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

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

EXHIBIT PAC-49R

SOAH DOCKET NO. 582-20-1895
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IN THE MATTER OF THE	**§**	**BEFORE THE STATE OFFICE**
APPLICATION OF PORT OF	**§**	
CORPUS CHRISTI AUTHORITY OF	**§**	**OF**
NUECES COUNTY FOR TPDES	**§**	
PERMIT NO. WQ0005253000	**§**	**ADMINISTRATIVE HEARINGS**

REMAND PREFILED TESTIMONY

OF

TIM OSTING, P.E.

ON BEHALF OF

PORT ARANSAS CONSERVANCY

SUBMITTED ON FEBRUARY 2, 2022

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

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

REMAND PREFILED TESTIMONY OF TIM OSTING, P.E.

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REMAND PREFILED TESTIMONY OF TIM OSTING, P.E.

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND OCCUPATION.

A. Tim Dennis Osting, P.E., D.WRE, Principal Engineer, Aqua Strategies Inc.

Q. ON WHOSE BEHALF ARE YOU PRESENTING TESTIMONY IN THIS PROCEEDING?

A. Port Aransas Conservancy.

Q. PLEASE IDENTIFY THE DOCUMENT MARKED AS EXHIBIT PAC-49R TO-1.

A. This is a copy of my resume showing selected recent work.

Q. DID YOU PREPARE THIS RESUME?

A. Yes.

Q. DOES EXHIBIT PAC 49-R TO-1 ACCURATELY REFLECT THE INFORMATION CONTAINED THEREIN?

A. Yes.

PAC offers Exhibit PAC-49R TO-1.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?

A. I received a B.S. in Civil Engineering (1998) from the University of Texas at Austin and an M.S.E. (2007) from the University of Texas at Austin in the Environmental Water Resources Engineering program.

Q. HOW ARE YOU CURRENTLY EMPLOYED?

A. Since July 2014, I have been employed at Aqua Strategies Inc.

Q. WHAT IS THE NATURE OF YOUR EMPLOYMENT?

A. I am the Principal Engineer and Chief Operating Officer. I primarily work on water resources projects. These types of projects include surface water planning and modeling (hydraulics, hydrology, water quality, habitat), environmental flows (bays and estuaries inflows, and instream flows), and field data collection (topography, cross-sections, bathymetry, vegetation, habitat, organism abundance, sediments, etc.).

Q. PRIOR TO JOINING AQUA STRATEGIES INC., FOR WHOM DID YOU WORK?

A. Prior to joining Aqua Strategies Inc., I worked for Espey Consultants Inc. dba RPS (also known as RPS Espey) from September 2005 through June 2014. From September 2001 through August 2005, I worked for the Texas Water Development Board (TWDB) and was Instream Flow Team Leader in the Surface Water Resources Division. From 1998 through September 2001, I worked for Steger and Bizzell Engineering as a designer assisting in survey data reduction, developing plats, construction plans and specifications, and coordinated permitting reviews for local site development projects. Between 1996 and 1998, I worked as a technician at the TWDB assisting with river studies and bay and estuary studies, including field studies, data processing and computer programming.

Q. WHAT WAS THE NATURE OF YOUR EMPLOYMENT WITH RSP ESPEY?

A. At RPS, I was Managing Engineer in the Water Resources group where I worked on water resources projects comparable to those described above associated with my current position at Aqua Strategies Inc.

Q. WHAT IS YOUR AREA OF EXPERTISE OR SPECIALIZATION?

A. I primarily work on water resources projects, particularly environmental flows, hydrology, hydraulics, water quality, field studies, and modeling. I have worked on projects in Texas in close participation with staff from federal, state and local resource agencies.

Q. PLEASE DESCRIBE A FEW PROJECTS THAT ARE INDICATIVE OF YOUR WORK RELATED TO THE WORK YOU WERE ASKED TO DO HERE.

A. Recently, while employed at Aqua Strategies Inc., I participated in a Texas Pollutant Discharge Elimination System (TPDES) permit application process where I used CORMIX to evaluate diffuser design for a plume resulting from discharge of negatively buoyant reverse osmosis reject water. I have participated as an engineering technical consultant or expert witness in numerous civil claims related to hydrology, flooding, sediments, and water quality, including TPDES permitting actions and Texas water rights permitting actions before the State Office of Administrative Hearings.

A. I have been responsible for design of multi-year field data monitoring programs and development of standard operating procedures for state agencies executed by agency staff; measurement of topography, bathymetry, sediments, water flow, water velocity, and water quality in streams, lakes and coastal waters in Texas; and use of the data in models.

A. Recently in coastal environments, I was Aqua Strategies project principal/project manager for several projects and I developed and refined multi-dimensional coastal models, restoration proposals, and designs that each required onsite measurements using Acoustic Doppler Current Profilers, survey-grade Global Positioning System (GPS) instruments, sediment coring devices, water quality probes, and other sampling gear.

A. Four of those coastal projects included: evaluation impacts of proposed jetties at the mouth of the San Bernard River; coastal hydrodynamic modeling, temperature modeling, and channel design related to restoration of Bahia Grande near Brownsville, TX; an alternatives analysis for augmenting freshwater inflow into East Matagorda Bay; and a volumetric survey for bird island restoration in Nueces Bay.

A. I have deployed ADCPs, echosounders, and survey-grade GPS at least 50 times for many projects in stream, lake and coastal areas, as recently as December 2021 in the Brazos River. While employed at Espey Consultants, I completed comparable work at additional

A. locations.

A. While employed at TWDB, I worked primarily on stream studies, but was also involved in coastal studies. In the 2000s I was field safety officer and crew coordinator for the TWDB San Bernard and Cedar Lakes minor estuary survey during which I was responsible for navigating boats and completing measurements using ADCP, GPS, and water quality instruments.

A. For the 1997 TWDB Lower Laguna Madre major estuary study, I installed and maintained automated instrumentation throughout the bay for roughly 6 weeks, and was also responsible for initial setup of ADCP instruments for participating staff with TWDB, TPWD, and USGS, and for computer programming for post-processing of the data.

Q. DO YOU CURRENTLY HAVE A COPY OF THE CORMIX MODEL?

A. Yes.

Q. WHICH VERSION DO YOU HAVE?

A. I have CORMIX 12.0GTH version v12.0.0.0.

Q. HAVE YOU HAD ANY SPECIAL TRAINING ON THE USE OF THE CORMIX MODEL?

A. Yes. In October 2021 I participated in a series of training sessions put on by MixZon, the company that leases the CORMIX model and taught by the owner of the company, Dr. Robert Doneker.

Q. WHY DID YOU TAKE THIS TRAINING?

A. The training had been arranged for Mr. Trungale. When he took another position out of state, I was offered to participate, since MixZon would allow the training to be transferred to me, but not cancelled with reimbursement of PAC for the costs.

Q. ARE YOU ABLE TO EVALUATE THE USE OF THE CORMIX MODEL HERE BASED ON YOUR EDUCATION AND EXPERIENCE WITH IT AND OTHER MODELS?

A. Yes.

Q. HAVE YOU RUN THE CORMIX MODEL FOR THE DISCHARGE PROPOSED HERE?

A. Yes.

Q. HAVE YOU RUN THE MODEL USING THE INPUTS AND ASSUMPTIONS USED BY THE PORT OR THE EXECUTIVE DIRECTOR (ED) OF TCEQ?

A. Yes.

Q. WERE YOU ABLE TO OBTAIN THE SAME RESULTS AS THE ED?

A. Yes, using the ED's inputs my results were essentially the same as the ED's. Minor differences in results I attribute to using a newer version of the CORMIX software.

Q. ARE YOU QUALIFIED TO EXPRESS OPINIONS ON THE USE OF THE SUNTANS?

A. Yes. My education and experience discussed above provides me with that expertise.

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

A. Yes.

Q. WHAT WERE YOU ASKED TO DO FOR PAC?

A. Last July, I was asked to assist PAC in evaluating the use of the CORMIX model, the results of the use, and the limitations on the use of the model. Since then, I have been asked to evaluate the conditions in the area of the discharge, data collected near the location of the discharge from Outfall 001, and to evaluate the use of the SUNTANS modeling for this discharge. I was engaged about the time the Joe Trungale took a job outside of Texas, and I was asked to perform some of the type of work I understand he had done using the CORMIX model for the Port's original application.

Q. WHAT RESOURCES DID YOU RELY ON IN PERFORMING YOUR WORK FOR PAC?

A. I have relied largely on my own education and experience. I have also relied upon some of the work of other experts working for PAC. I have relied upon data and reports provided to me.

Q. WHAT DOCUMENTS DID YOU VIEW IN PERFORMING YOUR ANALYSIS?

A. I reviewed a number of documents, including parts of the Port's amended application, the memo and report of the ED on the agency's modeling, and the CORMIX User's Manual. I reviewed some testimony from the prior hearing and some results of modeling performed by Joe Trungale and Dr. Scott Socolofsky for PAC. I have also reviewed documents prepared by Bruce Wiland. I have reviewed all or parts of depositions and prefiled testimony of some of the experts of the Port, the ED, and PAC. I have reviewed Port documents and data collected in the area of the discharge.

Q. HAVE YOU DISCUSSED YOUR OPINIONS OR THE BASIS FOR THEM WITH OTHER EXPERTS?

A. Yes.

Q. WITH WHOM?

A. Joe Trungale, Bruce Wiland, Dr. Barney Austin. and Dr. Scott Socolofsky. I also participated in one call with Dr. Robert Doneker.

Q. HAVE YOU RELIED ON ANY OF THEIR WORK OR OPINIONS IN DEVELOPING YOUR OPINIONS?

A. I have relied on some processing of the bathymetry data and flow conditions near the location of the proposed discharge, Outfall 001, that I developed with assistance from a staff at Aqua Strategies. I reviewed bathymetry information produced by Mr. Bruce Wiland. However, I developed my opinions on the use of the CORMIX model independently based on my education and experience, the modeling I performed, and my evaluation of condition in the channel in the area of the discharge.

Q. WHY DID YOU TALK WITH DR. DONEKER?

A. I participated in one conversation with Dr. Doneker. PAC had leased the CORMIX model for my use from MixZon, Dr. Doneker's company. As I understand the lease, MixZon provides technical assistance to those who lease it. Dr. Socolofsky or Mr. Lowerre, for him, had set the call and I was asked to participate. Most of the discussions were between Dr. Socolofsky and Dr. Doneker.

Q. DID DR. DONEKER OFFER ANY INSIGHTS TO THE MODEL THAT HAVE INFLUENCED YOUR OPINIONS?

A. He confirmed some of the opinions I had already had initially formed.

Q. WHICH OPINIONS WOULD THOSE BE?

A. He validated my opinions that the saline effluent plume would result in concentrated salinity in features such as the 90-foot hole and that, once on the bottom, the plume or a density current could not drain out by gravity and would not be easily mixed by the ambient water. He confirmed my belief that significant non-uniform flows and the irregular bathymetry of the site associated with the proposed POCCA discharge can limit how the model results should.be interpreted or used. He verified my understanding about the level of field and office work, and type of modeling, that would be needed to evaluate the dilution of the plume in areas of the near and far fields.

II. SUMMARY OF OPINIONS

Q. PLEASE SUMMARIZE THE OPINIONS YOU HAVE DEVELOPED

A. It is my opinion that:

1) the predictions from my modeling of the discharge with CORMIX correctly shows that the mixing of the effluent will be severely limited due to the location of the discharge ports, which will result in significantly higher salinity concentrations at most of the boundaries of the mixing zones in comparison with the results of the modeling by the Port and ED.

2) The CORMIX model correctly predicts one or more concentrated plumes will develop in the far-field, which are results that the SUNTANS modeling here did not and cannot predict.

3) The ADCP data collected by the Port shows significant non-uniform flow in the area of the discharge which raises additional question about how much the ED

should rely on the results of any CORMIX modeling results for the proposed outfall location here.

III. THE RESULTS OF YOUR CORMIX MODELING

Q. PLEASE EXPLAIN YOUR UNDERSTANDING OF THE OUTFALL FOR THE DISCHARGE

A. The Outfall 001 is the location of the actual discharge. That is the location of the 20 ports from which the effluent is discharged. It is often represented by a line on a map, with the center of the line at the location of the outfall. There are actually 20 different ports, each of which discharges effluent, and centered on the that outfall location. That can be confused with the location of the diffuser barrel which, for the Port's discharge, is proposed to be directly under the ports. The ports are connected to the barrel with 20 individual risers or pipes. The barrel, 20 risers, and 20 ports make up the diffuser.

The location of the center of the 20 ports is provided in the application as a specific point set of latitude and longitude figures. This was true for the original application as well and resolves the location issue that was apparently confused by some figures in the original application. However, we have that same problem here.

The amended application identified the discharge location at a depth of 19.5 meters, or about 64 feet, below the surface of the water at mean low tide. That is the depth that the ED uses for the agency's modeling.

However, based on my evaluation of that latitude and longitude for the discharge and the bathymetry data available to me, the location of some of the 20 discharge ports are underground, which would prevent those ports from serving their intended function.

I do not believe the discharge ports will be installed underground where the ports cannot discharge. But if the Port intends to dig or dredge to change the side of the bank and the side or side slope of the hole to place the ports where the application indicates, I have not seen any mention of that in the application. Because of the latitude and longitude for the outfall, I have to assume the ports are where the application claims they will be placed

Q. PLEASE IDENTIFY EXHIBIT PAC-49R TO-2.

A. This is an Exhibit which was prepared by Aqua Strategies staff under my direction to help me visualize the situation at and near the discharge. Because the Port did not provide the type of information that would allow me to determine where the discharge will actually be, if not buried, I wanted to determine what would be reasonable assumptions about the mixing from these ports at its areas nearby. And I was asked to determine the extent of this interaction with the side of the hole, the bank here, and at different distances from the bank.

The composite exhibit provides a map (top left panel), a profile showing the diffuser alignment (top right panel), three profiles perpendicular to the diffuser showing Parsons hypack point data and Parsons contours (bottom left panel), and two zoomed-in repeated profiles (bottom right panel). The map shows the location of Outfall 001 based upon the location from the TCEQ Critical Conditions Recommendation Memo (August 10, 2021), with 2020 NAIP aerial photo background, with Parsons 2 foot contours (adjusted by Bruce Wiland, and here displayed by AutoCAD at 0.5 foot intervals), and selected Parsons bathymetry point data transects extracted from Hypack records for June 8, 2021. That figure also includes drawings of the slope of the bank, which in the area of the discharge is about 19 degrees from horizontal.

The figures show how the bathymetric contours of the bank slope change from east to west along the length of the diffuser. Within one diffuser length east of the Outfall 001 location, that is within 98 feet (30 meters) to the east, the depth of the side slope reduces and gets shallower by 12 feet, i.e. higher in the water than the depth of ports for the outfall. Thus, for an ebb tide, the tide moving out to the east, the plume will for the faster current velocities travel eastward, and this slope will act as a nearby boundary.

This rise in the bathymetry to the east of the outfall is the underwater extension of the point of land coming out from Harbor Island. That rise in the bathymetry east, or toward the Gulf, is shown on Figure 1 in the amended application just after the memorandum from Dr. Tischler. There is another bathymetric high area to the west of the diffuser, which is the extension of the point of land on the other side of the outfall. This rise also causes the plume to divert from the predicted path that the CORMIX modeling predicts.

In fact, these two humps extending south into the channel form a kind of cove in which the outfall is located. This can also be seen on Figure 1 in the Port's application. As I will explain, it is this bathymetry along with existence of the hole extending down from this cove that is the major limiting factor on the use of the results of all runs with the CORMIX model at the boundaries of the mixing zone as reliable. At the mixing zone boundaries, the results are not reliable.

PAC offers Exhibit PAC-49R TO-2.

Q. YOU HAVE USED THE TERMS "BANK" AND SIDE SLOPE, PLEASE EXPLAIN IF THERE IS A DIFFERENCE.

A. I use the terms in similar ways. The bank here is the side of the channel, the slope of Harbor Island as it drops from the dry upland, past the water's edge, continuing down and past the discharge location to the bottom of the channel. I am using side slope to refer to the side of the hole. The side slope which goes around the perimeter and down to the bottom of the hole. So along the bank, the side slope is essentially the bank. Across the hole, I would refer to the side going down into the hole as the side slope.

Q. PLEASE IDENTIFY EXHIBIT PAC-49R TO-3.

A. This is an exhibit that I prepared to illustrate the approximate distance of the diffuser ports from the nearest shoreline. The location of Outfall 001 is approximately 118 feet (36 meters) from the nearest shoreline, toward the north east near the end of the point of land.

The ends of the diffuser barrel are each approximately 138 feet (42 meters) from the shoreline measured perpendicular to the diffuser barrel. The port located at the eastern end of the diffuser barrel is approximately 28 meters to the nearest shoreline, toward the north east near the end of the point of land.

With that information, and some guidance from the Port's original application, I made decisions on how I should model the discharge.

PAC offers Exhibit PAC-49R TO-3.

Q. WHY IS THAT DISTANCE BETWEEN THE DISCHARGE PORTS AND THE SIDE OF THE BANK IMPORTANT?

A. The distance is used as an input to the CORMIX model in cases, such as the one here, where plume interaction with the bank or side slope should be assumed or at least tested with the model. The CORMIX model has the ability to determine if a plume will interact with a bank (or here the side of the hole) and the impacts of such interaction.

Here, the interactions result in worse mixing according to the CORMIX model. The interactions limit the spread of the plume and thus the ability of the plume to mix with ambient water where it contacts the bank or side slope. Thus, the concentrations of salinity will remain higher in the plume than is predicted if these interactions are ignored, as was done in the modeling of the Port and the ED.

Q. PLEASE IDENTIFY EXHIBIT PAC-49R TO-4.

This exhibit is a set of five figures that illustrate the proposed location of diffuser ports with respect to the observed channel bottom Parsons bathymetry data points, along with how the CORMIX model represents the location of the discharge ports with respect to the channel bottom.

The first Figure 04(a) illustrates that the ED set up inputs to the CORMIX model (green shaded box) such that the ports are located above the CORMIX maximum depth at the ports and 229 ft (69.4 meters) away from the bank. Figure 04(b) is a visualization of an ED critical conditions CORMIX file using CorSpy, a program included with CORMIX, that allows a user to see how the model is representing the user's model inputs, specifically the diffuser dimensions and position related to the water surface, banks and slopes.

The CORMIX model setup by the ED characterizes the channel bed as being flat with a vertical bank—here essentially a wall—located 229 feet away. The CORMIX set up configuration (Figure 04(b)) is different than the observed bathymetry that shows the ports at the bank (Figure 04(a)). The ED set up is for the function in CORMIX referred to as the conservative model. That set has to be different for the brine modeling that I will discuss below.

Figure 04(c) illustrates how the location of the vertical bank was varied from 3 meters to 34.9 meters for my CORMIX model runs with the conservative modeling I describe below.

Figure 04(d) illustrates the port's location and depth with respect to the Parsons bathymetry data points using the same data as Figure 04(a) but on an unexaggerated horizontal and vertical scale. Figure 04(e) is a visualization using CorSpy of a new CORMIX run using the brine module that allows a side slope.

PAC offers Exhibit PAC-49R TO-4.

Q. WHAT DOES THE CORMIX MODEL PREDICT IF THE BANK INTERACTION IS CONSIDERED?

A. At the 0.8 meters per second channel velocity and for the 40.7 salinity concentration used by the Port and ED for the ambient conditions in many of their CORMIX runs, the table below provides my results for the seven runs with the conservative model, my one run with the brine modeling and one of ED's runs. These were all run with the conditions of 50% production, using the 5th percentile for temperature and 95th percentile for salinity. I ran the model with the different distances between the discharge and the bank/wall, as shown in the left column labeled Dist_m, and as shown in Exhibit PAC-49R TO-4(e). The conservative model used by the ED and me requires the placement of a wall to represent the bank.

Table 1. CORMIX Effluent Percentages for varying bank distances and slope; ambient velocity 0.80 meters per second

	%Effluent			**Resulting Salinity (ppt)**			**Salinity increase over ambient (ppt)**		
Dist_m	%effZID_28m	%eff100	%eff200	SalZID28m	Sal100m	Sal200m	dSalZID28m	dSal100m	dSal200m
0	53.60%	37.60%	19.90%	**55.65**	**51.15**	**46.17**	15.08	10.58	5.60
3	30.30%	18.70%	7.83%	**49.09**	**45.83**	**42.77**	8.52	5.26	2.20
5	30.30%	18.70%	7.83%	**49.09**	**45.83**	**42.77**	8.52	5.26	2.20
10	20.41%	11.90%	5.28%	**46.31**	**43.92**	**42.06**	5.74	3.35	1.49
15	17.20%	9.81%	4.39%	**45.41**	**43.33**	**41.80**	4.84	2.76	1.23
34.9	14.30%	8.06%	3.78%	**44.59**	**42.84**	**41.63**	4.02	2.27	1.06
69.8	**14.10%**	**7.87%**	**3.75%**	**44.54**	**42.78**	**41.62**	**3.97**	**2.21**	**1.05**
BRINE	**15.1%**	**8.49%**	**3.93%**	44.82	42.96	41.68	4.25	2.39	1.11
ED results 8/23/2021									
69.8	**14.6%**	**8.25%**	**3.91%**	44.68	42.89	41.67	4.11	2.32	1.10

With the bank more distant than 15 meters (49 feet), the plume exhibits similar percent effluent characteristics as the ED simulation with the bank at 69.8 meters.

Using CORMIX GTH 12.0 and a selection of files produced by Dr. Tischler with timestamp 06/23/2021, I was able to recreate the dilution results reported by both Dr. Tischler and by the ED's Katie Cunningham. Because I am using a newer version of the model than both the ED and Dr. Tischler used (they both used version 11), my model shows slightly different results.

Q. WHAT IS THE DIFFERENCE IN THE CONSERVATIVE AND BRINE RUNS WITH THE CORMIX MODEL?

A. The brine runs cannot include the bank as a wall, but allow it to use a sloping bank. My brine run uses a 19° side slope. That model resulted in comparable effluent percent as, although higher percent effluent than, the ED's model and higher percent effluent than my new 15 meters bank distance model.

What is critical to understand is that it is important to run both conservative and brine modeling for the type of concentrated brine discharge proposed by the Port. Neither set of runs can provide the right numbers where there are the types of flow and bathymetric conditions here. Both sets of runs provide information on what may occur.

Q. ARE THERE OTHER CONSIDERATIONS, BESIDES THE BANK AS A WALL OR AS A SLOPE?

A. Yes. Because the Port has moved the outfall into the cove, which will result in the plume contacting the humps or extensions of the points of land, any results of modeling with CORMIX have even more complex issues. The path of the plume for the faster channel velocities will not be the path the model predicts. The model cannot provide reliable figures for the percentage of effluent at the mixing zone boundaries.

Q. ARE THERE OTHER FACTORS YOU CONSIDERED IN DETERMINING WHAT CONDITIONS TO MODEL?

A. Yes. In addition to the modeling with the conservative model with the wall backed away from the outfall location, I was asked by PAC to assume the Port could move the location and analyze what the CORMIX model would predict at other locations. Those locations are the same as identified in my chart above. The results will be similar, if not the same, were the discharge moved, but not the wall.

Q. ANYTHING ELSE YOU DID IN YOUR MODELING?

A. Yes, I reviewed information in the original application, testimony by Dr. Tischler and information in PAC-49R TO-2, PAC-49R 03, and PAC-49R 04.

For example, in the original application, the Port did identify a range of riser heights for its modeling and design of the diffuser. The range is between 10 and 15 feet high (S App 0000358). And on page S APP 0000355 of the original application, after discussing the location of the discharge the application notes, “In addition, due to the presence of the Ship Channel, appropriate measures should be considered to protect the diffuser and ports.”

In his deposition, Dr. Tischler discussed riser heights of 3 or 4 meters. He also agreed that there are design considerations such as the torque that would result from the 8.2 meter velocity of the discharge out of the 20 ports which is a high velocity for diffusers, it is about 18 miles per hour.

As a result, I was comfortable with the distances from the outfall to the wall that I used. There are some physical limits on the length of risers and where the ports could be moved farther from the bank.

Q. PLEASE EXPLAIN EXHIBIT PAC-49R TO-6.

A. This exhibit is a collection of visualizations for the results of a CORMIX brine model I completed to consider the discharge ports proximity to the side slope. The results of that model run are tabulated in Table 1 in the row labeled brine.

PAC offers Exhibit PAC-49R TO-6.

Q. HOW WOULD YOU DESCRIBE THAT CORMIX MODEL YOU RAN?

A. To set up this CORMIX brine model, I used bank slope of 19 degrees. The effluent and ambient conditions scenario is based upon ED’s model run S_50_b_95, which is the 50% efficiency summertime temperature 5 percentile and salinity 95 percentile condition with ambient velocity of 0.8 meters per second. My results that are visualized are my new model run that I called S_50_b_95_brine2 (shown on the figures).

Q. WHAT DO THE VISUALIZATIONS OF MODEL RESULTS SHOW?

A. Because no single figure can provide a 3D view on flat paper, the exhibit includes four visualization figures that taken as a whole explain how the CORMIX model predicts the plume to behave in the model.

Exhibit PAC-49R TO-6(a) is a three-dimensional (3D) view from the air above the channel looking downward and generally toward the north east. This figure shows that in the near field the plume turns immediately downstream with the direction of the ambient current – here to the east or out toward the Gulf – with the plume initially as a narrow thin band attached to the side slope of the channel bank and extending upward to nearly the water surface. Then at approximately 100 meters at the line dividing the model near field region from the model far field region, the plume sinks down to form a layer or plume on the bank and spreads, traveling downgradient with gravity, along the slope of the bank as a density current.

The percent of effluent within the plume is shown with a color gradient. The color gradient scale, shown on the bottom left labeled "Discharge Excess (%)" shows diluted water with percent effluent of 1% as darker blue, with lower dilution high percent effluent of 100% as red. Areas of the plume prediction in the near field region showing as yellow and green range from 20% to 4% percent effluent, and areas in the far field region are generally blue and less than 2% effluent.

Q. PLEASE EXPLAIN THE DEPTH CONTOURS SHOWN ON THAT FIGURE.

Depth contours are shown on the flat plane side slope that CORMIX used to predict the plume. As discussed earlier, the bottom slope in the model is different than the complex depth patterns observed in the ship channel. Those observed patterns are not replicated in the model because the model cannot consider how the complex natural bathymetric contours extend and cross the path of the plume.

The model predictions on the simplified slope indicate a path of the plume in the model that, if the plume were in the ship channel, would mean it have to go underground – under the hump or arm of the cove within roughly 30 meters downstream were the plume to follow the path predicted by CORMIX.

Q. WHAT IS THE NEXT FIGURE LABELED CROSS-SECTION VIEW?

A. Exhibit PAC-49R TO-6(b) is another view of the same model result. This exhibit is a cross-section view, as if looking eastward, downstream toward the Gulf. The channel side slope is shown on the bottom, with the diffuser and ports shown near and just above the side slope emitting the plume. The plume remains in a narrow band parallel to the diffuser because it is swept downstream by the 0.8 meter per second ambient velocity ebb current in the channel. After the plume loses vertical momentum from emitting from the ports at over 8 meters per second, the plume falls to the bottom and spreads as a layer down the side slope as well as downstream out of view.

Q. WHAT ARE THE FIGURES LABELED SIDE VIEW?

A. Exhibit PAC-49R TO-6(c) is a side view of the same CORMIX prediction result, as if looking toward the north shore from the center of the channel. This perspective shows how the plume emits from the ports located near the bank and extends from the bottom to the water surface until the end of the near field region transitions to the far field region. The plume then settles to the bottom in a density current in the far field region.

Exhibit PAC-49R TO-6(d) is the same figure as TO-6(c) except with text labels showing the percent effluent at the location of the text. The labels indicate values that are consistent with the "Discharge Excess (%) color gradient." At approximately 20 meters downstream from the center of the diffuser, the percent effluent is labeled as 16.00 per cent at the centerline of the plume.

At approximately 100 meters downstream from the center of the diffuser, at the location where the near field region meets the far field region, the percent effluent at the surface is 4.43 per cent, 8.00 per cent at the centerline, and 4.43 percent at the bottom. At approximately 120 m where the plume has sunk to the bottom, the percent effluent at the centerline is 5.10 per cent.

These details are hard to see on a single figure, so the collection of figures is needed.

Q. WHAT IS THE RESULT OF THE USE OF THE DISTANCES TO THE DISCHARGE PORTS THAT THE PORT AND ED USED?

A. As my modeling shows, distances of 200 feet or more that the Port and the ED used show essentially no interaction with side slope of the hole/bank. Thus, based on their schematized channels, the Port and the ED, show better mixing when the ports are farther from the side slope compared to my new model predictions for the location of the discharge in the application reflecting more realistic distances to the side slopes of the hole.

Q. PLEASE EXPLAIN WHY YOU CAN USE THE DISTANCE TO THE BANK IN THE CONSERVATIVE MODEL RUNS.

A. The CORMIX model has been developed to investigate plume interaction with a bank. Because banks, channels and bottoms of rivers, lakes, bays and the ocean are not uniform, the user of the model has to schematize the channel to conditions that the model can use. Schematization is the choice of ambient water geometry, and the location of the diffuser within that ambient water body. Schematization is required and is addressed by the CORMIX User's Manual. That manual recognizes limits on such efforts to fit irregular channels into rectangular cross sections and such.

The schematization by the Port and the ED assumes for modeling that the channel has a flat bottom and a vertical wall on the left side (see PAC-49R TO-4).

My schematization also assumes the flat bottom and one vertical wall as the bank on the left side, but puts the location of the wall at the location of the bank where the discharge has been located. That is, the bank or side slope is located near the diffuser ports (e.g., see Table 1 for Dist_m = 0.0 and 3.0 meters). Moving the wall away from the outfall or vice versa (e.g. see Table 1 for increasing distances 5, 10, 15, 34.9 meters) allows me to understand the reduced potential for plume interaction at further distances from the wall and thus the bank.

Q. DOES YOUR SCHEMATIZATION ADDRESS ALL OF THE SIGNIFICANT BATHYMETRIC OR FLOW CONDITONS AT OR NEAR THE LOCATION OF THE DISCHARGE PORTS?

A. No, and that is not unusual. For example, hole cannot be addressed with schematization., The model can only represent simple geometry. Likewise, some flow conditions cannot be schematized, like unsteady flow or non-uniform flow exhibited in the channel near the proposed diffuser location. Those conditions need to be identified when any model is performed so they can be considered in determining whether the modeling results are conservative or reliable.

Schematization is appropriate for some aspects of the evaluation of the plume movement, like in open water areas distant from any side slope, bank or wall. Once the plume contacts a side slope of the hole away from the bank, the model cannot simulate the resulting plume interactions.

As the bathymetry data shows that the plume will not only interact with the side of the hole at or in short distances from the last of the ports, but it then, interacts with the underwater extensions of points of land on either side of the discharge location which are above the height of the centerline of the plume for some of the velocities in the current. For lower velocities, the plume will contact the sides slopes in other parts of the hole, further out into the channel.

Again, even with the schematization that I have used to develop my figures in the chart above, there remains issues of whether there will be worse mixing (increased percent effluent near the diffuser ports) because of additional interactions of the plume with the arms of the cove or further around on the side slopes of the hole to the south.

Q. HOW DOES THE NEW OUTFALL LOCATION COMPARE TO THE ONE IN THE ORIGINAL APPLICATION?

A. Due to such conditions, it is my opinion that the new location for the proposed discharge is worse for mixing. It is certainly worse for using the CORMIX model to determine mixing results.

While the CORMIX model can be used here, the plume interactions with the sides of the hole, and flow conditions in the area, suggest that the modeling for the Port's currently proposed location and other locations in my chart may not produce the actual worst-case scenario for salinity concentrations in the mixing zones.

Q. SHOULD THE CORMIX MODEL BE USED FOR THE PROPOSED DISCHARGE?

A. Yes. The predictions from the modeling provide valuable information. The predictions provide a good estimate of where the plume will interact with the north side of the hole, and where the plume will fall and intersect the east and west side of the hole. The model can be used to estimate the mixing that will occur and provide a basis for determining the concentrations of salinity when there is such interaction.

As the plume moves away from the bathymetry of the cove, the non-uniform flow conditions that I discuss below can again alter the mixing. The mixing will change when the plume then contacts the southern sides of the hole.

Again, except for conditions along the bank, it is my opinion that the results of the modeling with the CORMIX model are not reliable after the point the model predicts the plume continues through a low elevation area that, in the field, exists at a high elevation. That occurs before the plume gets to all of the mixing zone boundaries, and often before it gets to the ZID or ALMZ boundaries

However, I do agree with the model predictions in what the CORMIX model refers to as the far field. This is where the plume has fallen to the bottom and created a layer of water on the bottom of the channel. Since the velocities of the currents are evaluated by the model down to a 90 foot depth and the model does not predict the plume will be well mixed before it pancakes or flattens on the bottom, I have no reason to doubt that plumes with salinity concentrations of as low as 1 or 2 ppt and as high as 15 ppt in places will develop and move as one or more density currents into the shipping lane and across it for some distance.

Also, during some conditions when the plume depth is predicted by the CORMIX modeling to be lower than 64 feet (19.5 meters), the plume will intersect with the side slopes of the hole regardless of the direction of the plume and result in the hole filling with denser effluent water that contacted the side slope. That the same time some of the plume overflows into the shipping lane.

IV. OPINIONS REGARDING THE RESULTS OF THE SUNTANS MODEL

Q. PLEASE STATE YOUR OPINION ON THE USE OF THE SUNTANS MODEL FOR THIS DISCHARGE

A. It is my opinion that the SUNTANS modeling did not predict the type of density currents that the CORMIX model predicted because the SUNTANS model was not set up with the level of resolution needed to predict these types of plumes. I have the same opinion with regard to the type of salt mass balances or other efforts to spread into the SUNTANS model the amounts of salts from the discharge in the short or long-term.

Q. WHAT IS THE BASIS FOR YOUR OPINION?

A. The SUNTANS model does not have and would need to have a higher resolution grid (e.g. more smaller triangles) in the area of the ship channel to reflect the narrow width of the plume in these bottom layers within a kilometer of the diffuser. The SUNTANS model may be correct on the issue of whether salinity concentrations build up throughout the Corpus Christi Bay system, but the SUNTANS modeling here cannot predict what happens with salinity concentrations in the near field, the transition zone or the far field, to the extent the CORMIX model predicts far field conditions.

Those far field conditions occur when the plume has collapsed on the bottom of the channel. The model predicts that to happen generally within the Human Health Mixing Zones. As can be seen in on the first two figures in PAC-49R TO-6, that is true for the CORMIX brine modeling I performed. At distances of about 100 meters, the modeling shows the plume, which has spread toward the surface of the water, transitioning as it collapses to a thin plume on the bottom of the channel.

V. OPINIONS BASED ON THE ADCP DATA

Q. HAVE YOU REVIEWED THE ADCP DATA COLLECTED BY THE PORT?

A. Yes.

Q. WHAT INFORMATION DOES IT PROVIDE RELEVANT TO YOUR OPINIONS HERE?

A. The Acoustic Doppler Current Profiler (ADCP) data coupled with GPS and echosounder depth data shows that there is significant non-uniform flow in the area of the discharge during both ebb and flood tides, at least for the conditions there during the three days in June of 2021 when the data was collected.

Q. PLEASE IDENTIFY EXHIBIT PAC-49R TO-5.

A. This is an exhibit containing four pages that I prepared using Parsons field data and excerpts from the Parsons Field Sampling Technical Memorandum dated June 24, 2021. It is a collection of maps showing Parsons bathymetry and ADCP data points overlaying aerial photos, the outfall/discharge location, the mixing zones, and the diffuser.

PAC offers Exhibit PAC-49R TO-5.

Q. WHAT DO THE FIGURES SHOW?

A. On Figure PAC 49R-TO-5(a) the ADCP ensemble numbers are indicated, allowing identification of the discharge location (red diamond), diffuser (heavy blue line), zone of initial dilution (ZID) and velocity color contours on the ADCP figures excerpted from the Parsons Sampling Technical Memorandum.

Figure PAC 49R-TO-5(b) illustrates the location of the diffuser near ADCP ensemble number 4913, and the ZID near 4890.

Figure PAC 49R-TO-5(c) shows that the velocity during this flood tide in a blue color of approximately 0.25 meters per second in the vicinity of the diffuser and inside the ZID. This is slower roughly half the velocity in the mid-channel where green indicates 0.5 meter per second. A comparable pattern is exhibited for an ebb outgoing tide shown on Figure TO-5(d). The velocity changes significantly, increasing going north to south.

Based upon T4 and T1 ADCP transects that bracket the proposed diffuser location, velocity near the proposed discharge is typically half of velocity in the main channel. This is indicative at T4 for both ebb and flood tide on June 8, 2021. Ebb tide is shown in the figures.

The velocity frequency distribution in the shipping lane of the ship channel adjacent to the area of proposed discharge is approximated by the Port and the ED using the Parsons analysis of data from Aransas Pass Main Entrance Channel in 2019. However, based on ADCP data in the in the channel near the outfall location, the frequency distribution of velocity across the entire channel varies with a consistent bias.

Near the north bank closest to the proposed outfall location, the velocity was observed to be approximately one-half of the velocity in mid-channel farther from the outfall location. Because of this, the CORMIX model results, which were developed by the ED and which rely upon an ambient velocity based upon using 0.8 meters per second as a median velocity across the channel, are not a suitable assessment of the ambient velocity within the ZID. In fact, the ambient velocity within the ZID may be different than the ambient velocity in other mixing zones. The variability of flow in this area is referred to as non-uniform flow.

Q. WHAT IS THE SIGNIFICANCE OF SUCH NON-UNIFORM FLOW?

A. CORMIX does not simulate a plume under non-uniform ambient flow conditions. The model assumes uniform flow, i.e., all ambient velocity is the same and in one direction from top to bottom of the channel and horizontally also. As with a rectangular schematization of a channel that in the field is not regular or rectangular in shape, variation in ambient velocity can be considered, but some variation in ambient velocity will need to be ignored to rely on the predictions from the model that pass through multiple zones of different ambient velocity.

So, for example, the CORMIX model cannot model an eddy, which has non-uniform flow. Nor can CORMIX model the movement of a dense body of high salinity concentration water out of a hole surrounded by higher channel elevations like conditions evident in the 90 foot hole.

Q. WHY DOES THIS MATTER?

A. The ADCP velocity data attached to the Parsons hypack bathymetry point data indicates a reduced velocity field near the north bank for both incoming and outgoing tide at the proposed location of the diffuser. The reduced velocity occurs a distance within 50 meters toward the center of the channel from the proposed diffuser. This distance is coincident with the existence of a submerged bathymetric feature near a visible land extension or “point of land” extending from north shore southward toward the proposed location of the diffuser.

The reduced velocity in the near field of the diffuser compared to mid-channel velocity indicates that (1) the frequency occurrence of velocity measured elsewhere may not be indicative of frequency of occurrence of velocity near the proposed diffuser and (2) that the proposed discharge plume will likely encounter a near-port ambient velocity and then a different ambient velocity some distance away from the ports.

The variability in velocity fields, or non-uniform flow, cannot be analyzed using CORMIX. The discharge plume travels through two different ambient velocity conditions.

Despite this and considering the model limitations, CORMIX can still be used to evaluate a range of conditions and mixing for such conditions. The predictions from the model just need to be considered in light of what the model predicts for different conditions and what the model cannot address.

The complexity of the bathymetry of the site and non-uniform flow conditions as I have described make any use of the CORMIX model results unreliable at key locations, such as at some of the boundaries of the mixing zones or at 110 and 200 meters. This is because of the very close proximity of the diffuser ports to the side slope of the channel and to the deeper waters in the hole. This is the location the Applicant has proposed for its discharge and that location is the problem, not the model.

Here the Applicant and ED have oversimplified a complex system in the use of CORMIX for the current proposed location of Outfall 001. Considering the bathymetric reality, the location should be evaluated in a more robust way, with much more information on flow conditions and more detailed evaluations of the bathymetry. The consequence of using the ED's CORMIX model runs that do not adequately reflect the current proposed outfall location is that the actual dilution at the mixing zones is anticipated to be much higher than the ED expects.

This proposed discharge site cannot be assessed with a few days of data collection and a month of analyses. More detailed bathymetry would be needed to reach reliable conclusions. A real investigation of eddies and other causes of the non-uniform flow is needed.

Alternately, the discharge can be moved to a location that is more appropriate for the use of the CORMIX model. There appear to be some suitable locations, south of the cove or farther east. In any case, the location should also be away from the hole.

I am not endorsing any site; I do not know what the CORMIX model would predict for any other location. But there are clearly better locations nearby if the Port and ED intend to rely on the CORMIX model to determine the mixing of the effluent by the current proposed diffuser or any diffuser.

VI. CONCLUSION

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes. I reserve the right to change my opinions based upon availability of new information.