Nueces Bay Total Maximum Daily Load Project – Phase I
Interim Implementation Monitoring Data Report

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1.0 INTRODUCTION

1.1 Background

Nueces Bay (Segment 2482) is on the *2000 (and draft 2002) Texas Clean Water Act 303(d) List* of impaired waters for not meeting the oyster water use due to elevated zinc levels in oyster tissue. The Texas Total Maximum Daily Load (TMDL) Program in conjunction with the Coastal Management Program (CMP) funded two projects to: 1) verify the zinc impairment in oyster tissue, and 2) to develop a GIS zinc loadings model. Mrini ***et. al*** 2003 provides documentation of source assessment and zinc loadings into Nueces Bay. Modeling of information compiled and analyzed may indicate that elevated Total Zinc concentrations in Nueces Bay may be due to the discharge of once-through cooling water from the Nueces Bay Power Station (NBPS) obtained from the Corpus Christi Inner Harbor (Segment 2484). This Segment includes numerous industrial users with TCEQ permitted discharges to Inner Harbor waters. Results of these above mentioned projects are aiding in the development of a TMDL to allocate the allowable zinc load.

To augment the historical database, and to track the effectiveness of the reduction in loadings due to NBPS mothballing the plant in December 2002, there is a necessity to gather both Total and Dissolved Zinc in water implementation monitoring data using Ultra-Clean sampling methods and analysis (*EPA 1640–modified*). Use of this sophisticated method and accompanying low reporting limits are necessary because zinc is ubiquitous in the environment and is one of the most difficult trace metals to collect and analyze accurately without contamination. The ease of contaminating samples during sampling or analysis cannot be overestimated. Ambient zinc concentrations in seawater or brackish waters can typically be below one part per billion (ppb). For example, zinc levels measured in the study area as part of the Coastal Bend Bays & Estuaries Program Regional Coastal Assessment Program 2000 and 2001 (Nicolau and Nuñez 2004), averaged approximately 1 ppb with a maximum of <10 ppb. Although not specifically listed in the draft EPA method 1640, the pre-concentration techniques described in the method also work for zinc (P. Boothe, personal communication). The reason for not listing zinc is that it can be difficult to get the required field blanks and method blanks sufficiently low to permit the accurate determinations of low ambient seawater zinc concentrations. There is universal consensus in the oceanographic research community that many ambient trace metals (including zinc) can only be accurately determined in seawater using sophisticated analytical techniques such as the pre-concentration techniques described in method 1640 due to the severe analytical interferences for direct analysis methods posed by the high salt content of seawater.

1.2 Project Objectives

Project objectives are the collection of zinc in water and sediment data within Nueces Bay (Segment 2482), the Nueces River (Segment 2101), and the Corpus Christi Inner Harbor (Segment 2484). This effort will aid TCEQ in the statewide water quality assessment to determine if the designated uses are being met and to track the effect reduced zinc loadings to the bay (i.e. TMDL implementation) will have on water quality and ultimately in oyster tissue. This interim implementation monitoring data report details Phase I data collection efforts. As a multi-year data gathering effort to provide TCEQ with sufficient data to address

the zinc questions in Nueces Bay, no extensive detailed analysis will take place for this report. Detailed analysis and possible recommendations will be contained in the final project report.

2.0 METHODS

2.1 Sampling Process Design

The sample design resulted from program requirements of the Total Maximum Daily Load Program. Therefore, the sampling design for the project required providing data of sufficient quality to characterize zinc in water and zinc in sediment in Nueces Bay, Nueces River, and the Corpus Christi Inner Harbor for TMDL-related decisions.

For Phase I (June 2004 – May 2005), the CCS sampled eight (8) sites in Nueces Bay (Segment 2482), two (2) sites in the Nueces River (Segment 2101), and four (4) sites in the Corpus Christi Inner Harbor (Segment 2484) (Figure 2.1; Table 6.1.1) on a quarterly (bi-annual for sediment) basis for parameters as described in the Quality Assurance Project Plan (QAPP) and listed in Table 2.1. All data underwent quality assurance and complied with TCEQ Data Management protocol.

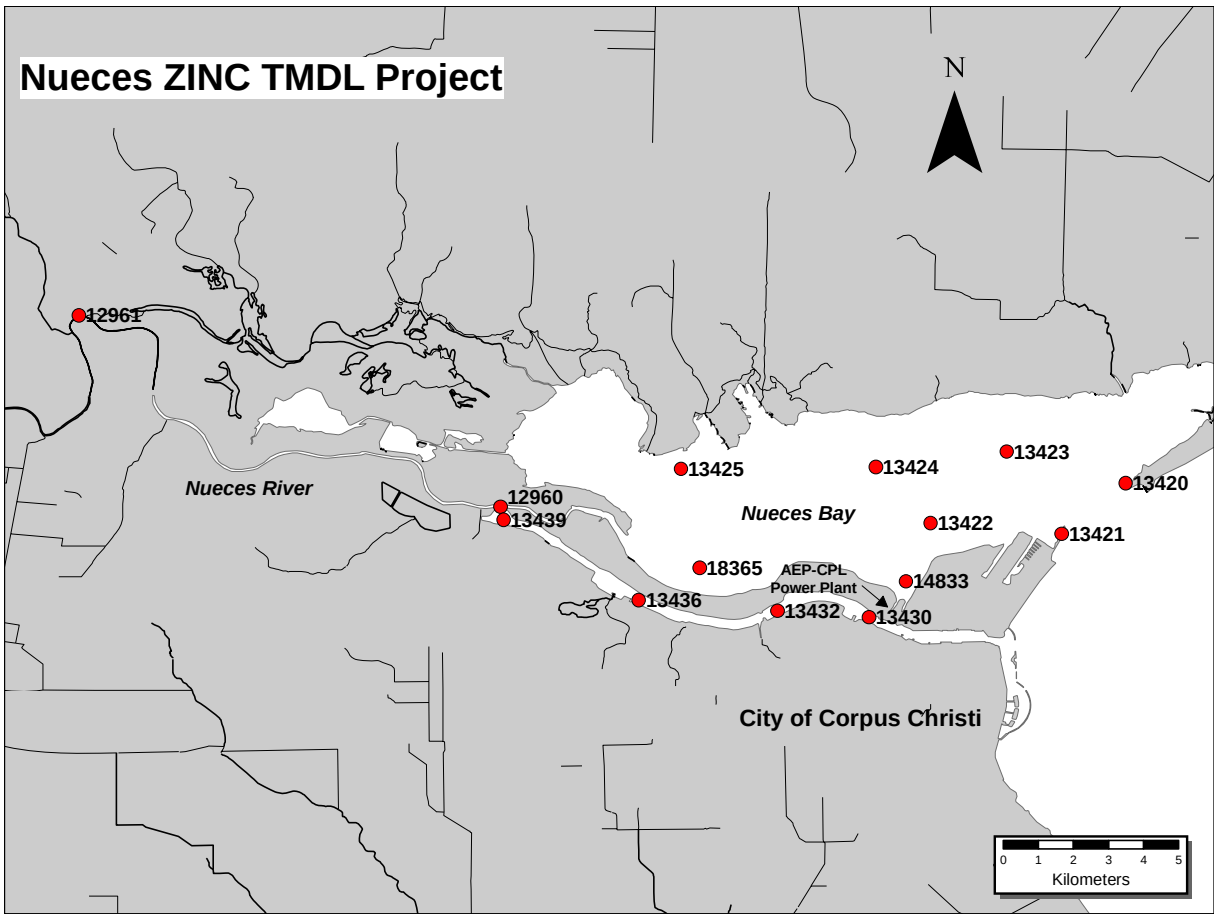

Fig. 2.1. Map of Nueces Total Maximum Daily Load sampling locations.

2.2 Parameters Sampled

Table 2.1 lists all parameters measured for the Nueces Bay TMDL project. Parameters measured but not presented within the scope of this report are available upon request to the CCS Project Managers.

Table 2.1. Parameters analyzed for the Nueces Bay Total Maximum Daily Load Project.

FIELD PARAMETERS (Water)	Units	TCEQ Parameter Codes
Total Depth	Meters	82903
Depth Sample Collected (Grab)	Meters	13850
Water Temperature (Grab)	°C	00010
Dissolved Oxygen Saturation (Grab)	%	00301
Dissolved Oxygen (Grab)	mg/L	00300
Conductivity (Grab)	µS/cm	00094
Salinity (Grab)	PSU	00480
pH (Grab)	S.U.	00400
Turbidity	Visual assessment	88842
Turbidity	NTU	82078
Secchi Depth	Meters	00078
Tide Stage	DNR Tide Gauge	89972
Water Color	Visual assessment	89969
Water Odor	Olfactory assessment	89971
Water Surface	Visual assessment	89968
FIELD PARAMETERS (Weather)	**Units**	**TCEQ Parameter Codes**
Air Temperature	°C	00020
Barometric Pressure	mm/Hg	NA
Cloud Cover	%	NA
Dew Point	°C	NA
Heat Index	°C	NA
Present Weather	Visual assessment	89966
Rainfall (Days since last)	Days	72053
Rainfall (Inches past 1 day)	Inches	82553
Rainfall (Inches past 7days)	Inches	82554
Relative Humidity	%	NA
Wind Chill	°C	NA
Wind Direction	Compass Direction	89010
Wind Speed	MPH	NA

Table 2.1. (continued).

TRACE METALS IN WATER	Units	TCEQ Parameter Codes
Zinc (Dissolved)	µg/L	01090
Zinc (Total)	µg/L	01092
TRACE METALS IN SEDIMENT	**Units**	**TCEQ Parameter Codes**
Zinc	mg/kg dry weight	01093
ORGANICS	**Units**	**TCEQ Parameter Codes**
Total Organic Carbon	mg/kg dry weight	81951
Total Solids	%	81373
SEDIMENT GRAIN SIZE	**Units**	**TCEQ Parameter Codes**
SGS Clay (<0.0039 mm)	% dry wt	82009
SGS Silt (0.0039 to 0.0625 mm)	% dry wt	82008
SGS Sand (0.0625 to 2.0 mm)	% dry wt	89991
SGS Gravel (>2.0 mm)	% dry wt	80256
ROUTINE CHEMISTRY (Water)	**Units**	**TCEQ Parameter Codes**
Total Suspended Solids (TSS)	mg/L	00530

2.3 Sampling Methods

The CCS followed sampling procedures for all parameters as documented in the TCEQ-approved QAPP (CCS 2004) as all data must undergo quality assurance and must comply with TCEQ Data Management protocol. A 2-person field crew conducted sampling from small craft (typically, 20-25 ft) on a quarterly (water) and biannual (sediment) basis. At each sampling site, field crews collected a core set of data and samples following methods and protocols as described in the TCEQ SWQM Procedures Manual or the QAPP. Core field data/samples include those specifically detailed in Table 2.1 and generally listed below with further detail provided in following sections:

1. Routine field parameters such as ambient weather conditions (Air Temperature, Wind Speed and Direction, Cloud Cover, etc)
2. Instantaneous water column profile (DO, pH, salinity, temperature, depth, etc.).
3. Routine chemical parameters (only TSS).
4. Total and Dissolved Zinc in water.
5. Zinc, Total Organic Carbon, and Sediment Grain size in Sediment.

Additional aspects outlined below reflect specific requirements for sampling parameters and/or provide additional clarification. The following sections describe the general methods and procedures for each core sampling activity that occurred at the sampling sites.

2.3.1. Field Sampling Procedures

The CCS followed the field sampling procedures documented in the TCEQ *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue* (December 2003). For trace element sampling, additional sampling guidance is provided in EPA Method 1669: *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (EPA 1999). Additional procedures for field sampling outlined in this section reflect specific requirements for sampling under this TMDL Project and/or provide additional clarification.

2.3.2. Site Location

This data collection effort involves monitoring water and sediment quality data to determine the effect reduced zinc loadings to the bay will have on water and sediment quality and for entry into the SWQM portion of the TRACS database. To this end, some general guidelines existed for selecting sampling sites, with overall consideration given for accessibility and safety. The establishment of sampling locations occurred prior to the commencement of sampling and determination of site selection utilized criteria described in the TCEQ Surface Water Quality Monitoring Procedures manual to the maximum extent practicable. Development of all monitoring activities was coordinated with the TCEQ TMDL Project Manager.

2.3.3. Water Column Measurements

The first activities conducted upon arriving onsite were those that involved routine field observations, such as ambient weather and water conditions. Water sampling and water column measurements followed, as these samples/data require collection before disturbing bottom sediments.

Water column profiles, involving a one-time grab sample, took place at each site to measure basic water quality parameters (see Table 2.1). We measured basic water quality parameters by using a multiparameter water quality instrument (e.g., YSI Sondes) with cable connection to a deck display. Hydrographic profiles, if required, took place according to the TCEQ Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue (December 2003) requirements for vertical depth profiles.

In addition, secchi depth measurements occurred at each station by using a standard 20-cm diameter black and white secchi disc lowered to the depth at which it was no longer discernable, then it was slowly retrieved until it reappeared, with that depth marked and recorded as secchi depth (rounded to nearest 0.5 m).

2.3.4. Routine Conventional Chemistry

Total Suspended Solids.

Approximately 1 liter of unfiltered seawater was collected at a depth of 30 cm. The samples were held in 1-L polypropylene bottles on wet ice in the field and stored at 4ºC to await laboratory determinations.

2.3.5. Trace Metals in Water (Total and Dissolved Zinc)

Avoiding contamination during sampling is an important contributor to the enhanced accuracy of clean metals data and all CCS personnel received prior training from Dr. Paul N. Boothe of Albion Environmental in the appropriate method, using the "clean hands – dirty hands" approach, for collecting trace metals samples.

Successful implementation of this approach is paramount in reducing contamination during sampling events, as the primary sources of sample contamination during clean metals sampling comes from airborne particulates and sample contact of contaminated surfaces. CCS personnel have been successfully performing these procedures since March 2000 (Nicolau and Nuñez 2004).

CCS field crews used specialized sampling kits developed by Albion Environmental and a peristaltic pump to obtain grab samples because accurate measurement of trace metals in saline waters requires large sample volumes. Each sampling kit configuration came individually bagged and separate from the Clean Boxes in which the actual collection of the water sample took place. Sample bottles within each kit had a unique identifying number and utilized certified LDPE bottles provided by Albion Environmental.

The usual approach was to attach the Teflon inlet tubing to a particle-free 15-foot PVC pole using metal-free cable ties. PVC pole placement into the water body required the inlet tubing be upstream of the sampling vessel. Dissolved metal samples required filtering the sample through a twice pre-cleaned (first at the manufacturer and second at Albion Environmental) Gelman 0.45µm large capacity capsule filter; with a new filter used for each dissolved sample taken at a site. Total metals samples followed the same procedures but without the use of the filter. To verify that no contamination occurred during sampling required taking a Field Blank sample at the end of each sampling day. Field Duplicate samples verified laboratory analysis and occurred once for each sampling event.

Please note that the above description is a simplified version of the sampling process. The proper way to perform trace metals sampling in estuarine waters, which eliminates field contamination and obtains the best sample possible, is complex and beyond the scope of this section. Additional detailed documentation exists in EPA Method 1669 *Sampling ambient water for trace metals at EPA water quality criteria levels* and Albion Environmental Standard Operating Procedures modified after EPA Method 1669. Both documents are available upon request to the CCS Project Manager.

2.3.6. Composited Sediments

At each site, a modified 0.04m^2 Van Veen sampler, was utilized to obtain multiple grabs. The surficial sediment layer (2 to <5 cm) and anaerobic layer (>5 to 9 cm) were collected by spatula or scoop and composited separately to provide sediment for the analyses of chemical contaminants, total organic carbon (TOC), and grain size determinations. A minimum of three grabs were composited for the final sample.

Surficial and anaerobic sediment from the individual grabs were combined into separate clean, high-grade stainless steel or Teflon vessel. Between grabs, each container of

composited sediment was held on ice and covered with a lid to protect the sample from contamination. Stirring blended in each addition of sediment to the composite, with the final mixture stirred well to ensure a homogenous sample. Sub-samples for the various analyses took place as follows:

Inorganic chemical contaminants (ZINC)

Approximately 500 g of composited sediment was placed in a clean, pre-labeled, wide-mouth LDPE bottle and held on wet ice while aboard. Upon transfer to shore storage the sample was held at 4ºC until laboratory processing commenced.

TOC

Approximately 500 g of composited sediment was placed in a small, clean, pre-labeled amber glass bottle/jar and held on wet ice aboard. Upon transfer to shore storage the sample was held at 4ºC until laboratory processing commenced.

Grain size determination

Approximately 500 g of composited sediment was placed in a clean, pre-labeled, wide-mouth LDPE bottle and held on wet ice while aboard. Upon transfer to shore storage the sample was held at 4ºC until laboratory processing commenced.

3.0 WATER MONITORING

3.1 TCEQ Criteria and Screening Levels

TCEQ uses many physical, chemical, and biological characteristics in assessing support of designated uses and criteria of a water body (Segment). Primarily, comparison of individual parameter values to either numerical criteria or screening levels determines the number of values exceeded. Based on number of exceedances, the assessment classifies a segment as either being in full support, partial support, or not supportive of the official designated use. Similar exceedances of numerical screening levels identify segments with no concerns or concerns for impairment. As defined in the Texas Surface Water Quality Standards (TSWQS) the identification of "primary concerns" relates directly to criteria adopted in the TSWQS that protect the designated use of a water body. Secondary concerns are parameters for which there are no existing standards adopted that have elevated concentrations exceeding screening levels. The 303(*d*) list contains Segments with primary concerns and while water bodies with secondary concerns appear on the 305(*b*) report, they are not included on the 303(*d*) list. Typically, areas exhibiting secondary concerns will receive more frequent and possible additional parameter monitoring (TCEQ 2003).

To establish whether Primary Concerns exist, and if a segment supports the Aquatic Life Use, TCEQ developed criteria for toxic substances in water. Criteria developed include 26 organic substances and a suite of 12 metals in dissolved and total forms, with Zinc concentrations based on a dissolved Tidal Water Chronic (TWC) criterion of 84.2 µg/L or ppb. TCEQ has no criteria or screening level to evaluate Total Zinc concentrations in the water.

3.2 Field Data

A select list of instantaneous field parameters and summary statistics appears in Data Tables 6.2.1, 6.2.2, and 6.3.1 through 6.3.5, respectively. During Phase I, the basic field data parameters; Dissolved Oxygen, or DO (mg/L), pH (su), Salinity (PSU), and Water Temperature (°C) yielded typical concentrations for time of year each sampling event occurred. Instantaneous measurements of salinity at many of the Nueces Bay stations were <10.00 PSU for the first two sampling events in 2004 due to continued precipitation and inflows, before rising to >20.00 PSU in Nueces Bay in the last two sampling events in 2005 (Table 6.3.1). Instantaneous measurements of DO were all > 5.00 mg/L (Table 6.3.2). Mean turbidity levels tended to be higher in the Nueces River Tidal and Nueces Bay areas with lowest mean levels recorded in the Corpus Christi Inner Harbor (Table 6.3.4).

3.3 TCEQ Routine Conventional Water Chemistry – Total Suspended Solids (TSS)

A complete list of individual TSS concentrations, along with summary statistics, appears in Chapter 6-Data Tables 6.4.1 and 6.4.2. TSS levels ranged from 9.00 mg/L at Station 13436 in the Corpus Christi Inner Harbor to 232.00 mg/L at Station 13423 in Nueces Bay. Analysis by Segment showed that except for the first sampling event in June 2004, mean TSS concentrations were always highest in Nueces Bay. Typically, the average depth at Nueces Bay stations was the shallowest at 1.48 m. This fact, coupled with mean wind speeds of 11.22 miles per hour during the study defines the turbid nature of Nueces Bay. Fig. 3.1 depicts mean TSS concentrations for all four sampling events combined.

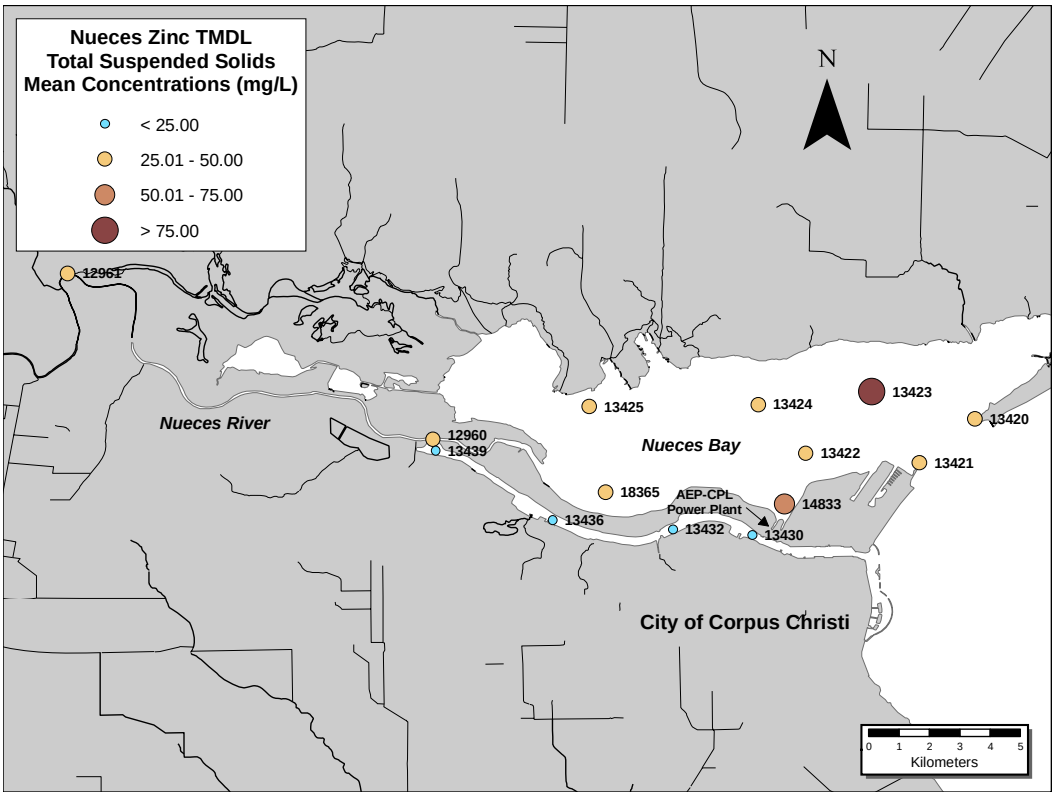

Fig. 3.1. Mean Total Suspended Solids concentrations (mg/L) for Phase I.

3.4 Trace Metals in Water

Phase 1 sampling showed no exceedance of the TCEQ criteria for zinc, with the highest concentration recorded being nearly seven times less than the criteria. Dissolved Zinc concentrations at Nueces Bay and Nueces River Tidal stations ranged from <0.20 ppb to 2.40 ppb and were typically lower than concentrations in the Corpus Christi Inner Harbor (Fig. 3.2; Table 6.6.1). Lowest mean concentrations typically occurred in the Nueces River Tidal Segment. Seasonal variability in Dissolved Zinc concentrations was observed with highest concentrations occurring during the third (January 2005) and fourth (May 2005) event (Table 6.6.1). Within these two segments Dissolved Zinc was found to be positively correlated with TSS (0.342, $p<0.05$) and wind speed (0.478, $p<0.05$). Dissolved Zinc concentrations at stations in the Corpus Christi Inner Harbor ranged from 1.67 ppb to 10.80 ppb with the greatest concentrations occurring during the third (January 2005) event (Table 6.6.1). Fig. 3.4 depicts mean Dissolved Zinc concentrations for all four sampling events combined.

Total Zinc concentrations at Nueces Bay and Nueces River Tidal stations ranged from 1.30 ppb to 43.40 ppb (Fig 3.3; Table 6.6.1). Lowest mean concentrations were typically located at Nueces River Tidal stations. Additionally, these stations exhibited the lowest seasonal variability. Stations 14833 and 18365 generally had highest concentrations within Nueces Bay. Within these two segments Total Zinc was positively correlated with TSS (0.848, $p<0.05$). Total Zinc concentrations in the Corpus Christi Inner Harbor ranged from 3.68 ppb to 12.40 ppb with the greatest concentrations occurring during the second (September 2004)

and third (January 2005) events (Table 6.6.1). Fig. 3.5 depicts mean Total Zinc concentrations for all four sampling events combined.

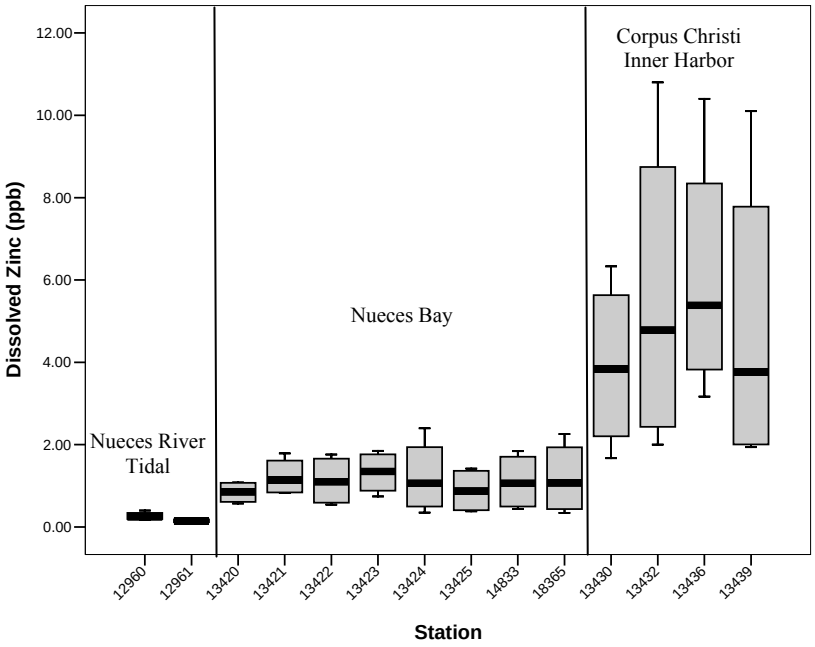

Fig. 3.2. Box and whisker plots of Dissolved Zinc for Nueces Bay TMDL stations during Phase I. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

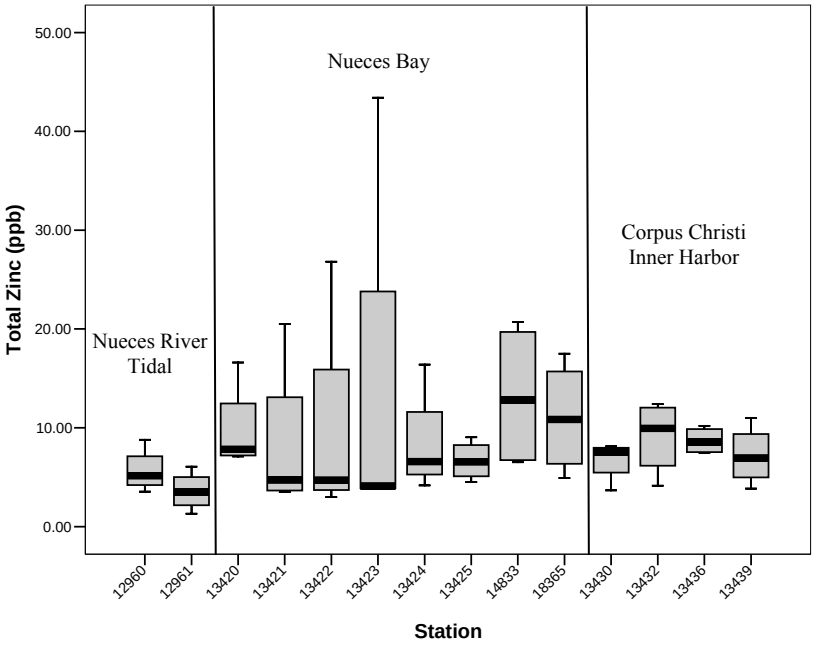

Fig. 3.3. Box and whisker plots of Total Zinc for Nueces Bay TMDL stations during Phase I. Boxes are interquartile ranges; horizontal lines within boxes are medians; whisker endpoints are high and low extremes.

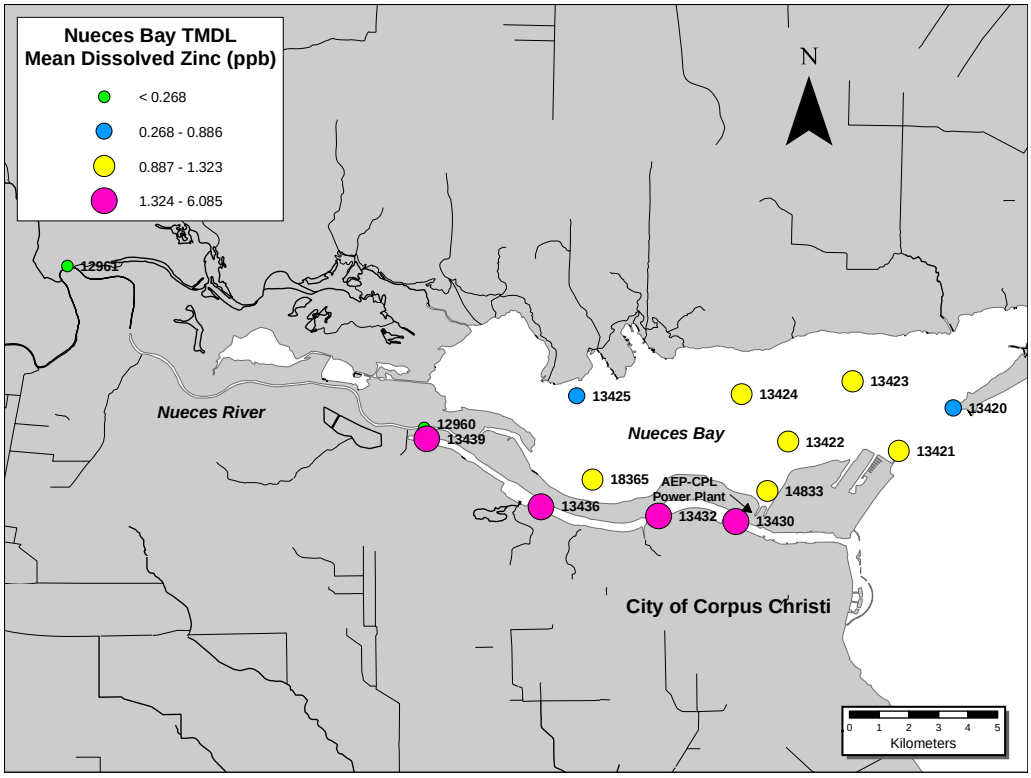

Fig. 3.4. Mean Dissolved Zinc concentrations (µg/L) for Phase I.

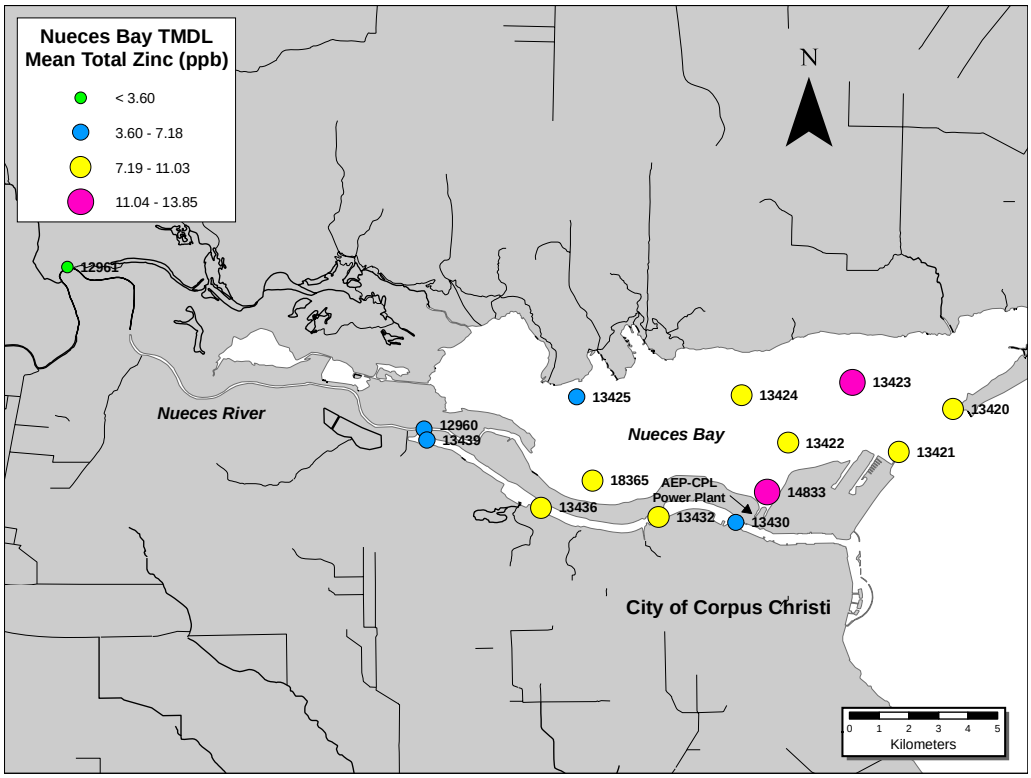

Fig. 3.5. Mean Total Zinc concentrations (µg/L) for Phase I.

4.0 SEDIMENT MONITORING

For this project we collected the Upper (2 to <5.0 cm), or recently deposited sediment, along with Lower (>5 to 9 cm), or slightly deeper sediment on a bi-annual basis to determine if increased zinc concentrations could be attributed to legacy deposition. Zinc data was log transformed with a One-Way ANOVA run between mean concentrations of Upper and Lower sediment samples. While there were some differences observed in zinc concentrations at a few stations, overall the results showed no statistically significant difference between depths ($F= 0.176$, $p= 0.676$). Since no statistically significant difference existed, we believe that collection of the slightly deeper sediment is not necessary and that sampling more stations within Nueces Bay might be a wiser use of resources. A complete list of both Upper and Lower individual sediment characteristics and zinc concentrations, along with summary statistics, appears in Data Tables 6.8.1 and 6.9.1 and 6.9.2.

4.1 TCEQ Sediment Quality Screening Levels

Currently, regulatory criteria do not exist for the majority of sediment contaminants. However, TCEQ does employ sediment-screening levels to assess *Secondary Concerns*; defined as parameters for which no adopted standard exists but which exhibit elevated concentrations exceeding these screening levels. Screening levels established by TCEQ utilize long-term data based on the 85th percentiles of all TCEQ SWQM data and the Probable Effects Level (PEL) guidelines developed by NOAA through its National Status and Trends Program. Currently the established screening levels for Zinc in sediment collected from the Upper, or surficial layer are 107 mg/kg or ppm for the 85th Percentile, and 124 mg/kg or ppm for the PEL.

TCEQ revises the sediment 85th percentiles on an annual basis while NOAA sediment guidelines derive from a multitude of nationwide datasets of sediment contamination and corresponding biological effects compiled by Long et al. (1995). A *Secondary Concern* is identified by TCEQ if both the 85th percentiles and PEL should be exceeded greater than 25% of the time based on the number of exceedances for a given sample size (TCEQ 2003). While concentrations above Threshold Effects Level (TEL) values do not aid TCEQ in identifying *Secondary Concerns*, they provide a baseline reference indicating increasing concentrations.

Depending on the effects level used, a wide range of interpretations is possible using these guidelines. Not considered regulatory criteria or standards, these screening levels and guidelines serve as a non-regulatory interpretive aid for sediment chemical data. Based on comparable datasets, but calculated differently (Long et al. 1995; MacDonald et al. 1996), the classification of these levels and their corresponding increasing effect thresholds employs the following terminology:

Threshold Effects Level	TEL	*Rare* adverse effects observed
Effects Range Low	ERL	Effects begin to occur in sensitive species
Probable Effects Level	PEL	*Frequent* adverse effects observed
Effects Range-Median	ERM	Median concentration of the compiled toxic data

4.2 Sediment Characteristics

Total Organic Carbon (TOC) provides a relative measure of organic matter contained in sediments and typically, elevated TOC percentages are associated with sediments high in Silt-Clay content. Generally, TOC values <2.0% indicate low enrichment.

TOC values in the Upper sediment layer were variable and ranged from <0.03% at Station 13421 in Nueces Bay to 1.20% at Station 12960 in the Nueces River Tidal segment and Station 13430 in the Corpus Christi Inner Harbor (Table 6.8.1). TOC values were also variable in the Lower sediment layer, ranging from 0.07% at Station 13421 in Nueces Bay to 1.60% at Station 13430 in the Corpus Christi Inner Harbor (Table 6.8.1). Analysis by Segment showed mean TOC concentrations were always lowest in Nueces Bay (Table 6.9.1). Fig. 4.1 depicts mean TOC concentrations for both sampling events combined.

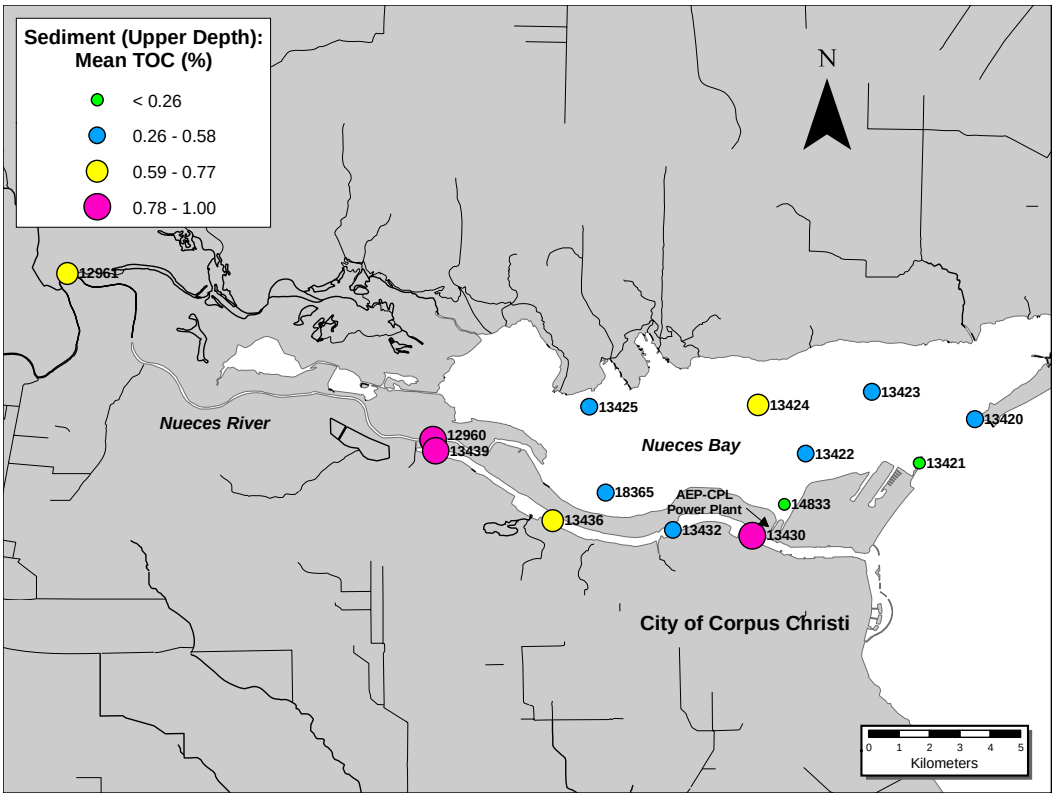

Fig. 4.1. Mean Total Organic Carbon concentrations (%) for Phase I.

The percentage of mud (Silt-Clay) within sediments is also an important aspect in the assessments of estuarine condition. Typically, as sediment grain size decreases, the risk of contamination increases due to the strong affinity metals have to adsorb to Silt-Clay particles. Sediment grain size is also a contributing factor effecting the distribution of marine benthic organisms.

Individual Silt-Clay proportions in the Upper and Lower sediment layers ranged from 4.61% and 4.51% at Station 13421 in Nueces Bay to 95.09% and 96.67% at Station 12960 in the Nueces River Tidal segment, respectively (Table 6.8.1). Analysis by Segment showed mean Silt-Clay proportions were always highest in the Nueces River Tidal segment, followed by the Corpus Christi Inner Harbor, and Nueces Bay (Table 6.9.2). Fig. 4.2 depicts mean Silt-Clay proportions for both sampling events combined.

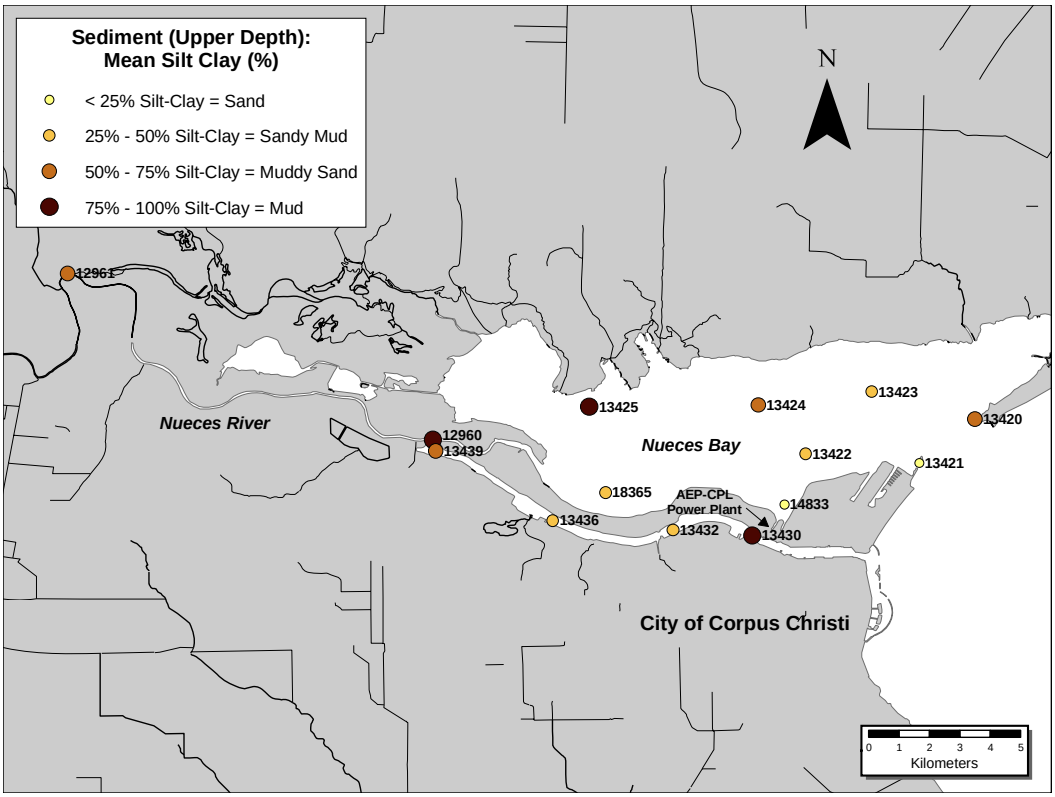

Fig. 4.2. Mean Silt-Clay proportions (%) for Phase I.

4.3 Zinc in Sediment

Zinc concentrations in the Upper and Lower sediment layers were variable and ranged from 8.00 mg/kg and 8.80 mg/kg at Station 13421 in Nueces Bay to 485.00 mg/kg and 1070.30 mg/kg at Station 12961 in the Nueces River Tidal segment (Table 6.8.1), respectively. Figs. 4.3 through Figs. 4.6 depict Upper and Lower sediment layer concentrations recorded for each sampling event during Phase I.

While the extremely elevated concentration recorded at Nueces River Tidal Station 12961 exceeded the 85th percentile and PEL screening values we feel this reading was an anomaly attributed to unusual circumstances at the sampling location. During the September 2004 event, sediment grabs took place downstream of the I-37 Bridge due to anchoring difficulties upstream caused by excessive river currents. This point happened to be near an area where three submerged cars were later discovered in July 2005. The second event in May 2005 was sampled upstream of the bridge (approximately 300 feet from September site) and yielded a concentration of 36.90 mg/kg.

Besides the unusual reading at Station 12961, all other samples were below the PEL. However, the September 2004 sampling event did produce exceedances of the 85th percentile and/or TEL at Station 13425 and Station 18365 in Nueces Bay and three exceedances of the 85th percentile and/or TEL in the Corpus Christi Inner Harbor at Stations 13430, 13436, and 13439 (Table 6.8.1).

In the May 2005 event, all four Inner Harbor stations (13430, 13432, 13436, and 13439), Station 18365 in Nueces Bay, and Station 12960 in the Nueces River Tidal segment exceeded the 85th percentile and/or TEL (Table 6.8.1). Analysis by Segment for both events showed mean zinc concentrations in the Upper and Lower sediment layers were always lowest in Nueces Bay (Table 6.9.2). Fig. 4.7 and Fig. 4.8 depict mean zinc concentrations in the Upper and Lower sediment layers for both sampling events.

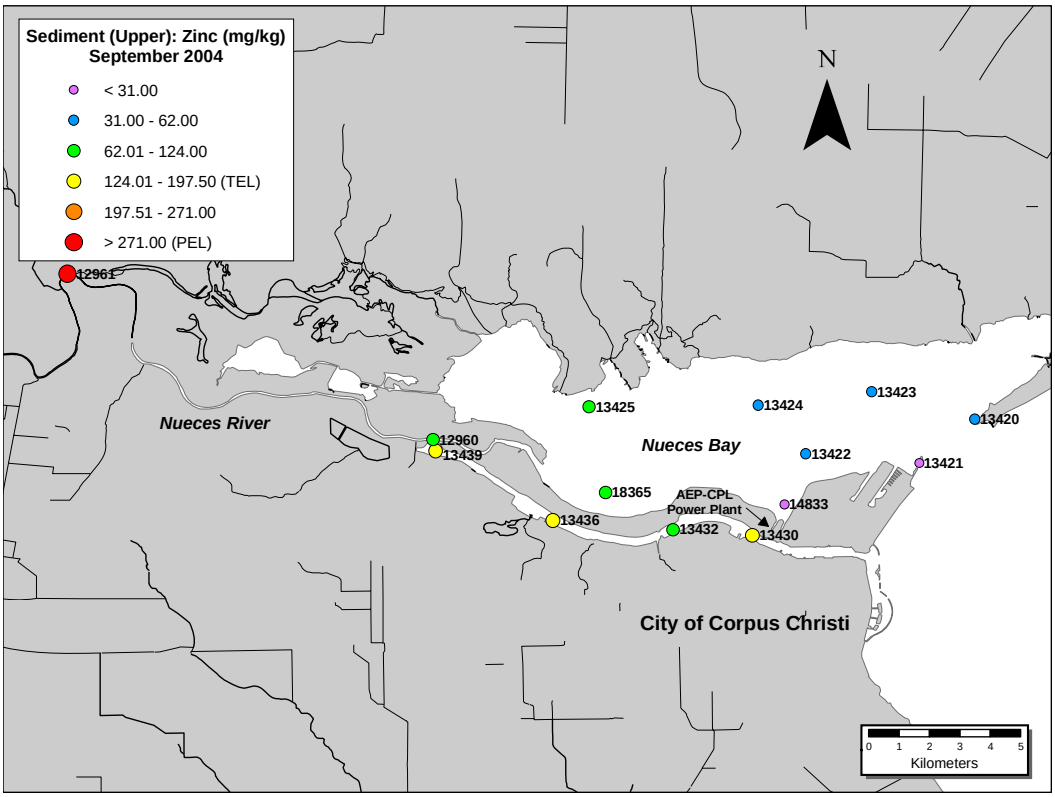

Fig. 4.3. Zinc (Upper) concentrations (mg/kg) for September 2004 event.

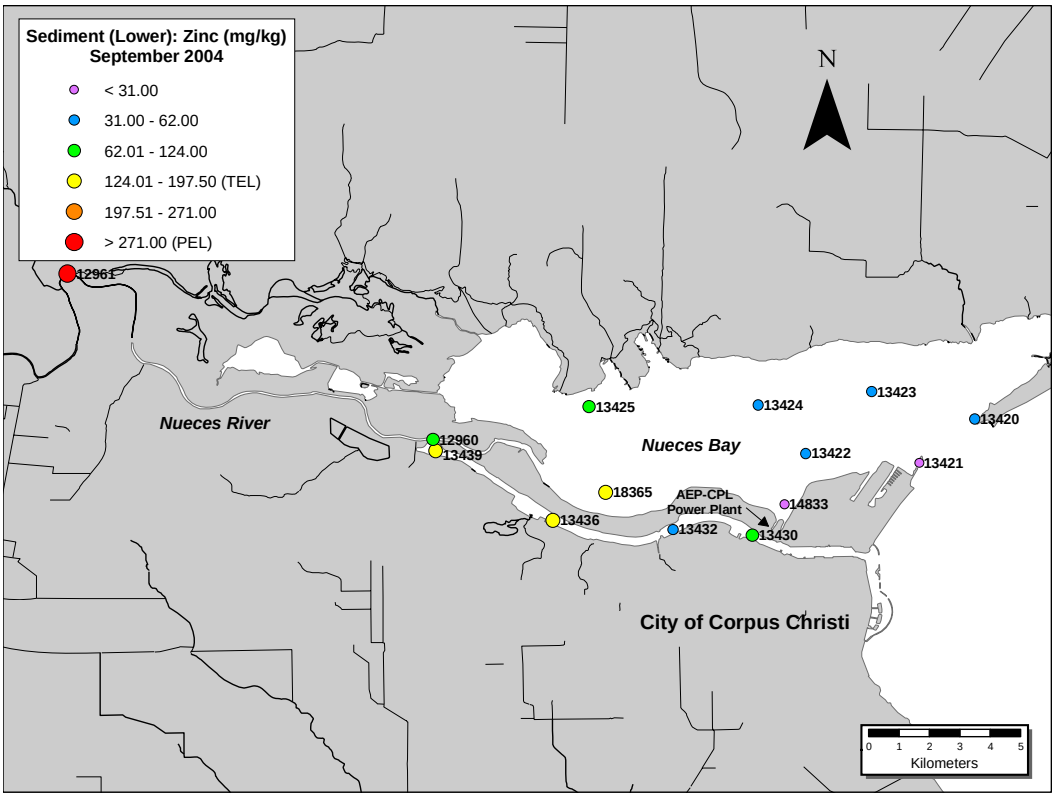

Fig. 4.4. Zinc (Lower) concentrations (mg/kg) for September 2004 event.

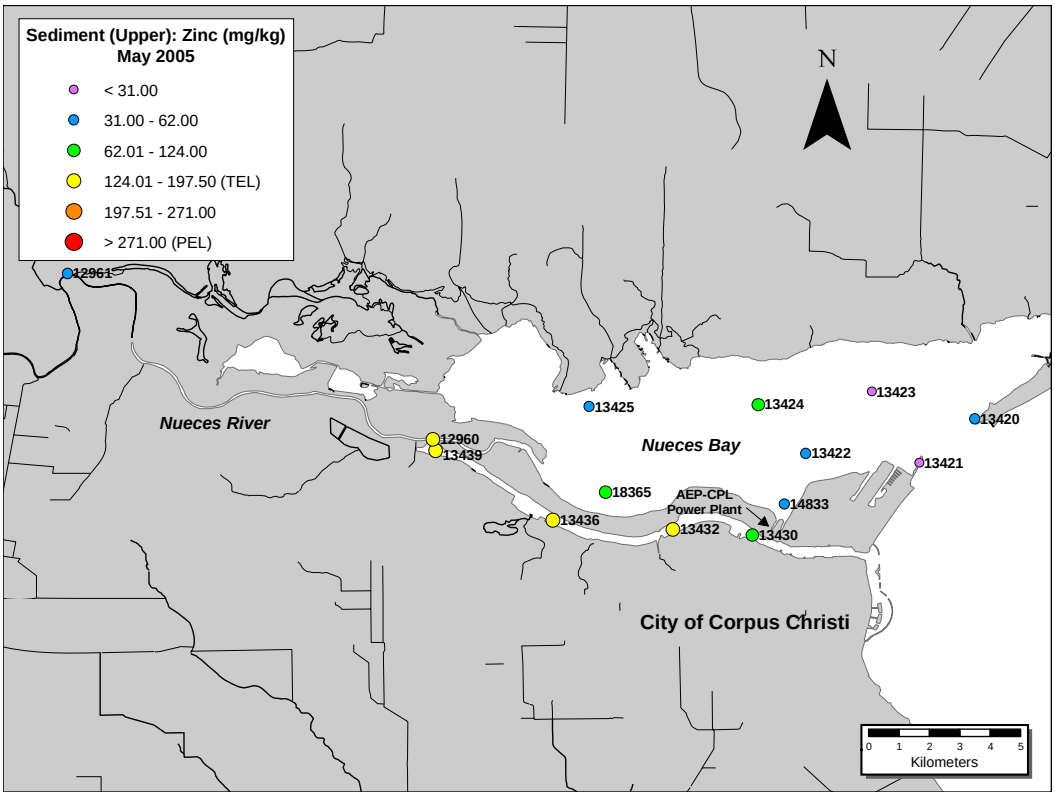

Fig. 4.5. Zinc (Upper) concentrations (mg/kg) for May 2005 event.

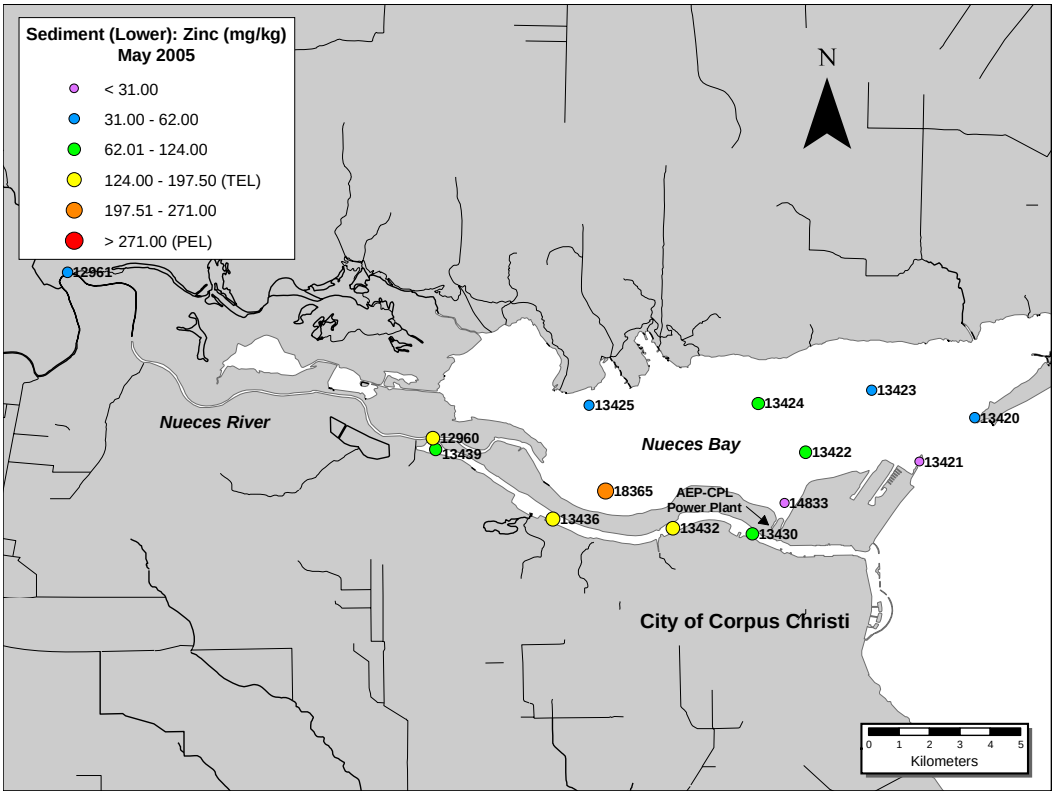

Fig. 4.6. Zinc (Lower) concentrations (mg/kg) for May 2005 event.

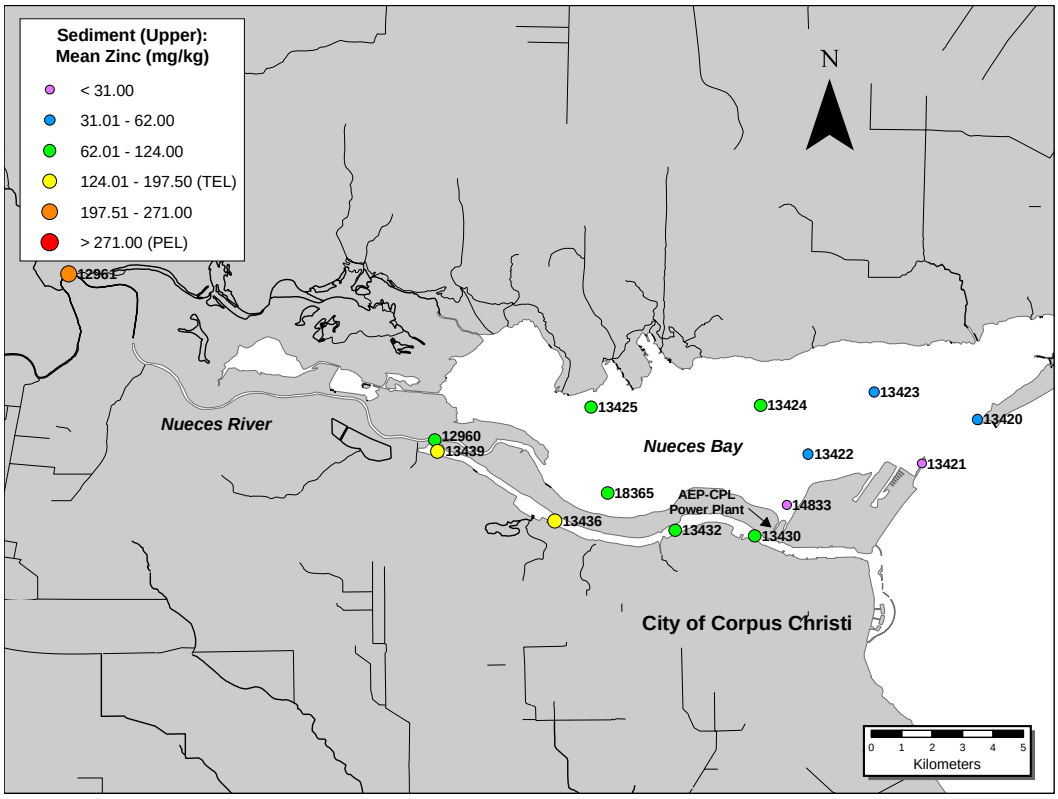

Fig. 4.7. Mean Zinc (Upper) concentrations (mg/kg) for both sampling events.

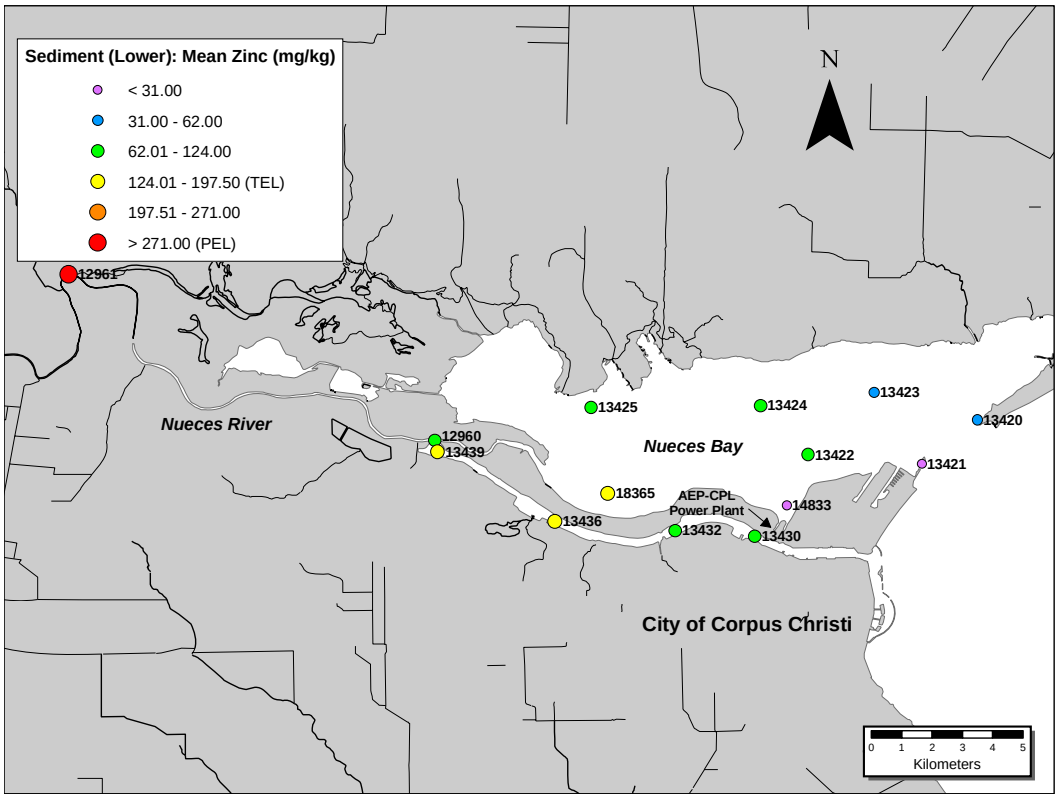

Fig. 4.8. Mean Zinc (Lower) concentrations (mg/kg) for both sampling events.

5.0 REFERENCES

Center for Coastal Studies. 2004. Quality Assurance Project Plan for the Nueces Bay Total Maximum Daily Load Project. Revision 1. 67 pp.

Nicolau, B. A. and Alex X. Nuñez. 2004. Coastal Bend Bays & Estuaries Program, Regional Coastal Assessment Program (RCAP): RCAP 2000 and RCAP 2001 Annual Report. Center for Coastal Studies, Texas A&M University-Corpus Christi. TAMUCC-CC-0406-CCS. 246 pp.

Texas Commission on Environmental Quality. 2003. Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue. TCEQ, Monitoring Operations Division, Austin, Texas. RG-415.

USEPA. 1999. Method 1669 "Sampling ambient water for trace metals at EPA water quality criteria levels". EPA 821-R-95-034. Office of Water, Washington, DC.

6.0 DATA TABLES

6.1 Station Information

Table 6.1.1. Segment designation, TCEQ Station ID, sample type, and station location coordinates for Nueces Bay TMDL stations. Sampling took place for four events (June 2004, September 2004, January 2005, and May 2005) for FD = Field Data, RC = Routine Conventional Water Chemistry, TM = Trace Metals-Water and for two events (September 2004 and May 2005) for TMSED = Trace Metals-Sediment.

Segment Number	Segment Name	TCEQ ID	Sample Type	Latitude (dd)	Longitude (dd)
2101	Nueces River Tidal	12960	FD, RC, TM, TMSED	27.84667	-97.52084
		12961	FD, RC, TM, TMSED	27.89583	-97.62917
2482	Nueces Bay	13420	FD, RC, TM, TMSED	27.85278	-97.36028
		13421	FD, RC, TM, TMSED	27.83972	-97.37666
		13422	FD, RC, TM, TMSED	27.84250	-97.41033
		13423	FD, RC, TM, TMSED	27.86083	-97.39083
		13424	FD, RC, TM, TMSED	27.85695	-97.42445
		13425	FD, RC, TM, TMSED	27.85639	-97.47450
		14833	FD, RC, TM, TMSED	27.82750	-97.41670
		18365	FD, RC, TM, TMSED	27.83104	-97.46967
2484	Corpus Christi Inner Harbor	13430	FD, RC, TM, TMSED	27.81833	-97.42622
		13432	FD, RC, TM, TMSED	27.82000	-97.44972
		13436	FD, RC, TM, TMSED	27.82278	-97.48528
		13439	FD, RC, TM, TMSED	27.84333	-97.52000

6.2 Field Parameters – Individual Concentrations for grab samples taken at 0.30 m depth

Table 6.2.1. Field Parameter concentrations at Nueces Bay TMDL stations for Sampling Event 1 (June 2004) and Sampling Event 2 (September 2004). * = no data collected.

June 2004	Segment	Segment Name	TCEQ_ID	Cond. (µmhos)	DO (mg/l^{-1})	DO Sat. (%)	pH (su)	Salinity (PSU)	Secchi Depth (m)	Total Depth (m)	Turbidity (NTU)	Water Temp (°C)
	2101	Nueces River Tidal	12960	694	7.49	101.30	8.11	0.33	0.30	2.00	*	28.33
	2101		12961	696	7.10	98.20	8.06	0.34	0.25	4.78	*	27.92
	2482	Nueces Bay	13420	28867	9.03	136.40	8.42	17.66	0.50	0.60	*	32.10
	2482		13421	33217	7.31	110.70	8.27	20.64	0.90	5.20	*	31.18
	2482		13422	15661	8.02	111.70	8.44	9.08	0.60	1.80	*	29.74
	2482		13423	23955	7.56	109.90	8.33	14.44	0.55	1.88	*	30.78
	2482		13424	15350	7.66	100.80	8.45	8.88	0.50	1.96	*	30.08
	2482		13425	8873	8.04	108.20	8.46	4.92	0.55	1.44	*	29.13
	2482		14833	13103	7.81	106.70	8.43	7.49	0.50	1.86	*	29.36
	2482		18365	8008	7.95	108.10	8.46	4.43	0.50	1.64	*	29.92
	2484	Corpus Christi Inner Harbor	13430	36124	6.56	97.04	8.16	22.73	1.10	15.00	2.50	29.31
	2484		13432	26448	7.29	109.10	8.24	22.93	1.10	15.00	2.60	29.17
	2484		13436	41168	7.69	115.40	8.17	26.27	1.10	15.00	0.80	29.21
	2484		13439	39828	9.34	139.10	8.35	25.31	1.00	15.00	*	28.77
September 2004	**Segment**	**Segment Name**	**TCEQ_ID**	**Cond. (µmhos)**	**DO (mg/l^{-1})**	**DO Sat. (%)**	**pH (su)**	**Salinity (PSU)**	**Secchi Depth (m)**	**Total Depth (m)**	**Turbidity (NTU)**	**Water Temp (°C)**
	2101	Nueces River Tidal	12960	708	6.06	77.70	7.81	0.34	0.30	1.50	44.00	28.09
	2101		12961	663	5.65	72.10	7.70	0.32	0.30	4.80	34.80	27.69
	2482	Nueces Bay	13420	34308	8.59	121.70	8.24	21.49	0.40	0.50	33.70	27.05
	2482		13421	43440	7.15	108.10	8.21	27.88	0.50	2.50	20.10	28.85
	2482		13422	16199	7.83	101.30	8.16	9.44	0.55	0.70	13.20	25.74
	2482		13423	32201	7.70	108.90	8.18	20.02	0.55	1.50	13.10	27.47
	2482		13424	8976	8.39	106.80	8.45	5.00	0.45	1.60	18.30	26.21
	2482		13425	5141	7.69	95.90	8.48	2.77	0.35	1.40	39.50	25.77
	2482		14833	15567	7.38	95.40	8.27	9.07	2.00	0.70	85.00	25.76
	2482		18365	3698	7.85	100.70	8.37	1.94	0.25	1.10	39.40	27.64
	2484	Corpus Christi Inner Harbor	13430	47635	5.19	80.60	8.07	30.88	2.00	14.70	4.30	29.46
	2484		13432	46843	5.83	90.00	8.05	30.31	2.50	11.20	1.00	29.22
	2484		13436	47219	5.06	78.30	7.95	30.59	4.00	14.70	0.10	29.32
	2484		13439	46959	5.20	80.70	7.90	30.39	3.50	15.10	0.40	29.44

Table 6.2.2. Field Parameter concentrations at Nueces Bay TMDL stations for Sampling Event 3 (January 2005) and Sampling Event 4 (May 2005). * = no data collected.

January 2005	Segment	Segment Name	TCEQ_ID	Cond. (µmhos)	DO (mg/l^{-1})	DO Sat. (%)	pH (su)	Salinity (PSU)	Secchi Depth (m)	Total Depth (m)	Turbidity (NTU)	Water Temp (°C)
	2101	Nueces River Tidal	12960	1341	9.08	102.90	8.14	0.67	0.35	1.70	27.10	21.29
	2101		12961	1030	8.79	94.40	7.78	0.51	0.30	3.00	22.00	18.64
	2482	Nueces Bay	13420	36274	9.51	101.20	7.92	22.89	0.50	0.50	12.80	11.72
	2482		13421	39845	8.71	98.70	7.87	25.44	0.70	2.50	7.10	13.89
	2482		13422	36105	8.81	98.30	7.86	22.82	0.60	1.40	9.00	13.93
	2482		13423	38324	8.49	96.60	7.86	24.33	0.80	1.40	6.10	14.42
	2482		13424	37809	8.38	95.40	7.81	24.02	0.57	1.50	11.00	14.51
	2482		13425	27606	8.12	103.00	8.04	16.99	0.30	1.00	28.10	22.10
	2482		14833	40464	8.36	110.10	8.10	25.90	0.50	0.70	12.50	21.50
	2482		18365	38819	8.01	105.70	8.05	24.74	0.30	1.20	29.80	21.90
	2484	Corpus Christi Inner Harbor	13430	43953	8.20	101.40	7.95	28.41	1.50	14.80	4.40	17.32
	2484		13432	44130	8.12	101.10	7.91	28.56	1.50	14.50	0.90	17.65
	2484		13436	44295	8.10	102.50	7.86	28.66	1.90	15.30	0.70	18.16
	2484		13439	44294	7.90	100.30	7.85	28.66	1.80	15.30	0.80	18.63
May 2005	**Segment**	**Segment Name**	**TCEQ_ID**	**Cond. (µmhos)**	**DO (mg/l^{-1})**	**DO Sat. (%)**	**pH (su)**	**Salinity (PSU)**	**Secchi Depth (m)**	**Total Depth (m)**	**Turbidity (NTU)**	**Water Temp (°C)**
	2101	Nueces River Tidal	12960	6051	8.96	106.00	8.50	3.29	0.45	1.58	20.80	22.80
	2101		12961	1396	8.50	102.30	8.28	0.70	1.25	2.87	16.10	24.51
	2482	Nueces Bay	13420	44657	7.25	112.30	8.06	28.84	0.20	0.40	54.10	25.52
	2482		13421	37590	7.27	100.30	8.00	23.88	0.20	3.50	69.70	24.81
	2482		13422	35282	7.58	106.60	8.11	22.19	0.10	1.30	82.50	26.28
	2482		13423	40697	7.20	101.90	8.02	26.01	0.10	1.40	135.90	25.52
	2482		13424	35005	7.89	109.50	8.09	22.00	0.25	1.40	50.00	25.67
	2482		13425	30342	8.41	107.20	8.09	28.85	0.75	0.70	26.60	21.95
	2482		14833	32808	8.58	119.70	8.17	20.47	0.10	0.70	51.50	26.44
	2482		18365	28523	8.15	103.80	8.09	17.61	0.65	1.30	19.30	22.25
	2484	Corpus Christi Inner Harbor	13430	44209	7.71	102.20	8.05	28.56	0.70	15.25	12.50	23.47
	2484		13432	44681	8.31	115.30	8.11	28.90	0.70	15.24	9.00	23.41
	2484		13436	44246	8.62	119.80	8.41	28.58	1.00	15.50	13.40	23.96
	2484		13439	43864	10.53	146.10	8.33	28.30	1.75	15.95	0.09	23.62

6.3 Field Parameters – Summary Statistics based on grab samples taken at 0.30 m depth

Table 6.3.1. Conductivity (µmhos) and Salinity (PSU) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. **Bold** = highest recorded mean concentrations. * = no data collected.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Conductivity	Event 1	2101	Nueces River Tidal	2	694	696	695
(µmhos)	(June 2004)	2482	Nueces Bay	8	8008	33217	18379
		2484	Corpus Christi Inner Harbor	4	26448	41168	**35892**
	Event 2	2101	Nueces River Tidal	2	663	708	686
	(September 2004)	2482	Nueces Bay	8	3698	43440	19941
		2484	Corpus Christi Inner Harbor	4	46843	47635	**47164**
	Event 3	2101	Nueces River Tidal	2	1030	1341	1186
	(January 2005)	2482	Nueces Bay	8	27606	40464	36906
		2484	Corpus Christi Inner Harbor	4	43953	44295	**44168**
	Event 4	2101	Nueces River Tidal	2	1396	6051	3724
	(May 2005)	2482	Nueces Bay	8	28523	44657	35613
		2484	Corpus Christi Inner Harbor	4	43864	44681	**44250**
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Salinity	Event 1	2101	Nueces River Tidal	2	0.33	0.34	0.34
(PSU)	(June 2004)	2482	Nueces Bay	8	4.43	20.64	10.94
		2484	Corpus Christi Inner Harbor	4	22.73	26.27	**24.31**
	Event 2	2101	Nueces River Tidal	2	0.32	0.34	0.33
	(September 2004)	2482	Nueces Bay	8	1.94	27.88	12.20
		2484	Corpus Christi Inner Harbor	4	30.31	30.88	**30.54**
	Event 3	2101	Nueces River Tidal	2	0.51	0.67	0.59
	(January 2005)	2482	Nueces Bay	8	16.99	25.90	23.39
		2484	Corpus Christi Inner Harbor	4	28.41	28.66	**28.57**
	Event 4	2101	Nueces River Tidal	2	0.70	3.29	2.00
	(May 2005)	2482	Nueces Bay	8	17.61	28.85	23.73
		2484	Corpus Christi Inner Harbor	4	28.30	28.90	**28.59**

Table 6.3.2. Dissolved Oxygen (mg/l^{-1} and % Saturation) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. **Bold** = highest recorded mean concentrations. * = no data collected.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Dissolved Oxygen	Event 1	2101	Nueces River Tidal	2	7.10	7.49	7.30
(mg/l^{-1})	(June 2004)	2482	Nueces Bay	8	7.31	9.03	**7.92**
		2484	Corpus Christi Inner Harbor	4	6.56	9.34	7.72
	Event 2	2101	Nueces River Tidal	2	5.65	6.06	5.86
	(September 2004)	2482	Nueces Bay	8	7.15	8.59	**7.82**
		2484	Corpus Christi Inner Harbor	4	5.06	5.83	5.32
	Event 3	2101	Nueces River Tidal	2	8.79	9.08	**8.94**
	(January 2005)	2482	Nueces Bay	8	8.01	9.51	8.55
		2484	Corpus Christi Inner Harbor	4	7.90	8.20	8.08
	Event 4	2101	Nueces River Tidal	2	8.50	8.96	8.73
	(May 2005)	2482	Nueces Bay	8	7.20	8.58	7.79
		2484	Corpus Christi Inner Harbor	4	7.71	10.53	**8.79**
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Dissolved Oxygen	Event 1	2101	Nueces River Tidal	2	98.20	101.30	99.75
(% Saturation)	(June 2004)	2482	Nueces Bay	8	100.80	136.40	111.56
		2484	Corpus Christi Inner Harbor	4	97.04	139.10	**115.16**
	Event 2	2101	Nueces River Tidal	2	72.10	77.70	74.90
	(September 2004)	2482	Nueces Bay	8	95.40	121.70	**104.85**
		2484	Corpus Christi Inner Harbor	4	78.30	90.00	82.40
	Event 3	2101	Nueces River Tidal	2	94.40	102.90	98.65
	(January 2005)	2482	Nueces Bay	8	95.40	110.10	101.13
		2484	Corpus Christi Inner Harbor	4	100.30	102.50	**101.33**
	Event 4	2101	Nueces River Tidal	2	102.30	106.00	104.15
	(May 2005)	2482	Nueces Bay	8	100.30	119.70	107.66
		2484	Corpus Christi Inner Harbor	4	102.20	146.10	**120.85**

Table 6.3.3. pH (su) and Water Temperature (°C) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. **Bold** = highest recorded mean concentrations. * = no data collected.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
pH	Event 1	2101	Nueces River Tidal	2	8.06	8.11	8.09
(su)	(June 2004)	2482	Nueces Bay	8	8.27	8.46	**8.41**
		2484	Corpus Christi Inner Harbor	4	8.16	8.35	8.23
	Event 2	2101	Nueces River Tidal	2	7.70	7.81	7.76
	(September 2004)	2482	Nueces Bay	8	8.16	8.48	**8.30**
		2484	Corpus Christi Inner Harbor	4	7.90	8.07	7.99
	Event 3	2101	Nueces River Tidal	2	7.78	8.14	**7.96**
	(January 2005)	2482	Nueces Bay	8	7.81	8.10	7.94
		2484	Corpus Christi Inner Harbor	4	7.85	7.95	7.89
	Event 4	2101	Nueces River Tidal	2	8.28	8.50	**8.39**
	(May 2005)	2482	Nueces Bay	8	8.00	8.17	8.08
		2484	Corpus Christi Inner Harbor	4	8.05	8.41	8.23
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Water Temperature	Event 1	2101	Nueces River Tidal	2	27.92	28.33	28.13
(°C)	(June 2004)	2482	Nueces Bay	8	29.13	32.10	**30.29**
		2484	Corpus Christi Inner Harbor	4	28.77	29.31	29.12
	Event 2	2101	Nueces River Tidal	2	27.69	28.09	27.89
	(September 2004)	2482	Nueces Bay	8	25.74	28.85	26.81
		2484	Corpus Christi Inner Harbor	4	29.22	29.46	**29.36**
	Event 3	2101	Nueces River Tidal	2	18.64	21.29	**19.97**
	(January 2005)	2482	Nueces Bay	8	11.72	22.10	16.75
		2484	Corpus Christi Inner Harbor	4	17.32	18.63	17.94
	Event 4	2101	Nueces River Tidal	2	22.80	24.51	23.66
	(May 2005)	2482	Nueces Bay	8	21.95	26.44	**24.81**
		2484	Corpus Christi Inner Harbor	4	23.41	23.96	23.62

Table 6.3.4. Secchi Depth (m) and Turbidity (NTU) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. **Bold** = highest recorded mean concentrations. * = no data collected.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Secchi Depth	Event 1	2101	Nueces River Tidal	2	0.25	0.30	0.28
(su)	(June 2004)	2482	Nueces Bay	8	0.50	0.90	0.58
		2484	Corpus Christi Inner Harbor	4	1.00	1.10	**1.08**
	Event 2	2101	Nueces River Tidal	2	0.30	0.30	0.30
	(September 2004)	2482	Nueces Bay	8	0.25	2.00	0.63
		2484	Corpus Christi Inner Harbor	4	2.00	4.00	**3.00**
	Event 3	2101	Nueces River Tidal	2	0.30	0.35	0.33
	(January 2005)	2482	Nueces Bay	8	0.30	0.80	0.53
		2484	Corpus Christi Inner Harbor	4	1.50	1.90	**1.68**
	Event 4	2101	Nueces River Tidal	2	0.45	1.25	0.85
	(May 2005)	2482	Nueces Bay	8	0.10	0.75	0.29
		2484	Corpus Christi Inner Harbor	4	0.70	1.75	**1.04**
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Turbidity	Event 1	2101	Nueces River Tidal	-	*	*	*
(NTU)	(June 2004)	2482	Nueces Bay	-	*	*	*
		2484	Corpus Christi Inner Harbor	3	0.80	2.60	**1.97**
	Event 2	2101	Nueces River Tidal	2	34.80	44.00	**39.40**
	(September 2004)	2482	Nueces Bay	8	13.10	85.00	32.79
		2484	Corpus Christi Inner Harbor	4	0.10	4.30	1.45
	Event 3	2101	Nueces River Tidal	2	22.00	27.10	**24.55**
	(January 2005)	2482	Nueces Bay	8	6.10	29.80	14.55
		2484	Corpus Christi Inner Harbor	4	0.70	4.40	1.70
	Event 4	2101	Nueces River Tidal	2	16.10	20.80	18.45
	(May 2005)	2482	Nueces Bay	8	19.30	135.90	**61.20**
		2484	Corpus Christi Inner Harbor	4	0.09	13.40	8.75

Table 6.3.5. Total Depth (m) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. **Bold** = highest recorded mean concentrations. * = no data collected.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Total Depth	Event 1	2101	Nueces River Tidal	2	2.00	4.78	3.39
(m)	(June 2004)	2482	Nueces Bay	8	0.60	5.20	2.05
		2484	Corpus Christi Inner Harbor	4	15.00	15.00	**15.00**
	Event 2	2101	Nueces River Tidal	2	1.50	4.80	3.15
	(September 2004)	2482	Nueces Bay	8	0.50	2.50	1.25
		2484	Corpus Christi Inner Harbor	4	11.20	15.10	**13.93**
	Event 3	2101	Nueces River Tidal	2	1.70	3.00	2.35
	(January 2005)	2482	Nueces Bay	8	0.50	2.50	1.28
		2484	Corpus Christi Inner Harbor	4	14.50	15.30	**14.98**
	Event 4	2101	Nueces River Tidal	2	1.58	2.87	2.23
	(May 2005)	2482	Nueces Bay	8	0.40	3.50	1.34
		2484	Corpus Christi Inner Harbor	4	15.24	15.95	**15.49**

6.4 Routine Conventional Water Chemistry – Individual Concentrations for grab samples taken at 0.30 m depth

Table 6.4.1. Total Suspended Solid concentrations (mg/l^{-1} or ppm) at Nueces Bay TMDL stations for all Sampling Events. **Bold** = highest recorded concentrations.

Segment	Segment Name	TCEQ ID	June 2004 (E1)	September 2004 (E2)	January 2005 (E3)	May 2005 (E4)	Mean of all Events
2101	Nueces River Tidal	12960	**80.00**	17.00	27.00	17.00	35.25
2101		12961	51.00	27.00	17.00	10.00	26.25
2482	Nueces Bay	13420	26.00	30.00	32.00	85.00	43.25
2482		13421	12.00	27.00	17.00	95.00	37.75
2482		13422	16.00	12.00	23.00	146.00	49.25
2482		13423	33.00	19.00	17.00	**232.00**	75.25
2482		13424	24.00	14.00	28.00	88.00	38.50
2482		13425	12.00	26.00	54.00	27.00	29.75
2482		14833	26.00	**78.00**	41.00	85.00	57.50
2482		18365	18.00	55.00	**72.00**	24.00	42.25
2484	Corpus Christi Inner Harbor	13430	11.00	14.00	18.00	28.00	17.75
2484		13432	10.00	17.00	18.00	28.00	18.25
2484		13436	9.00	18.00	12.00	25.00	16.00
2484		13439	12.00	10.00	12.00	20.00	13.50

6.5 Routine Conventional Water Chemistry –Summary Statistics based on grab samples taken at 0.30 m depth

Table 6.5.21. Total Suspended Solids (mg/l^{-1}) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. **Bold** = highest recorded mean concentrations.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Total	Event 1	2101	Nueces River Tidal	2	51.00	80.00	**65.50**
Suspended	(June 2004)	2482	Nueces Bay	8	12.00	33.00	20.88
Solids		2484	Corpus Christi Inner Harbor	4	9.00	12.00	10.50
(TSS)	Event 2	2101	Nueces River Tidal	2	17.00	27.00	22.00
	(September 2004)	2482	Nueces Bay	8	12.00	78.00	**32.63**
		2484	Corpus Christi Inner Harbor	4	10.00	18.00	14.75
	Event 3	2101	Nueces River Tidal	2	17.00	27.00	22.00
	(January 2005)	2482	Nueces Bay	8	17.00	72.00	**35.50**
		2484	Corpus Christi Inner Harbor	4	12.00	18.00	15.00
	Event 4	2101	Nueces River Tidal	2	10.00	17.00	13.50
	(May 2005)	2482	Nueces Bay	8	24.00	232.00	**97.75**
		2484	Corpus Christi Inner Harbor	4	20.00	28.00	25.25

6.6 Trace Metals in Water – Individual Concentrations for pumped grab samples taken at 0.30 m depth

Table 6.6.1. Zinc concentrations (µg/l^{-1} or ppb) at Nueces Bay TMDL stations for all Sampling Events. D = Dissolved and T = Total. Shaded = value exceeded TCEQ criteria level. **Bold** = highest recorded concentration.

Segment	Segment Name	TCEQ ID	June 2004 (E1)		September 2004 (E2)		January 2005 (E3)		May 2005 (E4)	
			T	D	T	D	T	D	T	D
2101	Nueces River Tidal	12960	**8.79**	0.18	5.45	0.21	4.89	0.29	3.54	0.40
2101		12961	6.06	0.16	3.96	0.13	3.04	0.10	1.30	< 0.20
2482	Nueces Bay	13420	7.11	0.65	7.29	0.57	8.34	1.08	16.60	1.06
2482		13421	3.50	0.85	5.69	0.83	3.80	1.44	20.50	1.79
2482		13422	5.00	0.55	3.00	0.64	4.39	1.76	26.80	1.56
2482		13423	4.18	0.74	3.82	1.02	4.00	1.85	**43.40**	1.68
2482		13424	6.81	0.65	4.18	0.35	6.37	2.40	16.40	1.48
2482		13425	4.51	0.43	7.47	0.38	9.05	1.31	5.68	1.42
2482		14833	6.95	0.56	**20.70**	0.44	6.52	1.84	18.70	1.57
2482		18365	7.78	0.53	17.50	0.34	**13.90**	2.26	4.92	1.61
2484	Corpus Christi Inner Harbor	13430	3.68	1.67	8.12	4.93	7.83	6.33	7.25	2.74
2484		13432	4.15	2.00	11.70	**6.69**	12.40	**10.80**	8.18	2.87
2484		13436	7.59	**4.48**	9.55	6.29	10.20	10.40	7.48	**3.17**
2484		13439	6.12	1.94	7.75	5.46	11.00	10.10	3.86	2.07

6.7 Trace Metals in Water – Summary Statistics based on pumped grab samples taken at 0.30 m depth

Table 6.7.1. Total and Dissolved Zinc (µg/l^{-1}) summary statistics, listed by TCEQ Segment, for Nueces Bay TMDL stations. Shaded = value exceeded TCEQ criteria level. **Bold** = highest recorded mean concentrations. TWC = Tidal Water Chronic.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Total Zinc	Event 1	2101	Nueces River Tidal	2	6.06	8.79	**7.43**
	(June 2004)	2482	Nueces Bay	8	3.50	7.78	5.73
TWC = NA		2484	Corpus Christi Inner Harbor	4	3.68	7.59	5.39
	Event 2	2101	Nueces River Tidal	2	3.96	5.45	4.71
	(September 2004)	2482	Nueces Bay	8	3.00	20.70	8.71
		2484	Corpus Christi Inner Harbor	4	7.75	11.70	**9.28**
	Event 3	2101	Nueces River Tidal	2	3.04	4.89	3.97
	(January 2005)	2482	Nueces Bay	8	3.80	13.90	7.05
		2484	Corpus Christi Inner Harbor	4	7.83	12.40	**10.36**
	Event 4	2101	Nueces River Tidal	2	1.30	3.54	2.42
	(May 2005)	2482	Nueces Bay	8	4.92	43.40	**19.13**
		2484	Corpus Christi Inner Harbor	4	3.86	8.18	6.69
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Dissolved Zinc	Event 1	2101	Nueces River Tidal	2	0.16	0.18	0.17
	(June 2004)	2482	Nueces Bay	8	0.43	0.85	0.62
TWC = 84.20		2484	Corpus Christi Inner Harbor	4	1.67	4.48	**2.52**
	Event 2	2101	Nueces River Tidal	2	0.13	0.21	0.17
	(September 2004)	2482	Nueces Bay	8	0.34	1.02	0.57
		2484	Corpus Christi Inner Harbor	4	4.93	6.69	**5.84**
	Event 3	2101	Nueces River Tidal	2	0.10	0.29	0.20
	(January 2005)	2482	Nueces Bay	8	1.08	2.40	1.74
		2484	Corpus Christi Inner Harbor	4	6.33	10.80	**9.41**
	Event 4	2101	Nueces River Tidal	2	< 0.20	0.40	0.30
	(May 2005)	2482	Nueces Bay	8	1.06	1.79	1.52
		2484	Corpus Christi Inner Harbor	4	2.07	3.17	**2.71**

6.8 Trace Metals in Sediment and Sediment Characteristics – Individual Concentrations

Table 6.8.1. Zinc concentration (mg/kg) and sediment characteristic concentrations (%) for Upper (U) and Lower (L) core depths at Nueces Bay TMDL stations for Sampling Event 2 (September 2004) and Sampling Event 4 (May 2005). Shaded = value exceeded TCEQ PEL and 85th percentile screening level. Shaded = value exceeded 85th percentile only. **Bold** = highest recorded concentration.

September 2004	Segment	Segment Name	TCEQ ID	Zn		TOC %		Gravel		Sand		Silt-Clay	
				U	L	U	L	U	L	U	L	U	L
	2101	Nueces River Tidal	12960	62.70	67.20	0.65	0.59	0.02	-	18.08	23.02	81.77	76.98
	2101		12961	**485.00**	**1070.30**	0.70	0.53	-	-	33.41	23.06	66.58	76.92
Zinc (Zn)	2482	Nueces Bay	13420	53.90	45.70	0.61	0.41	0.07	0.11	26.37	38.65	73.57	61.25
PEL = 271.0	2482		13421	13.20	12.00	0.09	0.07	0.31	0.26	93.55	**94.58**	6.14	5.17
85th Percentile = 107.0	2482		13422	55.30	59.00	0.58	0.59	4.07	**10.36**	52.03	54.77	43.89	34.87
	2482		13423	57.10	54.20	0.57	0.36	1.25	0.67	59.02	55.60	39.72	43.74
	2482		13424	53.40	58.90	0.31	0.63	3.69	5.09	67.81	66.31	28.49	28.60
	2482		13425	106.60	112.40	0.67	0.92	0.10	-	6.18	7.89	**93.71**	**92.11**
	2482		14833	17.00	17.40	0.15	0.21	-	0.52	**94.03**	93.71	5.97	5.78
	2482		18365	115.80	168.70	0.47	0.46	**7.73**	3.13	42.99	34.34	49.27	62.53
	2484	CC Inner Harbor	13430	125.40	107.40	0.79	**1.20**	0.09	-	12.43	16.59	87.49	83.41
	2484		13432	63.40	58.70	0.15	0.17	5.09	6.29	82.11	80.58	12.80	13.13
	2484		13436	144.70	178.60	0.88	0.88	-	-	44.91	45.15	55.09	54.85
	2484		13439	161.80	169.40	**1.00**	0.25	-	-	21.95	17.79	78.05	82.21
May 2005	**Segment**	**Segment Name**	**TCEQ ID**	**Zn**		**TOC %**		**Gravel**		**Sand**		**Silt-Clay**	
				U	L	U	L	U	L	U	L	U	L
	2101	Nueces River Tidal	12960	136.20	159.10	**1.20**	0.74	-	-	4.90	3.34	**95.09**	**96.67**
	2101		12961	36.90	45.40	0.68	1.20	0.01	0.54	37.65	36.19	62.34	63.28
Zinc (Zn)	2482	Nueces Bay	13420	45.50	44.10	0.55	0.63	-	0.62	45.80	39.45	54.20	59.93
PEL = 271.0	2482		13421	8.00	8.80	0.03	0.10	0.03	0.10	**95.35**	**95.39**	4.61	4.51
85th Percentile = 107.0	2482		13422	60.10	72.90	0.40	0.51	5.39	0.97	62.13	58.19	32.49	40.85
	2482		13423	23.80	61.70	0.45	0.48	2.09	4.14	60.92	52.75	36.99	43.11
	2482		13424	98.50	79.90	1.00	0.87	0.12	0.10	24.94	28.82	74.94	71.09
	2482		13425	42.10	41.80	0.44	0.42	-	-	27.37	39.07	72.62	60.93
	2482		14833	31.80	27.10	0.37	0.18	0.04	0.04	81.74	82.69	18.23	17.27
	2482		18365	102.50	**200.70**	0.54	0.60	**10.02**	**6.04**	53.19	43.97	36.79	49.98
	2484	CC Inner Harbor	13430	107.60	123.33	**1.20**	**1.60**	-	-	17.18	7.61	82.83	92.39
	2484		13432	**164.80**	155.10	0.73	0.76	0.30	0.46	58.13	53.20	41.21	46.34
	2484		13436	141.00	129.90	0.66	0.76	-	-	57.63	57.47	42.37	42.53
	2484		13439	129.50	109.30	0.87	0.93	0.91	4.06	42.66	33.98	56.43	61.95

6.9 Trace Metals in Sediment – Summary Statistics

Table 6.9.1. Total Organic Carbon (TOC) and Percent Sand in sediment summary statistics listed by TCEQ Segments, for Upper and Lower core depths at Nueces Bay TMDL Stations, for Sampling Event 2 (September 2004) and Sampling Event 4 (May 2005). **Bold** = highest recorded mean concentrations.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
TOC (%)	Event 2 (September 2004)	2101	Nueces River Tidal	2	0.65	0.70	0.68
		2482	Nueces Bay	8	0.09	0.67	0.43
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	0.15	1.00	**0.71**
Lower Core Depth		2101	Nueces River Tidal	2	0.53	0.59	0.56
		2482	Nueces Bay	8	0.07	0.92	0.46
		2484	Corpus Christi Inner Harbor	4	0.17	1.20	**0.63**
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
TOC (%)	Event 4 (May 2005)	2101	Nueces River Tidal	2	0.68	1.20	**0.94**
		2482	Nueces Bay	8	0.03	1.00	0.47
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	0.66	1.20	0.87
Lower Core Depth		2101	Nueces River Tidal	2	0.74	1.20	0.97
		2482	Nueces Bay	8	0.10	0.87	0.47
		2484	Corpus Christi Inner Harbor	4	0.76	1.60	**1.01**
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Percent Sand (0.0625 - 2.00 mm)	Event 2 (September 2004)	2101	Nueces River Tidal	2	18.08	33.41	25.75
		2482	Nueces Bay	8	6.18	94.03	**55.25**
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	12.43	82.11	40.35
Lower Core Depth		2101	Nueces River Tidal	2	23.02	23.06	23.04
		2482	Nueces Bay	8	7.89	94.58	**55.73**
		2484	Corpus Christi Inner Harbor	4	16.59	80.58	40.03
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Percent Sand (0.0625 - 2.00 mm)	Event 4 (May 2005)	2101	Nueces River Tidal	6	4.90	37.65	21.28
		2482	Nueces Bay	7	24.94	95.35	**56.43**
Upper Core Depth		2484	Corpus Christi Inner Harbor	12	17.18	58.13	43.90
Lower Core Depth		2101	Nueces River Tidal	2	3.34	36.19	19.77
		2482	Nueces Bay	15	28.82	95.39	**55.04**
		2484	Corpus Christi Inner Harbor	14	7.61	57.47	38.07

Table 6.9.2. Percent Silt-Clay and Zinc (mg/kg) in sediment summary statistics listed by TCEQ Segments, for Upper and Lower core depths at Nueces Bay TMDL Stations for Sampling Event 2 (September 2004) and Sampling Event 4 (May 2005). Shaded = value exceeded TCEQ PEL and 85th percentile screening level. Shaded = value exceeded 85th percentile only. **Bold** = highest recorded mean concentrations.

Parameter	Date	Segment	Segment Name	n (stations)	Min	Max	Mean
Percent Silt-Clay (< 0.0625	Event 2 (September 2004)	2101	Nueces River Tidal	2	66.58	81.77	**74.18**
		2482	Nueces Bay	8	5.97	93.71	42.60
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	12.80	87.49	58.36
Lower Core Depth		2101	Nueces River Tidal	2	76.92	76.98	**76.95**
		2482	Nueces Bay	8	5.17	92.11	41.76
		2484	Corpus Christi Inner Harbor	4	13.13	83.41	58.40
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
Percent Silt-Clay (< 0.0625	Event 4 (May 2005)	2101	Nueces River Tidal	2	62.34	95.09	**78.72**
		2482	Nueces Bay	8	4.61	74.94	41.36
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	41.21	82.83	55.71
Lower Core Depth		2101	Nueces River Tidal	2	63.28	96.67	**79.98**
		2482	Nueces Bay	8	4.51	71.09	43.46
		2484	Corpus Christi Inner Harbor	4	42.53	92.39	60.80
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
ZINC (mg/kg)	Event 2 (September 2004)	2101	Nueces River Tidal	2	62.70	485.00	**273.80**
		2482	Nueces Bay	8	13.20	115.80	59.04
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	63.40	161.80	123.83
Lower Core Depth		2101	Nueces River Tidal	2	67.20	1070.30	**568.75**
		2482	Nueces Bay	8	12.00	168.70	66.04
		2484	Corpus Christi Inner Harbor	4	58.70	178.60	128.53
Parameter	**Date**	**Segment**	**Segment Name**	**n (stations)**	**Min**	**Max**	**Mean**
ZINC (mg/kg)	Event 4 (May 2005)	2101	Nueces River Tidal	2	36.90	136.20	86.55
		2482	Nueces Bay	8	8.00	102.50	51.54
Upper Core Depth		2484	Corpus Christi Inner Harbor	4	107.60	164.80	**135.73**
Lower Core Depth		2101	Nueces River Tidal	2	45.40	159.10	102.25
		2482	Nueces Bay	8	8.80	200.70	67.13
		2484	Corpus Christi Inner Harbor	4	109.30	155.10	**129.41**