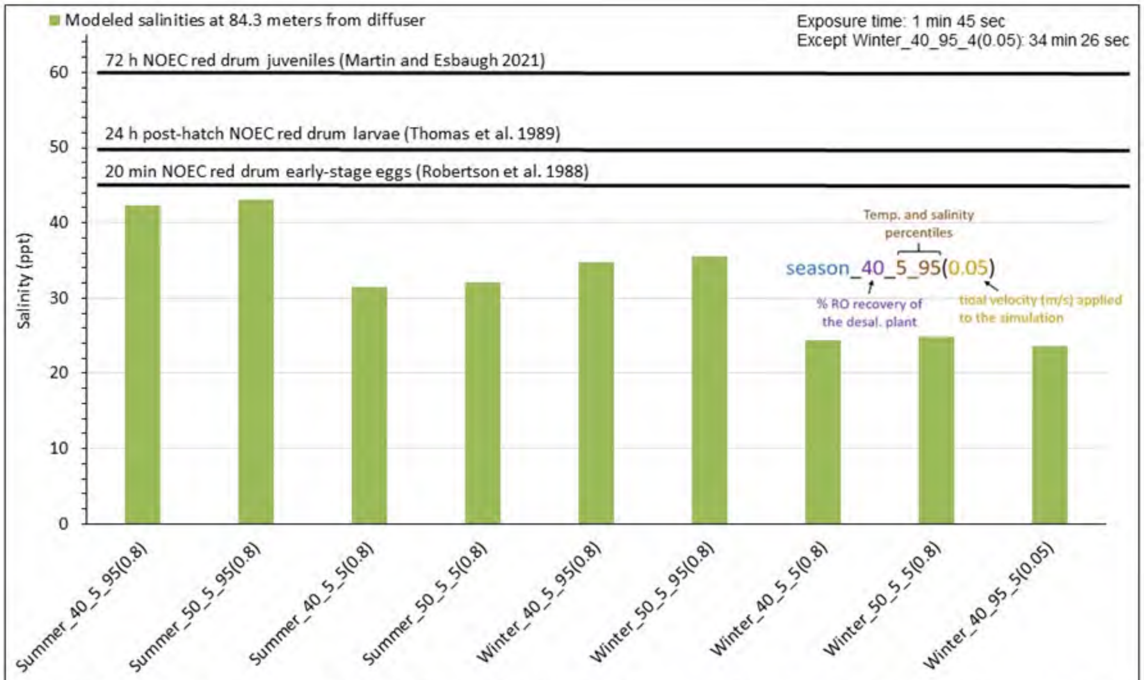
Q. What is the significance of the two exhibits that you have just described?

A. These two pieces of evidence establish in reasonable scientific probability that the salinity concentrations of the Effluent at the boundary of the chronic aquatic toxicity mixing zone in the CCSC are not expected to exceed the limit of 4 ppt or 10% above ambient concentration as established by USEPA (1986).

Q. What other exhibits reflect Step 4-Risk Estimation and what information do those other exhibits, if any, provide?

A. **Exhibit RE 1-3** compares the increases in CORMIX-estimated salinities (in ppt) at the boundary of the chronic aquatic toxicity mixing zone against three different NOECs for mortality:

- A 20-minute NOEC for red drum early stage eggs presented in Robertson et al. (1988)
- A 24-hour NOEC for red drum larvae presented in Thomas et al. (1989)
- A 72-hour NOEC for red drum juveniles presented in Martin and Esbaugh (2021).



Notes: NOEC = no-observed-effect concentration; ppt = parts per thousand; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

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Exhibit RE 1-3.
CORMIX Salinities (ppt) Compared to Red Drum Toxicity Thresholds (NOECs)

Q. What is the significance of this information?

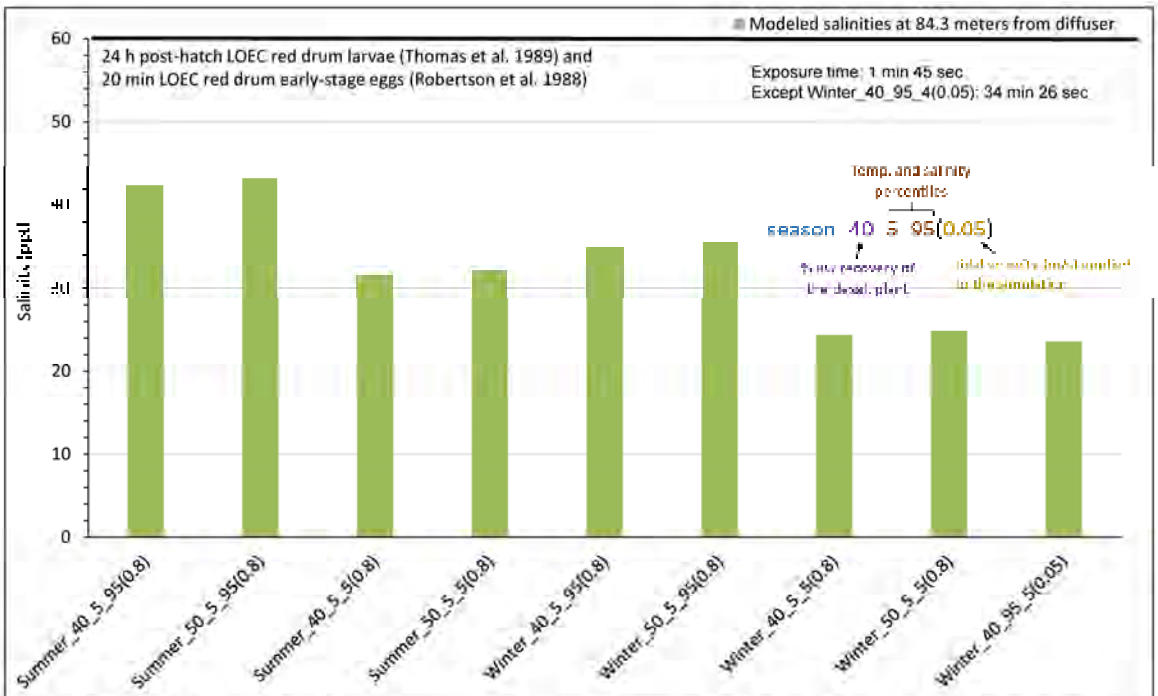
A. The exhibit shows that none of the estimated salinities at the boundary of the chronic aquatic toxicity mixing zone exceed the three NOEC thresholds. It must be noted that these three toxicity values are conservative because they represent concentrations at which no effect on mortality was reported in response to the exposures.

Q. Have you examined the increases in salinity at the boundary of the chronic aquatic toxicity mixing zone for these exhibits?

A. Yes. The previous Exhibit 1-3 utilized comparison to conservative NOECs.

Exhibit RE 1-4 compares the increases in CORMIX-estimated salinities (in ppt) at the boundary of the chronic aquatic toxicity mixing zone against three different LOECs for mortality:

- A 20-minute LOEC for red drum early stage eggs presented in Robertson et al. (1988)
- A 24-hour LOEC for red drum larvae presented in Thomas et al. (1989)



ppt = parts per thousand; NOEC = no observed effect concentration; LOEC = lowest observed effect concentration; Data shown are for the highest salinity tolerated over the most relevant duration. 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

Exhibit RE 1-4.
CORMIX Salinities (ppt) Compared to Red Drum Toxicity Thresholds (LOECs)

Q. What does this information tell you?

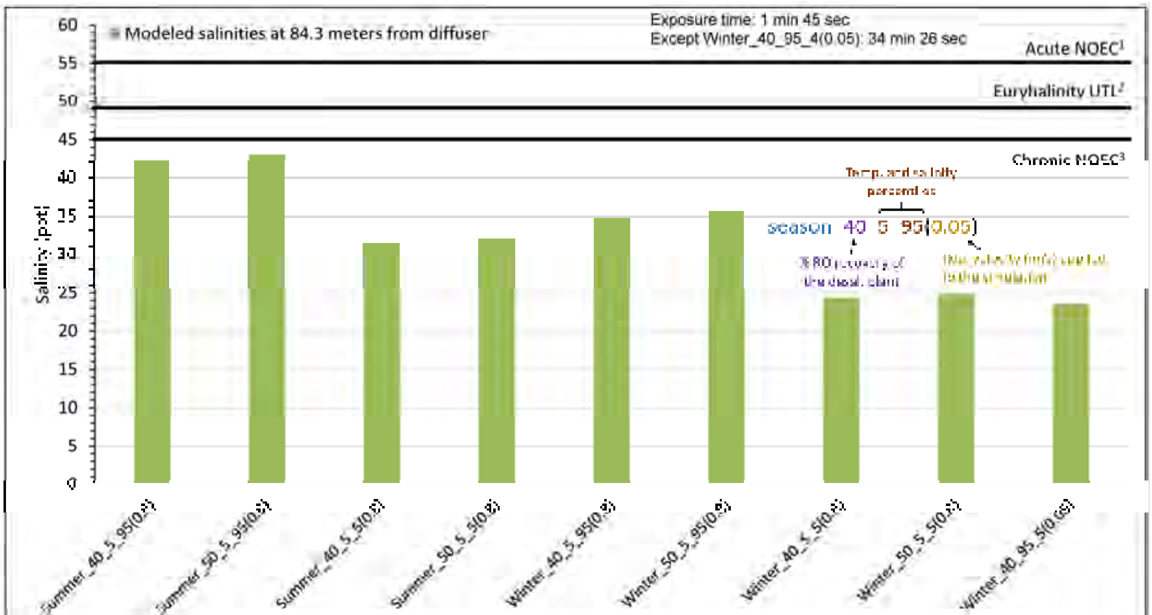
A. The exhibit shows that none of the estimated salinities at the boundary of the chronic aquatic toxicity mixing zone exceed published toxicity thresholds.

Q. Did you look at the increase in salinity at the boundary of the chronic aquatic toxicity mixing zone?

A. Yes, in Exhibit RE 1-5 that compares the increases in CORMIX-estimated salinities (in ppt) at the boundary of the chronic aquatic toxicity mixing zone against three additional toxicity thresholds:

- An acute NOEC (mortality) for mysid shrimp and inland silversides exposed to 55 ppt salinity for 2 minutes

- A chronic NOEC (mortality and growth) for mysid shrimp and inland silversides exposed to 45 ppt salinity for 7 days
- A euryhalinity upper threshold limit of 49 ppt published by Schultz and McCormick (2013). The UTL was derived using fish salinity toxicity data obtained from the Aquatic Sciences and Fisheries Abstracts database. The authors split the test type into "gradual" (i.e., a gradual increase or decrease in exposure salinities) or "direct" (i.e., an instantaneous exposure to different salinities). The UTL of 49 ppt represents the mean upper LC50 for those species classified as saltwater and exposed using a "direct" test type.



Notes: NOEC = no observed effect concentration; ppt = parts per thousand; UTL = upper tolerance limit; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone. Exposure time is the time needed, under these particular scenarios, for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.
[1]Highest concentration tested for acute, 2-minute salinity exposures to mysid shrimp and inland silverside performed in support of this project.
[2]Schultz and McCormick (2013)
[3]Highest concentration tested for chronic, 7-day salinity exposures to mysid shrimp and inland silverside performed in support of this project

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Exhibit KL 1 5.
CORMIX Salinities Compared to Euryhalinity UTL, Chronic NOEC, and Acute NOEC for Salinity

Q. What does this exhibit show?

A. The exhibit shows that none of the estimated salinities at the boundary of the chronic aquatic toxicity mixing zone exceed these three toxicity thresholds.

Q. What other information, if any, is relevant when considering these exhibits you have just described?

A. It is important to keep in mind that the salinity estimates provided in Exhibits RE 1-1 to RE 1-5 cannot be interpreted as "static" concentrations from the viewpoint of an early life stage of invertebrate or fish passing through the CCSC.

Q. Why is that?

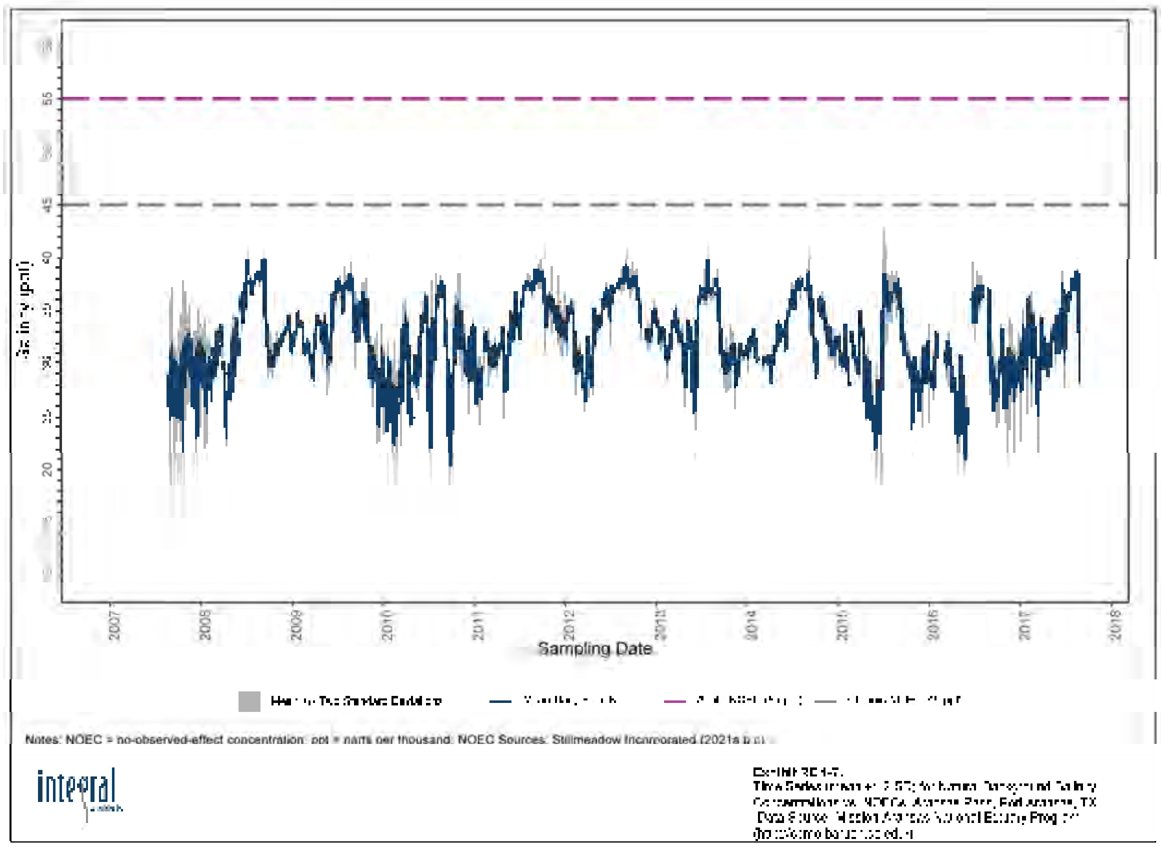
A. The reason is that embryo-larvae are expected to move through the ship channel with the prevailing tides. Under the scenarios presented in these exhibits, the CORMIX model calculates that it would take the Effluent plume less than 2 minutes to move from the diffuser to the boundary of the chronic aquatic toxicity mixing zone. That same travel time applies as well to an early life stage carried along by the tide. Hence, an important consideration in this evaluation is the short exposure durations that would be experienced by the early life stages of aquatic receptors moving through the plume area.

Q. What other exhibits reflect Step 4-Risk Estimation and what information do those other exhibits, if any, provide?

A. Exhibits RE 1-6, RE 1-7 show the following:

Exhibit RE 1-6 (Appendix 7) summarizes key output values generated by the numerous CORMIX scenarios evaluated by TCEQ for the Harbor Island desalination plant permit. The nine shaded scenarios, which represent the best- and worst-case scenarios for each season/percent recovery combination, provided the data used in Exhibits RE 1-1 to 1-4.

Exhibit RE 1-7 provides the mean ± 2 standard deviations for the natural background salinities measured in Aransas Pass between 2007 and 2017. In statistical terms, 95% of available data points fall within 2 standard deviations of the mean. The exhibit includes the acute (2-minute) NOEC for mortality and the chronic (7-day) NOEC for mortality and growth established for the mysid shrimp and silverside. This information shows that the surface water salinity in the CCSC is not expected to reach levels of concern, even when considering the anticipated small salinity increases at the boundary of the chronic aquatic toxicity mixing zone.



Q. What conclusions, if any, did you draw from the exhibits you have described as relevant to Step 4-Risk Estimation?

A. In summary, the information presented above combines data about natural background salinities, salinity toxicity, site-specific exposure durations, and the estimated Facility excess salinity levels above ambient conditions in the CCSC.

Q. What conclusions do you reach from this information?

A. When integrated together, this body of evidence demonstrates that in reasonable scientific probability even under the worst case conditions, aquatic species will not be adversely affected by increase in salinity from the Outfall.

Q. What other exhibits reflect your analysis in Step 4-Risk Estimation and what information do those other exhibits, if any, provide?

A. **Exhibit RE 1-8** evaluates the analytical data for two surface water samples collected as part of this project from the general vicinity of the Facility water intake structure in the Gulf of Mexico.

Q. Why did you review this information?

A. The goal was to determine if future Effluent might contain chemicals at concentrations above permit limits or marine surface water benchmarks.

Q. How did you conduct your analysis of this information?

A. All compounds detected above their reporting limits were multiplied by 50% to represent concentrations that might be present in the desalination plant effluent under a 50% freshwater extraction scenario. Both samples were analyzed for volatile organic compounds, semivolatile organic compounds, PCBs, oil and grease, and metals. No organics were detected above their analytical reporting limits and, therefore, were not considered further (note: oil and grease was detected above its reporting limit but lacks a permit limit or benchmark). Numerous metals were detected above their reporting limit and were evaluated using available permit limits or toxicity benchmarks.

Q. What does Exhibit RE 1-8 show?

A. No major organic contaminant classes in the two Gulf of Mexico surface water samples were present above their reporting limits and naturally occurring metals were below levels of concern for potential aquatic life effects.

Exhibit RE 1-8. Comparison of Gulf of Mexico Intake Samples Chemistry Data against Permit Limits and Marine Surface Water Benchmarks

									First Choice TCEQ Saltwater Criteria[f]		Second Choice EPA Saltwater AWQC[f]		Third Choice EPA R4 Saltwater Screening Values[f]		Hazard Quotient at the Diffuser (no dilution)[g]	
Chemicals[a]	Units	Result[b]	Qualifier[c]	Estimated Concentration in Effluent at the Diffuser[d]	Method Detection Limit	Reporting Limit	Daily Average Permit Limit[e]	Permit Limit Exceeded?	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
Volatile Organic Compounds (VOCs)																
No VOCs are present in the surface water sample above their RLs																
Semivolatile Organic Compounds (SVOCs)																
No SVOCs are present in the surface water sample above their RLs																
Polychlorinated Biphenyls (PCBs)																
No PCBs are present in the surface water sample above their RLs																
Total Metals																
Aluminum	µg/L	122.0		183.0	8.0	100	NA	—	—	—	—	—	--	1,500	--	<1
Arsenic	µg/L	3.01	J	4.5	2.5	20	381	no	149	78	69	36	69	36	<1	<1
Barium	µg/L	20.8	J	31.2	0.84	40	NA	—	150,000	25,000	—	—	110	4.0	<1	<1
Boron	µg/L	3,710		5,565	167	200	NA	—	—	—	—	—	--	1000[h]	--	**5.6[h]**
Calcium	µg/L	352,000		528,000	180	5000	NA	—	—	—	—	—	—	—	—	—
Copper	µg/L	1.82	J	2.73	1.70	20	39	no	13.5	3.6	4.8	3.1	4.8	3.1	<1	<1
Magnesium	µg/L	1,060,000		1,590,000	78.0	5000	NA	—	—	—	—	—	—	--	—	—
Manganese	µg/L	8.29	J	12.44	0.66	50	NA	—	—	—	—	—	—	100	—	<1
Mercury	µg/L	0.00065		0.00098	—	0.0005	5.37	no	2.1	1.1	1.8	0.94	1.8	0.94	<1	<1
Molybdenum	µg/L	9.27	J	13.91	4.90	50	NA	—	313,500	3,850	—	—	—	—	<1	<1
Nickel	µg/L	1.69	J	2.54	1.10	20	132	no	118	13.1	74	8.2	74	8.2	<1	<1
Potassium	µg/L	320,000		480,000	330	5000	NA	—	—	—	—	—	—	—	—	—
Sodium	µg/L	9,780,000		14,070,000	21000	200000	NA	—	—	—	—	—	--	--	--	—
Titanium	µg/L	6.66	J	9.99	3.90	50	NA	—	—	—	—	—	—	—	--	—
Oil & Grease																
Oil and Grease	mg/L	3.0		4.5		2.0			—	—	—	—	—	—	—	—

Notes:

Surface water analytical data source: ALS Environmental. 2021. Laboratory Results for Parsons-POCC Flow. Work Orders HS21060521 and HS21060616.

Bold values represent hazard quotients above 1; the surface water samples were not filtered and the analytical data represent total concentrations.

AWQC = ambient water quality criteria; EPA = U.S. Environmental Protection Agency; MDL = method detection limit; NA = not available; R4 = Region 4; RL = reporting limit; TCEQ = Texas Commission on Environmental Quality

[a] Only chemicals detected above the RL (for organics) or the MDL (metals and inorganics) are retained for further evaluation.

[b] The analytical data represent the highest-detected concentration for 2 intake water samples.

[c] J = analyte detected below quantitation limit

[d] The estimated concentration is based on the conservative assumption that the effluent is concentrated by 50% compared to the influent due to the removal of 50% freshwater via reverse osmosis. The estimated concentration was obtained by multiplying the values presented in the "Results" column by 1.5.

[e] These concentrations represent the aquatic life daily average effluent limits calculated by TCEQ and presented in Appendix A of the TPDES industrial waste water permit 0005253000 prepared for the proposed Harbor Island reverse osmosis desalination plant.

[f] Benchmark sources:

TCEQ: https://www.tceq.texas.gov/waterquality/standards and Supporting Documentation for TCEQ's Ecological Benchmark Tables comprise *RG-263b*

EPA: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

EPA R4: https://www.epa.gov/risk/regional-ecological-risk-assessment-era-supplemental-guidance

[g] The acute and chronic hazard quotients are based on the first, second, or third choice screening values, depending on availability.

[h] The screening value of 1,000 µg/L for boron is less than the background concentration of 4,500 µg/L reported for sea water (USEPA 1975).

Q. What does Exhibit RE 1-9 show?

A. **Exhibit RE 1-9** summarizes all the lines of evidence considered for Step 4-Risk Estimation and determines if the weight-of-evidence supports a conclusion of unlikely or likely impact.

Exhibit RE 1-9. Weight-of-Evidence (USEPA 1997, 1998, 2016; TCEQ 2018)
Considerations for Permitted Discharges to the Corpus Christi Ship Channel
POCC
Corpus Christi, Texas

Source of Evidence	Results	Unlikely Impact	Potential Impact
Habitat Assessment	Only limited permanent habitat is available for resident organisms in the deepwater tidal habitat (E1UBL) of the dredged channel - site-specific.	X	
Threatened and Endangered Species	Site-specific evaluation of the discharge area indicates no significant effects.	X	
Natural Salinity Variation	Site-specific background salinity variation indicates that resident organisms are naturally exposed to higher concentration extremes than the expected salinity discharge concentrations.	X	
EPA Salinity Levels	Modeled salinity concentrations at the end of the nearfield region are less than EPA salinity levels.	X	
Salinity Tolerance	The modeled salinity concentrations outside the nearfield region are within salinity tolerance of estuarine species that move through the tidal passageway.	X	
Salinity Laboratory Toxicity Tests	The modeled salinity concentrations outside the nearfield region are less than project-specific acute and chronic no-observed-effect concentrations and literature-derived toxicity endpoints for estuarine species that move through the tidal passageway.	X	
Intake Surface Water Quality	The intake surface water from the Gulf of Mexico is not located near chemical source areas and will not contain appreciable suspended solids/sediments. Also, screening against ecotoxicological benchmarks indicates that non-salinity related chemicals will not cause adverse effects. Segment 2481 (Corpus Christi Bay) is not impaired.	X	
Exposure Modeling of Salinity Plume	CORMIX modeling shows rapid effluent diffusion and dispersion in the nearfield area. SUNTANs modeling indicates that less than a maximum of 1 ppt salinity increase would occur in the farfield areas of the estuary.	X	
Spatial and Temporal Exposure	The modeled salinity concentrations return to ~2 ppt over background salinity at the end of the nearfield region. The majority of organisms moving through the channel will not encounter the salinity plume. The ship channel represents only 1 of 3 passageways for eggs and larvae to enter the estuary. Increased natural seasonal salinity only occurs for 3 months (25%) of the year.	X	

References:
USEPA (1997) Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments.
USEPA (1998) Guidelines for Ecological Risk Assessment.
USEPA (2016) Weight of Evidence in Ecological Risk Assessment.
TCEQ (2018) Conducting Ecological Risk Assessments at Remediation Sites in Texas.

Q. In reasonable scientific probability, meaning based upon the preponderance of the reliable data, do you have an opinion about whether the exposures identified in RE 1-9 will have an impact on aquatic life?

A. Yes.

Q. What is that opinion?

A. Based on reasonable scientific probability, the Effluent from the Outfall will not impact aquatic life or the environment.

Q. What other information did you look at in connection with Step 4-Risk Estimation?

A. I used the results from the CORMIX model that include worse-case scenarios (e.g., summer drought conditions, 95th percentile salinity and temperature inputs, slack tide) as conservative exposure concentrations to estimate the potential for salinity effects to aquatic life. It is important to note that the CORMIX model output represents centerline concentrations and that concentrations decrease away from the centerline according to a Gaussian (normal) distribution. In addition, I included a time component for each of the modeled salinity concentrations to provide a realistic estimate of worse-case exposure duration to aquatic organisms.

Q. What did you learn from the CORMIX modeling?

A. Modeled concentrations at the chronic toxicity mixing zone boundary fall within the two available EPA (1986) salinity levels, namely an increase of less than 4 ppt above ambient salinity (Exhibit RE 1-1) and an increase of less than 10% above ambient salinity (Exhibit RE 1-2). The USEPA (1986) salinity levels are based on protecting wildlife habitats. Also, salinity variation from natural levels should not exceed 4 ppt from natural variation in areas permanently occupied by food and habitat forming plants when natural salinity is between 13.5 and 35 ppt. For the protection of estuarine organisms, no changes in channels, basin geometry of the area, or in freshwater influx should be made that would cause permanent changes in isohaline patterns of more than ±10% of the natural variation.

Q. What else did you learn?

A. Modeled salinity concentrations at the boundary of the mixing zone represent an exposure time of 1 minute and 45 seconds and are less than red drum NOEC and LOEC toxicity thresholds (Exhibit RE 1-3 and RE 1-4).

Q. What else did you learn?

A. Modeled concentrations at the boundary of the mixing zone that represent an exposure time of 1 minute and 45 seconds are less than project-specific acute NOECs, chronic NOECs, and a literature-derived euryhalinity UTL (Exhibit RE 1-5).

Q. What conclusions, if any, did you draw from consideration of this other information that you have just described?

A. In summary, the comparisons of modeled salinity concentrations against available surface water salinity threshold concentrations establish in reasonable scientific probability that the expected changes in salinity from the Effluent will not be of sufficient magnitude or duration as to cause impacts to marine life.

Q. Can you explain what you mean or be more specific?

A. To provide a perspective on the natural ambient salinity concentrations in the ship channel prior to receiving desalination discharge, Exhibit RE 1-7 shows that short-duration peak salinity concentrations (2007–2017) in the ship channel do not approach project-specific toxicity test results (NOEC) conducted using EPA testing protocols and that effects are unlikely even with the increased salinity contribution from the Effluent. Exhibit RE 1-7 also shows natural salinity fluctuations in the CCSC of more than 20 ppt during the period of record. This demonstrates that native aquatic organisms are naturally exposed to wide salinity fluctuations, which are characteristic of estuaries.

Q. What other evaluations or analysis did you do, if any, in connection with Step 4-Risk Estimation?

A. I evaluated site-specific surface water quality data (RE 1-8) to estimate the range of concentrations of constituents of major contaminant classes in surface water samples collected in the Gulf of Mexico. These concentrations represent levels that may be present in the intake water extracted from the Gulf for use in the reverse-osmosis desalination process and could be concentrated and released in Effluent.

Q. What exactly did you do as part of this analysis?

A. The intake water Risk Estimation was conducted by comparing the chemical concentrations detected in two surface water samples to applicable ecological benchmarks from TCEQ and EPA. A hazard quotient (HQ) was used to estimate ecological risks for each detected compound. An HQ is the ratio of the measure of exposure (e.g., measured or modeled concentration) to a literature-based toxicity-based saltwater benchmark that is associated with no adverse effects. HQs less than or equal to 1 indicate a lack of ecological risk.

Q. What did this show?

A. As shown in Exhibit RE 1-7, no major organic contaminant classes in the two Gulf of Mexico surface water samples were present above their reporting limits. In addition, naturally occurring metals all had HQs less than 1, except for boron. A conservative EPA value was used for comparison because TCEQ does not provide saltwater criteria for boron. However, the EPA value for boron is less than the typical background concentration previously reported for seawater (USEPA 1975). Therefore, boron is not considered to be of concern for potential aquatic life effects.

Q. Anything else that you were able to discern?

A. Typical water treatment chemicals that may be used in reverse-osmosis saltwater desalination plants have low bioconcentration potential and are not recognized as persistent or bioaccumulative chemicals. Expert analysis by Alex Wesner, P.E. indicates that it is unlikely that water treatment compounds would be present at significant concentrations in the effluent.

Q. Overall, what conclusions did you make as a result of Step 4--Risk Estimation?

A. To integrate the lines of evidence considered in this ERA, Exhibit RE 1-9 summarizes the source of evidence and results and determines if the weight-of-evidence supports a conclusion of unlikely or likely impact. The weight-of-evidence conclusions are:

- The specific habitat present in the CCSC where Effluent will be discharged is a deepwater tidal habitat (Cowardin Classification E1UBL). Because of the deep channel and dredged bottom, the primary use of the habitat is as a temporary passageway connecting the Gulf of Mexico with the estuary system. No sensitive wetland vegetation (e.g., seagrass beds) are present in this area of the CCSC. Without permanent preferred habitat, it is **not likely** that most resident organisms would spend a significant amount of time in the area of the proposed discharge.

- Significant effects to threatened and endangered species are **not expected** because of the lack of preferred habitat, the limited potential for exposure to high salinity levels (small spatial scale and vertical component of a salinity plume), and the high mobility of these species.

Q. Any other conclusions?

A. Site-specific data on the background salinity variation in the CCSC indicate that resident organisms are naturally exposed to higher concentration extremes than the expected salinity discharge concentrations at the regulatory boundaries for the Effluent plume.

Q. Any other conclusions?

A. Modeled salinity concentrations at the end of the near-field region are less than EPA salinity threshold levels, fall within the natural salinity tolerances of estuarine species moving through the tidal passageway, and are less than project-specific acute and chronic NOECs established using EPA protocols, and less than literature-derived salinity toxicity endpoints.

Q. Any other conclusions?

A. The proposed location of the intake water structure in the Gulf of Mexico is not near known chemical source areas. Screening of the surface water analytical data against ecotoxicological benchmarks indicates that any non-salinity-related chemicals are not expected to cause adverse effects. Another important consideration is that high levels of suspended solids/sediments are not expected in the intake water. Most hydrophobic chemicals with a propensity to bioaccumulate are associated with sediments and are not expected to be present at appreciable concentrations in the water column. Additionally, TCEQ has determined that Segment 2481 (Corpus Christi Bay), which contains the area of the proposed discharge, is not impaired with chemical contaminants.

Q. What other conclusions have you reached?

A. Exposure modeling using CORMIX (~2 ppt over background at the end of the near-field region) and SUNTANs (maximum of 1 ppt increase in the far-field region) both show rapid effluent diffusion and dispersion under worse-case scenarios. Typical conditions would result in even lower estimated salinity increases.

Q. Any other conclusions?

A. The spatial and temporal aspects of exposure are critical to understanding potential risks in this dynamic tidal system. Based on worst-case CORMIX modeling, the salinity plume of the Outfall will only occupy a small portion (e.g., <5%) of the CCSC. Hence, the vast majority of organisms moving through the channel will not encounter any increase in salinity from the Outfall. An important physical characteristic of salinity plumes is their sinking nature due to higher specific gravity causing part of the plume to sink towards the bottom of the water column. This behavior would also limit the exposure potential of organisms (e.g., red drum pelagic eggs/larvae) that occupy upper levels of the water column. Eggs and larvae that enter Aransas Pass from the nearby Gulf of Mexico can move through Lydia Ann Channel, Aransas Channel, or the CCSC before reaching the shallow nursery areas in the bays. Hence, only a small portion of the total population of eggs and larvae that pass through Aransas Pass have the potential to encounter the salinity plume and the vast majority of those eggs or larvae will not be exposed to any measurable increase in salinity from the Outfall.

Q. Any other conclusions?

A. Temporal exposure is both related to seasonal spawning activity and actual residence time in the salinity plume. Because increased natural salinity typically occurs in the summer months, only approximately 3 months (25%) of the year would represent a higher potential for exposure to elevated salinity although at levels that in reasonable scientific probability will not cause harm to the environment or marine life. Exposure to the salinity plume will vary depending on the tidal cycle. Flood or ebb tide residence time is on the order of seconds to minutes because of the velocity of the incoming/outgoing tide, whereas slack tide residence time is on the order of minutes to 35 minutes. Please note that typical toxicity tests are conducted for exposure durations of at least 24 hours, which is many times longer than the exposures during slack tide from the Outfall. Using the results of such long-duration exposure tests to estimate site-specific impacts is expected to greatly overestimate the toxicity potential for short duration exposures expected in the vicinity of the Diffuser. Conservative assumptions, as described previously, for evaluating risk in this area may have over-estimated the potential for effects to aquatic life in the ship channel.

Q. **What else did you look at in Step 4?**
A. I looked at the weight of the evidence for the ecological risk assessment.

Q. **Why?**
A. EPA routinely uses weight of evidence approaches in ERA. Weight of evidence presents an approach where multiple lines of evidence are integrated to infer outcomes such as causality, impairment, and magnitude of effects. Weight of evidence is particularly important for ERA because of the complexity of ecological systems and due to the multiple lines of evidence (laboratory, field, and habitat data) that must be assembled and evaluated. Integration of the multiple lines of evidence helps support Risk Estimation and provides for more informative and defensible ERA conclusions.

Q. **What did you do?**
A. I compiled and evaluated relevant sources of evidence (Exhibit RE 1-9) applicable to determine ecological risk. Each source of evidence has a basis and is supported by defensible methods used in the ERA that, when considered together, support the conclusion that permitted discharges of the Effluent will in reasonable scientific probability not have an adverse impact on the environment or marine life.

Q. **What additional information, if any, did you need, but not have, in connection with Step 4-Risk Estimation?**
A. None.

Q. **Did you complete Step 4-Risk Estimation?**
A. Yes.

Q. Have you now shared with us the conclusions you were able to make as part of your completion of Step 4-Risk Estimation?

A. Yes.

VII. APPLICATION OF METHODOLOGY AND OPINIONS

Q. What else did you do in connection with your work on this matter?

A. I reviewed a paper prepared by Kristin Nielsen titled Proposed Harbor Island Seawater Reverse Osmosis Desalination Facility: A Prospective Evaluation of Ecotoxicological Risk (“Dr. Nielsen’s Paper”).

Q. What comments, if any, do you have about Dr. Nielsen’s Paper?

A. In general, Dr. Nielsen did not use site-specific data even though such data were available at the time the report was prepared. In addition, there are numerous incorrect technical assumptions and inaccurate conclusions in Dr. Nielsen’s Paper that make it unreliable for decision-making.

Q. Can you describe what you mean in more detail?

A. Yes. The following summarizes my opinions on this issue of Dr. Nielsen’s failure to follow the appropriate regulatory guidance for conduct of an ecological risk assessment.

- TCEQ and EPA ERA guidance require the use and consideration of available site-specific data, which were not considered in the Dr. Nielsen’s Paper; therefore, the conclusions reached are overly conservative, highly uncertain, and not consistent with regulatory requirements.
- Dr. Nielsen incorrectly defined the acronym “MAL” as the maximum allowable level in Table 4 of her Paper when in fact this acronym stands for maximum analytical level (which is a detection limit). Permit limits are higher than the maximum analytical level, so this usage is misleading. Her misuse of this term may indicate an unfamiliarity with the regulatory guidance.

Q. Did you have any other issues with Dr. Nielsen's paper?

A. Yes. She did not appropriately establish a conceptual site model.

Q. What do you mean?

A. Dr. Nielsen's conceptual site model does not accurately identify site-specific exposures within the discharge area mixing zone in the CCSC. The point sources of chemicals, Dr. Nielsen incorrectly identified on Figure 4 of the report, are not present near the intake location in the Gulf of Mexico. Soil and groundwater are not likely to be impacted by effluent discharge in the CCSC. No aquatic plants are present at the discharge location, the proposed effluent diffuser will be located 60 ft below the surface, and the habitat of the ship channel is Estuarine and Marine Deepwater habitat (E1UBL). Aquatic-dependent wildlife species (e.g., shore birds, wading birds) are also not likely to use this deep water habitat, do not forage in sediments located 60+ ft deep, and would not be exposed by direct contact or dietary intake as salt is not a bioaccumulative substance. Dr. Nielsen's claims about bioaccumulation of chemicals are not supported because the source intake water in the Gulf of Mexico does not contain measurable concentrations of PCBs and polycyclic aromatic hydrocarbons or other organic chemical constituents.

Q. What other opinions do you have about Dr. Nielsen's paper?

A. She did not correctly conduct an exposure assessment.

Q. What do you mean by that?

A. The following summarizes my opinions on this topic:

- A site-specific habitat evaluation or Exposure Assessment for the aquatic species potentially exposed to the desalination effluent in the ship channel was not performed.
- Modeling results relevant to early life stage fish and shellfish exposures were not evaluated. These results and estimated exposures are shown in my testimony to be of limited spatial scale and short exposure duration/residence time in the dynamic tidal system of the ship channel. Most aquatic receptors present in the ship channel are transients with limited exposure potential to the added salinity

in the surface water. In addition, these organisms will not be exposed to higher concentrations in their preferred habitats, which are in the shallows and seagrass beds located outside of the area of influence from the discharge.

- Surrogate exposure concentrations used in the risk assessment are not reasonably expected to occur as they are not derived from site-specific media associated with surface water intake from the Gulf of Mexico in the vicinity of Aransas Pass. Chemical analyses of surface water samples collected in the vicinity of the proposed intake structure in support of this testimony did not identify the presence of industrial chemicals required for analysis by the TCEQ permit application.

Q. Do you have any other criticisms of Dr. Nielsen's paper?

A. Yes. She did not identify the contaminants of concern appropriately.

Q. What do you mean?

A. The following summarizes my opinions on this issue:

- Inappropriate use of environmental media (sediment, oysters, and fish liver) from Corpus Christi, Aransas, and Copano bays, which are not located near the proposed facility, were used to conduct a risk assessment pertaining to a surface water intake issue. Intake water will come from the Gulf of Mexico not the Corpus Christi Bay complex.
- The contaminants listed in Tables 2 and 3 of Dr. Nielsen's report are not reasonably expected to be present at high levels in surface water at the intake location in the Gulf of Mexico.

Q. What other comments, if any, do you have about Dr. Nielsen's work on this matter?

A. She did not review the wetland habitats and endangered species correctly.

Q. Can you summarize your opinions?

A. Yes. The following discussion summarizes my opinions.

- Evaluation of habitat value, protected species status, and susceptibility of receptors is overstated and not realistic based on the actual habitat conditions at the proposed outfall and the expected exposure conditions, particularly exposure duration, in a large tidal ship channel.
- Although effects to threatened and endangered species are identified, a lack of preferred habitats in the vicinity of the proposed effluent outfall and low exposure potential and duration for these receptors makes that claim highly unlikely.
- Figure 2 of the ERA report shows seagrass cover near the discharge location. This information is not accurate. Seagrass beds are found elsewhere in the estuary, but only a single wetland habitat occurs at the discharge location, namely an estuarine and marine deep-water habitat classified as an Estuarine (E) Subtidal (1) Unconsolidated Bottom (UB) Subtidal (L) (E1UBL). This deep-water tidal habitat has an unconsolidated bottom that lacks wetland vegetation.

Q. Do you have any opinions regarding Dr. Nielsen's analysis of the toxicity from increased salinity exposure?

A. Yes, she did not correctly examine increased salinity as a potential toxicant in the aquatic environment.

Q. Please explain

A. Here is what I mean:

- Fish and invertebrate salinity tolerances or published salinity toxicity data, which represent the primary environmental impact consideration for desalination plants, were not considered.
- Inaccurate claims were made regarding the high potential for mixture interactions that modify toxicity even though salinity is widely recognized as the primary risk driver for desalination discharges. Similar unsupported claims were made about long residence time for the increased salinity in the discharge area even though significant and consistent tidal flushing occurs in the ship channel and modeling results demonstrate that this is not the case.

- No site-specific data were provided as a basis to support the assertion that pharmaceutical compounds acting as endocrine disruptors and/or reproductive toxicants are present at high levels in the proposed surface water intake area in the Gulf of Mexico.
- Inaccurate conclusions about effects on benthic invertebrate assemblages in the vicinity of the proposed outfall were made when the actual benthic communities expected to occur likely represent disturbed communities living in a routinely dredged shipping channel that does not provide optimal benthic habitat. Similarly, the proposed discharge area is primarily a transient ecological habitat and passageway, which differs from considering the area in the immediate vicinity of the diffuser as high ecological value habitat.

Q. What general conclusions or opinions do you have, if any, concerning Dr. Nielsen's work on this matter?

A. In summary, Dr. Nielsen's report is not site-specific and makes numerous incorrect technical assumptions. As a result, her conclusions are not defensible, and the report does not materially contribute to an accurate understanding of the potential environmental impacts associated with the proposed release of desalination plant effluent in the CCSC.

Q. What tests, if any, conducted by Dr. Nielsen did you review?

A. I reviewed the salinity toxicity tests (Test #1 and Test #3) conducted by Kristin Nielsen.

Q. What comments do you have on the salinity toxicity testing conducted by Dr. Nielsen, if any?

A. The results of the two unpublished 72-hour acute toxicity tests (referred to as the "Nielsen Report #1" and "Nielsen Report #3" below) do not meet the minimum requirements for consideration in a regulatory decision-making context for the reasons outlined below.

Q. Why not?

A. The reasons are summarized below and pertain to the lack of peer review, not following established testing guidelines, inconsistent reporting and reproducibility of toxicity endpoints, inadequate quality assurance and quality control, insufficient details on test exposure setup, and inadequate testing setup and reporting for the LT50 test.

Q. Any other comments?

A. **Neither of Dr. Nielsen's reports have been peer reviewed or published**.

- A lack of quality control and rigorous peer review is believed to have resulted in data quality issues, as outlined below.

Q. What do you mean that the studies do not have quality control or rigorous peer review?

A. The tests did not follow specific, established guidelines.

- Nielsen Report #1 states that the test partially relied on protocols presented in EPA-821-R-02-014 (USEPA 2002a, Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms) but does not specify which aspects of the study follow what particular guidance. USEPA (2002a) provides six test methods, three of which pertain to brackish/marine fish species.
- Nielsen Report #3 does not make any reference to guidelines or protocols.
- The two growth endpoints (namely body area and eye size normalized to length) evaluated in the Nielsen tests are not included as acceptable test endpoints in either the acute toxicity testing guidelines referenced in Nielsen Report #1. The use of "chronic" toxicity endpoints (i.e., growth measured in terms of surface area and eye size) to evaluate the outcome of an acute test is problematic. USEPA (2002b) specifies that the endpoint of interest in an acute toxicity test is mortality. By design and intent, chronic endpoints are reserved for chronic toxicity tests.
- For chronic larval fish testing (both sheepshead minnow and silverside) where growth is an endpoint, USEPA (2002b) states that formalin or ethanol should be used to preserve the test organisms. Larvae to be processed immediately should be sacrificed in an ice batch of deionized water. Nielsen Report #1 used MS222 to terminate the test organisms. It is unknown if this difference in protocol might have affected the growth measurements.

Q. Do you have any other comments regarding these tests?

A. Yes. They are as follows:

- The data from Nielsen Report #1 and Nielsen Report #3 were used to calculate survival endpoints (NOECs, LOECs, and LC50s) at 24, 48 and 72 hours using the EPA Whole Effluent Toxicity (WET) NPDES Spreadsheet (https://www.epa.gov/npdes/whole-effluent-toxicity-wet-npdes-spreadsheet). For those endpoints that were included in the reports, the results from the EPA WET spreadsheet were confirmed except for the 72-hour LC50 results for Nielsen Report #1. In Nielsen Report #1, the NOEC, LOEC and LC50 were 40, 45, and 41.8 ppt, respectively. However, these endpoints calculated with the EPA WET spreadsheet were 45, 50, and 44.69 ppt, respectively. The reason for these discrepancies that result in higher toxicity endpoints using the EPA WET calculations should be investigated to confirm that the statistics used to calculate the toxicity results in the reports are appropriate.
- The mortality NOECs and LOECs in Nielsen Report #3 were much lower (35 ppt NOEC and 37 ppt LOEC at both 48 and 72 hours) than those presented in Nielsen Report #1 (45 and 50 ppt at 24 hours, and 40 and 45 ppt at 72 hours). No reason is provided for these substantially different results.
- Growth endpoints appear to have been measured in both studies, but a lack of reporting of any growth data in Nielsen Report #3 precluded comparisons.

Q. Anything else?

A. The quality assurance and quality control were inadequate, likely resulting in not meeting various EPA acceptability criteria.

Q. Please explain your opinions.

A. Survival of the red drum control organisms at the end of the Test #1 exposure period fell below the minimum-acceptable regulatory threshold of 80% required in EPA standardized acute tests (USEPA 2002b, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms). The rationale for lowering the acceptable minimum control survival threshold down to 70% is poorly documented. Neither Nielsen Report #1 nor #2 mentioned performing a standard reference toxicant test to assess the health of the organisms used in the exposures. Therefore, the quality of the batch of red drum embryos exposed to the salinities in both tests is unknown. It is important to measure batch quality because different batches of test organisms may differ in their health condition, which could alter their susceptibility to toxicants.

Q. Do you have any other observations or comments about Dr. Nielsen's work?

A. Dr. Nielsen did not address the unusually high hatch variability observed in some of the lower-salinity concentrations used in Test #3, or what potential consequences this variability may have had on the toxicity results. Loading of embryos into the Test 1 exposure vessels was inconsistent. As a result, the initiation counts in individual vessels ranged from 19 to 26 (20 was the intended number), one vessel lacked any embryos, and one cracked vessel lost its embryos.

Q. Any further observations or comments regarding Dr. Nielsen's work?

A. The water quality parameters in both reports also fell short of EPA protocol requirements. Nielsen Report #1 states: "All water quality parameters remained within acceptable ranges throughout the 72-hour study." However, no supporting data were provided to confirm this statement or allow for independent review and evaluation. Nielsen Report #3 provided water quality results, but not for the 68.7 ppt exposures. Also, the water quality in some of the Test #3 vessels exceeded both a) the ±2 ppt EPA recommendation for salinity (USEPA 2002a) and b) the requirement that water temperatures cannot deviate by more than 3°C (max-min) during a given test (USEPA 2002a). Salinities and temperatures in several of the exposure vessels ranged up to 5 ppt above target concentrations, and up to 5°C during the test, thereby exceeding protocol thresholds and potentially affecting the conclusions. For example, at the target concentration of 45 ppt, salinity was measured at 50 ppt.

Q. Do you have any other criticisms of Dr. Nielsen's tests?

A. Yes. The Nielsen reports omitted a number of test exposure setup details.

Q. Please be more specific.

A. Here are a few examples:

- Nielson Report #3 and/or Report #1 do not provide information on test solution renewals (if any), the reason for using two testing cohorts, the method used to determine larval mortality, and the reason for using 5 control replicates but 10 test replicates.
    - Differences between the two tests in terms of spawning salinities (31 ppt in Test #1 versus 35 ppt in Test #3) were not justified.
    - Neither report provided much information on the source of the red drum brood stock or the conditions in which the adults were kept prior to spawning.
    - Neither of the Nielsen reports described the procedure used to measure the "surface area" of each surviving larva, or the approach used to normalize eye size to length.
    - Nielsen Report #1 stated that weight was not retained as an endpoint because the red drum larvae were too small at the end of the exposure period to be assessed for growth based on weight. It is unclear if that position represents the author's opinion or if published literature confirms that this endpoint is indeed not feasible for red drum larvae. However, it is possible that this omission is simply because the study design was not conducive to measuring growth endpoints.

Q. Anything else?

A. Yes. The testing setup and reporting for the LT50 test were inadequate, for example:

- LT50 test results provided in two locations in the data sheets stated that fry were transferred from 37 to 68.7 ppt, whereas the text portion of Nielsen Report #3 stated that the fry were transferred from 35 to 68.7 ppt. This detail requires clarification because negative effects were reported at 37 ppt in the main experiment, which implies that these fry may already have been stressed, making them more sensitive to additional change.
- Calculating an LT50 for exposure to full strength effluent does not represent a realistic exposure scenario. Larvae exposure to full strength effluent is essentially

impossible because the function of the diffuser is to rapidly disperse the effluent stream, which occurs within a fraction of a second.

- The results from LT50 tests can be highly variable as a result of factors (e.g., health of test organisms, genetic variability) that cannot be controlled precisely. The LT50 test may provide a guide to median lethal time but it is not a repeatable test that can be used in regulatory toxicity testing.

Q. Have you now provided us with your conclusions, observations and/or comments regarding Dr. Nielsen's work in this matter?

A. Yes.

Q. Do you have an opinion about whether Dr. Nielsen's toxicity testing are sufficiently reliable to be given weight in this matter?

A. I do.

Q. What is that opinion?

A. It is my opinion that because of the significant and numerous questions and comments I have identified about that testing above, Dr. Nielsen's testing cannot be considered reliable and should be given no weight.

VII. FINAL CONCLUSION

Q. You have provided us with a significant amount of information and analysis, it might be helpful for you now to quickly summarize the overall conclusions that you have reached after conducting your work in this matter--what are your overall conclusions Dr. Fontenot?

A. Based on careful review of the background salinity variations in surface water from the CCSC, combined with spatial and temporal exposure considerations and studies of salinity toxicity and tolerance, I conclude that the predicted changes in salinity resulting from the Effluent will not be of sufficient magnitude or duration to cause significant impacts to the estuarine community that may be present in the receiving water of the channel.

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Jessie Harbin, CLERK

Appendix 1

Lance W. Fontenot, Ph.D., PWS
Curriculum Vitae

Lance W. Fontenot, Ph.D., PWS
Principal

Education and Credentials

Ph.D., Zoology, Clemson University, Clemson, South Carolina, 1995

M.S., Biology, Southeastern Louisiana University, Hammond, Louisiana, 1990

B.S., Zoology, Southeastern Louisiana University, Hammond, Louisiana, 1987

Professional Wetland Scientist, (License No. 2565)

Continuing Education and Training

USACE-Sponsored Wetland Delineator Certification Training Program

Professional Affiliations

Society of Environmental Toxicology and Chemistry (Technical Reviewer)

Society of Wetland Scientists

Professional Profile

Dr. Fontenot specializes in assessing the human health and ecological effects of hazardous substance releases. His academic background in ecology and environmental toxicology, combined with applied consulting experience in toxicology and ecological studies, provides a unique approach to the field of risk assessment. Dr. Fontenot has more than 25 years of experience in teaching, technical literature review, and scientific research. He has published articles on several aspects of ecotoxicology and on other basic ecological studies, usually involving aquatic environments.

Dr. Fontenot has served as a technical reviewer and on the editorial board for the Society of Environmental Toxicology and Chemistry's journal *Environmental Toxicology and Chemistry*. Dr. Fontenot has experience in the preparation of human health risk assessments as well as ecological risk assessments and biological inventories. He has utilized the EPA Risk Assessment Guidance for Superfund, ASTM International Standard Guide for Risk-Based Corrective Action, Texas Risk Reduction Program, and the Louisiana Department of Environmental Quality (LDEQ) Risk Evaluation/ Corrective Action Program (RECAP) regulations for risk assessment projects. His field experience has included sample collection of soil, water, sediment, invertebrates, mussels, fish, amphibians, reptiles, birds, and mammals. Dr. Fontenot is qualified as an expert in environmental toxicology, risk assessment, and biology and has provided testimony on environmental impacts from a range of activities including oil and gas, pesticide use, and process/ stormwater discharges in Louisiana and Texas.

Relevant Experience

Risk Assessment

Industrial Clients, Louisiana—Prepared LDEQ RECAP Management Option 1 (MO-1), MO-2, and MO-3 risk assessments and developed environmental site investigations to support RECAP for more than 20 industrial clients in Louisiana.

Pesticide Manufacturer, St. Gabriel, Louisiana—Conducted a toxicity assessment for two semivolatile constituents (*o*-toluidine and 5-chloroaminotoluene) and proposed toxicity criteria for use in calculating LDEQ risk-based corrective action levels. The assessment and action levels were accepted by LDEQ.

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Chemical Manufacturer, Donaldsonville, Louisiana—Conducted a toxicity assessment for ammonia and calculated LDEQ RECAP standards for use in a RECAP MO-1 risk assessment. Developed a Groundwater Biogeochemical Characterization Program to determine the biodegradation potential of ammonia in shallow groundwater.

Chemical Company, Oakdale, Louisiana—Prepared LDEQ RECAP MO-1 and MO-2 risk assessments and developed environmental site investigations to support RECAP. Conducted toxicity assessment and developed a reference dose (RfD) for tall oil for the calculation of LDEQ RECAP standards. RECAP risk assessments and toxicity assessment were accepted by LDEQ and utilized for corrective action.

Major Railroad Company, Eunice Train Derailment, Louisiana—Participated in emergency response and risk communication activities associated with a major train derailment in Louisiana. Prepared LDEQ RECAP MO-1, MO-2, and MO-3 risk assessments and supported environmental site investigations. Conducted toxicity assessment and developed an RfD for disodium iminodiacetate for calculation of LDEQ RECAP standards. Utilized soil attenuation model for development of soil RECAP standards protective of groundwater. Conducted multiple fish tissue investigations and demonstrated that consumption of fish caught within the Eunice City Lake posed no excess health risk to human recreational receptors due to site-related constituents of concern (COCs). A health consultation conducted by ATSDR concurred with the results of the fish tissue investigations. Served as task manager for field sampling of surface water, sediment, and fish from a lake and bayou. Calculated LDEQ RECAP standards for sediment, surface water, and fish tissue.

USACE New Orleans District, Inner Harbor Navigation Canal—Conducted an evaluation of the potential risks to human health and the environment associated with the low-level organic chemical concentrations to be placed in the proposed confined disposal facility (CDF). An evaluation of potential human health risks was conducted based on normal operation of the CDF and an extreme catastrophic failure due to hurricane events or other significant flood events of the CDF (both operational and closed). The human health evaluation showed that the number of exposure pathways that could result in impacts to human health was limited, especially after closure of the facility. Human health risks from contact with dredged material placed in the facility even under an extreme failure were minimal based on comparison to conservative risk standards assuming no dilution of the dredged materials after release from the CDF. Risks after construction were considered to be even lower. Successfully conducted a RECAP evaluation utilizing existing data to confirm for LDEQ that the dredged material posed no significant risk to human health or the environment and was, therefore, exempt from solid waste regulations. This determination significantly reduced the cost of construction, impact to project schedule (associated with permitting a disposal unit), and long-term maintenance requirements associated with an LDEQ Solid Waste Permit.

Major Railroad Company, Southeast Louisiana—At a former wood treating facility, performed passive sampling using SiREM's SP3™ sampler in sediment below the mudline to measure upwelling groundwater COC concentrations before the groundwater transitioned into surface water. Passive sampling data were evaluated within the context of EPA guidance on evaluating groundwater–surface water interactions to update the conceptual site model. Porewater concentrations of PAHs and pentachlorophenol (PCP), as measured by passive samplers, were used to evaluate the contaminant flux and to perform a screening level evaluation of the potential for human health and ecological risks. Passive sampling results enabled the identification of the location and concentrations of COC flux within the transition zone. EPA's equilibrium partitioning sediment benchmarks (ESB) screening approach for PAH mixtures was utilized to refine the screening level estimates and provide focus areas for further evaluation.

Trade Association, Baton Rouge, Louisiana—Developed a white paper for risk communication of ethylene oxide emissions to address growing concerns related to cancer risk associated with ethylene oxide emissions. Local industrial facility managers used the white paper as talking points.

Utility Supplier, South Louisiana—Provided exposure assessment, toxicological support and review of the public health effects claims from an accidental release of hydrated lime into a residential community.

Oil and Gas Supplier, South Louisiana—Performed LDEQ RECAP site investigations at three former petroleum release sites located in south Louisiana that were used as bulk storage sites for hydrocarbon products including crude oil, jet fuel, diesel fuel, and waste oil. BTEX, TPH, and PAH impacts were observed during the tank removal/closure activities and the LDEQ required additional assessment of the soil and groundwater. The sites were evaluated using RECAP under MO-1 and MO-2. For each site, a conceptual site model was developed to guide the investigation and RECAP evaluation. Activities included preparation of a RECAP investigation work plan, collection of soil and groundwater data, preparation of a RECAP report, and negotiations with the agency. LDEQ subsequently approved the RECAP reports for all three sites and granted a "no further action" determination. Based on the findings at each site, the BTEX, TPH, and PAH in soil and groundwater were within the limits of the respective limiting RECAP standards.

Former Retail Gasoline and Diesel Station, Natchitoches, Louisiana—Performed assessment, monitoring, and reporting activities for a former retail gasoline and diesel station located in Natchitoches, Louisiana. Activities included preparation of a RECAP investigation work plan, collection of additional soil and groundwater data for an expanded RECAP parameter list, preparation of a RECAP report, and negotiations with the agency. LDEQ subsequently approved the RECAP report. Based on the findings of the RECAP report, the COCs have been reduced to a single constituent (benzene) in one medium (groundwater). A corrective action plan was prepared to address the benzene in groundwater at the site. Corrective action was implemented and LDEQ regulatory closure was achieved.

Energy Company, South Louisiana—For the proposed development and permitting of an industrial riverfront area that included plans for dredging sediment and soil, performed environmental due diligence and property transaction support, onsite environmental investigations of soil and groundwater to clear areas for environmental concerns, onsite waste management assistance and developed remediation cost estimates. Offshore investigations included subaqueous soil sampling of multiple groundwater bearing zones to evaluate potential migration of volatile organic compounds (VOCs) of concern in groundwater from adjacent areas of documented contamination. Sampling was conducted utilizing a barge mounted drilling rig to target the elevations of the groundwater zones. Results demonstrated that VOCs have not migrated to the sediment and soil areas proposed for dredging within the shallow groundwater zones. Permitting support was also provided for soil, groundwater, and wetland environmental issues and contingency planning for the potential of encountering contaminated sediment/soil during proposed dredging.

Former Louisiana State Police Firing Range, South Louisiana—Performed field screening utilizing x-ray fluorescence (XRF) to identify areas of elevated lead concentrations to develop a more focused and cost-effective scope of work for the environmental site assessment (ESA) to be conducted for the property. Conducted a limited soil and groundwater assessment that verified impacted soil areas identified by XRF screening and identified lead impacts in shallow groundwater.

Chemical Manufacturer, Westwego, Louisiana—Prepared five LDEQ RECAP MO-1 risk assessments at a chemical manufacturing facility with soil and groundwater impacted by volatile and semivolatile constituents, PCBs, and metals. The assessments were accepted by LDEQ and regulatory closure was achieved.

Inactive and Abandoned Facility, Louisiana—Performed preliminary risk screening, using LDEQ RECAP guidance, for an inactive and abandoned facility in Louisiana that was under consideration for Superfund listing. Conducted additional RECAP MO-1 risk assessment and field screening of soils for PCBs using a rapid immunoassay field screening kit.

Underground Storage Tanks, Shreveport, Louisiana—Prepared an LDEQ RECAP risk assessment and closure plan for an underground storage tank site in Louisiana. The assessment and corrective action were accepted by LDEQ.

Petrochemical Manufacturer, Louisiana—Prepared a baseline risk assessment work plan as part of a RCRA facility investigation (RFI) for two units at a Louisiana chemical manufacturing facility with soil and groundwater impacted by volatile and semivolatile constituents. Prepared LDEQ RECAP MO-1 and MO-2 risk assessments and supported environmental site investigations for the RFI. Successfully utilized the RECAP investigation for the response to an EPA RCRA 3013 Order.

Dutchtown Superfund Site, Dutchtown, Louisiana—Developed risk-based corrective action levels for groundwater, protective of a downgradient surface water resource, as part of the contingency measures for the monitoring program at the Dutchtown Oil Treatment Superfund site in Louisiana. The corrective action levels were accepted by EPA Region 6.

Industrial Landfill, Baton Rouge, Louisiana—Task manager for a human health and ecological risk assessment requiring development of site specific health-based levels for metals and organics in groundwater discharging to surface water at a major industrial landfill in Louisiana. An MO-3 baseline risk assessment was prepared to evaluate potential human health and environmental risks associated with a closed landfill. Historical analytical data indicated the occurrence of several constituents in well samples collected at the landfill. Because of the proximity of a surface water body to the site, the focus of the risk assessment was to evaluate the potential impact of leachate discharging from the landfill into the surface water body. Results of the RECAP Ecological Risk Assessment Checklist indicated that the site did not meet the criteria for exclusion from further ecological assessment because of the long-term threat of release (via groundwater discharge) to the surface water body. Therefore, a screening level ecological risk assessment was conducted that evaluated the potential effects of groundwater discharge to aquatic receptors in the surface water body. A comparison of maximum predicted groundwater discharge concentrations (within the surface water body assuming no dilution) to ambient water quality criteria or to toxicological screening benchmarks for freshwater aquatic biota when LDEQ or EPA criteria were not available revealed that none of the COCs exceeded their risk-based aquatic toxicity criteria. The RECAP MO-3 risk assessment was accepted by LDEQ.

Agricultural Chemical Manufacturing Facility, Luling, Louisiana—Prepared a risk assessment as part of the RCRA Corrective Action Program being conducted at two solid waste management units. The risk assessment was consistent with the requirements of RECAP and evaluated the results of the RFI and site-specific exposure conditions for the development of the risk assessment. The screening option of the LDEQ RECAP guidance was employed to select COCs. A site conceptual exposure model was developed that depicted the potential sources of COCs, chemical release and transport mechanisms, affected media, known and potential routes of migration and potential human and ecological receptor populations. MO-1 RECAP standards were developed for COCs that exceeded LDEQ RECAP screening standards in groundwater. Concentrations of 1,2-dichloroethane and benzene exceeded the limiting MO-1 RECAP standards. Although BIOSCREEN modeling results demonstrated that groundwater would not migrate appreciably from the area where COCs were detected, the results of the MO-1 risk assessment indicated that corrective action was warranted for groundwater. A monitored natural attenuation compliance program was chosen to address the area of the site that exceeded the RECAP standards. The MO-1 RECAP standards were proposed as an action standard for the monitored natural attenuation compliance program. Conducted additional RECAP MO-1 and MO-2 risk assessments for other areas at the facility.

Gillis W. Long Hansen's Disease Center, Carville, Louisiana—Performed an environmental site investigation for three former disposal areas (i.e., landfills). The purpose of the investigation was to provide appropriate data sufficient to meet the requirements of the LDEQ RECAP. The investigation focused on assessing shallow soils and groundwater in the interior and the immediate area surrounding each landfill. A RECAP screening option evaluation was performed to identify areas of investigation and COCs. A conceptual site model was developed to depict the potential exposure pathways under both current and potential future exposure scenarios. The soil quality data compiled during the investigation indicated minor to moderate impacts of shallow soils at each landfill. The shallow groundwater data indicated that there were no adverse impacts to groundwater due to the landfill operations. Performed a MO-1 risk assessment of the three landfills. Results of the risk assessment indicated that corrective action was warranted for soils at one landfill only; no further action at this time was recommended for the remaining two landfills. A soil cap/cover was recommended as the appropriate corrective action. A cap of clay and vegetated soil was placed over the affected area to prevent exposure to elevated lead concentrations.

Big Lake West Former Crude Oil Terminal, Big Lake, Louisiana—Performed an environmental site investigation and LDEQ RECAP risk assessment for the Big Lake West Former Crude Oil Terminal. Five areas of investigation for soil and groundwater were defined during the RECAP process and included both industrial and residential land use. Benzene, ethylbenzene, naphthalene, 2-methylnaphthalene, benzo[*a*]pyrene, and gasoline-, diesel-, and oil-range total petroleum hydrocarbons (TPH-GRO, TPH-DRO, and TPH-ORO) were the COCs. Corrective action was warranted for soil at the site for the protection of human health and the environment. The area of investigation for soil was defined by the limiting RECAP standards for TPH-DRO and benzo[*a*]pyrene. A corrective action plan was prepared and implemented to address the areas of corrective action identified for soil in the area of investigation. After additional RECAP evaluation using site-specific fate and transport modeling, corrective action for groundwater was not required at the site. The assessment and corrective action were accepted by LDEQ.

Superfund Site, Northwest Florida—Conducted a baseline ecological risk assessment associated with the operation of a battery reclamation facility at an NPL site in Florida. Results of the ecological assessment were used to develop an alternative approach to the EPA-accepted record of decision (ROD), which specified the dredging of approximately 29 acres of wetlands. As part of the approach, worked closely with EPA Region 4, Florida Department of Environmental Protection, and the U.S. Fish and Wildlife Service to design a strategy to conduct the required ecological assessment activities in a cost-effective manner that would satisfy the requirements of the regulatory community. This was one of the first ecological risk assessments mandated by EPA Region 4 to be conducted according to its Ecological Risk Assessment Guidance for Superfund (EPA 540-R-97-006, OSWER Directive 9285.7-25). As part of the ecological risk assessment, developed a detailed sampling and analysis plan for the evaluation of potential impacts to the wetland ecosystem potentially impacted by site activities. Tasks completed as part of the evaluation included surface water and sediment collection for metals analysis and for use in sediment toxicity tests using *Chironomus riparius* and *Hyalella azteca*. Prey species tissue samples were collected and analyzed to validate food-web exposure models and to determine site-specific bioaccumulation factors. A vegetation evaluation was conducted to determine the occurrence of, and potential for, cypress regeneration within the wetland ecosystem. Successfully completed the rigorous time-critical sampling event under EPA oversight. Following receipt of the analytical results, performed a weight-of-evidence evaluation to determine the potential impacts to the wetland ecosystem. The results of the evaluation were used to determine appropriate and realistic remediation goal options within the wetland system for protection of ecological populations and to develop an amendment to the ROD.

Superfund Site, Louisiana—Conducted a peer review of the ecological risk assessment prepared for a Superfund site in Louisiana with impacted soil, groundwater, surface water, and sediment. Recommendations included clarifications of the technical approach and adherence to established EPA ecological risk assessment guidance.

Petrochemical Plant, Port Neches, Texas—Prepared Texas Commission on Environmental Quality (TCEQ) affected property assessment reports for an industrial client in southeast Texas. Five affected property assessment reports, two response action plans, and multiple post-response action care reports were accepted by TCEQ. The response action plan for a landfill area included the use of dredged material as a cover. Performed a toxicity assessment and developed an RfD for morpholine to use for calculation of protective concentration levels.

Specialty Petrochemical Manufacturer, Baytown, Texas—Prepared two Risk Reduction Standard 2 closures and conducted additional risk assessment activities to support the RFI. Results were used to establish remedial goals for the groundwater corrective action program.

Chemical Facility, Galena Park, Texas—Prepared a screening-level ecological risk assessment for a chemical facility in Texas with PAH-impacted soils. Results of the Tier 2 screening-level ecological risk assessment indicated the potential for ecological risks to terrestrial receptors exposed to soils at one area of concern.

Synthetic Rubber Manufacturing Facility, Orange, Texas—Provided technical review and assistance with project strategies for an ecological risk assessment of PAH- and metal-impacted sediment at a synthetic rubber manufacturing facility in Texas.

Petrochemical Manufacturing Facility, Houston, Texas—Prepared a baseline human health risk assessment for a chemical facility in Texas with organic, pesticide, and metal constituents in groundwater.

Major Railroad Company, Gautier, Mississippi—Prepared a site-specific risk assessment to evaluate post-Hurricane Katrina risks to human health and the environment at a former wood treating and preserving facility in Mississippi. Major activities included a human health risk assessment of contaminants in soil, groundwater, sediment, and biota; ecological risk assessment of contaminants in sediment and biota; site-specific biological investigations; sediment quality triad assessment; and evaluation of benthic macroinvertebrate communities and fish and crab tissue residues. The human health and ecological risk assessment were approved by the Mississippi Department of Environmental Quality (MDEQ).

Petroleum Storage Sites, Southern Mississippi—Performed Phase II ESA soil and groundwater sampling activities at two petroleum release sites. Phase II ESA investigation results were evaluated using MDEQ Tier 2 Petroleum Hydrocarbon Evaluation – TPH Fractioning to limit the extent of corrective action required.

Human Health and Ecological Risk Assessment of PCBs, Crystal Springs, Mississippi—Prepared a human health and ecological risk assessment of PCBs in soil, sediments, and biota at a lake in Mississippi. Site-specific ecological field studies included benthic macroinvertebrate community evaluation and fish and crawfish tissue residue evaluation.

Major Railroad Company, Gautier, Mississippi—Performed an ecological risk assessment and assisted in the preparation of a human health risk assessment and a remedial action plan, for a former wood treating and preserving facility in Mississippi with PAH and PCP constituents in soil, groundwater, and sediments. The risk-based remedial action plan was approved by MDEQ.

Shipbuilding Facility, Pascagoula, Mississippi—Developed risk-based cleanup goals for volatile organic compounds in groundwater, protective of a downgradient surface water resource, at a shipbuilding facility in Mississippi. The cleanup goals were considered in the decision-making process for termination of the remedial system currently in operation.

Major Utility, Kingston, Tennessee—Prepared ecological risk assessments of amphibian and reptile receptors for the baseline ecological risk assessment of the Kingston Ash Recovery Project in Roane County, Tennessee.

Major Railroad Company, Jacksonville, Florida—Prepared a screening-level ecological risk assessment for an industrial client in Florida with PAH- and pesticide-impacted sediment, surface water, and soil. This project included the derivation of site-specific sediment quality criteria and evaluation of benthic macroinvertebrate survey data.

Ecological Risk Assessments at a Chemical Facility, Mulberry, Florida—Prepared a screening-level ecological risk assessment and baseline ecological risk assessment problem formulation for a chemical facility in Florida with metal-impacted sediment, surface water, and soil.

U.S. Army, Fort Gordon, Georgia—Prepared screening-level ecological risk assessments for sediment waste management units as part of the RFI process.

Fertilizer Facility, Dodge City, Kansas—Performed an ecological exclusion screening and checklist as part of the RFI for the facility. Utilized a comprehensive habitat-based approach and ecological exposure analysis to demonstrate that the site meets the criteria for exclusion from further ecological assessment.

Industrial Clients, Alabama, Florida, Louisiana, and Texas—Prepared ecological reconnaissance reports and checklists for ecological assessment/sampling as part of the RFI for chemical manufacturing facilities in Alabama, Florida, Louisiana, and Texas.

Surface Water

Paper Mill, Bogalusa, Louisiana—Emergency Response Coordinator and Biological Team leader for a fish kill incident response and recovery evaluation in southeastern Louisiana. Performed endangered species agency coordination, fish population monitoring, and fish/seafood tissue safety evaluation. Coordinated with U.S. Fish and Wildlife Service for the threatened Gulf sturgeon and special endangered species protocol daily reporting for Gulf sturgeon as a result of the process wastewater discharge to the Pearl River.

Pest Control Company, Southeast Texas—Conducted an evaluation of a fish kill resulting from a pesticide application (Patrol® and Tekko Pro®) for mosquito control adjacent to a pond. Compiled a literature review on the ecotoxicity and fate and transport properties of the pesticides and identified contract laboratories for nonstandard analysis of the pesticides. Collected surface water, sediment, tap water, and fish tissue samples and provided interpretative reporting for the fish kill incident.

USACE, New Orleans District—Supported preparation of baseline salinity conditions and preliminary ecological impact analysis for the Violet Freshwater Diversion project. This analysis included determination of the presence of endangered or threatened species and evaluation of the potential impacts on critical habitats.

Louisiana Department of Natural Resources, South Pecan Island Freshwater Diversion, Vermilion Parish, Louisiana—Technical reviewer for effects of salinity changes on fresh, intermediate, and brackish marshes for the South Pecan Island Freshwater Diversion, Vermilion Parish, Louisiana. An evaluation of the environmental assessment prepared by NOAA indicated there would not be water quality effects on wetland creation and restoration. The evaluation also concluded that there were no known endangered or threatened species, critical habitat, marine mammals, or other nontarget species occurring in the area.

Refinement of Aquatic Life Use Categories, Terrebonne Basin, Louisiana—Led a team that collected physical, chemical, and biological data to establish a basis for the refinement of aquatic life use categories and applicable water quality criteria for freshwater and estuarine water bodies in the Terrebonne Basin of Louisiana. In the Terrebonne Basin, all bodies of water are specified for the protection of fish and wildlife propagation and have a dissolved oxygen) criteria of either 4 mg/L (for estuarine waters) or 5 mg/L (for freshwater and coastal marine waters). Thus, a study was conducted in the basin to collect information that can be used as a basis for adjusting the dissolved oxygen criteria for water bodies within the basin to better reflect natural conditions. A reconnaissance was conducted to ensure the highest quality waters were chosen. Physical, chemical, and hydrological measurements were collected during each sampling event. Habitat assessment and biological sampling was performed only during the critical season (summer) events. Fish and small animals, such as insects living on the bottom, were collected at all locations. Benthic macroinvertebrates were collected at each location. The results of water quality analyses indicated that the selected sites did represent "least impacted" conditions with respect to basic water quality parameters. With respect to dissolved oxygen, however, average levels decrease to below the 5 mg/L criterion at some time (usually during the summer) at almost all of the freshwater and mixed salinity sites. The majority of the selected reference sites in the Terrebonne Basin supported a reasonably diverse and healthy biological community, despite the fact that dissolved oxygen is below the current standard. Neither minimum nor average dissolved oxygen below 4–5 mg/L appeared to be correlated with reductions in species richness or diversity.

Pipeline Company, South Louisiana—For a major pipeline company, collected data for a natural resource damage assessment pre-assessment for a gasoline spill in Louisiana, including field sampling of water, sediment, fish, and mussels. Environmental sampling reports were prepared that documented the methods used and summarized results of each investigation.

Petrochemical Manufacturer, Louisiana—Prepared a literature review of the environmental fate and toxicity of cyanide-bearing waste effluents. Performed stormwater sampling for NPDES permits.

Petrochemical Facility, Port Neches, Texas—Assessed the potential impact of constituents in a stormwater discharge at a petrochemical facility in Texas in accordance with applicable water quality standards, Texas Natural Resource Conservation Commission standards, and EPA Region 6 permitting policy.

Major Railroad Company, Effingham, Illinois—Reviewed aquatic toxicity data for two organic compounds (*tert*-butyl phenol and butyraldehyde) and the calculation methodology used by the Illinois Environmental Protection Agency for development of water quality criteria to determine conformance with regulatory requirements and to evaluate possible alternative criteria development approaches.

Ecological Studies

Major Railroad Company, Eunice Train Derailment, Louisiana—Conducted a comprehensive ecotoxicological tissue residue and pathology study on turtles from the Eunice City Lake in response to reports of turtles being affected by an apparent shell disease. The findings of this study demonstrated that the turtle shell disease observed in red-eared slider turtles was not related to the chemicals from the train derailment.

Frog Population Assessment, Western Massachusetts—Prepared a literature-based frog population assessment and conducted a laboratory audit of a frog reproduction and development toxicity study. Conducted a northern leopard frog egg mass survey in PCB-contaminated wetland habitats.

Chemical Manufacturer, Westwego, Louisiana—Conducted wetland delineation using the USACE Wetlands Delineation Manual to define the extent of wetlands surrounding an industrial landfill.

Major Telecommunications Client, South Louisiana—Conducted wetland assessments and delineations in South Louisiana using the USACE Wetlands Delineation Manual. Obtained wetland permits following USACE, New Orleans District, guidelines.

Ready-Mix Concrete Plant, Baton Rouge, Louisiana—Conducted a field delineation of the area to survey the extent of impacted wetlands by recently deposited cement fines. Soil pits were used to distinguish between the cement fines and native soils within the wetland area and also to determine the volume of cement fines present. Healthy vegetated areas with historical cement fines were considered as the limit of the delineation. After completion of the soil delineation, the limits of areas that required excavation were identified with survey stakes and approximate depths of cement fines were recorded. Approximately 1,700 cubic yards of cement fines were removed from the jurisdictional wetland area. USACE indicated that the voluntary restoration was satisfactory, and no additional action was required. However, a voluntarily replanting of the project area was implemented. Planting consisted of 250 trees (200 cypress and 50 water hickory) planted on an approximately 12- by 12-ft spacing. The area was inundated to a depth of approximately 1 ft during this planting. An additional 50 willow oak trees were planted. Based on a qualitative estimate, greater than 90 percent tree survival was achieved.

Major Railroad Company, Eunice Train Derailment, Louisiana—Obtained emergency wetland permit for remediation activities for a tributary and bayou adjacent to a train derailment site. Completed remediation of tributary by removal of contaminated sediments and restored tributary to natural conditions. Developed wetland restoration plan for a railroad bridge replacement and environmental remediation that included restoration to pre-project natural surface contours and restoration of bottomland hardwood wetlands in the mitigation area by planting appropriate tree seedlings as needed to fulfill compensatory mitigation requirements specified in the USACE permits. Restoration of 4.5 acres of wetlands with bottomland hardwood adjacent to the proposed bridge replacement and environmental remediation site was completed.

Kansas Lane Connector Environmental Impact Statement, Monroe, Louisiana—Senior ecologist for the Kansas Lane Connector environmental impact statement in Monroe, Louisiana, for the Louisiana Department of Transportation and Development (LADOTD). Responsible for wetlands, threatened and endangered species desktop research and field surveys. Protected species included the pallid sturgeon, red cockaded woodpecker, bald eagle, and the Louisiana black bear.

Kansas Lane-Garrett Road Connector and Interchange Improvements Environmental Assessment, Monroe, Louisiana—As, senior ecologist, completed technical review of the draft wetlands delineation and findings technical memorandum for the Kansas Lane-Garrett Road connector and interchange improvements environmental assessment in Monroe, Louisiana, for LADOTD. Changes in the features of this interchange improvement and railroad overpass project increased the project footprint. New areas impacted were reviewed against available electronic data to confirm the presence/absence of wetlands signatures. Also responsible for review of findings related to threatened and endangered species and critical habitat presence.

Chef Menteur Bridge and Approaches Replacement Environmental Assessment, Louisiana—Served as senior ecologist for the Chef Menteur Bridge and Approaches Replacement environmental assessment and line and grade study for a high-priority bridge replacement for LADOTD. Responsibilities included fieldwork; wetlands, biological, and desktop research; and related coordination of the Phase I ESA technical documents.

LA 143–US 165 Connector and Ouachita River Bridge, Louisiana—Served as senior ecologist for the LA 143–US 165 Connector and Ouachita River Bridge, Ouachita Parish, Louisiana, for the LADOTD. Responsible for wetlands, threatened and endangered species desktop research and field surveys.

Wetlands Delineation Update and Permit Revisions, Louisiana—Senior ecologist for the wetlands delineation update and permit revisions for the Kansas Lane Extension update of the Jurisdictional Determination, Wetlands Delineation, and Mitigation Plan submitted to the Vicksburg District of the USACE.

I-49 South-Raceland to Westbank Expressway Environmental Impact Statement, Louisiana—Served as senior ecologist for the I-49 South-Raceland to Westbank Expressway environmental impact statement for LADOTD for final field investigations and sample collection for the wetlands delineation report produced for the second segment of this interstate project on the West Bank of the Mississippi River in Lafourche and Jefferson Parishes, Louisiana. Also responsible for desktop research and fieldwork related to threatened and endangered species presence and impacts. Protected species included piping plover, bald eagle, West Indian manatee, brown pelican, pallid sturgeon, Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and the loggerhead sea turtle.

Ecological Database and Biological Inventory, Louisiana—Reviewed an ecological database and biological inventory and evaluation report of an aquatic ecosystem for a major industrial client in Louisiana. Recommendations included clarification of technical approach and data limitations.

Southeastern Louisiana University, Louisiana—Assisted in field sampling of fishes from the Tangipahoa River and processing of plankton net samples from Pass Manchac in Louisiana. Assisted in a study of the ecology of alligators from the Manchac Wildlife Management Area in Louisiana.

Louisiana Department of Wildlife and Fisheries Reptile and Amphibian Task Force—Served as a member of the task force and, in this capacity, conducted a hazard assessment of pesticides to amphibian and reptile populations.

EPA Region 4—Provided technical assistance for a PCB bioaccumulation study in an aquatic food web conducted by EPA. Northern water snakes (*Nerodia sipdeon*) were collected from a PCB-contaminated watershed and ecological data provided for the study.

South Carolina Wildlife and Marine Resources Department, Clemson, South Carolina—Conducted a status survey of the threatened bog turtle, *Clemmys muhlenbergii*, for the South Carolina Wildlife and Marine Resources Department. A final report was submitted to the department and the U.S. Fish and Wildlife Service.

Selected Expert Testimony

Pesticide Spray Drift and Crawfish Mortality, Louisiana—Provided expert opinion and trial testimony for the defense of a pesticide spray drift and crawfish mortality case. The case involved the environmental toxicity and aquatic assessment of two pesticides (Curacron and Baythroid). The case was decided in favor of the defendants.

Oilfield Legacy Site, South Louisiana—Provided expert opinion and deposition testimony regarding alleged environmental damages and human health risks for the defense of an oilfield "legacy" site in south Louisiana. The case settled.

Crawfish Pond and Hydrocarbons, Louisiana—Provided deposition testimony for the defense of a crawfish pond case. The case involved the potential impact of hydrocarbons on the taste and marketability of crawfish. The case settled.

Pesticide Use for Mosquito Control, South Louisiana—Provided expert litigation support in the matter of a pesticide (permethrin) used in aerial applications for adult mosquito control in south Louisiana. The evaluation utilized the exposure assessment and ecological effects elements of EPA ecological risk assessment guidance, established fish kill investigation principles, and a review of toxicological data to conclude that ultra-low volume aerosol applications of permethrin were not likely to have caused a crawfish kill.

Oilfield Legacy Cases, Louisiana—Provided litigation support for multiple oilfield "legacy" cases in south Louisiana regarding site investigation, risk assessment, and ecological damages.

Selected Publications

Clarkson, J.R., L. Fontenot, and L. Yu. 2005. Sulfates. pp. 110–112. In: *Encyclopedia of Toxicology.* Second Edition. Elsevier Inc.

Fontenot, L.W., G.P. Noblet, J.M. Akins, M.D. Stephens, and G.P. Cobb. 2000. Bioaccumulation of polychlorinated biphenyls in ranid frogs and northern water snakes from a hazardous waste site and a contaminated watershed. *Chemosphere* 40:803–809.

Platt, S.G., K.R. Russell, W.E. Snyder, L.W. Fontenot, and S. Miller. 1999. Distribution and conservation status of selected amphibians and reptiles in the Piedmont of South Carolina. *J. Elisha Mitch. Sci. S.* 115:8–19.

Fontenot, L.W., G.P. Noblet, S.G. Platt, and J.M. Akins. 1996. A survey of the herpetofauna inhabiting polychlorinated biphenyl contaminated and reference watersheds in Pickens County, South Carolina. *J. Elisha Mitch. Sci. S.* 112:20–30.

Fontenot, L.W., and S.G. Platt. 1996. *Regina septemvittata* (queen snake): Reproduction. *Herpetological Review* 27:205.

Fontenot, L.W., and W.F. Font. 1996. Helminth parasites of four species of aquatic snakes from two habitats in southeastern Louisiana. *Journal of the Helminthological Society of Washington* 63:66–75.

Fontenot, L.W. 1995. Utilization of amphibians and reptiles and their parasite communities as bioindicators of environmental contamination. Dissertation, Clemson University.

Fontenot, L.W., and S.G. Platt. 1995. The status of the bog turtle (*Clemmys muhlenbergii*) in South Carolina. *Bulletin of the Chicago Herpetological Society* 30:145-147.

Fontenot, L.W., C. Rockett, W. Mashburn, J. Gottschalk, G. Noblet, and R.L. Dickerson. 1995. Effect of Aroclor 1254 exposure on bullfrog (*Rana catesbeiana*) helminth parasite burden and CYP1A1 activity. *The Toxicologist* 15:189.

Platt, S.G., and L.W. Fontenot. 1995. Geographic distribution. *Eleutherodactylus planirostris* (greenhouse frog). *Herpetological Review* 26:207.

Fontenot, L.W., G.P. Noblet, and S.G. Platt. 1994. Rotenone hazards to amphibians and reptiles. *Herpetological Review* 25:150–156.

Platt, S.G., and L.W. Fontenot. 1994. Geographic distribution. *Anolis sagrei* (brown anole). *Herpetological Review* 25:33.

Platt, S.G., and L.W. Fontenot. 1994. Geographic distribution. *Macroclemys temminckii* (alligator snapping turtle). *Herpetological Review* 25:75.

Fontenot, L.W., S.G. Platt, and M.B. Strayer. 1993. A survey of the distribution and abundance of the bog turtle, *Clemmys muhlenbergii*, in South Carolina. *Carolina Herpetology* 1:1–2.

Platt, S.G., and L.W. Fontenot. 1993. Bullfrog (*Rana catesbeiana*) predation on Gulf Coast toads (*Bufo valliceps*) in Louisiana. *Bulletin of the Chicago Herpetological Society* 28:189–190.

Fontenot, L.W., S.G. Platt, and C.M. Dwyer. 1993. Observations on crayfish predation by water snakes, *Nerodia* (Reptilia: Colubridae). *Brimleyana* 19:95–99.

Platt, S.G., and L.W. Fontenot. 1992. The red-eared slider, *Trachemys scripta elegans* (Weid), in South Korea. *Bulletin of the Chicago Herpetological Society* 27:113–114.

Fontenot, L.W. 1990. Helminth parasites of aquatic snakes from southeastern Louisiana. Thesis, Southeastern Louisiana University.

Platt, S.G., C.G. Brantley, and L.W. Fontenot. 1989. Herpetofauna of the Manchac Wildlife Management Area, St. John the Baptist Parish, Louisiana. *Proceedings of the Louisiana Academy of Sciences* 52:22–28.

Fontenot, C.L., Jr., and L.W. Fontenot. 1989. *Amphiuma tridactylum*: Feeding. *Herpetological Review* 20:48.

Fontenot, L.W., and W.F. Font. 1989. Trematode parasites of *Amphiuma tridactylum* and *Siren intermedia* from Louisiana. *Proceedings of the Louisiana Academy of Sciences* 52:70.

Peer Review

Perform peer review for the University of Wisconsin Sea Grant College Program as well as the following journals: *Environmental Toxicology and Chemistry*, *Archives of Environmental Contamination and Toxicology*, *American Midland Naturalist*, and *The Journal of Parasitology.*

Presentations/Posters

Pautler, B., J. Roberts, M. Healey, J. Conder, D. Toler, L. Fontenot, and S. Aufdenkampe. 2020. Groundwater/surface water interactions at the transition zone: Utilizing an in-situ passive sampling program to evaluate groundwater upwelling. SCICON2: Society of Environmental Toxicology and Chemistry North America 41st Annual Meeting.

Fontenot, L.W. 2018. Effects of salt water intrusion on coastal amphibian populations: biodiversity and evolutionary perspectives. Louisiana Coastal Geology Symposium 2018, Baton Rouge, LA. July 11.

Fontenot, L.W. 2017. Safety of dietary supplements. Louisiana Solid Waste Association Environmental Conference, Lafayette, LA. March 15–17.

Fontenot, L.W. 2016. Bioindicator approaches to assess environmental health. Louisiana Solid Waste Association Environmental Conference, Lafayette, LA. March 16–18.

Fontenot, L., and S. Sager. 2014. Proposed revisions to Louisiana Department of Environmental Quality Risk Evaluation/Corrective Action Program – RECAP 2014. Railroad Environmental Conference, University of Illinois at Urbana-Champaign, IL. October 28.

Shisler, J., M. Adkins, J. Beckner, T. Iannuzzi, and L. Fontenot. 2013. Creation of a multi habitat system on upland and subaqueous caps at the former Gautier oil site, Gautier, MS. Seventh International Conference on Remediation of Contaminated Sediments, Dallas, TX. February 4–7.

Iannuzzi, T., M. Adkins, L. Fontenot, J. Shisler, and J. Beckner. 2013. Determining risk-based remedial goals for estuarine river and marsh sediments at a former wood treating facility, Gautier, MS. Seventh International Conference on Remediation of Contaminated Sediments, Dallas, TX. February 4–7.

Iannuzzi, T., J. Beckner, L. Fontenot, M. Adkins. 2012. A risk-based remedy for wood treating compounds in estuarine river and marsh sediments adjacent to the former Gautier oil site, Gautier, MS. Society of Environmental Toxicology and Chemistry North America 33rd Annual Meeting.

Jones, D., M. Beauchemin, N. Bonnevie, D. Buys, L. Fontenot, B. Fulton, C. Meyer, J. Meyer, D. Rigg, T. Schlekat, A.R. Stojak, M. Wacksman, S. Young, and N. Carriker. 2012. Ecological risk assessment for Phase 3 of the TVA Kingston Ash Recovery Project; Roane County, TN. Society of Environmental Toxicology and Chemistry North America 33rd Annual Meeting.

Iannuzzi, T., L. Fontenot, and M. Adkins. 2011. Sediment quality triad assessment to support remedy development for an estuarine system adjacent to a former wood treatment site. Railroad Environmental Conference, University of Illinois at Urbana-Champaign, IL. October 25.

Fontenot, L., and J. Ellis. 2011. RECAP overview and technical approaches. Presented to CenterPoint Energy, Shipley Snell Montgomery, LLP, and Taylor, Porter, Brooks & Phillips L.L.P. September 26.

Fontenot, L.W., J. Ellis, and G. Cramer. 2010. Utilization of RECAP for legacy oil field sites: Technical approaches and draft LDNR guidance for Site Evaluation and Remediation Procedures (SERP). Louisiana Solid Waste Association 30th Annual Conference, Lafayette, LA. March 24–26.

Sager, S., K. Baker, J.R. Clarkson, H. Hayward, L. Yu, L. Fontenot, C. Day, and B. Locey. 2009. Evolving strategies for integration of human health and ecological risk assessment in the United States and the United Kingdom. Society of Environmental Toxicology and Chemistry North America 30th Annual Meeting, New Orleans, LA. November 19–23.

Fontenot, L.W., T.S. Isacks, and M.M. Fontenot, Jr. 1999. Toxicity assessment and development of risk-based remediation goals for *o*-toluidine and 5-chloroaminotoluene. Air & Waste Management Association, Fall Environmental Conference, RECAP/Risk Assessment Session, Baton Rouge, LA. November 8.

Fontenot, L.W. 1999. Assessing effects of pesticides on amphibian populations in Louisiana. Society of Environmental Toxicology and Chemistry, South Central Chapter Meeting, Houston, TX. April 12–13.

Fontenot, L.W., T.A. Ayers, C.H. Day, S.B. Ellingson, and S.L. Sager. 1998. Ecological risk assessment of endocrine-disrupting chemicals to amphibians. ASTM Eighth Symposium on Environmental Toxicology and Risk Assessment: Standardization of Biomarkers for Endocrine Disruption and Environmental Assessment, Atlanta, GA. April 20–22.

Fontenot, L.W. 1997. A phased approach for evaluation of contaminated sediments: Applications for ecological risk assessment. Society of Environmental Toxicology and Chemistry, Southeastern Chapter Meeting, Pensacola, FL. May 8–10.

Fontenot, L.W. 1996. Framework for ecological risk assessment. Louisiana State University Continuing Education Course: Ecotoxicological Risk Assessment, Baton Rouge, LA. February 9.

Fontenot, L.W. 1996. Ecological risk assessment case Study. Louisiana State University Continuing Education Course: Ecotoxicological Risk Assessment, Baton Rouge, LA. February 9.

Fontenot, L.W. 1995. Ecological risk assessment. 5th Annual Conference & Technical Exhibition, The American Society of Environmental Sciences, Lafayette, LA. October 7.

Fontenot, L.W., G.P. Noblet, and G.P. Cobb. 1995. Use of amphibians and reptiles and their parasite communities as bioindicators of environmental contamination. International Congress on Hazardous Waste: Impact on Human and Ecological Health, Atlanta, GA. June 5–8.

Fontenot, L.W., G. Noblet, W. Mashburn, C. Rockett, and R.L. Dickerson. 1995. Effect of Aroclor 1254 exposure on bullfrog (*Rana catesbeiana*) helminth parasite burden and CYP1A1 activity. Annual Meeting of the Association of Southeastern Biologists and the Southeastern Society of Parasitologists, Knoxville, TN. April 20.

Fontenot, L.W., C. Rockett, W. Mashburn, J. Gottschalk, G. Noblet, and R.L. Dickerson. 1995. Effect of Aroclor 1254 exposure on bullfrog (*Rana catesbeiana*) helminth parasite burden and CYP1A1 activity. Annual Meeting of the Society of Toxicology, Baltimore, MD. March 5–9.

Fontenot, L.W., and G.P. Noblet. 1994. A comparison of the helminth parasites of water snakes (*Nerodia sipedon*) from PCB-contaminated and reference localities. Annual Meeting of the Southeastern Society of Parasitologists, Baton Rouge, LA. March 28–30.

Wood, P.D., J. Akins, L.W. Fontenot, P. Silwal, and G.P. Cobb. 1993. Trophic movement of PCBs on hazardous waste sites. Society of Environmental Toxicology and Chemistry, Carolinas SETAC Chapter Meeting, Clemson, SC. May 6–8.

Fontenot, L.W., and G.P. Noblet. 1993. Parasites as bioindicators of toxic pollution: An amphibian model system. Annual Meeting of the Association of Southeastern Biologists and the Southeastern Society of Parasitologists, Virginia Beach, VA. April 14–16.

Fontenot, L.W. 1991. Ecological relationships between helminth parasites and aquatic snakes from Louisiana. North Carolina Herpetological Society Conference and General Meeting, Fall 1991, Raleigh, NC. November 2.

Fontenot, L.W., and W.F. Font. 1990. Helminth communities of aquatic snakes from southeastern Louisiana. Annual Meeting of the Southeastern Society of Parasitologists, Boone, NC. April 10–13.

Fontenot, L.W., and W.F. Font. 1990. Host specificity of the trematode parasites of sympatric aquatic snakes from southeastern Louisiana. Annual Meeting of the Louisiana Academy of Sciences. Baton Rouge, LA. February 1–3.

Fontenot, L.W., and W.F. Font. 1989. Trematode parasites of *Amphiuma tridactylum* and *Siren intermedia* from Louisiana. Annual Meeting of the Louisiana Academy of Sciences, Alexandria, LA. February 2–4.

Fontenot, L.W., and W.F. Font. 1988. Trematode parasites of aquatic snakes from southeastern Louisiana. Annual Meeting of the Southeastern Society of Parasitologists, Clemson, SC. March 30–April 1.

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STATE OFFICE OF
ADMINISTRATIVE HEARINGS
Jessie Harbin, CLERK

Appendix 2

Reference List Compendium

Exhibit REF 1: Reference List Compendium

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Appendix 3

List of Exhibits

Exhibit LIST 1. List of Exhibits in Support of Dr. Lance Fontenot's Testimony

Exhibit #	Description
Exhibit ERA-1	Conceptual Diagram of Ecological Risk Assessment Framework
PROBLEM FORMULATION (PF)	
PF 1 HABITAT MAPS	
Exhibit PF 1-1	Habitat areas in Close Proximity of the Proposed Desalination Plant
Exhibit PF 1-2	Conceptual plan for the Proposed Desalination Plant Surface Water Intake Structure
Exhibit PF 1-3	Habitat Areas in the Estuary around the Proposed Desalination Plant (wide view)
Exhibit PF 1-4	Shellfish Harvest Areas in the Estuary around the Proposed Desalination Plant (wide view)
PF 2 SITE PHOTOS	
Exhibit PF 2-1	View of the Corpus Christi Ship Channel from Port Aransas
Exhibit PF 2-2	View of the Corpus Christi Ship Channel from the North Side of the Access Road
Exhibit PF 2-3	View of the Corpus Christi Ship Channel from the North Side of the Port Aransas Ferry Landing
PF 3 LISTED SPECIES	
Exhibit PF 3-1	Presence of Federal and State-Listed Species Recorded near the Project Area
Exhibit PF 3-2	Threatened and Endangered Species That May Occur near the Project Area
PF 4 SPECIES/LIFESTAGE DISTRIBUTIONS	
Exhibit PF 4-1	Red Drum Life Cycle
Exhibit PF 4-2	Vertical Distribution of Red Drum Eggs
Exhibit PF 4-3	Fecundity of Six Gulf of Mexico Estuarine Target Species
PF 5 GENERAL HABITAT REQUIREMENTS	
Exhibit PF 5-1	General Habitat Requirements for Different Life Stages of Six Indicator Estuarine Species Commonly Found in and around the Aransas Pass Estuaries
PF 6 ANNUAL BACKGROUND SALINITIES	
Exhibit PF 6-1	Examples of Annual Surface Water Salinity Variations (2010, 2012, 2015), Aransas Pass, Port Aransas, TX
PF7 CONCEPTUAL SITE MODEL	
Exhibit PF 7-1	Conceptual Site Model
EXPOSURE ASSESSMENT (EA)	
EA 1 EARLY LIFE STAGE TRANSPORT CONSIDERATIONS	
Exhibit EA 1-1	Summary of Modeled Particle Transport Percent Allocations in the Three Channels and Aransas Pass
Exhibit EA 1-2	Estimate of Particle Transport Percent Allocations into Channels from Dawson et al. 2021
Exhibit EA 1-3	Estuarine Monitoring Locations for the Dawson et al. 2021 Particle Transport Percent Allocations
EA 2 CORMIX EFFLUENT PLUME	
Exhibit EA 2-1	Scientific Representation of the Desalination Plant Effluent Plume Developed from CORMIX Results
EA 3 PARTICLE ANIMATIONS	
Exhibit EA 3-1	Top-Down Screenshot of a Timed Animation of Passive Particles Moving with an Incoming Tide in the Vicinity of the Proposed Effluent Diffuser
Exhibit EA 3-2	Side-View screen Shot of a Timed Animation of Passive Particles Moving at Three Tidal Velocities in the Vicinity of the Proposed Effluent Diffuser
Exhibit EA 3-3	Side-View Screenshot of a Timed 3D Animation of Passive Particles Moving with an Incoming Tide in the Vicinity of the Proposed Effluent Diffuser
EA 4 MAXIMUM NATURAL BACKGROUND SALINITIES	
Exhibit EA 4-1	Summary of Natural Salinity Exceedances > 40 ppt in Aransas Pass
Exhibit EA 4-2	Exceedances of 40 ppt in the Historical Salinity Data Set Collected from Aransas Pass (2007-2017)
Exhibit EA 4-3	Maximum Background Salinities in Aransas Pass (2007-2017), Aransas Pass, Port Aransas, Texas
EA 5 NATURAL VARIATIONS IN BACKGROUND SALINITIES	
Exhibit EA 5-1	Stacked Salinity Time Series - Greyscale (2007-2017), Aransas Pass, Port Aransas, TX
Exhibit EA 5-2	Example of a Daily Salinity Time Series at Higher Salinities (Sep 2013), Aransas Pass, Port Aransas, TX
Exhibit EA 5-3	Example of a Daily Salinity Time Series at Lower Salinities (May 2016), Aransas Pass, Port Aransas, TX
EA 6 EXPOSURE POTENTIAL	
Exhibit EA 6-1	Evaluation of the Exposure Potential of Estuarine Target Species/Life Stages in the Corpus Christi Ship Channel in the Vicinity of the Proposed Desalination Plant Effluent Diffuser
EFFECT ASSESSMENT (EFA)	
EFA 1 SALINITY TOXICITY TEST RESULTS	
Exhibit EFA 1-1	Published Salinity Toxicity Results and Tolerance Ranges for Life Stages of the Six Target Aquatic Species
Exhibit EFA 1-2	Salinity Toxicity Data for Eggs and Larvae of the Red Drum
Exhibit EFA 1-3	Literature Data on Salinity Toxicity for the Six Target Aquatic Species
Exhibit EFA 1-4	Survival Results of Toxicity Testing Performed in Support of the Harbor Island Desalination Permit Application
EFA 2 SALINITY TOLERANCES	
Exhibit EFA 2-1	Relative Abundance and Salinity Tolerances for Key Estuarine Species Present in Aransas and Corpus Christi Bays, TX
Exhibit EFA 2-2	Salinity Tolerances for the Six Target Aquatic Species Based on Field Observations in Texas Estuarine Habitats

EFA 3 WATER TREATMENT CHEMICALS	
Exhibit EFA 3-1	Aquatic Toxicity Test Results for Bromoform
Exhibit EFA 3-2	Aquatic Toxicity Test Results for Chloroform
Exhibit EFA 3-3	TCEQ Surface Water Benchmarks for Bromoform and Chloroform
RISK ESTIMATION (RE)	
Exhibit RE 1-1	CORMIX Salinities (ppt) Compared to the USEPA (1986) Salinity Level of 4 ppt above Ambient
Exhibit RE 1-2	CORMIX Salinities (ppt) Compared to the USEPA (1986) Salinity Level of 10% above Ambient
Exhibit RE 1-3	CORMIX Salinities (ppt) Compared to Red Drum Toxicity Thresholds (NOECs)
Exhibit RE 1-4	CORMIX Salinities (ppt) Compared to Red Drum Toxicity Thresholds (LOECs)
Exhibit RE 1-5	CORMIX Salinities (ppt) Compared to a Euryhalinity UTL, Chronic NOEC, and Acute NOEC for Salinity
Exhibit RE 1-6	Key CORMIX Model Output for 84.3 Meters from the Diffuser
Exhibit RE 1-7	Time Series (mean ± 2 SD) for Natural Background Salinity Concentrationsvs. NOECs (2007-2017), Aransas Pass, Port Aransas, TX
Exhibit RE 1-8	Comparison of Gulf of Mexico Intake Samples Chemistry Data against Permit Limits and Marine Surface Water Benchmarks
Exhibit RE 1-9	Weight-of-Evidence (USEPA 1997, 1998, 2016; TCEQ 2018) Considerations for Permitted Discharges to Corpus Christi Ship Channel

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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**

The Direct Testimony of Lance Fontenot and Appendix can be found with the link below:

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Appendix 5

Exposure Assessment Exhibits

Exhibit EA 1-1. Summary of Modeled Particle Transport Percent Allocations in the Three Channels and Aransas Pass

Location	Brown et al. 2000	Brown et al. 2004			Dawson et al. 2021
		All particles	Competent particles	Pulse two	
Corpus Christi Ship Channel	60	60	50	18	10.6-28.3
Lydia Ann Channel	18	30	43	80	66-81
Aransas Channel	3	10	7	NA	4.5-7.74
Aransas Pass	17	NA	NA	NA	NA
Total	98	100	100	98	NA

Exhibit EA 1-2. Estimate of Particle Transport Percent Allocation into Channels from Dawson et al. 2021

Initial Condition I	Current Bathymetry	Percent	Proposed Bathymetry	Percent	Assumed Percent CC Ship Channel Transport (RB2 + CB) Current	Proposed
AB	375	84.8	333	81.2		
RB1	20	4.5	26	6.3		
RB2	12	2.7	11	2.7	10.6	12.4
CB	35	7.9	40	9.8		
Total	442		410			
Initial Condition II						
AB	103	71.5	70	66.0		
RB1	10	6.9	6	5.7		
RB2	3	2.1	8	7.5	21.5	28.3
CB	28	19.4	22	20.8		
Total	144		106			
Initial Condition III						
AB	278	79.2	301	79.0		
RB1	19	5.4	24	6.3		
RB2	15	4.3	8	2.1	15.4	14.7
CB	39	11.1	48	12.6		
Total	351		381			
Initial Condition IV						
AB	918	72.6	997	74.3		
RB1	98	7.7	87	6.5		
RB2	55	4.3	70	5.2	19.7	19.2
CB	194	15.3	188	14.0		
Total	1265		1342			

Exhibit EA 1-3. Estuarine Monitoring Locations for the Dawson et al. 2021 Particle Transport Percent Allocations

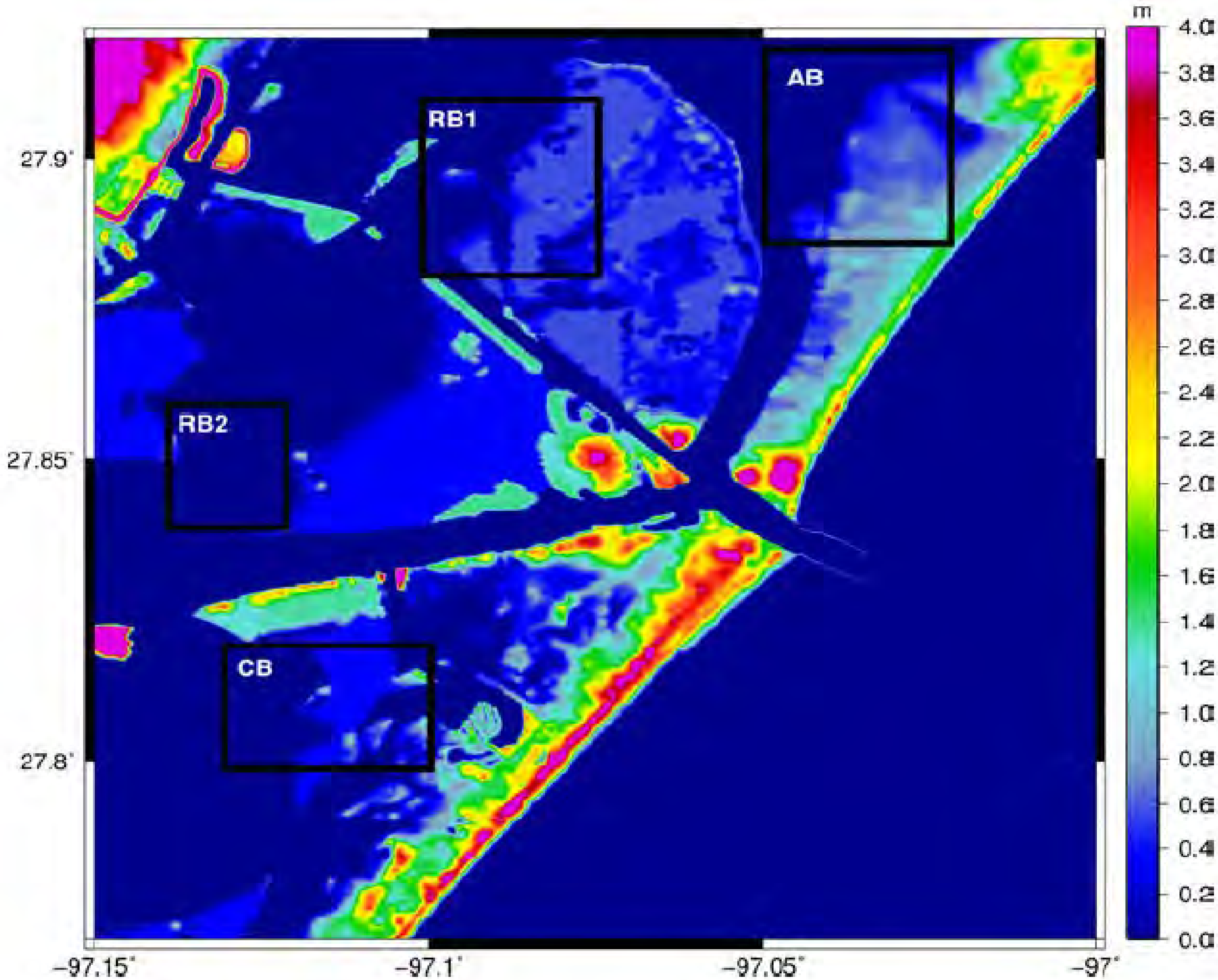

Figure 5: Monitoring locations, color spectrum denotes bathymetry above NAVD88 in meter.

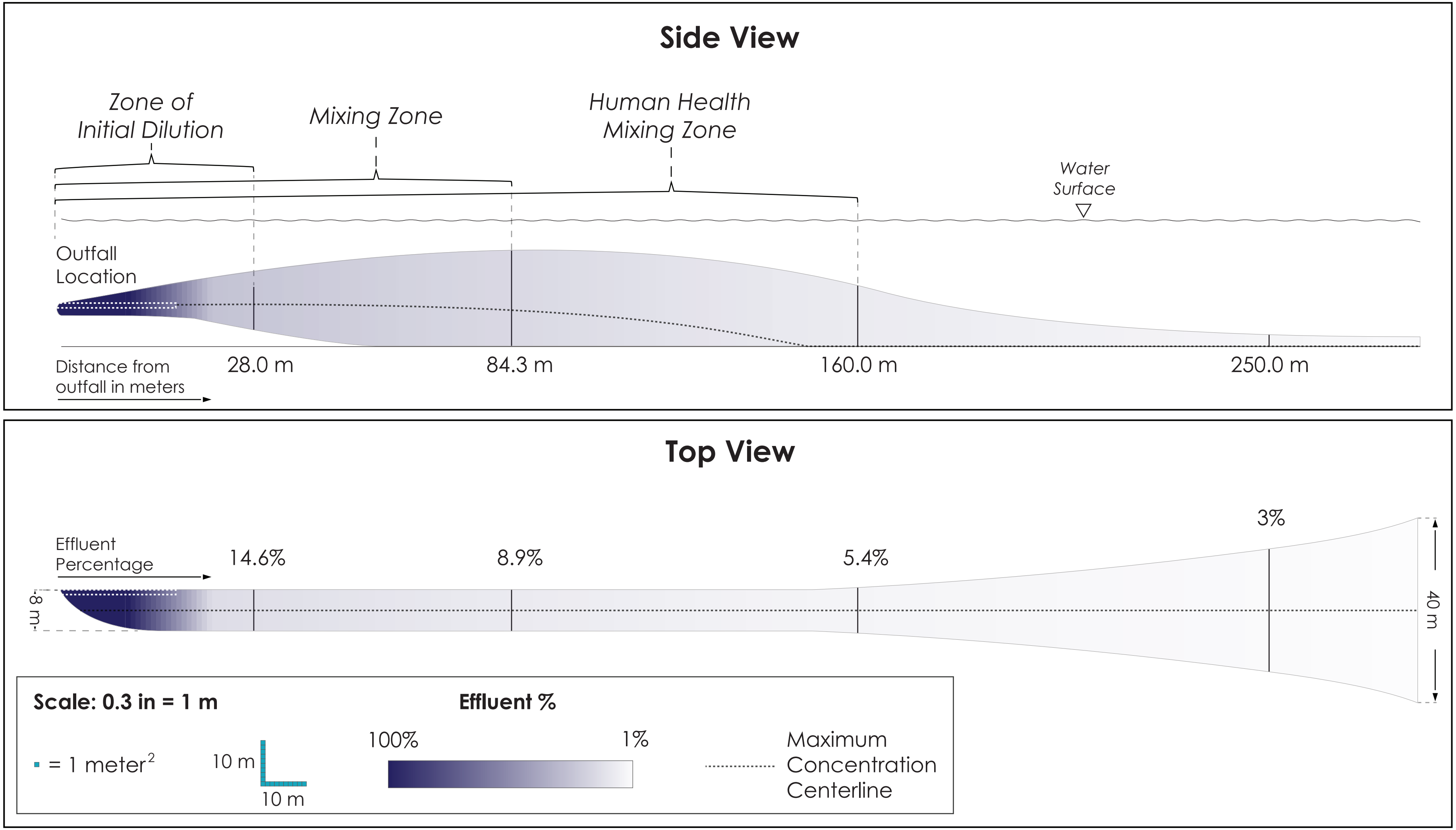

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Exhibit EA 2-1. Scientific representation of the desalination plant effluent plume developed from CORMIX results.

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Exhibit EA 3-1.
Top-Down Screenshot of a Timed Animation of Passive Particles Moving with an Incoming Tide in the Vicinity of the Proposed Effluent Diffuser

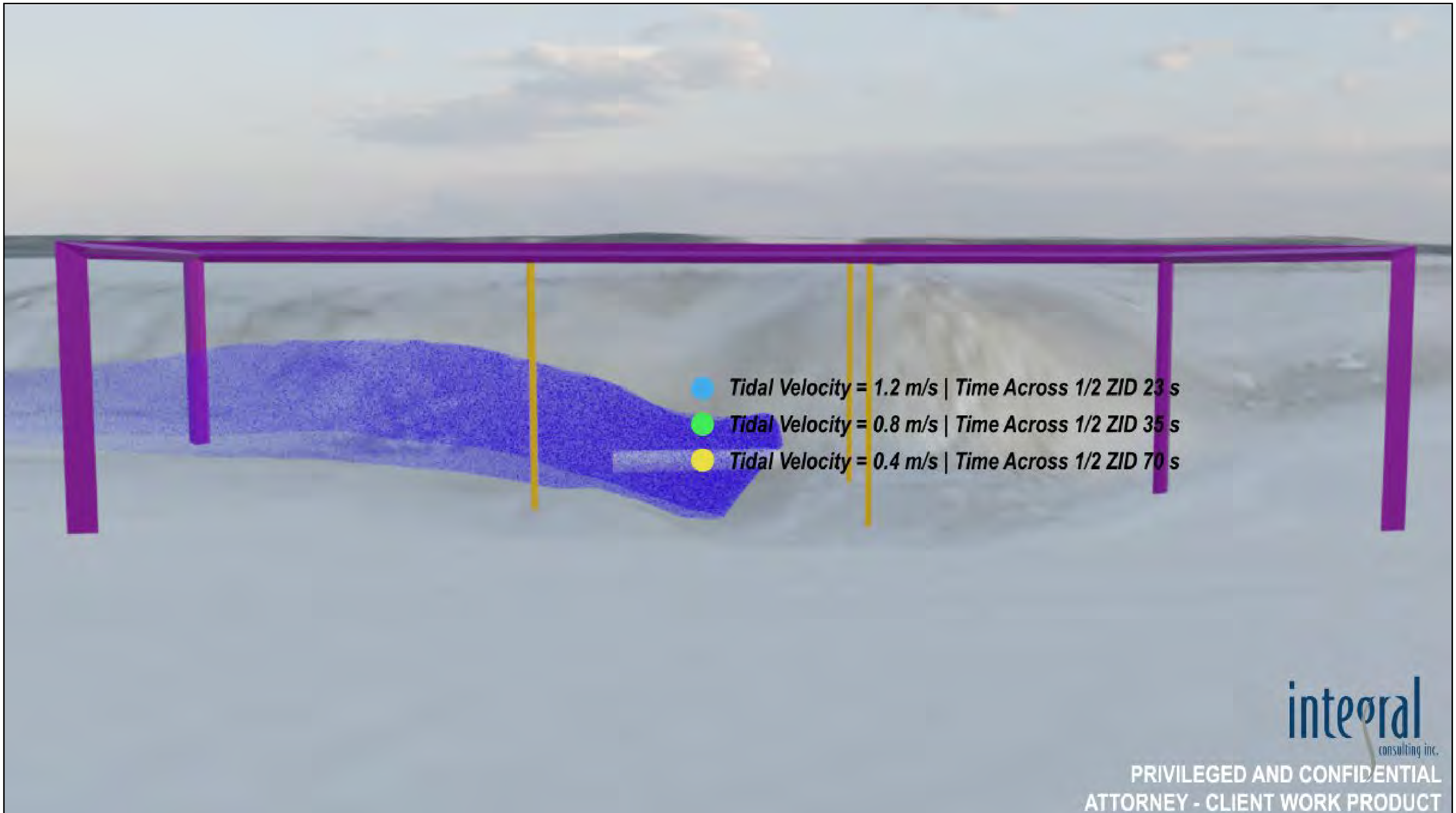

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Exhibit EA 3-2.
Side-View Screenshot of a Timed Animation of Passive Particles Moving at Three Tidal Velocities in the Vicinity of the Proposed Effluent Diffuser

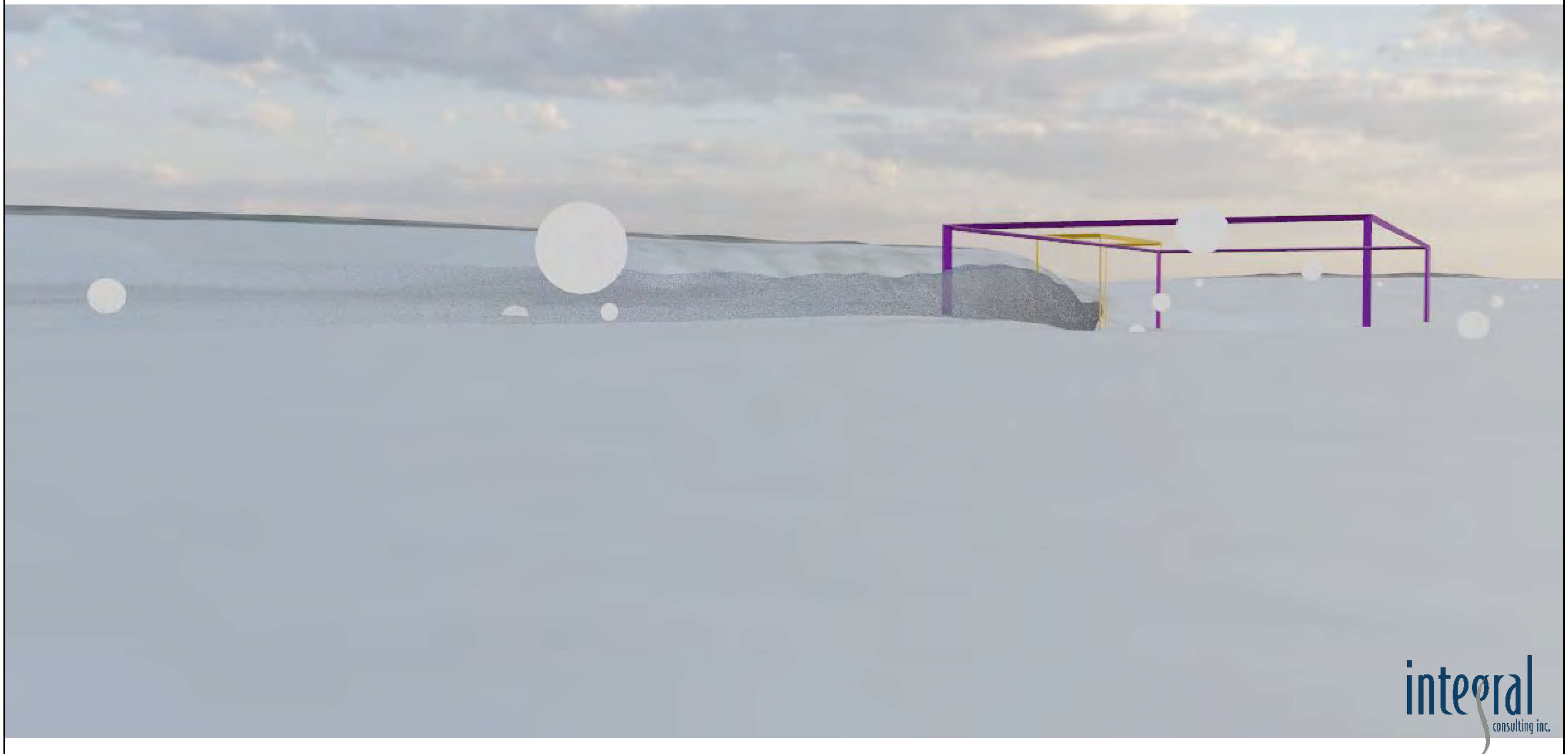

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Exhibit EA 3-3.
Side-View Screenshot of a Timed 3D Animation of Passive Particles Moving with an Incoming Tide in the Vicinity of the Proposed Effluent Diffuser

Exhibit EA 4-1. Summary of Natural Salinity Exceedances > 40 ppt in Aransas Pass

Year	Salinity > 40 ppt		Maximum
	Minutes	% of year	Salinity (ppt)
2007[a]	0	0%	35.0
2008	165	0.03%	40.1
2009	270	0.05%	41.1
2010	0	0%	37.9
2011	375	0.07%	40.7
2012	1575	0.30%	41.3
2013	960	0.18%	41.3
2014	795	0.15%	41.9
2015	0	0%	39.4
2016	0	0%	37.9
2017[b]	45	0.01%	40.3

Notes: ppt = parts per thousand

[a] Salinity data available August 24−December 31 only

[b] Salinity data available January 1−August 28 only

Exhibit EA 4-2. Exceedances of 40 ppt in the Historical Salinity Data Set Collected from Aransas Pass (2007−2017)

Date	No. of readings	No. of readings > 40 ppt	Consecutive readings > 40 ppt	Total hours	Total hours > 40 ppt	Consecutive hours > 40 ppt	Minimum (ppt)	Maximum (ppt)	Mean (ppt)	Mean stdev (ppt)	95% UCL
7/6/2008	96	3	1	24	0.75	0.25	38.4	40.1	39.6	0.3	39.6
9/8/2008	96	8	8	24	2	2	37.6	40.1	39.3	0.8	39.4
8/23/2009	96	4	2	24	1	0.5	37.2	40.5	38.5	0.9	38.6
8/24/2009	96	1	1	24	0.25	0.25	37.1	40.3	37.7	0.8	37.9
8/26/2009	96	5	2	24	1.25	0.5	37.2	41.1	38.0	0.9	38.2
8/28/2009	96	3	2	24	0.75	0.5	37	40.3	37.9	0.9	38.1
8/29/2009	96	3	2	24	0.75	0.5	37.1	40.5	38.0	0.9	38.1
8/30/2009	96	1	1	24	0.25	0.25	37	40.1	37.8	0.9	38.0
8/31/2009	96	1	1	24	0.25	0.25	37	40.2	37.7	0.8	37.8
9/27/2011	96	1	1	24	0.25	0.25	37.7	40.1	38.4	0.6	38.6
9/28/2011	96	6	4	24	1.5	1	37.3	40.7	38.5	0.8	38.6
9/29/2011	95	1	1	23.75	0.25	0.25	37.8	40.2	38.4	0.7	38.5
9/30/2011	96	3	3	24	0.75	0.75	37.7	40.2	38.4	0.8	38.5
10/10/2011	96	11	9	24	2.75	2.25	34.7	40.3	37.4	2.0	37.8
10/14/2011	95	3	3	23.75	0.75	0.75	28.8	40.1	35.4	2.6	35.8
8/30/2012	95	11	11	23.75	2.75	2.75	37.8	40.4	39.0	0.7	39.1
8/31/2012	96	14	14	24	3.5	3.5	38	41	38.5	0.9	38.7
9/3/2012	96	6	5	24	1.5	1.25	38.1	40.8	38.9	0.6	39.0
9/4/2012	96	19	14	24	4.75	3.5	38.1	41.2	39.1	0.9	39.3
9/5/2012	96	16	10	24	4	2.5	37.9	41.3	38.9	0.9	39.0
9/6/2012	96	22	22	24	5.5	5.5	38	41.2	38.9	1.1	39.1
9/7/2012	96	14	8	24	3.5	2	38	41	38.8	0.9	39.0
9/8/2012	96	1	1	24	0.25	0.25	37.8	40.3	38.5	0.6	38.6
9/19/2012	96	1	1	24	0.25	0.25	36.6	40.1	37.9	1.2	38.1
10/14/2012	96	1	1	24	0.25	0.25	37.5	40.1	38.2	0.6	38.3
7/24/2013	96	4	3	24	1	0.75	37	40.3	37.7	0.9	37.9
7/26/2013	96	11	8	24	2.75	2	37.5	41.2	38.4	1.0	38.6
7/27/2013	96	32	18	24	8	4.5	37.8	41.3	39.5	1.0	39.7
7/28/2013	96	9	6	24	2.25	1.5	37.6	40.7	38.8	0.9	39.0
7/29/2013	96	2	2	24	0.5	0.5	37.4	40.2	38.1	0.7	38.2
9/2/2013	96	2	2	24	0.5	0.5	37.3	40.1	38.0	0.8	38.2
9/3/2013	96	3	2	24	0.75	0.5	37.3	40.4	38.0	0.9	38.2
9/4/2013	96	1	1	24	0.25	0.25	37.3	40.3	37.9	0.7	38.0
9/5/2014	96	8	4	24	2	1	34.4	41	37.4	1.9	37.8
9/6/2014	96	23	12	24	5.75	3	35.8	41.9	38.5	1.4	38.7
9/7/2014	96	7	4	24	1.75	1	34.9	41.3	38.1	1.1	38.3
9/8/2014	96	8	5	24	2	1.25	33.9	40.9	36.4	1.9	36.7
9/9/2014	96	1	1	24	0.25	0.25	34.6	40.3	36.7	1.6	37.0
9/10/2014	96	6	5	24	1.5	1.25	34.7	40.7	37.5	1.3	37.7
8/16/2017	96	3	3	24	0.75	0.75	37.9	40.3	38.6	0.7	38.7

Notes: ppt = parts per thousand

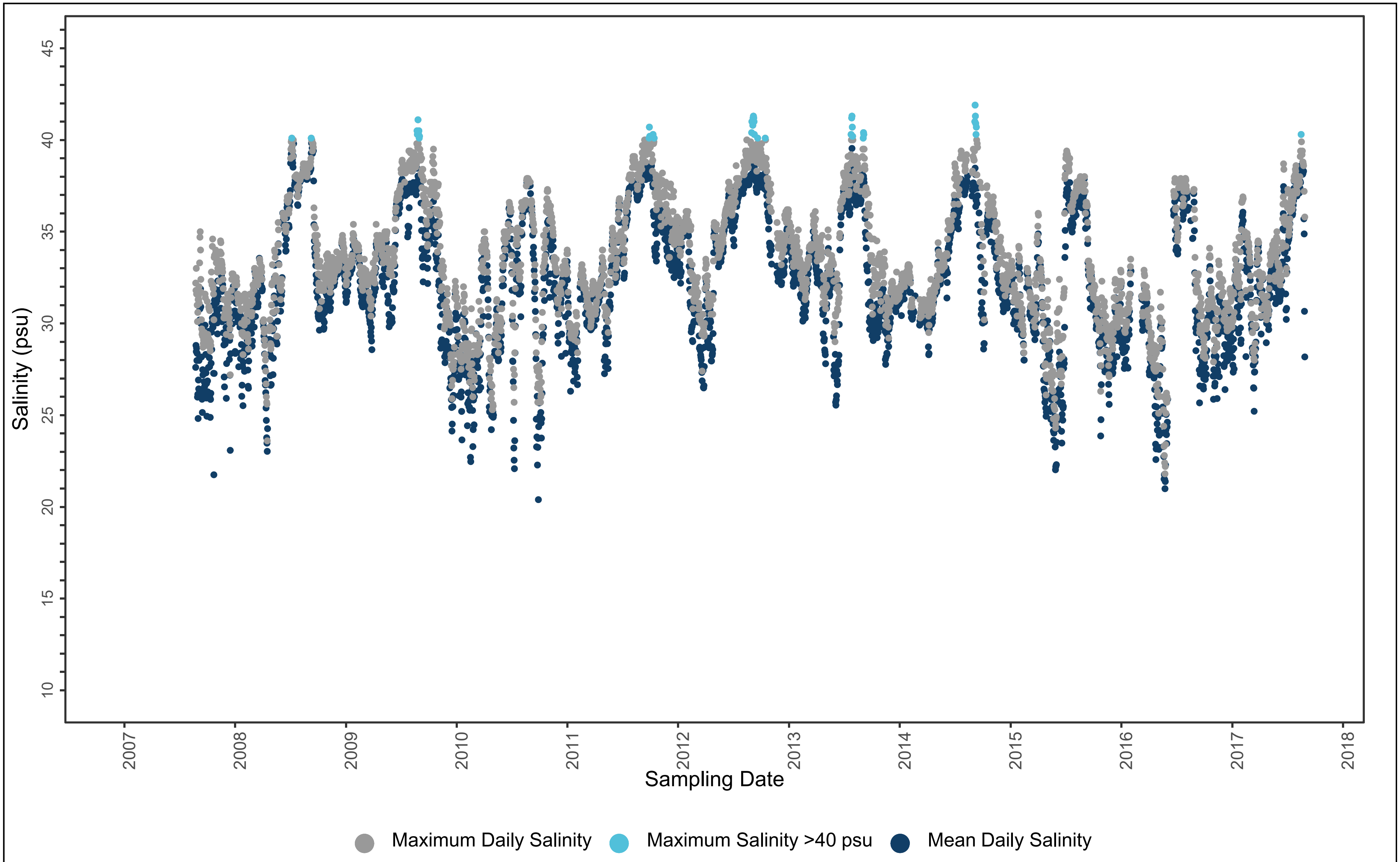

Exhibit EA 4-3.
Maximum Background Salinities in Aransas Pass (2007−2017)
Aransas Pass, Port Aransas, Texas
Data Source: Mission-Aransas National Estuary Program
(http://cdmo.baruch.sc.edu/)

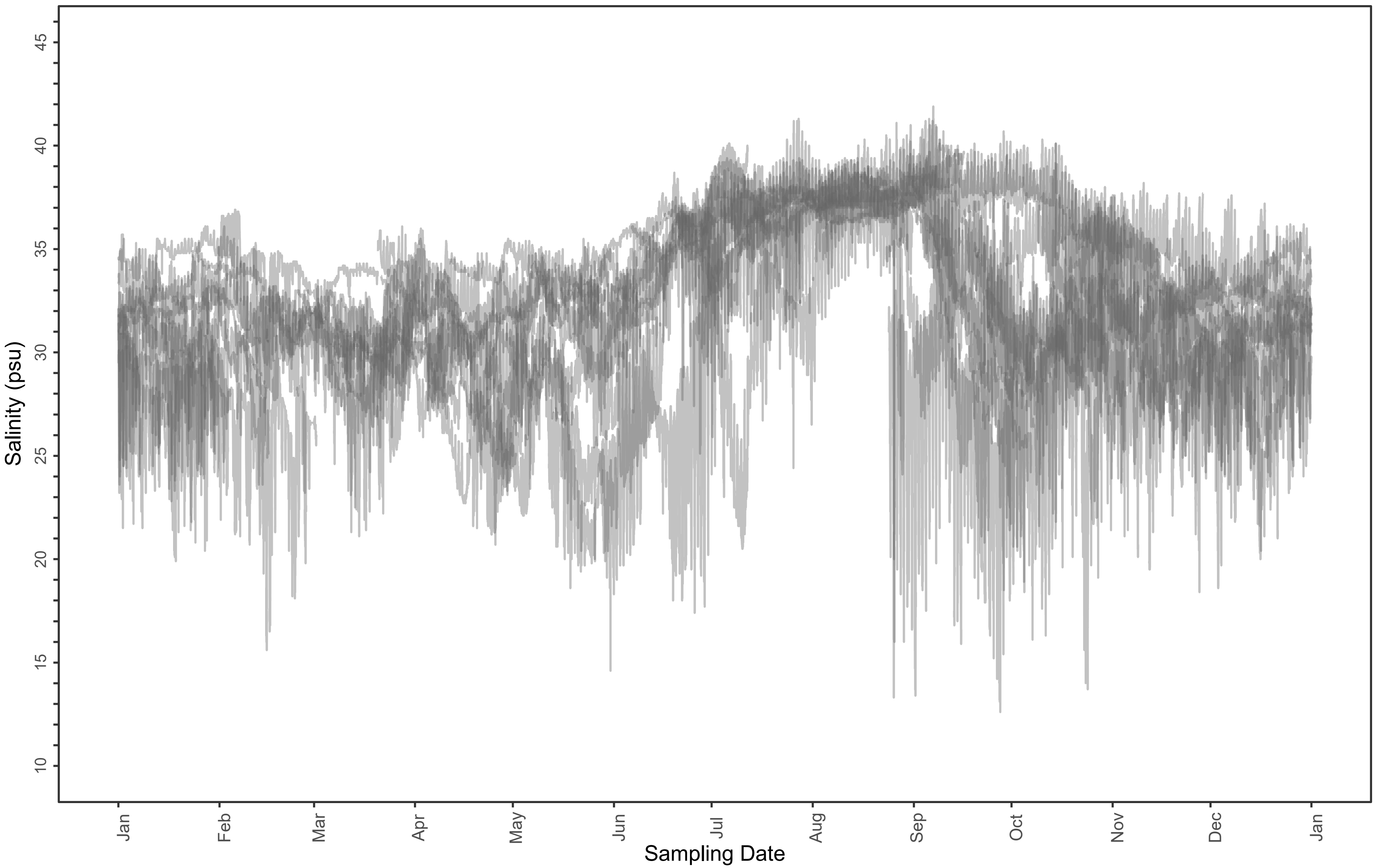

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Exhibit EA 5-1
Stacked Salinity Time Series - Greyscale (2007-2017)
Aransas Pass, Port Aransas, TX
Data Source: Mission-Aransas National Estuary Program
(http://cdmo.baruch.sc.edu/)

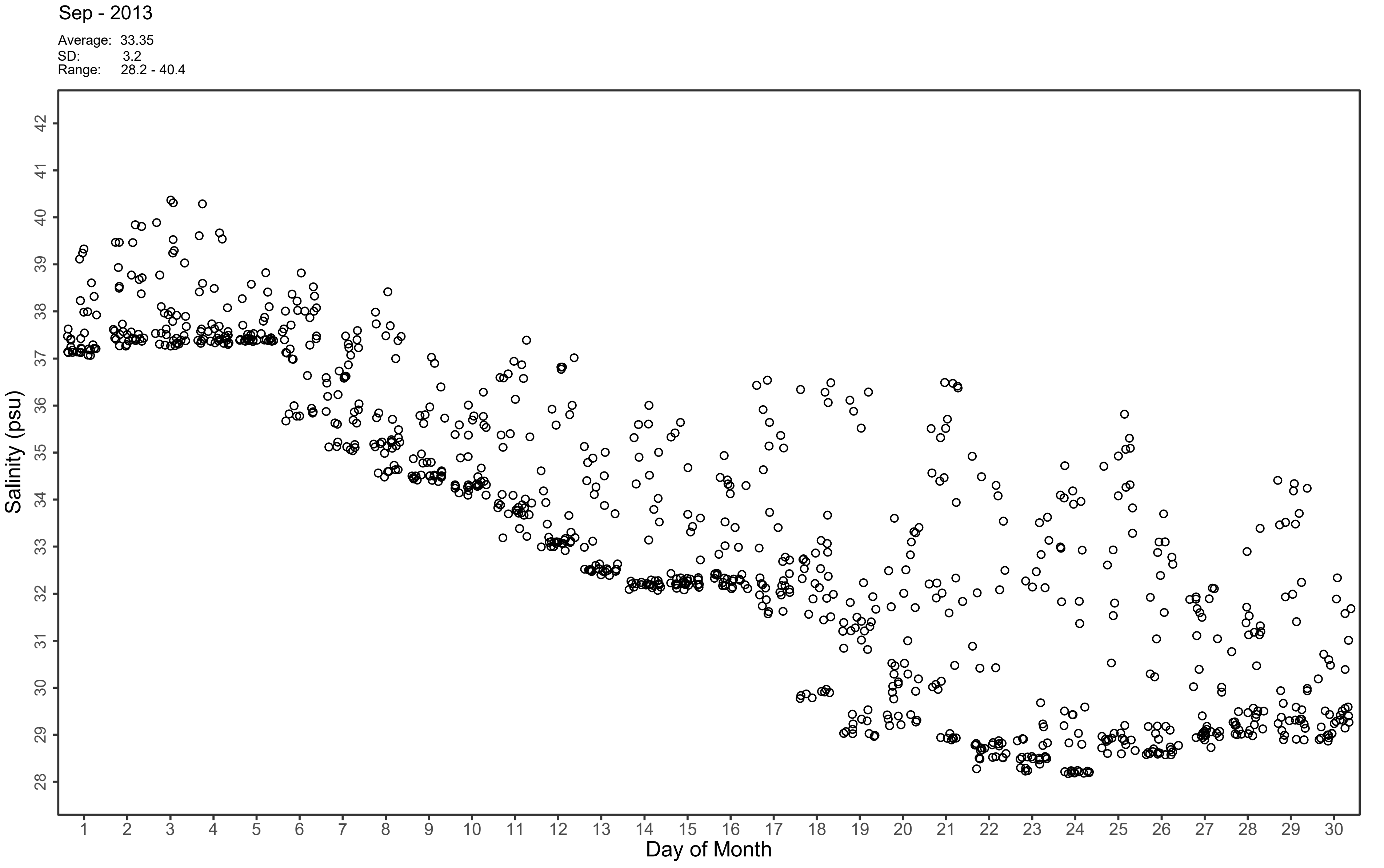

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Exhibit EA 5-2.
Example of a Daily Salinity Time Series at Higher Salinities (Sep 2013)
Aransas Pass, Port Aransas, TX
Data Source: Mission-Aransas National Estuary Program
(http://cdmo.baruch.sc.edu/)

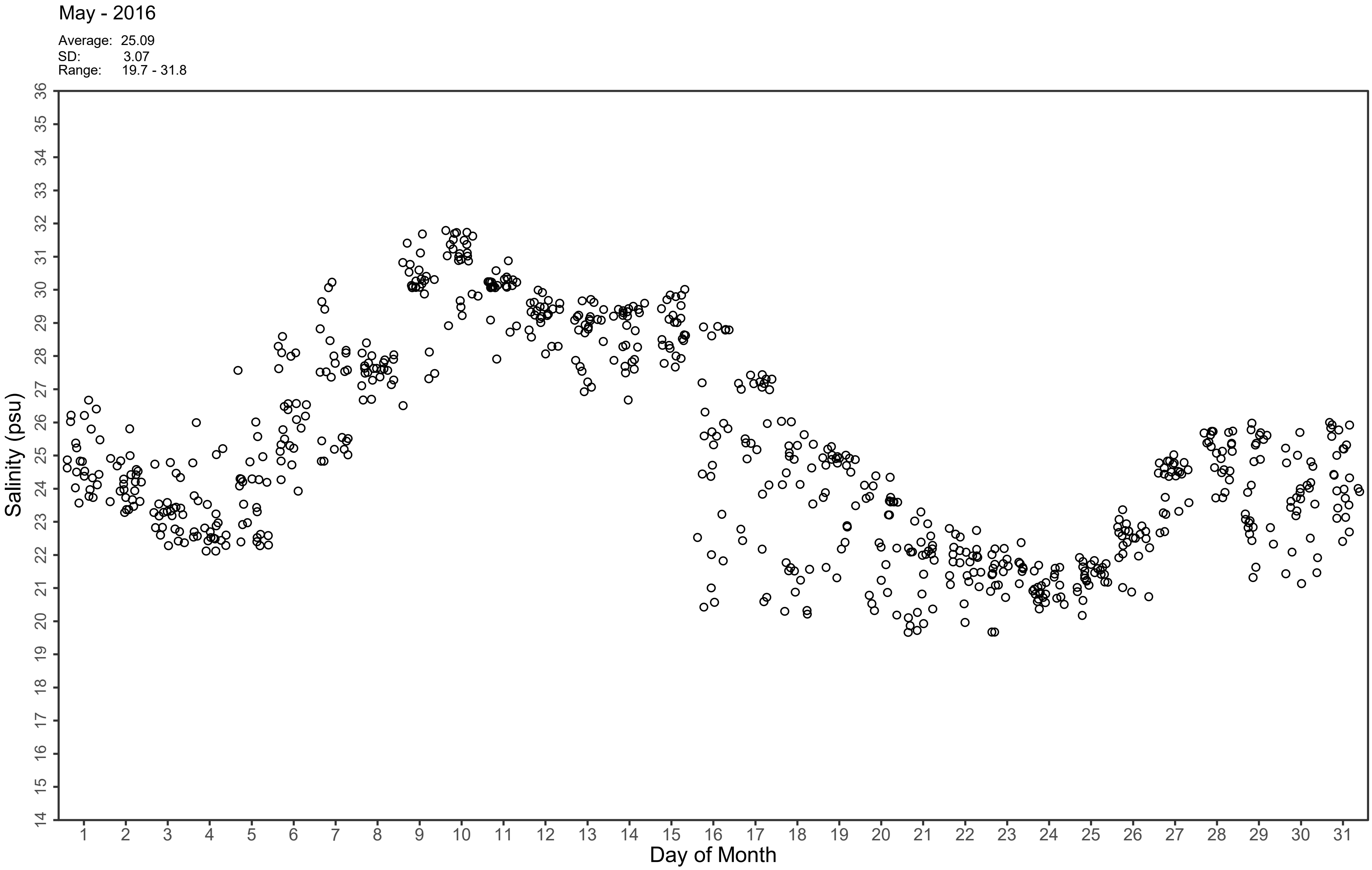


Exhibit EA 5-3.
Example of a Daily Salinity Time Series at Lower Salinities (May 2016)
Aransas Pass, Port Aransas, TX
Data Source: Mission-Aransas National Estuary Program
(http://cdmo.baruch.sc.edu/)

Exhibit EA 6-1. Evaluation of the Exposure Potential of Estuarine Indicator Species/Life Stages in the Corpus Christi Channel in the Vicinity of the Proposed Desalination Plant Effluent Diffuser

	Egg					Larva					Juvenile					Adult				
	Exposure Potential to Desalination Effluent					Exposure Potential to Desalination Effluent					Exposure Potential to Desalination Effluent					Exposure Potential to Desalination Effluent				
	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential	Habitat[a]	Exposure Duration	Fraction of Available Organisms	Width of ZID vs. Channel	Aggregate Exposure Potential
Blue crab	X	NA	NA	NA	NA	•	low	low	low	low	•	low	low	low	low	•	moderate	low	low	low
American oyster	o	low	low	low	low	o	low	low	low	low	•	low	low	low	low	•	low	low	low	low
White shrimp	X	NA	NA	NA	NA	X	NA	NA	NA	NA	•	low	low	low	low	•	low	low	low	low
Red drum	o	low	low	low	low	o	NA	NA	NA	NA	•	low	low	low	low	•	low	low	low	low
Spotted seatrout	o	low	low	low	low	•	low	low	low	low	•	low	low	low	low	•	low	low	low	low
Atlantic croaker	X	NA	NA	NA	NA	•	low	low	low	low	•	low	low	low	low	•	low	low	low	low

Notes: NA = not applicable; ZID = zone of initial dilution

[a] Suitability of the habitat in the ship channel in the vicinity of the desalination effluent diffuser; modified from Table 6 (Habitat Associations) in Pattillo et al. (1997). The "habitat domain" representative of the general location of the effluent diffuser is assumed to consist of both "inlet mouth" and "channel."

Habitat qualifiers:

Absent = X

Transitory = o

Present = •

[b] Exposure potential to desalination effluent

Exposure qualifiers:

Duration of continuous exposure to desalination effluent (professional judgment): low = minutes to 1 hour; moderate = 1 hour to days; high = multiple days

Fraction of available organisms in the ship channel in the vicinity of the diffuser potentially exposed to desalination effluent (professional judgment): < 1% = low; 1-10% = moderate; > 10% is high

Width of ZID (43 ft; from CORMIX model) vs. ship channel (1,200 ft): <5% = low; 5-20% = moderate; > 20% = high

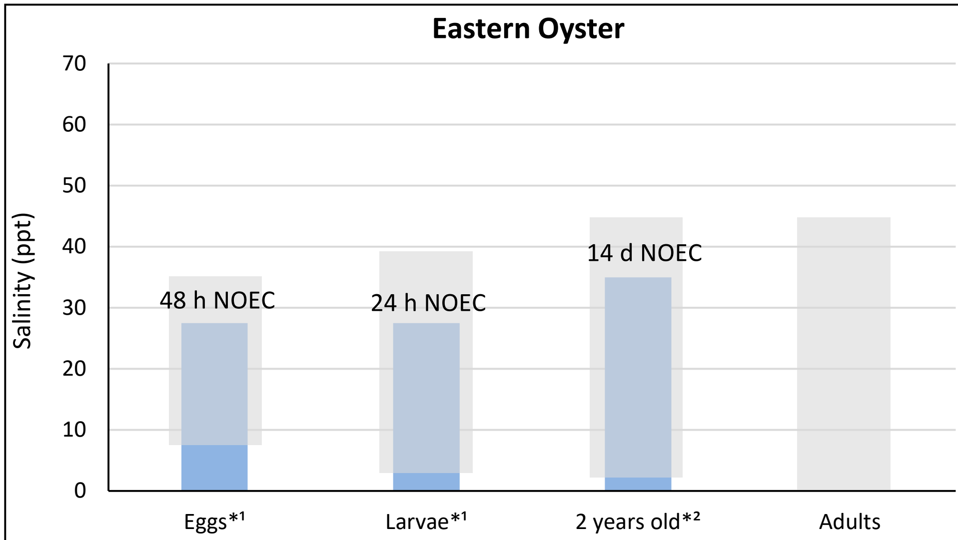
Exposure potential: low | moderate | high

FILED
582-20-1895
1/12/2022 11:34 PM
STATE OFFICE OF
ADMINISTRATIVE HEARINGS
Jessie Harbin, CLERK

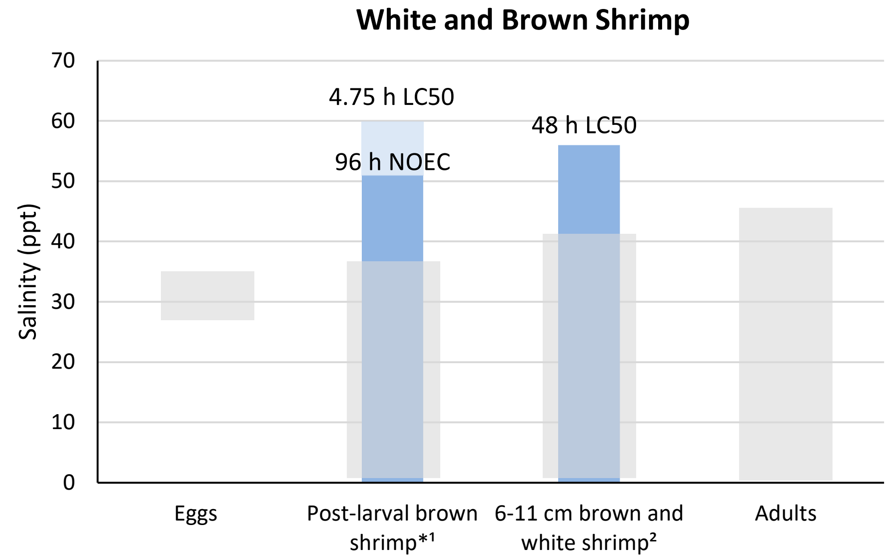
ACCEPTED
582-20-1895
1/13/2022 9:22 AM
STATE OFFICE OF
ADMINISTRATIVE HEARINGS
Jessie Harbin, CLERK

Appendix 6

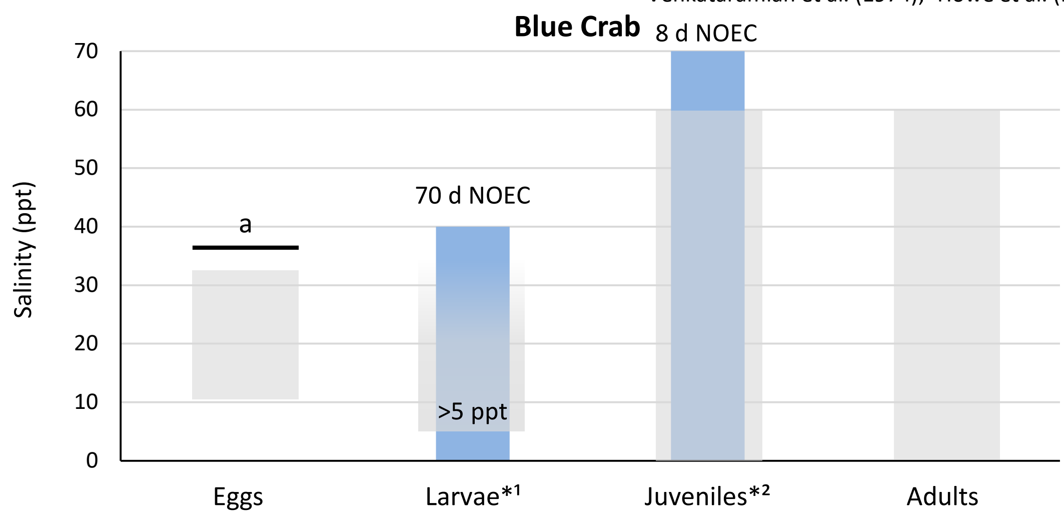
Effects Assessment Exhibits



[1]MacInnes and Calabrese (1979); [2]Larsen et al. (2013)



[1]Venkataramiah et al. (1974); [2]Howe et al. (1982)



[1]Costlow (1967); [2]Guerin and Stickle (1992); Larval salinity tolerance was reported as >5 ‰

Notes: LC50 = median lethal concentration; NOEC = no-observed-effect concentration; ppt = parts per thousand; *Highest concentration tested

[a] "...the blue crab does normally live in the open sea and the writer has observed females in berry swimming at the surface of the open sea several miles from shore" (Gunter 1950). This study reported average monthly salinities at Port Aransas of up to 36 ppt. Gray boxes show published salinity tolerance ranges for each life stage. The toxicity results pertain exclusively to mortality.

Sources: Pattillo et al. (1995, 1997); Confluence Environmental Company (2021); Sellers and Stanley (1984); Stanley and Sellers (1986); Reagan (1985); Longley (1994).

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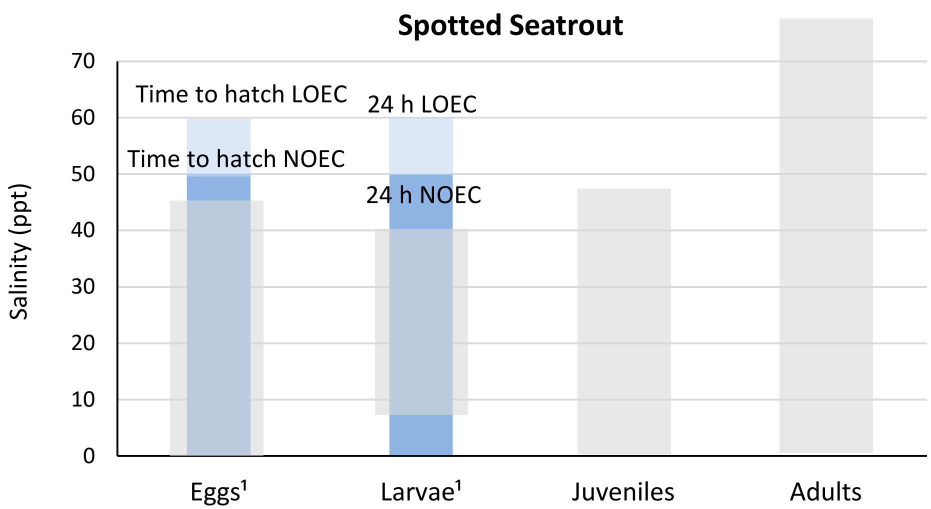
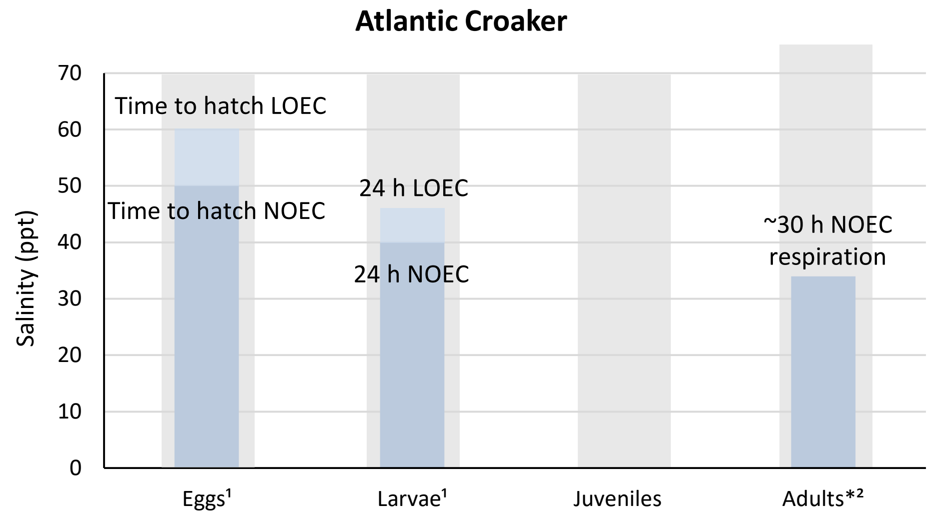
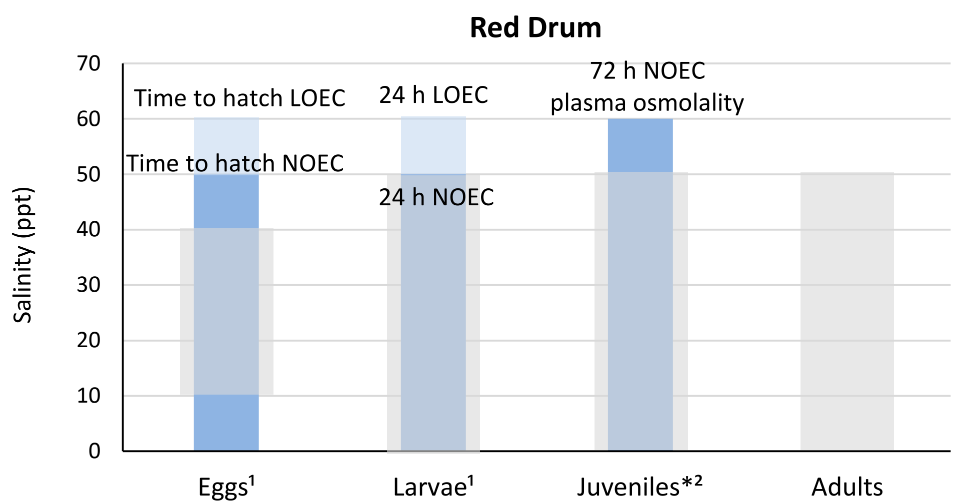
Exhibit EFA 1-1.
Published Salinity Toxicity Results and Tolerance Ranges for Life Stages of the Six Target Aquatic Species



[1]Thomas et al. (1989)



[1]Thomas et al. (1989); [2]Moser and Gerry (1989)



[1]Thomas et al. (1989); [2]Martin and Esbaugh (2021)

Notes: LC50 = median lethal concentration; LOEC = lowest-observed-effect concentration; NOEC = no-observed-effect concentration; ppt = parts per thousand; *Highest concentration tested
Gray boxes show published salinity tolerance ranges for each life stage. The toxicity results pertain exclusively to mortality, unless otherwise stated.
Sources: Pattillo et al. (1997); Confluence Environmental Company (2021); Sellers and Stanley (1984); Stanley and Sellers (1986); Lassuy (1983a); Lassuy (1983b); Reagan (1985); Longley (1994).

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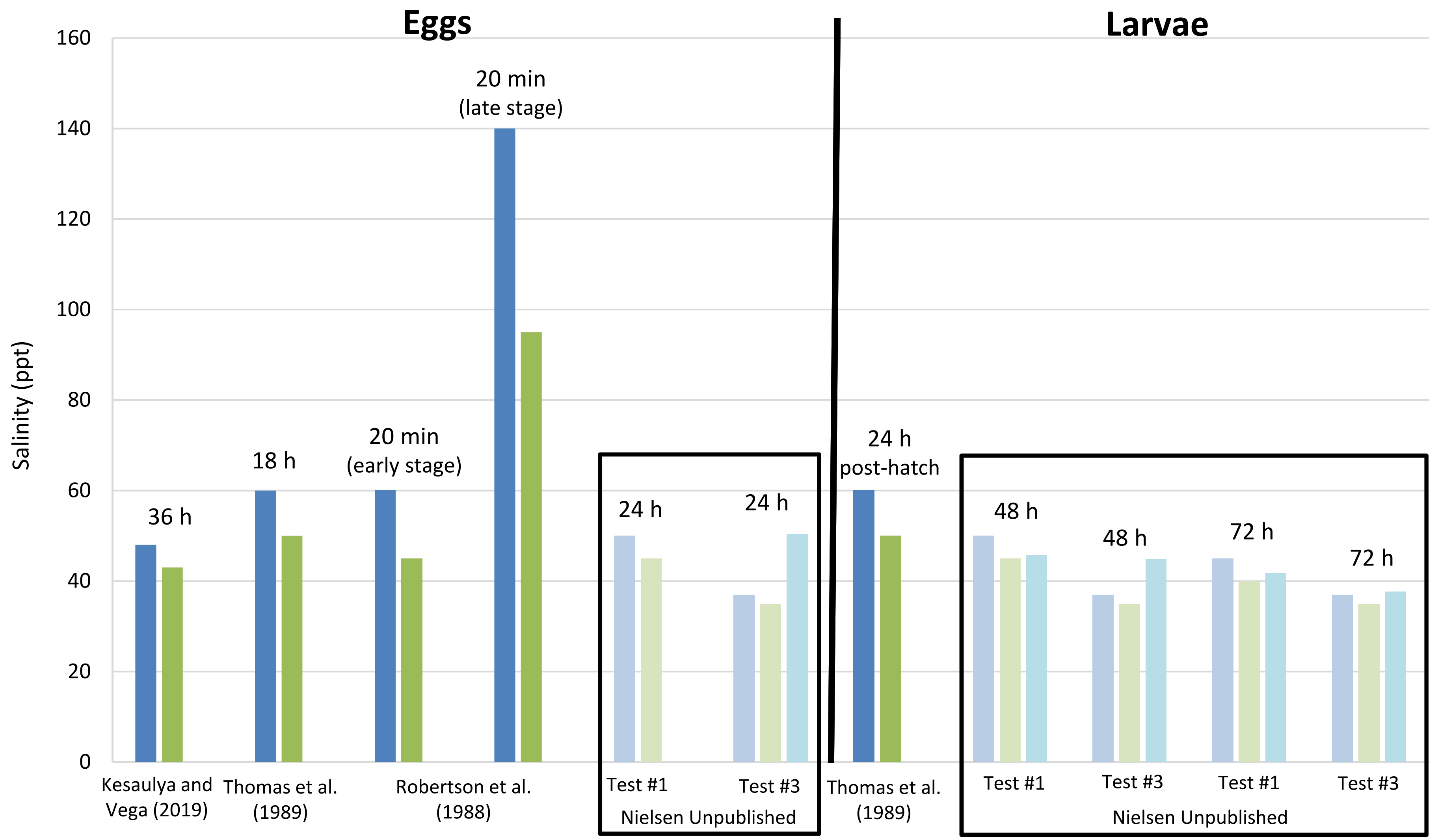
Exhibit EFA 1-1. (cont.)
Published Salinity Toxicity Results and Tolerance Ranges for Life Stages of the Six Target Aquatic Species



Notes: LC50 = median lethal concentration; LOEC = lowest-observed-effect concentration; NOEC = no-observed-effect concentration;
Time above bars represents exposure duration with embryo stage in parentheses where applicable

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Exhibit EFA 1-2.
Salinity Toxicity Data for Eggs and Larvae of the Red Drum

Exhibit EFA 1-3. Literature Data on Salinity Toxicity for the Six Target Aquatic Species

Species	Life stage	Duration	Temperature (°C)	Salinities Tested (‰)	Acclimated salinity (‰)	Endpoint	Result	Reference
Eastern Oyster (*Crassostrea virginica*)	Embryos	48 hours	20, 25 and 30	17.5, 22.5, 27.5	26	Mortality	No significant effects	MacInnes, J. R., and A. Calabrese. 1979
	Larvae	24 hours	20, 25 and 30	17.5, 22.5, 27.5	26	Mortality	No significant effects	MacInnes, J. R., and A. Calabrese. 1979
	2 year old	14 days	Not stated	15, 25, 35	Salinity at harvest ranged from 15.8 to 29.6	Mortality	NOEC (0.05% mortality) = 35 ‰	Larsen, A. M., et al. 2013.
White Shrimp (*Penaeus setiferus*)	6-11 cm	96 hours	25	Up to 50 ‰ above background	"similar salinities"	Mortality	LC50 (96 h) = 52 ‰; LC50 (48 h) = 56 ‰	Howe, N. R., W. D. Quast, and L. M. Cooper. 1982
	Post-larval	30 days	24.5 to 26	2, 5, 10, 25, 40	25	Mortality	No significant effects	Zein-Eldin, Z. P.1963
Brown Shrimp (*Penaeus aztecus*)	Post-larval and juveniles	96 hours	21, 26, and 31	0.34, 1.02, 1.7, 3.4, 8.5, 17.0, 25.5, 34.0, 42.5, 47.6, 51.0, 59.5	25.5	Mortality	No effects: 8.5 to 34.0 ‰ (21°, 26° and 31°C) 13-20 mm: LC30 (12 h) = 59.5‰; NOEC = 51 ‰; LOEC = 59.5 ‰ 21-45 mm: LC50 (55.75 h) = 51 ‰; LC50 (4.75 h) = 59.5 ‰; NOEC = 47.6 ‰; LOEC = 51 ‰ 50-75 mm: LC50 (37 h) = 51 ‰; LC50 (4.95 h) = 59.5 ‰; NOEC = 42.5 ‰; LOEC = 47.6 ‰	Venkataramiah, A., G. J. Lakshmi, and G. Gunter. 1974
	Post-larval	24 hours	7, 15, 25, 30, 35	4 to 40	25	Mortality	No significant effects	Zein-Eldin, Z. P., and D. V. Aldrich. 1965
	6-11 cm	96 hours	25	Up to 50 ‰ above background	"similar salinities"	Mortality	LC50 (96 h) = 52 ‰; LC50 (48 h) = 56 ‰	Howe, N. R., W. D. Quast, and L. M. Cooper. 1982
	Post-larval	30 days	24.5 to 26	2, 5, 10, 25, 40	25	Mortality	No significant effects	Zein-Eldin, Z. P.1963
Blue Crab (*Callinectes sapidus*)	Juvenile	21 days	23	0, 2.5, 5, 10, 25, 35, 50, 60, 70	40	Mortality	No effect before day 8 (21-day LC50 ≥ 56 ‰)	Guerin, J. L., and W. B. Stickle. 1992
	Larvae	70 days	15, 20, 25, and 30	Transferred from 30 to 20, 35, and 40	26.7	Mortality	NOEC (0% mortality) = 40 ‰ (25 and 30 °C)	Costlow, J. D. 1967.
Spotted Seatrout (*Cynoscion nebulosus*)	Larvae	18 hours	28	0 to 56	24 and 32	Mortality	LD50 (1 day old) = 45.4 ‰ LD50 (3 day old) = 42.5 ‰ LD50 (9 day old) = 49.8 ‰	Banks, M. A., G. J. Holt, and J. M. Wakeman. 1991.
	Larvae and juveniles	2 to 6 hours	24, 28, 30 and 32	5, 10, 20, 35 and 45	Acclimated to test salinities	Mortality	100% mortality at 45 ‰ (24 and 28°C) NOEC = 45‰ at 30°C	Wuenschel, M. J., R. G. Werner, and D. E. Hoss. 2004
	Larvae	Not stated	Not stated	Not stated	Not stated	Mortality	"Larval spotted seatrout did not survive in salinities <5 or >50 ‰"	Taniguchi, A. K. 1981 (In Wuenschel, M. J., R. G. Werner, and D. E. Hoss. 2004)
	Eggs and larvae	24 hours (hatch), 3 day (survival); 18 hours (acute salinity tolerance)	24	20, 30 and 40‰; Ten salinities (0–60‰, with intervals of 4 to 8‰)	35	Hatch rate; Survival	Hatch rates were >50% in the highest test salinity (60‰). LC50s (3-day survival) were similar to spawning salinities (31.3‰ at a spawning salinity of 30‰ and 39.9‰ at a spawning salinity of 40‰).	Kucera, C. J., C. K. Faulk, and G. J. Holt. 2002.
	Eggs	Up to 4 months	18 to 28	10, 15, 25, 35, 50	Adults acclimated to 30	Fertilization success and hatching	NOEC = 35 ‰; LOEC = 50 ‰	Thomas et al., 1989
	Eggs	Time to hatch	28	0 to 60	32	Hatch rate	NOEC = 50 ‰ and LOEC = 60 ‰ when eggs were transferred at 12 hr post-fertilization	Thomas et al., 1989
	Larvae	24 hours	28	0 to 60	32	Mortality	NOEC = 50 ‰; LOEC = 60 ‰	Thomas et al., 1989
	Larvae	18 hours	28	0 to 56 (intervals of 4-8)	32	Mortality	LD50 (1 day old) = ~45 ‰ LD50 (3 day old) = ~42 ‰ LD50 (5 days old) = ~45 ‰ LD50 (7 days old) = ~44 ‰ LD50 (9 days old) = ~50 ‰ (estimated from graph)	Thomas et al., 1989

Exhibit EFA 1-3. Literature Data on Salinity Toxicity for the Six Target Aquatic Species

Species	Life stage	Duration	Temperature (°C)	Salinities Tested (‰)	Acclimated salinity (‰)	Endpoint	Result	Reference
Atlantic Croaker (*Micropogonias undulatus*)	Adult	~30 hours total	28	15 to 34	34	Respiration	No significant effects	Moser, M. L., and L. R. Gerry. 1989
	Eggs	1 to 3 months	Adjusted to mimic seasonal changes	5, 15, 25, 35, 45, 50	Adults acclimated to 30	Fertilization and hatching success	NOEC = 35 ‰; LOEC = 45 ‰	Thomas et al., 1989
	Eggs	Time to hatch	24	0 to 60	32	Hatching success	NOEC = 50 ‰ and LOEC = 60 ‰ when eggs were transferred at 12 hr post-fertilization	Thomas et al., 1989
	Larvae	24 hours	24	0 to 60	32	Mortality	NOEC = 40 ‰; LOEC = 45 ‰	Thomas et al., 1989
	Larvae	18 hours	24	0 to 50 (intervals of 4-8)	32	Mortality	LD50 (1 day old) = ~38 ‰ LD50 (3 day old) = ~44 ‰ LD50 (5 days old) = ~33 ‰ LD50 (7 days old) = ~35 ‰ (estimated from graph)	Thomas et al., 1989
Red Drum (*Sciaenops ocellatus*)	Juvenile	168 hours	22	60	30	Plasma osmolality and muscle water	Significant impacts in the first 24 h; organisms fully acclimated to acute hypersalinity transfer by 72 h.	Martin, L., and A. J. Esbaugh. 2021
	Eggs	Time to hatch	24 to 26	15, 20, 25, 30	26 to 32	Hatching success	No significant effects	Holt et al. 1981
	Larvae	14 days	24 to 26	15, 20, 25, 30	26 to 32	Mortality	No significant effects	Holt et al. 1981
Red Drum (*Sciaenops ocellatus,* cont.)	Not stated	12 hours (respiration); 24 hours (blood values)	24	0, 10, 35, 60	Raised at 35. Acclimation to test conditions for 24 hours before test initiation.	Respiration and blood osmolality	No significant effects	Ern, R., and A. J. Esbaugh. 2018
	Eggs	36 hours	25	28, 33, 38, 43, 48	38	Hatching success	Lowest hatching at 48 ‰, highest hatching at 38 ‰. The best hatch-out and growth rates were 33 – 43 ‰	Kesaulya, I., & Vega, R. 2019.
	Juveniles	30 days	16	0, 8, 16, 24, 32	Not stated	Mortality	No significant effects	Zhiqiang, J. I. A. N. G., L. I. U. Gang, and J. Bai. 2005. (abstract only)
	Juveniles	9 hours transport and 3 days observation	25 and 30	2, 4, 8, 16, 35	Acclimated to test salinities	Mortality	No significant effects at 24 h or 14 days	Weirich, C. R., and J. R. Tomasso. 1991.
	Juveniles	48 hours	28	± 10 ‰ for a final range of 1-50	30	Standard Metabolic Rate	NOEC = 40 ‰ (transfer from 30 ‰). No statement was made about the 40 to 50 ‰ transfer survival.	Wakeman, J. M., and D. E. Wohlschlag. 1985.
	Juveniles	Up to 6 hours for salinity change then monitored for 96 hours	25.8	Start salinities: 30.0 to 36.2‰ Ending salinities: 41.1 to 46.0‰ (+10‰ treatment) and 49.9 to 55.9‰ (+20‰ treatment)	35	Mortality	Controls were not significantly different from 10‰ treatments. (NOEC = 46 ‰; LOEC = 55.9 ‰)	McDonald, D. L., et al. 2016.
	Juveniles	1 hours	Not stated	+ 20‰ (20 to 40‰ in 1 h); + 35‰ (20 to 55‰ in 1 h)	Not stated	Mortality	NOEC: 20‰ salinity increase (100% survival) 35‰ salinity increase (from 20‰ to 55‰ in 1 h) resulted in 0–47% survival.	Lopez, S. M. 2015 (In McDonald, D. L., et al. 2016)
	Juveniles	30 days	29.8	Freshwater and 35 ‰	Acclimated to test salinities	Mortality	93% survival at both salinities.	Crocker, P. A., et al. 1981.
	Eggs	18 hours	28	0 to 60	32	Hatch rate	NOEC = 50 ‰ and LOEC = 60 ‰ when eggs were transferred at 12 hr post-fertilization	Thomas et al., 1989
	Larvae	24 hours	28	0 to 60	32	Mortality	NOEC = 50 ‰; LOEC = 60 ‰	Thomas et al., 1989
	Larvae	18 hours	28	0 to 50 (intervals of 4-8)	32	Mortality	LD50 (1 day old) = ~41 ‰ LD50 (3 day old) = ~33 ‰ LD50 (5 days old) = ~42 ‰ LD50 (7 days old) = ~45 ‰ LD50 (9 days old) = ~45 ‰ (estimated from graph)	Thomas et al., 1989
	Eggs and Larvae	40 hours (20 min exposure)	23-25	30, 37.5, 45, 60, 95, 140	30-32	Hatch rate (24 h) and Mortality	Morula (early) stage: NOEC = 45 ‰, LOEC = 60 ‰ Tail bud (late) stage: NOEC = 95 ‰, LOEC = 140 ‰	Robertson et al., 1988

Exhibit EFA 1-3. Literature Data on Salinity Toxicity for the Six Target Aquatic Species

Species	Life stage	Duration	Temperature (°C)	Salinities Tested (‰)	Acclimated salinity (‰)	Endpoint	Result	Reference
	Eggs and larvae	72 hours	28	35, 37, 39, 41, 43, 45, 68.7	Spawning salinity of 35 ‰	Mortality	48 hour NOEC = 35 ‰; LOEC = 37 ‰ 48-hour LC50 = 44.8 ‰ 72-hour NOEC = 35 ‰; LOEC = 37 ‰ 72-hour LC50 = 37.7 ‰	Nielsen, 2021b
	Eggs and larvae	72 hours	28	31, 35, 40, 45, 50, 60, 68.7	Not stated (control salinity of 31 ‰)	Mortality	24 hour NOEC = 45 ‰; LOEC = 50 ‰ 72-hour NOEC = 40 ‰; LOEC = 45 ‰ 72-hour LC50 = 41.8 ‰	Nielsen, 2021a

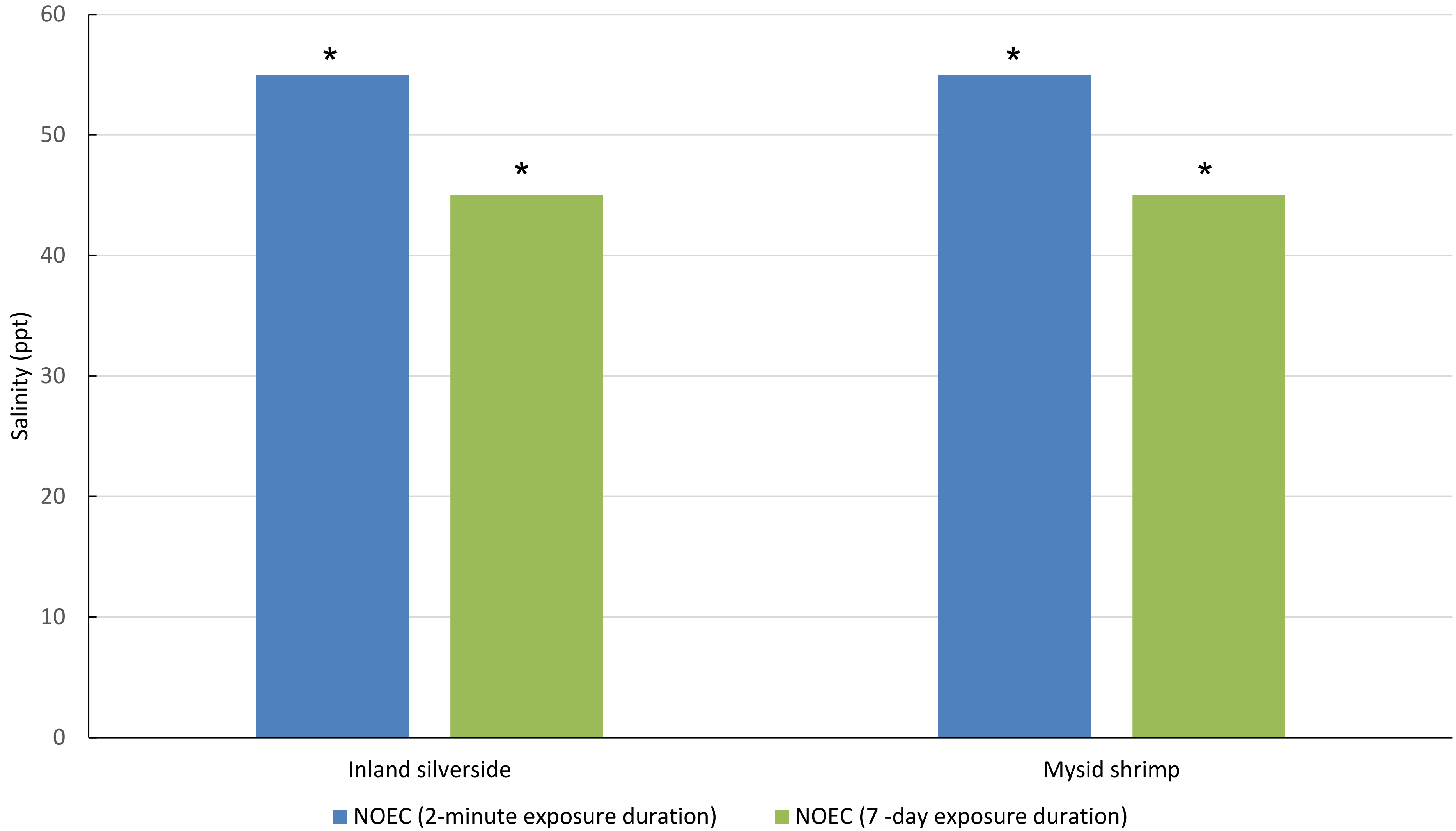
Notes:

LC50 = median lethal concentration

LD50 = median lethal dose

LOEC = lowest-observed-effect level

NOEC = no-observed-effect level



Notes: NOEC = no-observed-effect concentration; ppt = parts per thousand
Sources: Stillmeadow Incorporated (2021a,b,c)
In the acute toxicity experiments, the authors noted that observations were made at 1 and 24 hours post-study termination showing "no significant mortality in either species in any salinity." However, no additional details were provided.
*Each of these NOECs is the highest concentration tested. Therefore, the concentration at which effects may occur cannot be determined from these results.

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Exhibit EFA 1-4.
Survival Results of Toxicity Testing Performed in Support of the Harbor Island Desalination Permit Application

Exhibit EFA 2-1. Relative abundance and salinity tolerances for key estuarine species present in Aransas and Corpus Christi Bays, TX

		Aransas Bay					Corpus Christi Bay					Salinity Tolerances (parts per thousand) by Lifestage			
		Life Stage[a]					Life Stage[a]					Embryo	Larva	Juvenile	Adult
Species	**Scientific Name**	**S**	**E**	**L**	**J**	**A**	**S**	**E**	**L**	**J**	**A**	**min-max**	**min-max**	**min-max**	**min-max**
Eastern oyster	*Crassostrea virginica*	○	○	○	○	○	○	○	○	○	○	7.5-35	3-39	2-43.5	0.5-43.5
White shrimp	*Penaeus setiferus*			○	◉	○				◉	◉	27-35	0.4-37.4	0.3-41.3	0.1-45.3
Blue crab	*Callinectes sapidus*	○	○	○	●	◉	○	◉	◉	●	◉	10.3-32.6[b]	>5	0-60	0-60
Spotted seatrout	*Cynoscion nebulosus*	○	○	○	○	○	○	○	○	○	○	5-45	8-40	0-48	0.2-77
Atlantic croaker	*Micropogonias undulatus*			◉	◉	◉			◉	◉	◉	0-70	0-70	0-70	0-75
Red drum	*Sciaenops ocellatus*				○	√				○	√	10-40	<1-50	0-50	0-50

Sources:
Pattillo et al. (1997, 1995); Confluence Environmental Company (2021); Sellers and Stanley (1984); Stanley and Sellers (1986); Lassuy (1983a,b); Reagan (1985); Longley (1994)

Notes:
[a] S = spawning; E = egg; L = larval; J = juvenile; A = adult
√ = rare; ○ = common; ◉ = abundant; ● = very abundant; blank = not present
NA = not available

Exhibit EFA 2-2. Salinity Tolerances for the Six Target Aquatic Species Based on Field Observations in Texas Estuarine Habitats

Salinity Tolerances (ppt)			
Minimum	**Maximum**	**Preference or Optimum (ppt)**	**Observation/Comment**
			Eastern Oyster (*Crassostrea virginica*)
--	--	20 to 21	Larval spat setting requirement in Galveston Bay, TX
0.5	27	--	Field distribution in Mesquite Bay, TX
--	43.5-45	--	Distribution limit in Redfish and Corpus Christie Bays, TX
			White Shrimp (*Penaeus setiferus*)
2.9	45.3	--	Field distribution in Mesquite Bay, Texas
2.1	36.6	10-14.9	Field distribution in Copano and Aransas Bays, Texas; range of greatest abundance, although still common at ≤4.9 ppt
2	45	--	Field distribution in Texas bays and lagoons of northwestern Gulf of Mexico
--	--	<10	Preference based on population distributions in Texas waters
			Blue Crab (*Callinectes sapidus*)
22.9	32.4	>30	Salinity range for capture of egg-bearing females near Aransas Pass, TX
--	--	>20	Occurrence of spawning and early development in Texas bays
--	--	<1.9	Peak abundance of juvenile blue crabs in Texas bays
2.8	40.6	--	Field distributions in Mesquite Bay, Texas
2.0	37.2	10-20	Field distribution in Copano and Aransas Bays, Texas; range of greatest abundance
--	45	--	Blue crabs observed leaving Upper Laguna Madre, Texas, as salinity increased
2	60	--	Field distribution in Texas bays and lagoons of northwestern Gulf of Mexico
			Spotted Seatrout (*Cynoscion nebulosus*)
--	≤60	<45	"Young" collected up to about 60 ppt in Laguna Madre, Texas; no spawning if salinity exceeds 45 ppt
--	<55	15-35	Absent above 55 ppt in Baffin and Alazon Bays, Texas; most abundant at a salinity range between 15 and 35 ppt
2.3	34.9	5-20	Field distribution in Copano and Aransas Bays, Texas; more than 80% collected in salinities ranging between 5 and 20 ppt
<5	77	--	Field distribution in Texas bays and lagoons of northwestern Gulf of Mexico
1.5	45.3	--	Field distribution in Mesquite Bay, Texas
			Atlantic Croaker (*Micropogonias undulatus*)
--	--	<15	More abundant in Texas waters at salinities below 15 ppt
2	>60	--	Recorded occurrence in northwestern Gulf and Laguna Madre, Texas
			Red Drum (*Sciaenops ocellatus*)
2.1	32.4	<15	Field distribution in Copano and Aransas Bays, Texas; greatest abundance at <15 ppt
0	> 50	20-40	Field distribution in Texas bays; range of preference (most abundant in 30-35 ppt)
--	--	< 50	Populations in Laguna Madre, Texas severely limited at >50 ppt

Primary source: Table 6.7.3 in Longley, W.L., ed. 1994. Freshwater inflows to Texas bays and estuaries: ecological relationships and methods for determination of needs. Texas Water Development Board and Texas Parks and Wildlife Department, Austin, TX. 386 pp.

Exhibit EFA 3-1. Aquatic Toxicity Test Results for Bromoform

Bromoform: 75-25-2; Source	Test type	Species	Duration	Endpoint	Result	Comments
https://echa.europa.eu/brief-profile/-/briefprofile/100.000.778	Biodegradation	Not applicable	28 days	Biodegradation	6% biodegradation after 28 days	Not readily biodegradable under the terms and conditions of OECD Guideline No 301D.
	Toxicity to aquatic algae and cyanobacteria	*Pseudokirchneriella subcapitata*	72 hours	EC50 (growth rate)	13 mg/L	
			72 hours	EC50 (biomass)	12 mg/L	
			72 hours	LOEC	18 mg/L	
			72 hours	NOEC	2.8 mg/L	
	Short-term toxicity to aquatic invertebrates	*Daphnia magna*	24 hours	LC50	56 mg/L	
			48 hours	LC50	46 mg/L	
			48 hours	NOEC	< 7.8 mg/L	
	Short-term toxicity to fish	Bluegill (*Lepomis macrochirus)*	24 hours	LC50	33 mg/L	
			96 hours	LC50	29 mg/L	
https://comptox.epa.gov/dashboard/dsstoxdb/results?search=DTXSID1021374#toxicity-values	Acute mortality	Sheepshead minnow	Not reported	LC50	7.1 mg/L	
	Acute mortality	Opossum shrimp	Not reported	LC50	76.3 mg/L	
	Acute mortality	Opossum shrimp	Not reported	LC50	24.4 mg/L	
	Acute mortality	Sheepshead minnow	Not reported	LC50	19 mg/L	
	Acute mortality	Littleneck clam	Not reported	LD0	7 mg/L	
	Chronic mortality	Common carp	Not reported	LC50	52 mg/L	
	Acute mortality	Opossum shrimp	Not reported	LC50	60.1 mg/L	
	Acute mortality	Sheepshead minnow	Not reported	LC50	18 mg/L	
	Acute mortality	Water flea	Not reported	LC50	44 mg/L	
	Chronic mortality	Common carp	Not reported	LC50	80 mg/L	
	Acute mortality	Sheepshead minnow	Not reported	LC50	18 mg/L	
Gibson et al. 1979a. Toxicity and Effects of Bromoform on Five Marine Species	Acute mortality	*P. aztecus*	96 hours	LC50	26 mg/L (95% CI: 33 - 20 mg/L)	>19 mg/L, an avoidance response to the bromoform source occurred within 60 seconds of exposure; >31 mg/L, a narcotic-like effect occurred within 120 minutes and continued throughout the experiment or until death.
	Acute mortality	*M. mercenaria*	96 hours	LC50	140 mg/L	A 96-hr exposure period was inadequate to generate meaningful LC50 data on clams and oysters. Mortalities occurred during the 3-day period following the 96 hours of exposure to bromoform. At >10 mg/L, filtering ceases and the bivalves close and remain closed for much of the exposure period.
	Acute mortality	*C. virginica*	96 hours	LC50	40 mg/L	Same as above
	Acute mortality	*B. tyrannus*	96 hours	LC50	12 mg/L (95% CI: 15 - 9 mg/L)	As the menhaden approached death they began to lose equilibrium and lay on their sides at the bottom of the tank. Opercular movement gradually decreased until all movement stopped.
Gibson et al. 1981	Bioaccumulation	*P. aztecus, M. mercenaria, C. virginica, and B. tyrannus*	Bromoform was present in all exposed animal tissues within 24 hours and was depurated within 48 hours.	Bioaccumulation	The uptake and depuration of bromoform was rapid.	In the mollusk species, there was bioaccumulation above water concentrations in the first week of exposure, and then the tissue concentrations fell to levels approximately equal to the water concentrations. The shrimp and menhaden also bioaccumulated bromoform above water concentrations in the first week of exposure, but then the tissue concentrations fell to approximately 0.4 µg/g and remained at this level independent of water concentrations.
Gibson et al. 1979b. Bioaccumulation and depuration of bromoform in five marine species	Bioaccumulation	*P. aztecus, M. mercenaria, C. virginica, and B. tyrannus*	Not reported	Not reported	The uptake and depuration was rapid (equilibrium was reached in 24 to 48 hours), and the concentration factors were relatively low (<1 to 10 times the water concentration).	Likely an earlier version of the above paper
Agus et al. 2009	Review	Mussel and oyster larvae	Not reported	LC50	1 mg/L	These appear to be the most sensitive species with respect to trihalomethane toxicity. At lower chronic exposure levels, the trihalomethanes are bioaccumulated and induce production of stress proteins. LC50 reported is likely from the study below.
Stewart et al. 1979	Acute Toxicity	*Crassostrea virginica* larvae	48 hours	LC50	1 mg/L	Bromoform was studied as 0.05, 0.1, 1.0 and 10 mg/L. Approximately 60% mortality at 10 mg/L (endpoints estimated from graph)

Notes:
EC50 = median effective concentration
LC50 = median lethal concentration
LOEC = lowest-observed-effect concentration
NOEC = no-observed-effect concentration

Exhibit EFA 3-2. Aquatic Toxicity Test Results for Chloroform

Source	Test Type	Species	Duration	Endpoint	Results	Comments
https://echa.europa.eu/registration-dossier/-/registered-dossier/14964	Biodegradation	Not applicable	Not reported	Biodegradation	Not readily biodegradable under aerobic conditions.	The guideline-compliant study performed by MITI (1992) indicated no ready biodegradability with aerobic conditions. Also the study carried out by Bouwer et al. (1981) did not find ready biodegradability of chloroform under aerobic conditions.
	Toxicity to aquatic algae and cyanobacteria	*Chlamydomonas reinhardii*	72 h	EC50	13.3 mg/	Inhibition was only measured related to biomass for each concentration and not related to algal growth rate, which is usually the preferred observational endpoint.
			72 h	EC10	3.61 mg/L	
	Long-term toxicity to aquatic invertebrates	*D. magna*	21 days	NOEC	6.3 mg/L	The NOEC is based on reproduction endpoints.
	Short-term toxicity to aquatic invertebrates	*Crassostrea gigas*	48 h	LOEC	80.4 mg/L	LC50 values for *D. magna* were 29 mg/L, 79 mg/L and 79 mg/L respectively. The NOEC values were < 7.8 mg/L and 48 mg/L in two of the tests. The most reliable test was carried out with marine oyster larvae (*Crassostrea gigas*). The EC50 value established in the study for abnormal development of the giant Pacific oyster embryos was 152.5 mg/L.
			48 h	NOEC	50.4 mg/L	
			48 h	EC50	152.5 mg/L	
	Long-term toxicity to fish	Japanese Medaka fish (*Oryzias latipes*)		NOEC	0.151 mg/L	Only one valid study on the long-term toxicity of chloroform to fish has been found, which is on the Japanese Medaka fish. The NOEC conncentration established for long-term exposure of Medaka fish to chloroform was 1.463 mg/L based on lesions found in the gallbladder and the bile duct.
			Not reported	LOEC	1.463 mg/L	
	Short-term toxicity to fish	*Oncorhynchus mykiss*	96 h	LC50	18 mg/L	The experiments carried out with different freshwater fish species had testing periods ranging from 96 hours to 14 days. The LC50 values found in the studies range from 18 mg/L for *Oncorhynchus mykiss* to 171 mg/L for *Pimephales promelas*.
		Limanda limanda (SW)	96 h	LC50	28 mg/L	Only one study delivers information about the acute toxicity of chloroform to the saltwater fish species *Limanda limanda*. The study tends to show that the acute toxicity of chloroform to fish species is rather similar in freshwater and saltwater systems.
https://chemview.epa.gov/chemview/proxy?filename=tscats/88920010594_67663_19D57840B58B15D485257132004BD24D.pdf	Acute mortatlity	*Oncorhynchus mykiss*	96 h	LC50	18.2 mg/L	Possibly same endpoint as reported above.
	Acute mortatlity	Largemouth bass, *Micropterus salmoides*	96 h	LC50	51 mg/L	
	Acute mortatlity	Channel catfish, *Ietalurus punctatus*	96 h	LC50	75 mg/L	
https://comptox.epa.gov/dashboard/dsstoxdb/results?search=DTXSID1020306#toxicity-values	Acute toxicity	rainbow trout	Not reported	LOEC	20 mg/L	
	Chronic toxicity	diatom	Not reported	EC50	437 mg/L	
	Acute toxicity	goldfish	Not reported	EC50	167 mg/L	
	Chronic toxicity	green algae	Not reported	EC50	560 mg/L	
	Chronic toxicity	green algae	Not reported	EC0	1100 mg/L	
	Acute toxicity	water flea	Not reported	EC50	90 mg/L	
	Acute toxicity	brine shrimp	Not reported	IC50	37 mg/L	
	Chronic toxicity	blue-green algae	Not reported	EC0	185 mg/L	
	Acute toxicity	water flea	Not reported	EC50	64.9 mg/L	
	Chronic toxicity	green algae	Not reported	EC50	950 mg/L	
	Chronic toxicity	green algae	Not reported	EC10	440 mg/L	
	Acute toxicity	brine shrimp	Not reported	EC50	68 mg/L	
	Acute toxicity	water flea	Not reported	EC100	500 mg/L	
	Chronic toxicity	water flea	Not reported	EC50	60 mg/L	
	Acute mortality	rainbow trout	Not reported	NOEC	42 mg/L	
	Chronic reproduction	water flea	Not reported	EC50	336 mg/L	
	Acute mortality	bluegill	Not reported	NOEC	75 mg/L	
	Chronic reproduction	water flea	Not reported	EC50	311 mg/L	
	Chronic mortality	water flea	Not reported	NOEC	3.4 mg/L	
	Chronic reproduction	water flea	Not reported	EC50	368 mg/L	
	Acute mortality	japanese medaka	Not reported	NOEC	122 mg/L	
	Acute mortality	northern pink shrimp	Not reported	NOEC	32 mg/L	
	Acute mortality	bluegill	Not reported	NOEC	100 mg/L	
	Chronic reproduction	water flea	Not reported	EC50	343 mg/L	
	Acute mortality	water flea	Not reported	NOEC	3.6 mg/L	
	Chronic reproduction	water flea	Not reported	NOEC	200 mg/L	
	Chronic reproduction	water flea	Not reported	EC50	288 mg/L	
	Acute mortality	water flea	Not reported	NOEC	1.8 mg/L	
	Acute mortality	water flea	Not reported	NOEC	7.8 mg/L	
	Acute mortality	rainbow trout	Not reported	NOEC	24 mg/L	
	Chronic reproduction	water flea	Not reported	EC50	295 mg/L	
	Chronic mortality	water flea	Not reported	NOEC	120 mg/L	

Exhibit EFA 3-2. Aquatic Toxicity Test Results for Chloroform

Source	Test Type	Species	Duration	Endpoint	Results	Comments
Agus et al. 2009	Acute toxicity	Mussel and oyster larvae	Not reported	LC50	1 mg/L	These appear to be the most sensitive species with respect to trihalomethane toxicity. At lower chronic exposure levels, the trihalomethanes are bioaccumulated and induce production of stress proteins.
Stewart et al. 1979	Acute toxicity	*Crassostrea virginica* larvae	48 h	LC50	2 mg/L	Mortality: 70% (chloroform) at 10 mg/L estimated from graph. Chloroform was studied at 0.05, 0.1, 1.0, and 10.0 mg/L (endpoints estimated from graph).
Batley and Simpson 2020	Acute toxicity	*Crassostrea virginica*	Not reported	LC50	2 mg/L	The LC50 value for larval survival was 2 mg/L for chloroform. Chloroform was lost from solution by volatilization. LC50 reported is likely from the study above.

Notes:
EC50 = median effective concentration
LC50 = median lethal concentration
LOEC = lowest-observed-effect concentration
NOEC = no-observed-effect concentration

Exhibit EFA 3-3. TCEQ Surface Water Benchmarks for Bromoform and Chloroform

Chemical of Concern	CAS No.	Freshwater Acute Benchmark (mg/L)	note	Freshwater Chronic Benchmark (mg/L)	note	Saltwater Acute Benchmark (mg/L)	note	Saltwater Chronic Benchmark (mg/L)	note
Tribromomethane (bromoform)	75-25-2	0.897	a	0.149	a	7.32	a	1.22	a
Chloroform	67-66-3	5.37	b	1.79	b	8.4	b	2.8	b

Taken from 2021 TCEQ Ecological Screening Bencmarks (https://www.tceq.texas.gov/assets/public/remediation/eco/TCEQ%20Ecological%20Screening%20Benchmarks.xlsx)

a Benchmark derived by TCEQ using the LC_{50} approach in accordance with the Texas Surface Water Quality Standards 30 TAC 307.6 (c) (7) before 2016.

b Benchmark derived by TCEQ using the LC_{50} approach in accordance with the Texas Surface Water Quality Standards 30 TAC 307.6(c)(7) after 2016.

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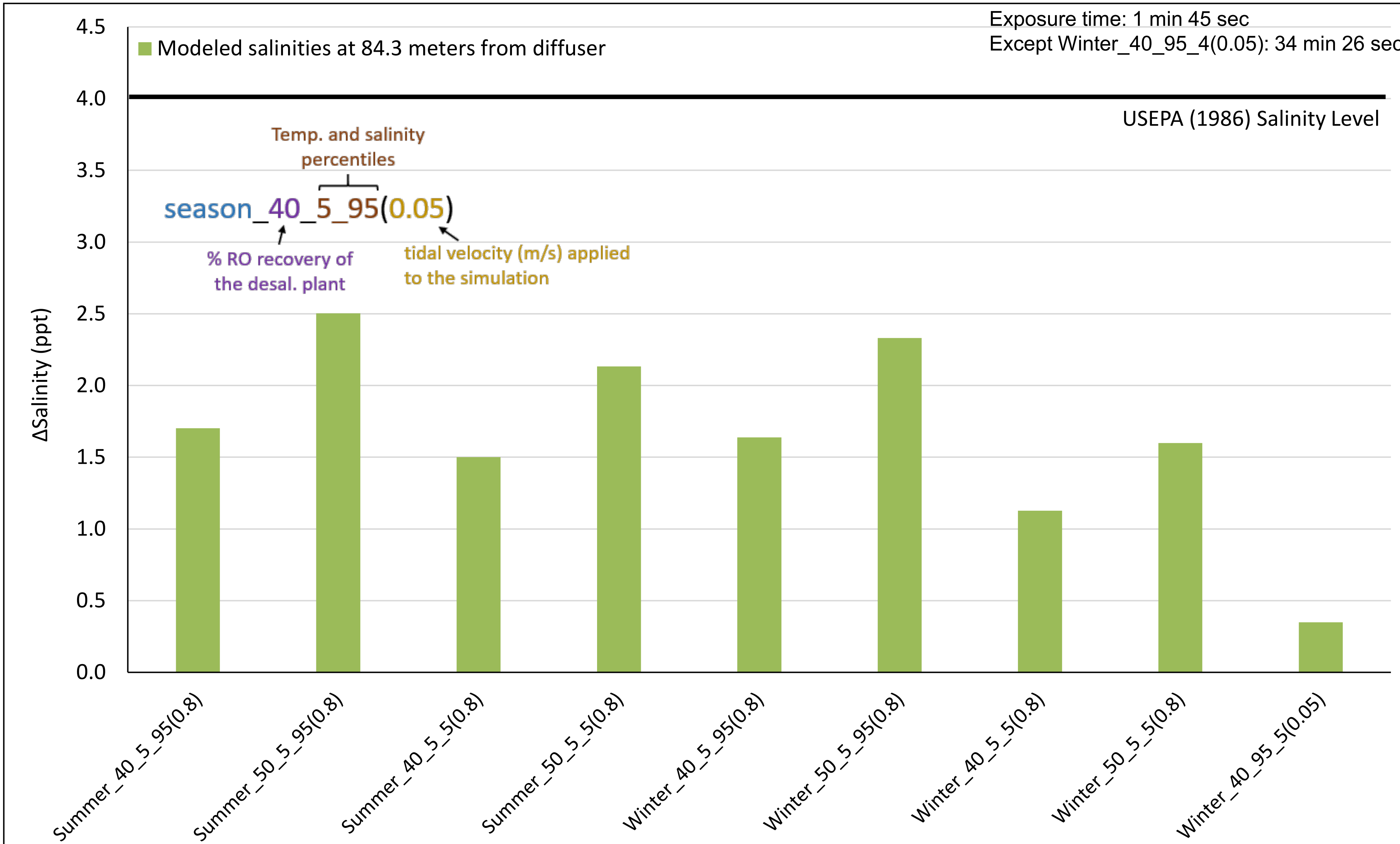
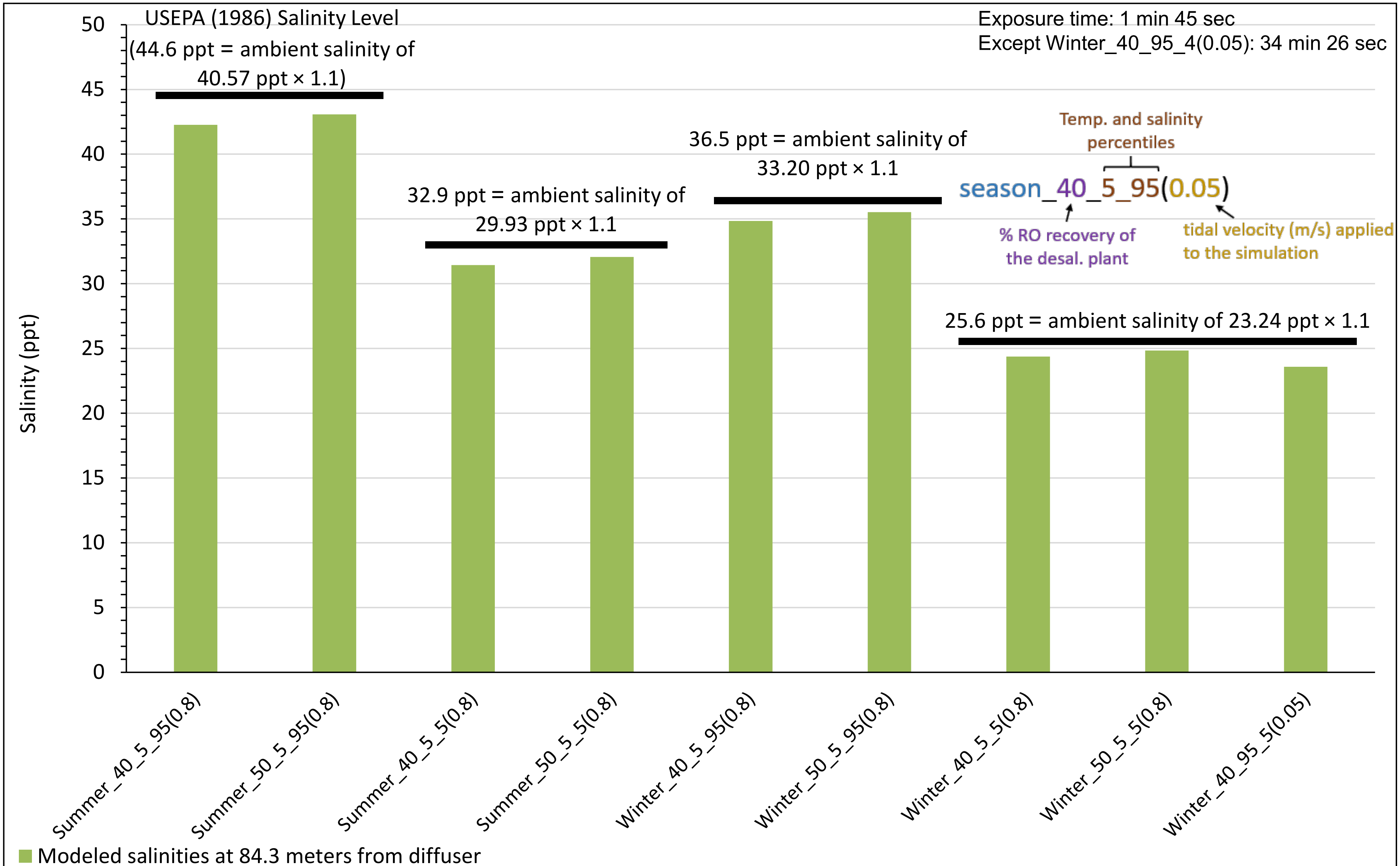
Appendix 7

Risk Estimation Exhibits



Notes: ppt = parts per thousand; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

Exhibit RE 1-1.
CORMIX Salinities (ppt) Compared to the USEPA (1986) Salinity Level of 4 ppt above Ambient



Notes: ppt = parts per thousand; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

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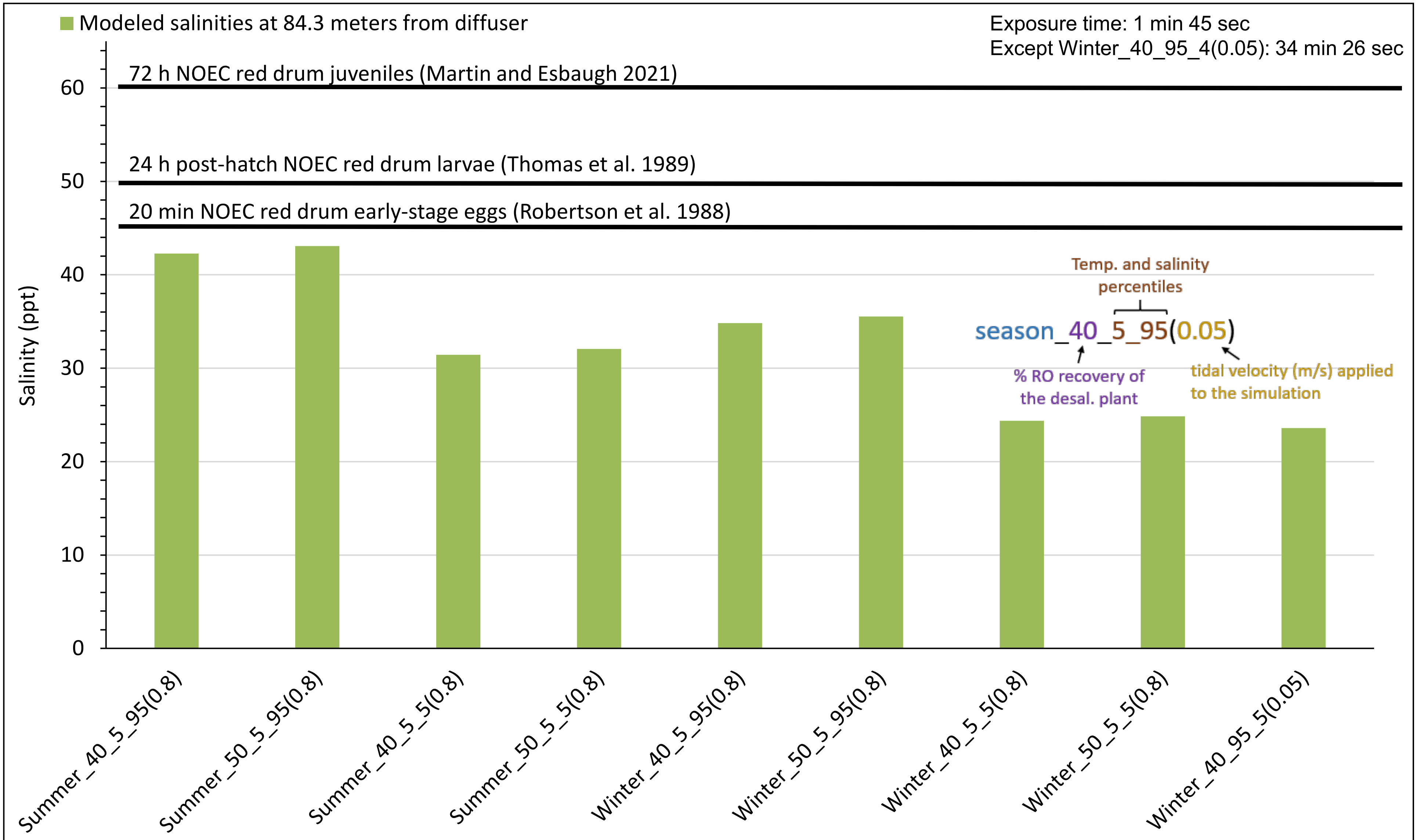
Exhibit RE 1-2.
CORMIX Salinities (ppt) Compared to the USEPA (1986) Salinity Level of 10% above Ambient



Notes: NOEC = no-observed-effect concentration; ppt = parts per thousand; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

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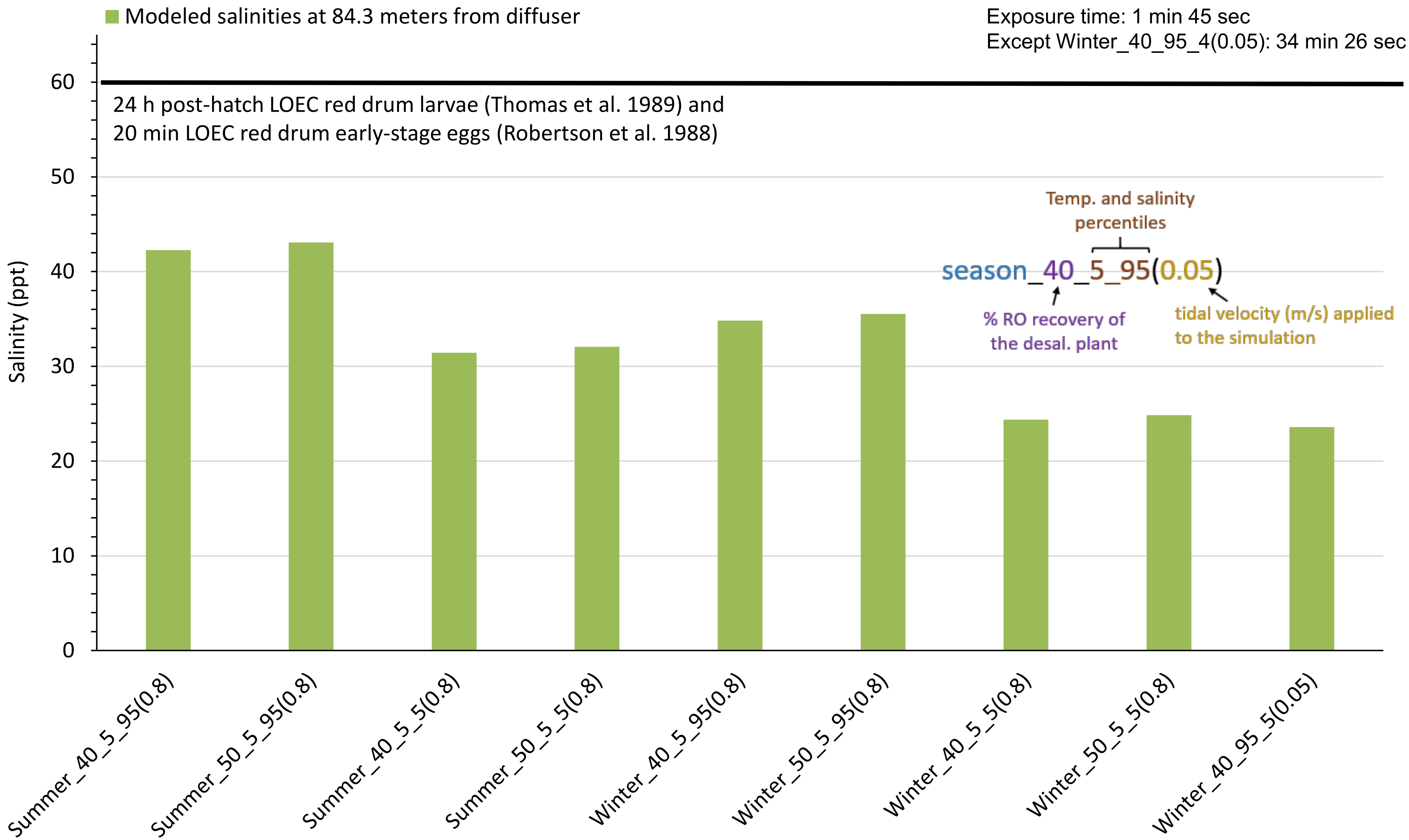
Exhibit RE 1-3.
CORMIX Salinities (ppt) Compared to Red Drum Toxicity Thresholds (NOECs)



ppt = parts per thousand; NOEC = no observed effect concentration; LOEC = lowest observed effect concentration; Data shown are for the highest salinity tolerated over the most relevant duration. 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

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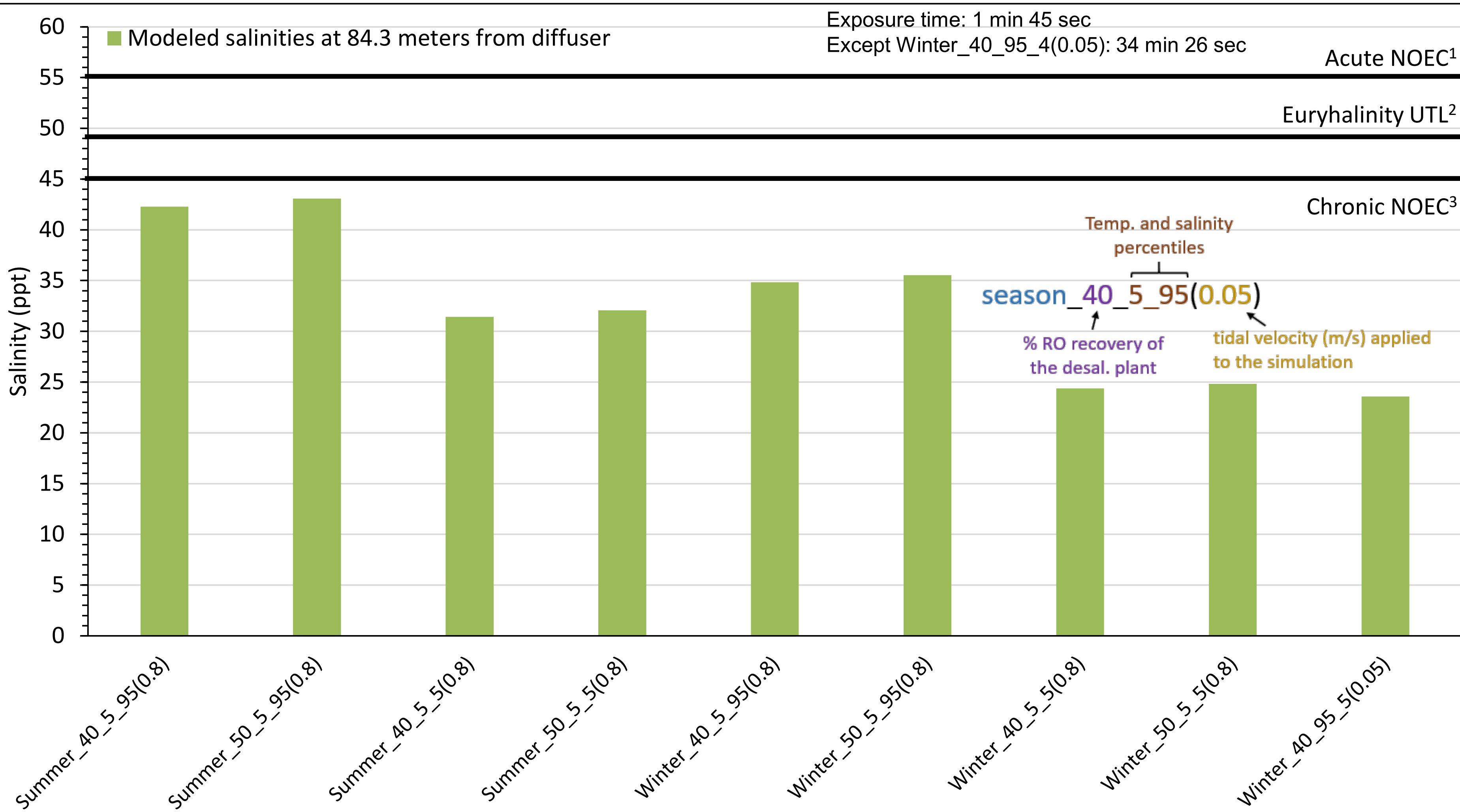
Exhibit RE 1-4.
CORMIX Salinities (ppt) Compared to Red Drum Toxicity Thresholds (LOECs)



Notes: NOEC = no observed effect concentration; ppt = parts per thousand; UTL = upper tolerance limit; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Exposure time is the time needed, under these particular scenarios, for the effluent plume to travel from the diffuser to 84.3 meters down-current. This is the same for all but the last scenario because each scenario uses the same tidal speed.

[1]Highest concentration tested for acute, 2-minute salinity exposures to mysid shrimp and inland silverside performed in support of this project.

[2]Schultz and McCormick (2013)

[3]Highest concentration tested for chronic, 7-day salinity exposures to mysid shrimp and inland silverside performed in support of this project.

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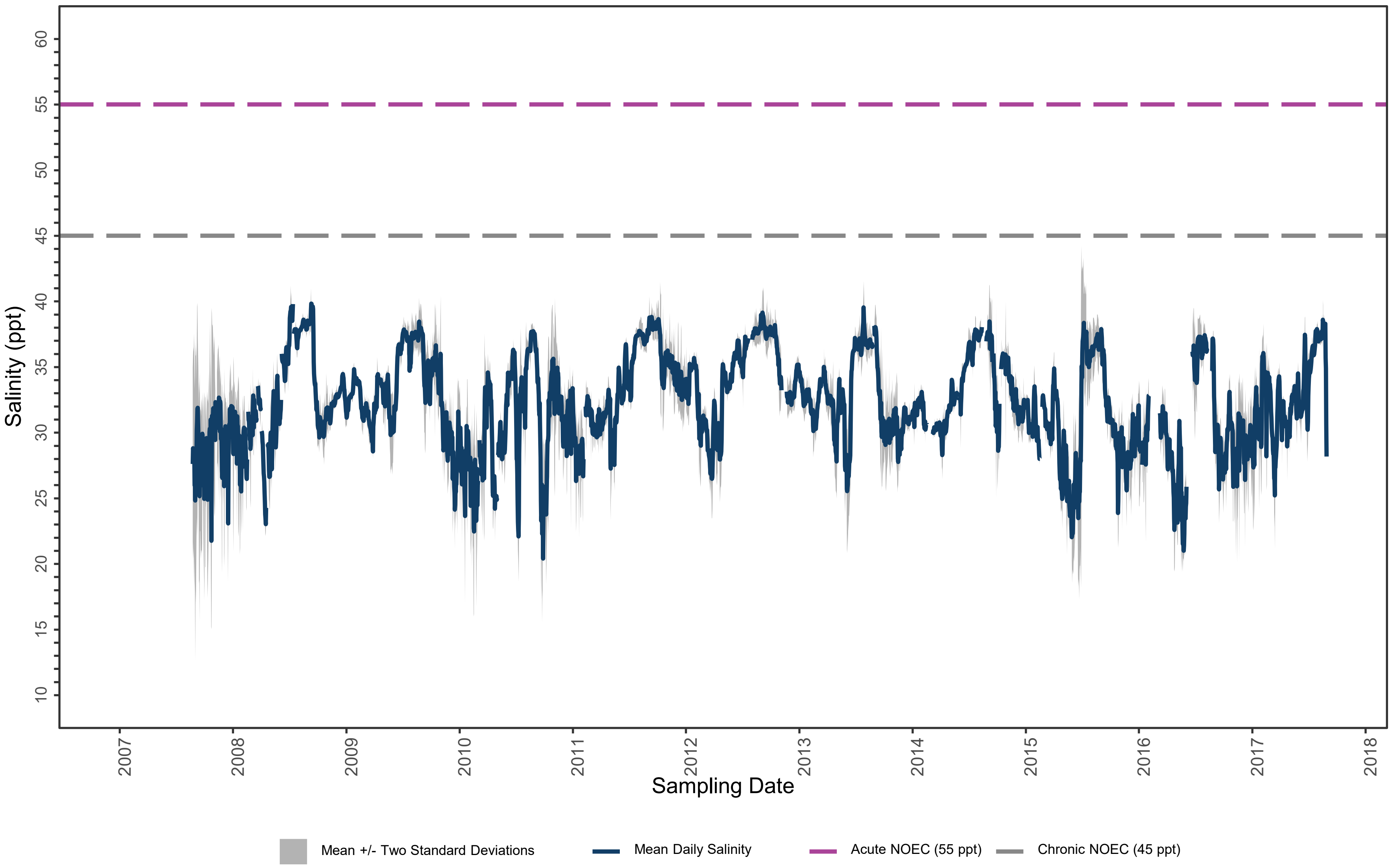
Exhibit RE 1-5.
CORMIX Salinities (ppt) Compared to a Euryhalinity UTL, Chronic NOEC, and Acute NOEC for Salinity

Exhibit RE 1-6. Key CORMIX Model Output for 84.3 Meters from the Diffuser

TCEQ Case ID	CORMIX Input Parameters[a]	Ambient Salinity (ppt)	Salinity (Δ ppt above ambient)	Total Salinity (ppt)	Salinity (% above ambient)	Travel time (minutes and seconds)
S_50_a	Summer_50_5_5(0.8)	29.93	2.13	32.06	7%	1 :45
S_50_a_95	Summer_50_5_5(0.8)_95	29.93	2.13	32.06	7%	1 :45
S_50_b	Summer_50_5_95(0.8)	40.57	2.50	43.07	6%	1 :45
S_50_b_95	Summer_50_5_95(0.8)_95	40.57	2.50	43.07	6%	1 :45
S_50_c	Summer_50_95_5(0.8)	29.93	2.13	32.06	7%	1 :45
S_50_c_95	Summer_50_95_5(0.8)_95	29.93	2.13	32.06	7%	1 :45
S_50_d	Summer_50_95_95(0.8)	40.57	2.50	43.07	6%	1 :45
S_50_d_95	Summer_50_95_95(0.8)_95	40.57	2.50	43.07	6%	1 :45
S_40_a	Summer_40_5_5(0.8)	29.93	1.50	31.43	5%	1 :45
S_40_b	Summer_40_5_95(0.8)	40.57	1.70	42.27	4%	1 :45
S_40_c	Summer_40_95_5(0.8)	29.93	1.50	31.43	5%	1 :45
S_40_c_strat	Summer_40_95_5(0.8)_stratified	29.93	1.50	31.43	5%	1 :45
S_40_c_strat_2	Summer_40_95_5(0.8)_stratified2	29.93	1.50	31.43	5%	1 :45
S_40_d	Summer_40_95_95(0.8)	40.57	1.70	42.27	4%	1 :45
W_50_a	Winter_50_5_5(0.8)	23.24	1.60	24.84	7%	1 :45
W_50_a_95	Winter_50_5_5(0.8)_95	23.24	1.60	24.84	7%	1 :45
W_50_b	Winter_50_5_95(0.8)	33.20	2.33	35.53	7%	1 :45
W_50_b_95	Winter_50_5_95(0.8)_95	33.20	2.33	35.53	7%	1 :45
W_50_c	Winter_50_95_5(0.8)	23.24	1.60	24.84	7%	1 :45
W_50_c_95	Winter_50_95_5(0.8)_95	23.24	1.60	24.84	7%	1 :45
W_50_d	Winter_50_95_95(0.8)	33.20	2.33	35.53	7%	1 :45
W_50_d_95	Winter_50_95_95(0.8)_95	33.20	2.33	35.53	7%	1 :45
W_40_a	Winter_40_5_5(0.8)	23.24	1.13	24.37	5%	1 :45
W_40_b	Winter_40_5_95(0.8)	33.20	1.64	34.84	5%	1 :45
W_40_c	Winter_40_95_5(0.8)	23.24	1.13	24.37	5%	1 :45
W_40_c_strat	Winter_40_95_5(0.8)_stratified	23.24	1.13	24.37	5%	1 :45
W_40_c_05	Winter_40_95_5(0.05)	23.24	0.35	23.59	2%	34 :26
W_40_c_06	Winter_40_95_5(0.06)	23.24	0.38	23.62	2%	28 :46
W_40_c_08	Winter_40_95_5(0.08)	23.24	0.84	24.08	4%	17 :34
W_40_c_09	Winter_40_95_5(0.09)	23.24	0.89	24.13	4%	15 :37
W_40_c_1	Winter_40_95_5(0.1)	23.24	0.94	24.18	4%	14 :03
W_40_c_2	Winter_40_95_5(0.2)	23.24	1.13	24.37	5%	7 :02
W_40_c_3	Winter_40_95_5(0.3)	23.24	1.13	24.37	5%	4 :41
W_40_c_4	Winter_40_95_5(0.4)	23.24	1.13	24.37	5%	3 :31
W_40_c_5	Winter_40_95_5(0.5)	23.24	1.13	24.37	5%	2 :49
W_40_c_6	Winter_40_95_5(0.6)	23.24	1.13	24.37	5%	2 :20
W_40_c_7	Winter_40_95_5(0.7)	23.24	1.13	24.37	5%	2 :00
W_40_c_8	Winter_40_95_5(1)	23.24	1.13	24.37	5%	1 :24
W_40_c_9	Winter_40_95_5(1.2)	23.24	1.13	24.37	5%	1 :10
W_40_c_10	Winter_40_95_5(1.5)	23.24	1.13	24.37	5%	0 :56
W_40_c_11	Winter_40_95_5(1.7)	23.24	1.13	24.37	5%	0 :50
W_40_c_12	Winter_40_95_5(2)	23.24	1.13	24.37	5%	0 :42
W_40_d	Winter_40_95_95(0.8)	33.20	1.64	34.84	5%	1 :45

ppt = parts per thousand; 84.3 meters denotes the boundary of the chronic aquatic toxicity mixing zone; Travel time is the time needed, under these particular scenarios, for the effluent plume to travel from the diffuser to 83.4 meters down-current; data presented in associated graphs are shaded in gray and represent the best- and worst-case scenarios for each season/percent recovery combination. Due to the additional tidal velocity scenarios, Winter_40 has three scenarios highlighted: the worst case, the overall best-case (0.05 m/s tidal velocity), and the best case at 0.8 m/s tidal velocity.

[a]Input parameters (in order) are the following: season; percent reverse osmosis recovery; temperature and salinity percentiles; tidal velocity (m/s) applied to the simulation. Additional parameters including whether the water was stratified and if the proposed permitted effluent rate of 95.6 MGD was used ("_95") are included where applicable.



Notes: NOEC = no-observed-effect concentration; ppt = parts per thousand; NOEC Sources: Stillmeadow Incorporated (2021a,b,c)

Exhibit RE 1-7.
Time Series (mean +/- 2 SD) for Natural Background Salinity Concentrations vs. NOECs, Aransas Pass, Port Aransas, TX
Data Source: Mission-Aransas National Estuary Program (http://cdmo.baruch.sc.edu/)

Exhibit RE 1-8. Comparison of Gulf of Mexico Intake Samples Chemistry Data against Permit Limits and Marine Surface Water Benchmarks

Chemicals[a]	Units	Result[b]	Qualifier[c]	Estimated Concentration in Effluent at the Diffuser[d]	Method Detection Limit	Reporting Limit	Daily Average Permit Limit[e]	Permit Limit Exceeded?	First Choice TCEQ Saltwater Criteria[f]		Second Choice EPA Saltwater AWQC[f]		Third Choice EPA R4 Saltwater Screening Values[f]		Hazard Quotient at the Diffuser (no dilution)[g]	
									Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
Volatile Organic Compounds (VOCs)																
No VOCs are present in the surface water sample above their RLs																
Semivolatile Organic Compounds (SVOCs)																
No SVOCs are present in the surface water sample above their RLs																
Polychlorinated Biphenyls (PCBs)																
No PCBs are present in the surface water sample above their RLs																
Total Metals																
Aluminum	µg/L	122.0		183.0	8.0	100	NA	--	--	--	--	--	--	1,500	--	<1
Arsenic	µg/L	3.01	J	4.5	2.5	20	381	no	149	78	69	36	69	36	<1	<1
Barium	µg/L	20.8	J	31.2	0.84	40	NA	--	150,000	25,000	--	--	110	4.0	<1	<1
Boron	µg/L	3,710		5,565	167	200	NA	--	--	--	--	--	--	1000[h]	--	**5.6**[h]
Calcium	µg/L	352,000		528,000	180	5000	NA	--	--	--	--	--	--	--	--	--
Copper	µg/L	1.82	J	2.73	1.70	20	39	no	13.5	3.6	4.8	3.1	4.8	3.1	<1	<1
Magnesium	µg/L	1,060,000		1,590,000	78.0	5000	NA	--	--	--	--	--	--	--	--	--
Manganese	µg/L	8.29	J	12.44	0.66	50	NA	--	--	--	--	--	--	100	--	<1
Mercury	µg/L	0.00065		0.00098	--	0.0005	5.37	no	2.1	1.1	1.8	0.94	1.8	0.94	<1	<1
Molybdenum	µg/L	9.27	J	13.91	4.90	50	NA	--	313,500	3,850	--	--	--	--	<1	<1
Nickel	µg/L	1.69	J	2.54	1.10	20	132	no	118	13.1	74	8.2	74	8.2	<1	<1
Potassium	µg/L	320,000		480,000	330	5000	NA	--	--	--	--	--	--	--	--	--
Sodium	µg/L	9,780,000		14,670,000	21000	200000	NA	--	--	--	--	--	--	--	--	--
Titanium	µg/L	6.66	J	9.99	3.90	50	NA	--	--	--	--	--	--	--	--	--
Oil & Grease																
Oil and Grease	mg/L	3.0		4.5		2.0			--	--	--	--	--	--	--	--

Notes:

Surface water analytical data source: ALS Environmental. 2021. Laboratory Results for Parsons-POCC Flow. Work Orders HS21060521 and HS21060616.

Bold values represent hazard quotients above 1; the surface water samples were not filtered and the analytical data represent total concentrations.

AWQC = ambient water quality criteria; EPA = U.S. Environmental Protection Agency; MDL = method detection limit; NA = not available; R4 = Region 4; RL = reporting limit; TCEQ = Texas Commission on Environmental Quality

[a] Only chemicals detected above the RL (for organics) or the MDL (metals and inorganics) are retained for further evaluation

[b] The analytical data represent the highest-detected concentration for 2 intake water samples

[c] J = analyte detected below quantitation limit

[d] The estimated concentration is based on the conservative assumption that the effluent is concentrated by 50% compared to the influent due to the removal of 50% freshwater via reverse osmosis. The estimated concentration was obtained by multiplying the values presented in the "Results" column by 1.5.

[e] These concentrations represent the aquatic life daily average effluent limits calculated by TCEQ and presented in Appendix A of the TPDES industrial waste water permit 0005253000 prepared for the proposed Harbor Island reverse osmosis desalination plant.

[f] Benchmark sources:

TCEQ: https://www.tceq.texas.gov/waterquality/standards and Supporting Documentation for TCEQ's Ecological Benchmark Tables comprise RG-263b

EPA: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

EPA R4: https://www.epa.gov/risk/regional-ecological-risk-assessment-era-supplemental-guidance

[g] The acute and chronic hazard quotients are based on the first, second, or third choice screening values, depending on availability

[h] The screening value of 1,000 µg/L for boron is less than the background concentration of 4,500 µg/L reported for sea water (USEPA 1975).

Exhibit RE 1-9. Weight-of-Evidence (USEPA 1997, 1998, 2016; TCEQ 2018)
Considerations for Permitted Discharges to the Corpus Christi Ship Channel
POCC
Corpus Christi, Texas

Source of Evidence	Results	Unlikely Impact	Potential Impact
Habitat Assessment	Only limited permanent habitat is available for resident organisms in the deepwater tidal habitat (E1UBL) of the dredged channel - site-specific.	X	
Threatened and Endangered Species	Site-specific evaluation of the discharge area indicates no significant effects.	X	
Natural Salinity Variation	Site-specific background salinity variation indicates that resident organisms are naturally exposed to higher concentration extremes than the expected salinity discharge concentrations.	X	
EPA Salinity Levels	Modeled salinity concentrations at the end of the nearfield region are less than EPA salinity levels.	X	
Salinity Tolerance	The modeled salinity concentrations outside the nearfield region are within salinity tolerance of estuarine species that move through the tidal passageway.	X	
Salinity Laboratory Toxicity Tests	The modeled salinity concentrations outside the nearfield region are less than project-specific acute and chronic no-observed-effect concentrations and literature-derived toxicity endpoints for estuarine species that move through the tidal passageway.	X	
Intake Surface Water Quality	The intake surface water from the Gulf of Mexico is not located near chemical source areas and will not contain appreciable suspended solids/sediments. Also, screening against ecotoxicological benchmarks indicates that non-salinity related chemicals will not cause adverse effects. Segment 2481 (Corpus Christi Bay) is not impaired.	X	
Exposure Modeling of Salinity Plume	CORMIX modeling shows rapid effluent diffusion and dispersion in the nearfield area. SUNTANs modeling indicates that less than a maximum of 1 ppt salinity increase would occur in the farfield areas of the estuary.	X	
Spatial and Temporal Exposure	The modeled salinity concentrations return to ~2 ppt over background salinity at the end of the nearfield region. The majority of organisms moving through the channel will not encounter the salinity plume. The ship channel represents only 1 of 3 passageways for eggs and larvae to enter the estuary. Increased natural seasonal salinity only occurs for 3 months (25%) of the year.	X	

References:

USEPA (1997) Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments.

USEPA (1998) Guidelines for Ecological Risk Assessment.

USEPA (2016) Weight of Evidence in Ecological Risk Assessment.

TCEQ (2018) Conducting Ecological Risk Assessments at Remediation Sites in Texas.