



Nueces Delta Environmental Monitoring Project

Final Report

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Nueces Delta Salinity Effects from Pumping Freshwater into the Rincon Bayou

INTRODUCTION

This project's focus is monitoring the hydrological effects of the Rincon Bayou Pipeline (RBP) in the Nueces Delta near Corpus Christi, Texas (**Figure 1**). This report highlights trends in salinity changes throughout pumping events and provides a detailed look at the effects seen during the 2022-2023 sampling year (September 1, 2022 to August 31, 2023). The results of this study are used for the continual adaptation of a water management plan that will help water managers make decisions on quantity, timing, and duration of pipeline inflows that are most productive and important to the ecology of the Nueces Delta.

The Nueces Delta has been a scientific research focus due to its hypersaline condition (Matthews and Mueller 1987; Whitley and Stockwell 1995; Montagna et al. 2002; Palmer et al. 2002; Montagna et al. 2009; Hill et al. 2011; Nueces BBEST 2011; Nueces BBASC 2012; Hodges et al. 2012). Because of watershed impoundments, riverbank modifications, and increased urbanization along the Nueces River, the Nueces Delta is no longer connected to the Nueces River, except through the Nueces River overflow channel that was permanently opened in 2001. Because of these factors, the majority of freshwater flow is diverted from the river directly to the bay, bypassing the delta. The only natural means of freshwater flow through the Nueces Delta is during severe flooding events or local heavy rainfall causing the flow to over bank into the delta (BOR 2000; Pulich et al. 2002; Hill et al. 2011). Decreased inflows into the delta and prolonged Texas droughts have caused frequent hypersaline conditions in the Nueces Delta. Freshwater inundation within the Nueces Delta over the past 30 years has been insufficient in volume and distribution to maintain a healthy marsh, the lack of sediment loading in the system is leading to the delta front eroding into Nueces Bay, the marsh plants are under stress, and the connectivity of aquatic habitat is threatened (Hodges et al. 2012).

In the 1990's, studies found these hypersaline conditions could harm the ecological and biological processes of the marsh and degrade the overall health of the Nueces Estuary. This impact evoked the state of Texas to develop an inflow criterion for freshwater inflows (Dunton and Alexander 2000; Montagna et al. 2002; Palmer et al. 2002). The resultant 2001 Agreed Order, from the Texas Commission on Environmental Quality (TCEQ), requires the City of Corpus Christi (City) to provide no less than 151,000 acre-feet (186,255,757 m³) per year to the Nueces Estuary (TCEQ 1995). Each month the City is required to "pass through" inflow to the Nueces Estuary equal to the measured instream flow into the Choke Canyon Reservoir/Lake Corpus Christi Reservoir System up to a target amount (TCEQ 1995). The target amount varies by month and is calculated based on the combined storage volume of the Reservoir System. The City may receive credits for excess flow from the previous month or from relief credits based on salinity measured at the SALT03 monitoring station in Nueces Bay (Montagna et al. 2009).

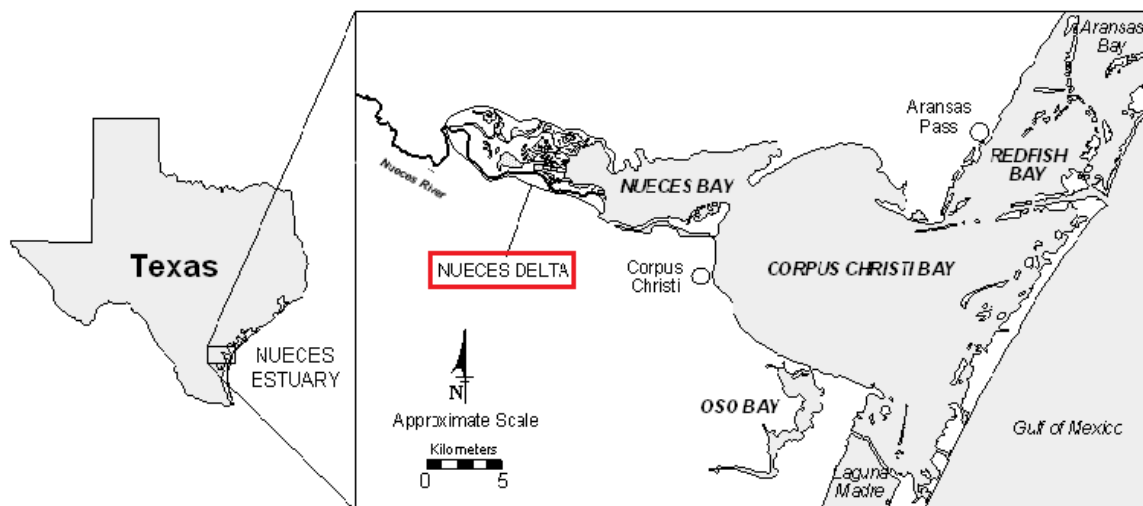


Figure 1. Location of the Nueces Delta within Texas and the Nueces Watershed.

To efficiently deliver freshwater to the Nueces Delta, the City built the Rincon Bayou pump station and pipeline (RBP) to divert up to 3,000 acre-feet (3,700,446 m³) of required “pass throughs” directly to the upper Rincon Bayou in the Nueces Delta. The RBP became operational in November 2007. The RBP pump station includes three 350 horsepower mixed flow submersible pumps capable of moving up to 60,000 gallons per minute with all three pumps operating (**Table 1; Figure 2**). The number of days to deliver a given volume of freshwater through the RBP depends on the number of pumps used.

Table 1. Capacity of the Rincon Bayou Pipeline

	Number of Rincon Bayou Pumps in Operation		
	1	2	3
Flow, gallons/minute	28,000	46,000	60,000
Flow, cubic feet/second	62	102	134
Flow, acre-feet/day	124	203	265
Total kW	230	455	675

This project’s principal objective is to maintain environmental data collection stations measuring water quality parameters in the Nueces Estuary as a result of the freshwater releases of the RBP. The data collected during this period is made available to CBBEP personnel in support of the Rincon Bayou Pipeline Management Plan which helps water managers make decisions on quantity, timing, and duration of pipeline inflow events that are most productive and significant to the ecology of the Nueces Delta. This report focuses on identifying the RBP freshwater

inflows events in the Nueces Delta and provides data collected between September 1, 2022, and August 31, 2023.



A)



B)

Figure 2. View of RBP pumping facilities depicting A) the intake pumps located on the Nueces River above the Calallen Dam and B) the pipeline outfall in the Rincon Bayou. Photos taken by Jace Tunnell.

METHODS

The Coastal Bend Bays & Estuaries Program (CBBEP) contracts this salinity-monitoring project to the Conrad Blucher Institute for Surveying and Science (CBI) at Texas A&M University - Corpus Christi (TAMU-CC). This project includes three environmental data collection stations.

Nueces Bay Weather Station (NUDEX), Nueces Delta 2 (NUDE 2), and the Nueces Bay Water Level (NUDEBAY), are all monitoring various conditions within the Nueces River Delta and bay. (Figure 3)

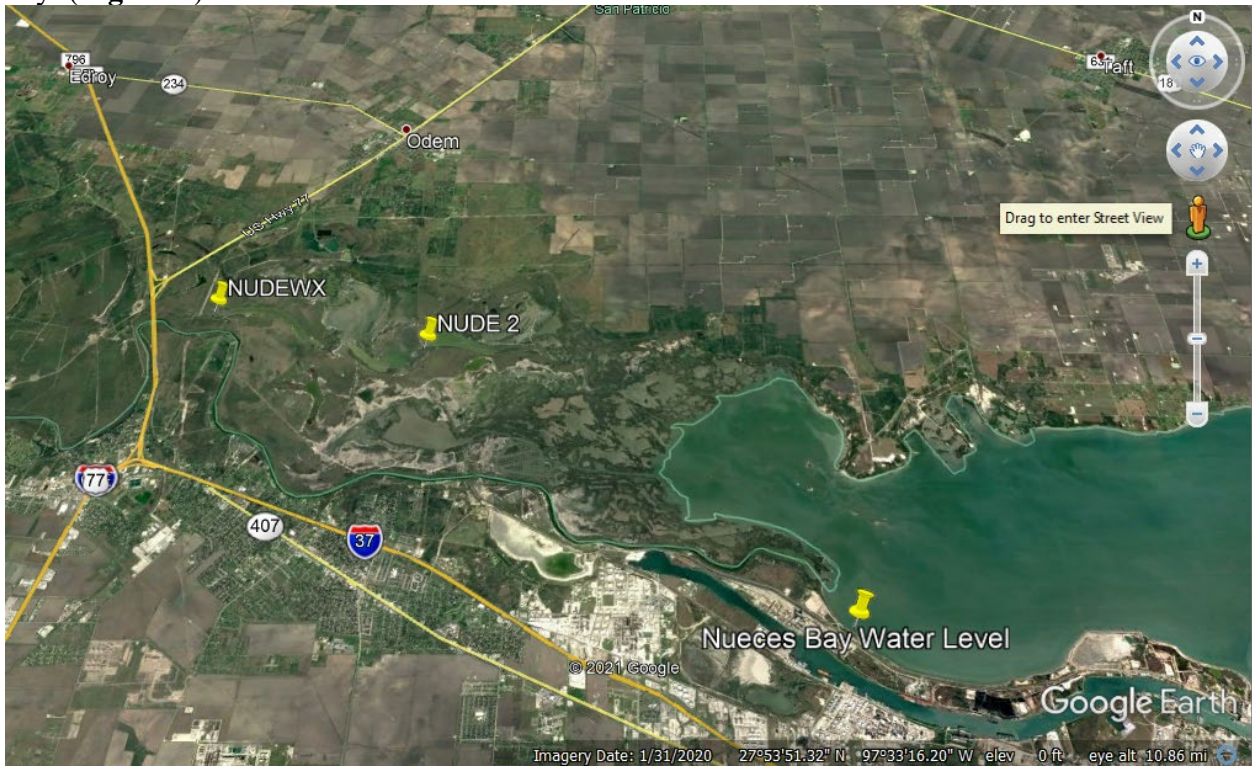


Figure 3. Map of the three environmental monitoring stations (NUDE2, NUDEWX, and NUDEBAY).

The Nueces Delta Weather Station (NUDEWX) is located on Rincon Bayou downstream from the RBP outfall (27.897582°N, -97.616524°W). The station measures wind speed (m/s), wind direction (°), barometric pressure (mbar), precipitation (mm), relative humidity (%), and solar radiation (cal/cm²/min). The CBI performs a monthly maintenance to NUDEWX including a rain gauge calibration check. NUDE2 is in the middle reach of Rincon Bayou and measures conductivity and water temperature while the Nueces Bay Water Level station measures water level (m), wind speed (m/s), wind gusts (m/s), wind direction (°), and barometric pressure (mbar). NUDEBAY 185 is serviced annually following standards established by NOAA CO-OPS (<http://tidesandcurrents.noaa.gov/>). The NUDE 2 uses a of Hydrolab® CMS5 water quality datasonde interfaced with cellular IP modem and is serviced monthly. The station is polled by an automated computer program designed and implemented by the Information Technology staff at CBI. Data is stored in CBI's database and available via the project webpage at <https://lighthouse.tamucc.edu/stnlist/>. The Hydrolab® CMS5, at NUDE 2, measures water quality parameters: water temperature (°C), specific conductance (µS/cm), and salinity (ppt). Activities are performed in accordance with the EPA approved Quality Assurance Project Plan (QAPP).

RESULTS AND DISCUSSION

From September 2022 to July 2023, the Nueces River Authority reported 2 major pumping events totaling 15,217 acre-feet (Table 2 and Figure 5). At the time of this report, the August pass thru information was not available on the Nueces River Authority website.

Table 2. 2022-2023 Rincon Bayou Pumping Events

Year	Pumping Event	Dates of Event	Duration (days)	Avg. water level (m above MSL)	Acre-Foot Pumped
2022-2023	83	Sep. 7 to Oct 9, 2022	32	0.44	6,158
	84	May 16 to July 20, 2023	65		9,059

Local rainfall varied spatially between the National Weather Service (National Weather Service 2018) at Corpus Christi International Airport (CRP) at 27°46'22.43"N, 97°30'8.47"W and at NUDEWX at 27°53'50.47"N, 97°36'58.73"W with more rainfall frequently occurring at CRP (Table 3). NUDEWX is approximately 11 miles northwest of CRP and is located directly in the Nueces Delta. Despite the regional difference in rainfall, both locations recorded slightly different rainfall trends, but were representative of the general meteorological conditions in the Nueces Delta watershed.

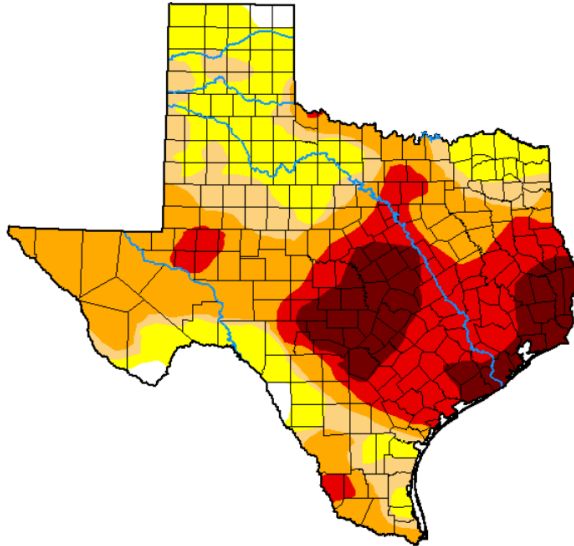
**Table 3
Total rainfall per 2022-2023 sampling year for NUDEWX and CRP.**

	2022-2023
NUDEWX	23.4_in
CRP	31.58 in

The 2022-2023 sampling period 31.58 of rainfall was recorded at CRP, and 18.2 at NUDEWX.

**U.S. Drought Monitor
Texas**

August 29, 2023
(Released Thursday, Aug. 31, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.55	98.45	75.83	61.41	32.33	12.64
Last Week 08-22-2023	4.13	95.87	78.71	62.10	33.99	11.67
3 Months Ago 05-30-2023	39.95	60.05	33.52	16.16	4.71	0.29
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 08-30-2022	9.53	90.47	76.03	52.48	26.38	5.28

Intensity:
 None (White) D2 Severe Drought (Orange)
 D0 Abnormally Dry (Yellow) D3 Extreme Drought (Red)
 D1 Moderate Drought (Light Orange) D4 Exceptional Drought (Dark Red)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

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Western Regional Climate Center



droughtmonitor.unl.edu

Figure 4. Drought condition figure throughout the state of Texas 2023, which will generally be representative of drought, conditions throughout the 2022-2023 sampling year.

As indicated in Figure 4, the state is in an extreme dry drought. As of August 29, 2023, Lake Corpus Christi reservoir level was 57.84% of capacity while Choke Canyon reservoir was 27.91%.

Salinities recorded at NUDE2 generally dropped shortly after a pumping event was initiated and gradually increased after the end of a pumping event (Figure 5 and 6).

Singular Pumping Event (September 7 to October 9, 2023)

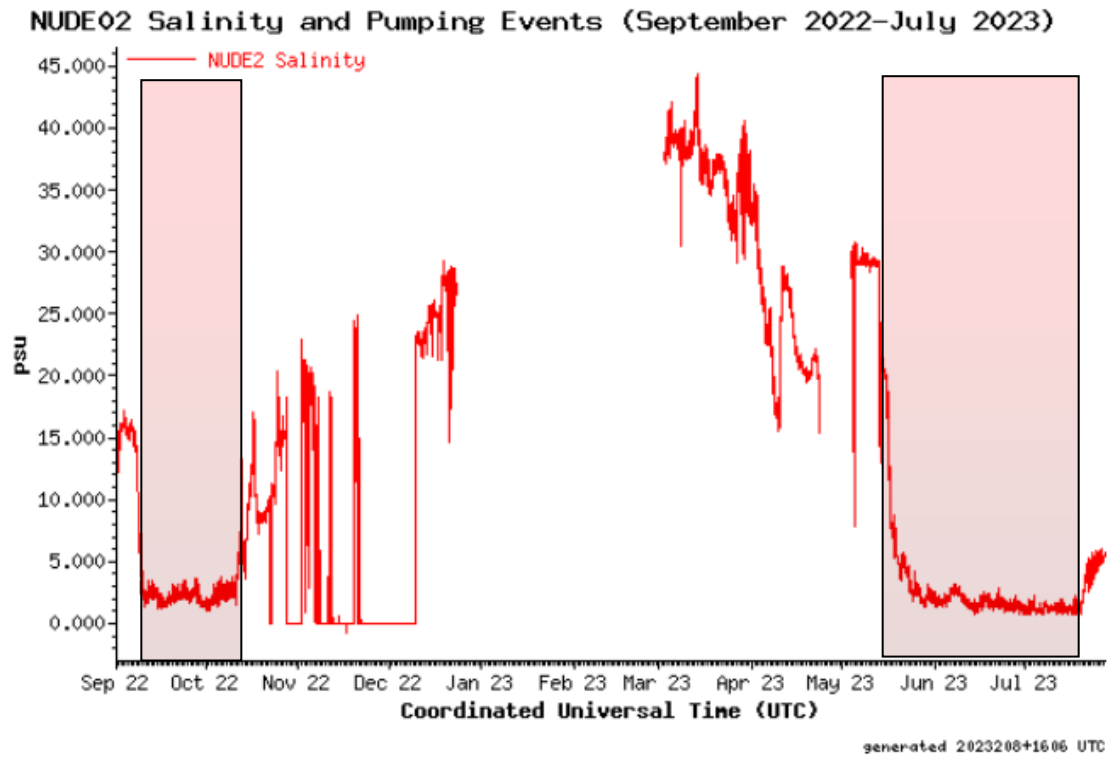
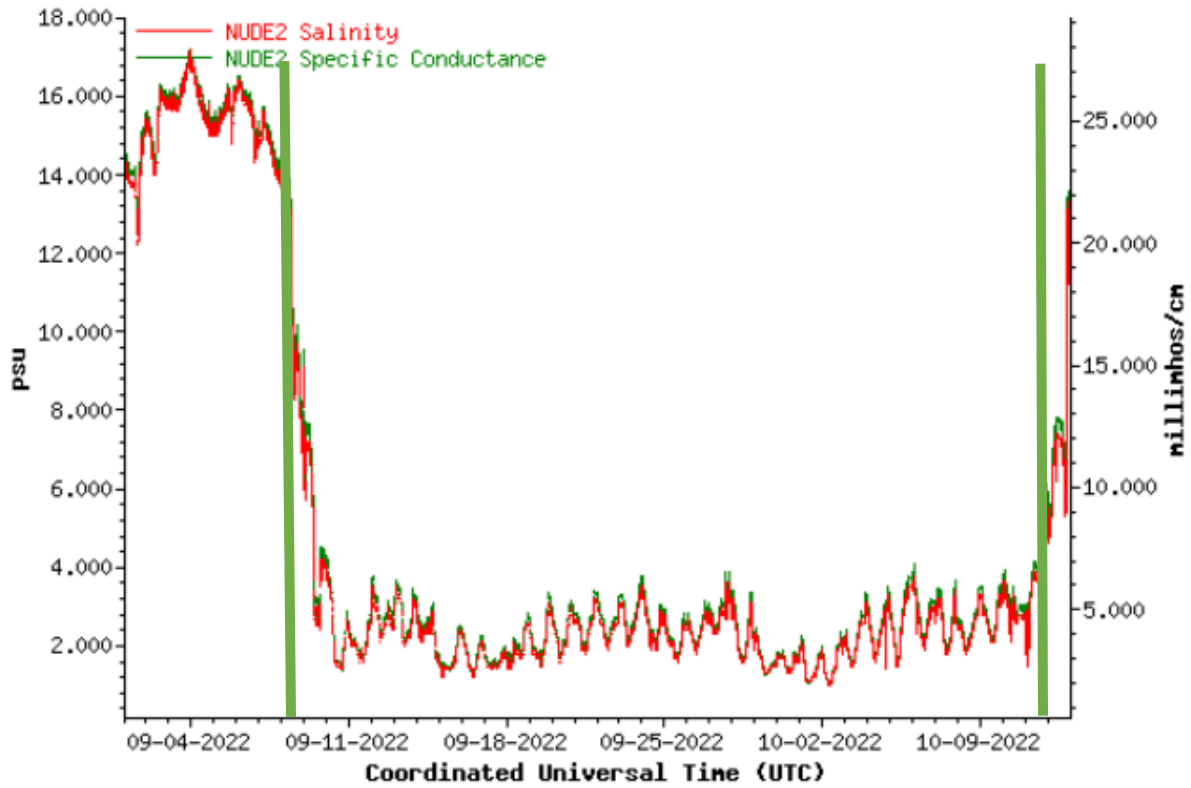


Figure 5. NUDE2 salinity during the 2022-2023. Red blocks indicate the timing of the pumping events. *The mid-January to March 2023 gap in data is a result of vandalism at the station that required the station to be down until repairs could be made.



generated 2023208+1506 UTC

Figure 6. The pumping event from September to October 2022. Vertical lines represent the start (left line) and end (right line) of pumping events.

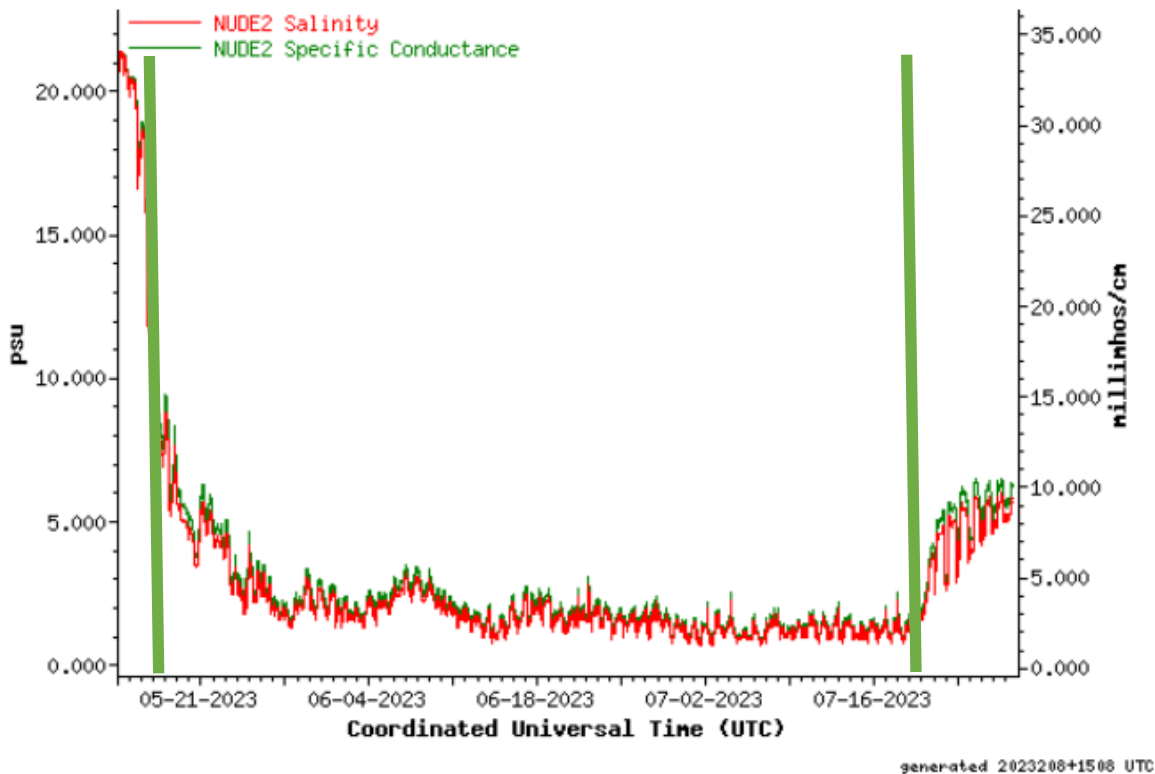


Figure 7. The pumping event from May to July 2023. Vertical lines represent the start (left line) and end (right line) of pumping events.

In addition to freshwater inflows, the salinities in the Nueces Delta are also influenced by tidal variations which will cause movements of fresh, and saltwater separated by a halocline (Adams and Tunnell 2010). As the tide rises, saltwater nearer to the bay is forced further back into the delta, and as the tide lowers, freshwater located further away from the bay is pulled closer to the bay.

Diurnal tidal variation appeared to have little to no effect on salinities at NUDE2 during pumping events. Wind direction, wind velocity, evaporation and rainfall during pumping events have all had an effect on hydrodynamics in the Nueces Delta (Adams and Tunnell 2010).

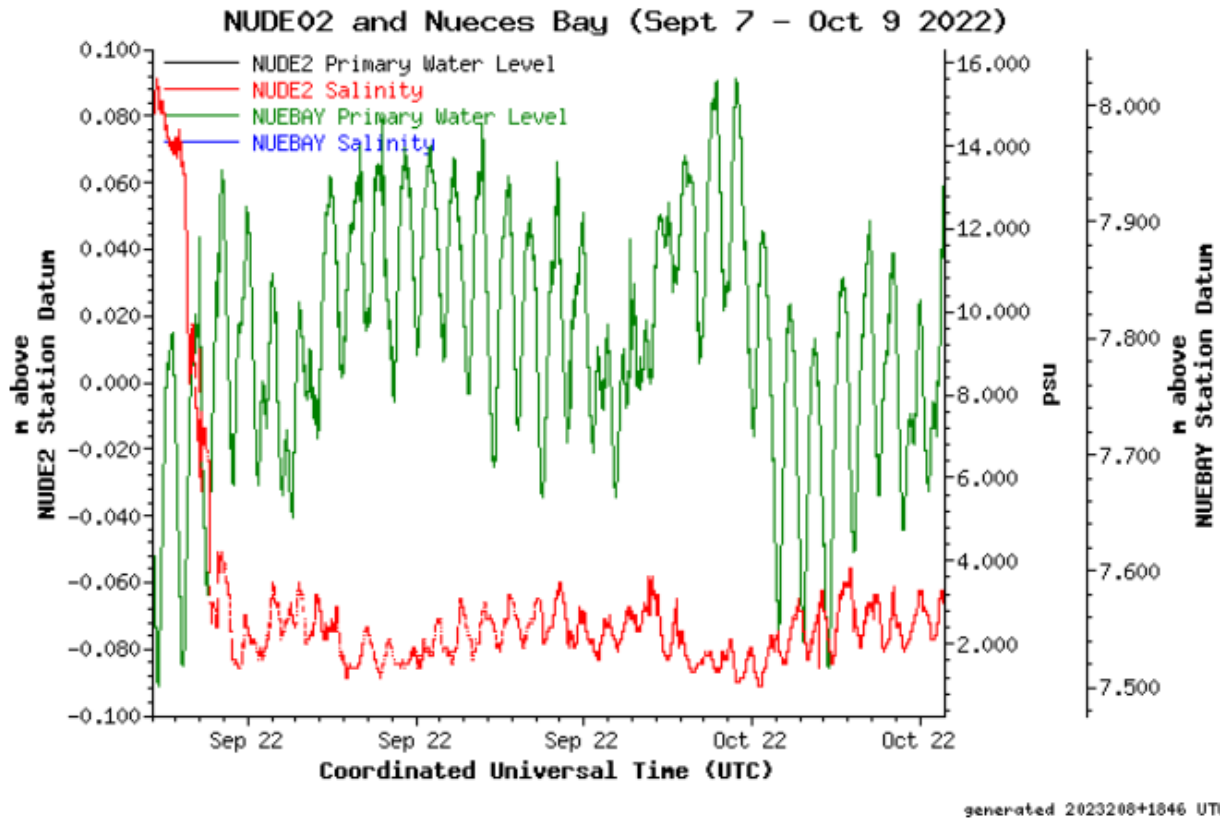


Figure 8. NUDE2 salinity (red line) and NUEBAY water level (green line) during first pumping event.

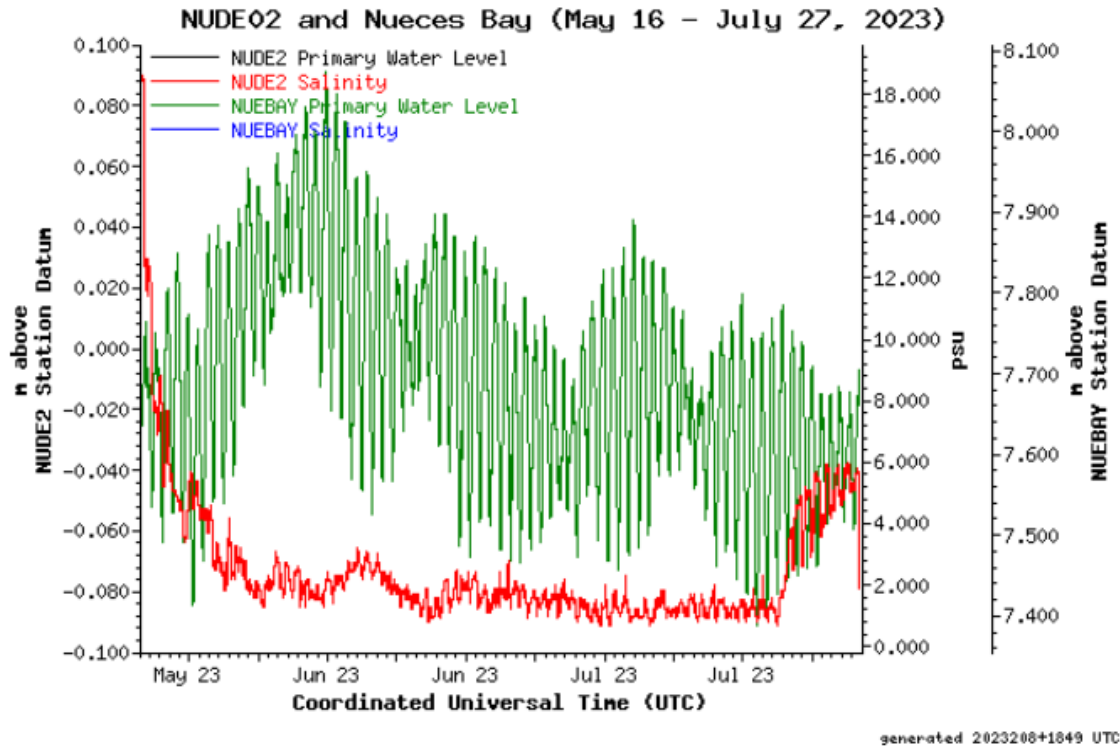


Figure 9. NUDE2 salinity (red line) and NUBAY water level (green line) during second pumping event.

CONCLUSIONS

From September 2022 through July 2023, 15,217 ac. ft. of water was pumped via the RBP during 2 events. During the reporting period there were only two pumping event and minimal rainfall which did not affect the salinity as much as in previous years. As of the date of this report, salinity at NUDE 2 was being reported at 5.4 psu.

Figure 5 shows the yearlong salinity changes during the reporting period. Salinity was lower in the early months of the reporting period and gradually increased, with fluctuations, with the highest-level reporting in April 2023. Salinity levels began to diminish in June 2023 during a large pumping event.

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