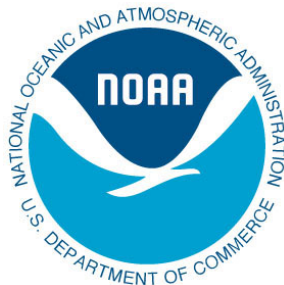


**Oso Bay and Laguna Madre
Total Maximum Daily Load Project – Phase III and IV
Data Report**

A report of the Coastal Coordination Council pursuant to
National Oceanic and Atmospheric Administration
Award Nos. NA17OZ2353 and NA03NOS4190102



Prepared for:

**Texas General Land Office
1700 North Congress Avenue
Austin, Texas 78701-1495**

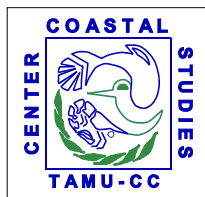
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1.0 INTRODUCTION

1.1 Background

Oso Bay (Segment 2485) and the Laguna Madre (Segment 2491) are on the *2002 Texas Clean Water Act 303(d) List* of impaired waters for not meeting the aquatic life use due to depressed dissolved oxygen. The Texas Commission on Environmental Quality's (TCEQ) Total Maximum Daily Load (TMDL) Program, in conjunction with the Coastal Management Program (CMP), funded a project to characterize the Oso Bay/Oso Creek watershed while using a control site in the Upper Laguna Madre. Phase I began in October 1999 as a six month sampling effort to characterize and assess the water quality and biota of the Oso Creek/Oso Bay Watershed System. Sampling involved the collection of routine field data and water chemistry parameters, macroinvertebrate organisms, epifaunal and nekton organisms, and microbial indicator organisms (Nicolau 2001).

Phase II extended this initial project for an additional 6 months to September 2000. In an attempt to address depressed dissolved oxygen (DO) levels, a 24-hour monitoring program also took place at four fixed platform locations within Oso Bay and one fixed platform reference location in the Upper Laguna Madre. This effort resulted in data collection for a portion of the 2000 index period (August 17 through October 15) and for all of the 2001 index period (March 15 through October 15). Project conclusions stated the DO standard is not being met under present conditions and the current method of establishing limits, standards, and criteria screening levels may not accurately reflect the water body in question (Nicolau 2001).

Data analysis revealed wide diurnal fluctuations and the physical and chemical nature of the system plays a large part in naturally occurring fluctuations of DO, a vital aquatic life parameter. One primary reason relates to the inverse relationship of salinity and temperature to DO, where increasing salinity and temperature will depress DO levels. In addition, increased biological activity, associated with daily regime of oxygen production through photosynthesis, and oxygen consumption through respiration, influences DO concentrations seen in the water column. However, these depressed DO levels are often common and routinely expected in shallow, warm water, highly saline systems typical of the South Texas region and are not necessarily indicative of "impaired" water quality.

The exceptional habitat designation for both Oso Bay and the Upper Laguna Madre is justifiable, but it is clear that natural hydrodynamics play a critical part in low DO levels. The possibility exists that criteria for exceptional habitat will never be attainable within both systems based on the present fixed numerical value. It is clear that prevailing conditions associated within these unique areas is problematic in accurately assessing support of the aquatic life criteria.

1.2 Project Objectives

Phase I and II results identified a need to develop site-specific criteria for DO as a variable DO criteria based on the relationship between salinity and temperature may be more appropriate for assessing water quality than the present fixed numerical criteria system. Therefore, Phase III (August 2003 through July 2004) and Phase IV (August 2004 through July 2005) project objectives were to collect additional water quality data necessary for TCEQ to develop site-specific DO criteria for Oso Bay and the Laguna Madre.

2.0 METHODS

2.1 Sampling Process Design

Four sites in Oso Bay and six sites in the Laguna Madre were sampled monthly for Phase III (August 2003 - July 2004) and Phase IV (August 2004 - July 2005) for 24-Hour parameters as described in the Quality Assurance Project Plan (QAPP) and listed in Table 2.1. Routine Conventional and Biological Oxygen Demand sampling took place for eight months during the TCEQ index period (March 15 - October 15) during each year. In addition, one TCEQ station (13444) was sampled monthly (vertical profiles) using a YSI multiparameter instrument for routine field measurements. All data underwent quality assurance and complied with TCEQ Data Management protocol.

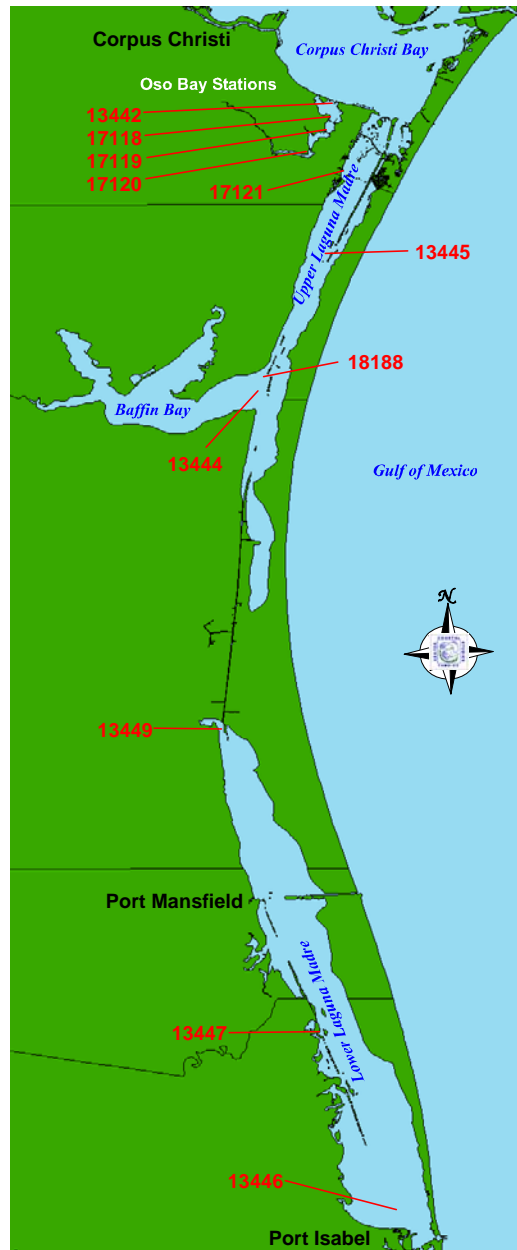


Fig. 2.1. Map of Oso Bay and Laguna Madre TCEQ sampling locations.

2.2 Parameters Sampled

Table 2.1 lists all parameters measured for Oso Bay and Laguna Madre TMDL. 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 Oso Bay and Laguna Madre 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 ⁻¹	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
PAR – Terrestrial	µmol s ⁻¹ m ⁻²	NA
PAR – Flat Cosine	µmol s ⁻¹ m ⁻²	NA
PAR – Spherical	µmol s ⁻¹ m ⁻²	NA
Seagrass Percent Cover	%	NA
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	
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
Biological Oxygen Demand (Water)	Units	TCEQ Parameter Codes
In-situ 24-Hr-Winkler	mg/l ⁻¹	03922

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Table 2.1. (continued).

24-HOUR PARAMETERS	Units	TCEQ Parameter Codes
Water Temperature Number of Measurements in 24-Hrs	Integer	00221
Water Temperature 24-Hr Minimum	°C	00211
Water Temperature 24-Hr Maximum	°C	00210
Water Temperature 24-Hr Average	°C	00209
Dissolved Oxygen % Saturation Number of Measurements in 24-Hrs	Integer	20391
Dissolved Oxygen Saturation 24-Hr Minimum	%	20388
Dissolved Oxygen Saturation 24-Hr Maximum	%	20389
Dissolved Oxygen Saturation 24-Hr Average	%	20390
Dissolved Oxygen Number of Measurements in 24-Hrs	Integer	89858
Dissolved Oxygen 24-Hr Minimum	mg/l ⁻¹	89855
Dissolved Oxygen 24-Hr Maximum	mg/l ⁻¹	89856
Dissolved Oxygen 24-Hr Average	mg/l ⁻¹	89857
Conductivity Number of Measurements in 24-Hrs	Integer	00222
Conductivity 24-Hr Minimum	µS/cm	00214
Conductivity 24-Hr Maximum	µS/cm	00213
Conductivity 24-Hr Average	µS/cm	00212
Salinity Number of Measurements in 24-Hrs	Integer	00220
Salinity 24-Hr Minimum	PSU	00219
Salinity 24-Hr Maximum	PSU	00217
Salinity 24-Hr Average	PSU	00218
pH # of Meas. in 24-Hrs	Integer	00223
pH 24-Hr Minimum	S.U.	00216
pH 24-Hr Maximum	S.U.	00215
ROUTINE CHEMISTRY (Water)	Units	TCEQ Parameter Codes
Alkalinity (Total)	mg/l ⁻¹	00410
Ammonia-Nitrogen	mg/l ⁻¹	00610
Nitrate/Nitrite-Nitrogen	mg/l ⁻¹	00630
Total Kjeldahl Nitrogen (TKN)	mg/l ⁻¹	00625
Chloride	mg/l ⁻¹	00940
Sulfate	mg/l ⁻¹	00945
Orthophosphate	mg/l ⁻¹	70507
Total Phosphorus	mg/l ⁻¹	00665
Total Organic Carbon (TOC)	mg/l ⁻¹	00680
Total Dissolved Solids (TDS)	mg/l ⁻¹	70300
Total Suspended Solids (TSS)	mg/l ⁻¹	00530
Volatile Suspended Solids (VSS)	mg/l ⁻¹	00535
Chlorophyll <i>a</i>	µg/l ⁻¹	32211
Pheophytin <i>a</i>	µg/l ⁻¹	32218

2.3 Sampling Methods

2.3.1. Field Sampling Procedures

The CCS followed sampling procedures for field, biological, and conventional chemical parameters documented in the approved QAPP (Center for Coastal Studies 2003 and 2004). 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.

2.3.2. Site Location

The sampling locations for the 24-Hr DO platforms and in-situ 24-Hr BOD arrays were established prior to the commencement of sampling. Site selection was determined using criteria described in the TCEQ Surface Water Quality Monitoring Procedures manual to the maximum extent practicable.

The inclusion of Oso Bay Stations 17120, 17119, 17118, and 13442 maintained continuity with past projects with all stations representing various aspects of Oso Bay (Nicolau 2001). Within the Upper Laguna Madre, Station 17121 on the western shore was chosen to maintain continuity with past projects and be representative of “typical” shallow vegetated seagrass habitat. Station 13445 was re-located slightly southeastward from the historical position on the edge of the Gulf Intracoastal Waterway to be representative of a slightly more vegetated seagrass habitat. Station 18188, located in approximately the same depths, was representative of more open water areas of the Upper Laguna Madre and had some associated seagrass habitat. All Stations were subject to influxes of drift algae and wrack material.

Within the Lower Laguna Madre, Station 13449 represented a shallower, semi-vegetated seagrass area while Station 13446 represented the more open waters of the Lower Laguna Madre with associated seagrass habitat. The remaining site, Station 13447, located in a sparsely vegetated area was heavily influenced by the Arroyo Colorado and may be more indicative of conditions within the lower portions of this Tidal Segment than the Laguna Madre.

2.3.3. Habitat Evaluation

Initial qualitative observations were made in the field to document certain attributes or conditions of the site that helped to characterize the overall ecological health. Qualitative observations were made, and noted, for the occurrence of submerged aquatic vegetation (SAV), and the presence of marine debris, etc. In addition, if there was obvious evidence of disruptive anthropogenic activities (e.g., dredging or landfill activity), these qualitative observations were noted with a brief description on the appropriate field form. Monthly qualitative observations occurred to make note of any habitat changes observed over time.

2.3.4. Data Collection, Deployment of Multiprobe Instrumentation, and In-situ BOD Sampling Array's

Day one of data/sample collection involved collection of 1) Routine Field data, 2) grab sample water column measurements, 3) Routine Conventional Water Chemistry samples, 4)

deployment of two replicate in-situ 24-Hr BOD sampling arrays, and 5) deployment of Multiprobe instruments. In-situ 24-Hr BOD sampling arrays involved the placement of two Light and two Dark bottles at approximately 1.0 to 1.5 foot levels while Multiprobe instruments were suspended from floatation devices so that the measurement probes remained as close as possible to the 1 foot depth requirement required by TCEQ. Upon successful deployment, field crews returned to port and prepared for the next days sampling event. A minimum of 24 hours elapsed before second day data/sample collection began at the first station deployed on day one.

2.3.5. Retrieval of Multiprobe Instrumentation and In-situ BOD Sampling Array's

The first activities conducted upon arriving onsite the second day were 1) downloading of data from the Multiprobe instrumentation, and 2) collection and preservation of the in-situ 24-Hr BOD sampling bottles. Upon retrieval of the Multiprobe instruments, all data collected over the 24-Hr period were downloaded to an onboard computer for transportation back to port and further analysis. A YSI 58 Dissolved Oxygen Meter equipped with a YSI 5905 BOD Probe was used in the field to collect a BOD measurement from one Light and one Dark bottle from each array. The remaining bottles were transported back to the laboratory to be analyzed according to methods described in the QAPP.

2.3.6. Hydrographic Profile

Water column profiles, involving a one time grab sample, were performed at each site to measure basic water quality parameters. Basic field water quality parameters were measured using a hand-held multiparameter water quality probe (e.g. YSI Sondes) with cable connection to a deck display. Hydrographic profiles were conducted according to the TCEQ SWQM Procedures Manual (2003) requirements for vertical depth profiles.

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3.0 DATA RESULTS

The following tables provide data results for the Phase III and IV portions of the project. As a data gathering effort, to provide TCEQ with sufficient data to address DO questions in the Laguna Madre and Oso Bay, no analysis was required on the part of the Center for Coastal Studies.

Table 3.1. 24-Hr Average Water Temperature (°C) recorded at each sampling location from August 2003 through July 2005. * No data recorded due to loss of instrument. – No Data required to be collected.

Month	Oso Bay				Upper Laguna Madre			Lower Laguna Madre		
	13442	17118	17119	17120	17121	13445	18188	13449	13447	13446
August-03	31.01	31.05	32.20	32.02	30.60	30.56	30.21	28.96	29.31	26.86
September-03	29.68	29.54	29.82	30.29	29.60	28.28	28.28	28.23	28.14	28.18
October-03	25.88	27.35	27.59	26.24	25.86	24.03	24.42	25.28	25.89	25.52
November-03	22.57	22.83	22.82	23.36	25.38	25.53	25.92	19.77	19.94	20.16
December-03	13.88	14.00	14.60	15.57	20.09	19.65	19.07	14.09	14.20	14.30
January-04	11.96	11.69	12.47	12.48	18.72	18.23	17.03	15.66	17.07	16.36
February-04	15.94	16.86	17.76	18.83	14.43	13.98	14.71	18.13	18.24	15.64
March-04	20.50	21.05	21.46	21.72	22.56	22.38	22.23	22.95	23.20	21.70
April-04	25.13	25.23	24.98	24.56	24.94	25.04	24.34	23.59	23.94	23.22
May-04	23.88	24.43	24.62	24.83	27.93	28.01	27.57	27.62	27.68	26.06
June-04	29.76	29.92	30.15	31.20	27.58	27.38	26.78	27.58	28.15	27.85
July-04	30.06	29.90	30.55	31.05	31.41	31.73	30.94	30.15	30.66	29.87
August-04	31.83	31.84	32.29	32.90	29.90	30.29	29.83	28.46	29.28	29.91
September-04	27.59	27.68	27.87	28.69	30.89	30.73	30.57	28.87	29.89	30.02
October-04	27.38	28.05	27.91	27.92	28.54	28.80	28.41	27.25	27.88	26.18
November-04	22.49	23.41	23.68	23.81	24.33	24.32	24.23	23.79	24.47	24.70
December-04	19.51	21.12	21.51	21.38	18.25	17.25	16.05	14.49	13.51	17.02
January-05	15.13	20.80	14.51	16.29	16.25	15.61	15.65	16.31	17.88	16.91
February-05	14.87	17.73	19.02	18.73	22.20	21.45	21.42	22.29	22.71	18.18
March-05	*	21.47	21.26	21.59	22.67	22.61	22.09	24.03	23.35	22.16
April-05	22.73	22.90	22.50	23.22	24.05	24.92	24.38	23.53	23.67	23.32
May-05	25.89	26.25	26.28	26.40	26.26	26.64	26.27	28.04	27.86	26.98
June-05	29.31	29.68	29.95	30.78	31.00	31.04	30.62	29.41	29.06	28.78
July-05	30.91	31.46	32.08	33.39	30.55	30.91	31.21	29.80	29.82	29.69
August-05	31.59	31.00	31.44	32.68	-	-	-	-	-	-

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Table 3.2. 24-Hr Average Salinity (PSU) recorded at each sampling location from August 2003 through July 2005. * No data recorded due to loss of instrument. – No Data required to be collected.

Month	Oso Bay				Upper Laguna Madre			Lower Laguna Madre		
	13442	17118	17119	17120	17121	13445	18188	13449	13447	13446
August-03	36.28	39.29	39.18	42.60	46.01	43.67	46.26	44.71	44.58	40.33
September-03	38.54	37.91	37.14	39.60	40.99	41.85	43.14	25.38	6.09	31.11
October-03	25.48	26.03	25.07	31.56	33.75	34.37	35.19	35.21	6.88	23.12
November-03	28.31	29.00	29.85	28.63	36.91	34.99	33.57	29.42	12.14	30.71
December-03	28.85	28.50	29.03	29.32	29.55	34.65	30.62	34.32	17.31	30.79
January-04	30.11	31.00	32.10	29.53	30.85	32.15	33.59	34.43	22.92	30.97
February-04	30.51	30.89	31.23	30.52	31.68	31.87	33.12	34.50	20.41	29.74
March-04	30.05	31.15	30.58	31.20	31.68	32.05	31.92	32.19	24.51	30.57
April-04	20.00	13.68	8.53	7.45	34.06	33.94	31.76	28.55	24.23	36.45
May-04	18.43	12.96	15.69	16.63	28.28	30.13	28.56	26.50	31.43	35.56
June-04	26.80	29.48	30.98	29.74	28.66	32.54	31.32	30.51	24.11	36.27
July-04	27.32	30.60	30.47	29.61	29.10	31.71	29.74	33.09	38.44	37.53
August-04	29.13	33.12	32.78	32.88	34.96	38.09	37.65	37.10	37.08	37.88
September-04	21.95	17.50	20.72	26.19	29.54	30.62	34.70	40.36	31.06	33.87
October-04	28.08	28.09	28.26	28.69	33.80	37.26	40.01	37.99	35.46	36.36
November-04	32.01	33.58	34.56	35.57	27.81	32.66	36.08	32.92	32.80	36.05
December-04	26.82	31.20	30.29	29.96	30.18	33.44	34.98	38.06	34.04	34.24
January-05	28.65	29.02	30.12	28.45	28.60	31.54	34.09	37.99	31.92	32.29
February-05	27.29	27.90	27.32	26.95	28.10	31.44	32.33	37.74	30.30	32.80
March-05	*	23.33	24.96	25.03	25.72	30.90	32.93	35.39	33.67	32.05
April-05	26.30	27.24	26.57	28.27	27.28	33.04	38.03	38.63	33.49	36.97
May-05	30.27	26.56	24.44	28.68	37.76	41.22	40.66	38.87	36.86	38.15
June-05	33.12	39.62	42.78	42.26	44.70	42.38	41.08	42.64	36.58	37.87
July-05	37.83	44.94	46.59	46.47	47.67	46.34	48.02	41.62	25.71	38.00
August-05	42.43	54.49	55.01	54.21	-	-	-	-	-	-

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Table 3.3. 24-Hour Average Dissolved Oxygen recorded at each sampling location from August 2003 through August 2005, with percent exceedance of the criteria. Red shading represents a value below applicable TCEQ 24-Hour Average Criteria of 5.0 mg l⁻¹. * No data recorded due to loss of instrument. ** No data – did not meet QA/QC. No Data required to be collected.

Month	Oso Bay				Upper Laguna Madre			Lower Laguna Madre		
	13442	17118	17119	17120	17121	13445	18188	13449	13447	13446
August-03	6.38	5.88	5.58	5.82	5.40	6.19	6.60	5.28	4.75	6.57
September-03	6.20	5.85	6.11	5.65	5.68	5.55	5.56	5.83	5.62	7.72
October-03	5.67	6.03	7.03	6.93	5.28	7.47	7.36	7.00	9.99	8.30
November-03	7.21	7.04	6.60	7.07	6.32	5.93	6.29	8.16	10.18	7.56
December-03	8.98	9.98	9.65	9.35	9.42	7.97	7.61	8.15	11.91	9.22
January-04	9.20	9.36	9.26	9.63	7.97	7.67	8.85	7.44	8.23	8.08
February-04	8.54	8.12	7.86	8.10	7.92	8.00	7.79	8.05	11.87	8.95
March-04	8.42	7.70	7.73	7.55	7.22	7.30	7.49	6.85	7.56	8.51
April-04	7.88	6.08	4.93	5.09	5.94	6.37	6.85	6.75	6.73	7.18
May-04	8.49	7.28	7.04	7.20	7.13	7.14	7.84	6.52	6.41	6.93
June-04	6.37	5.93	5.75	6.40	7.37	6.85	6.60	6.76	5.59	6.57
July-04	5.98	6.13	5.95	6.25	6.41	7.04	6.67	6.70	5.56	**
August-04	6.14	5.60	5.46	5.93	5.38	5.81	6.08	6.08	5.84	6.26
September-04	7.87	8.19	7.09	6.53	7.70	**	6.18	5.63	6.72	7.90
October-04	6.66	6.09	6.20	6.52	5.80	6.35	6.48	5.58	5.80	5.53
November-04	7.00	5.53	5.67	5.96	6.39	7.01	7.08	7.06	7.02	7.55
December-04	9.56	10.27	9.04	8.11	8.63	8.54	8.88	9.75	10.06	8.86
January-05	8.28	7.53	8.52	8.44	9.23	9.08	9.51	7.88	9.39	8.44
February-05	10.29	8.97	8.47	9.31	7.71	7.49	7.42	6.97	7.78	7.80
March-05	*	7.92	7.28	7.82	8.63	8.09	7.18	7.76	7.25	6.98
April-05	7.62	7.27	7.82	7.32	8.51	8.03	7.30	7.04	7.52	6.73
May-05	6.92	7.38	7.97	7.30	6.88	7.63	7.02	5.60	5.64	7.03
June-05	6.15	5.63	5.85	6.48	7.20	6.62	8.18	6.01	4.43	6.88
July-05	6.66	6.27	6.41	6.20	5.13	6.14	6.00	6.11	7.22	6.06
August-05	6.72	6.83	4.94	6.27	-	-	-	-	-	-
Percent Exceedance	0.0%	0.0%	8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.3%	0.0%

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Table 3.4. 24-Hr Minimum Dissolved Oxygen recorded at each sampling location from August 2003 through August 2005 with the total percent exceedance of the criteria, or <4.0mg/l⁻¹, percent >3.0 mg/l⁻¹ but <4.0 mg/l⁻¹, percent >2.0 mg/l⁻¹ but <3.0 mg/l⁻¹, and percent <2.0 mg/l⁻¹. Red shading represents a value below the applicable TCEQ Minimum Criteria of 4.0 mg l⁻¹ or ≥ the 25% level. * No data recorded due to loss of instrument lost. ** No data – did not meet QA/QC. – No Data required to be collected.

Month	Oso Bay				Upper Laguna Madre			Lower Laguna Madre		
	13442	17118	17119	17120	17121	13445	18188	13449	13447	13446
August-03	3.89	4.08	3.84	4.46	1.76	4.14	5.44	3.98	3.76	4.32
September-03	4.31	3.55	3.51	4.44	3.59	4.23	4.80	4.29	3.84	5.98
October-03	5.16	4.34	4.24	5.01	4.03	5.47	6.60	5.36	7.59	5.86
November-03	6.51	6.23	6.09	6.58	4.22	5.05	5.66	6.62	8.15	6.19
December-03	7.84	6.94	6.82	8.15	7.44	6.61	4.82	7.28	9.79	7.82
January-04	8.53	8.62	8.62	8.42	6.22	6.80	8.32	6.68	6.52	7.30
February-04	7.87	7.18	7.27	6.82	7.18	7.54	7.43	6.84	8.75	7.30
March-04	6.75	6.36	5.46	6.36	5.85	6.18	6.48	5.79	6.79	6.76
April-04	4.88	4.03	3.78	4.88	3.99	4.90	6.07	5.05	5.56	5.03
May-04	6.83	6.50	6.35	6.77	4.17	5.29	6.75	5.60	5.68	5.45
June-04	5.04	4.04	4.05	5.82	4.25	4.78	5.87	5.12	2.84	4.64
July-04	4.94	4.45	4.75	5.57	0.35	5.00	5.19	4.76	4.91	**
August-04	4.50	3.77	3.92	4.57	2.09	3.48	5.35	4.50	5.07	4.16
September-04	5.97	6.66	5.60	5.25	4.32	**	4.67	3.59	4.74	6.08
October-04	6.35	5.91	5.94	5.96	3.26	4.47	5.53	4.55	4.94	3.74
November-04	5.41	4.29	3.96	4.53	4.98	5.74	6.19	5.86	5.31	6.34
December-04	8.54	8.25	7.36	6.12	6.94	7.20	7.74	7.85	8.54	7.39
January-05	7.79	6.75	7.87	7.39	7.49	7.93	7.84	6.59	6.90	7.63
February-05	9.13	7.68	6.99	7.39	5.53	5.66	6.55	5.72	5.85	6.48
March-05	*	6.76	5.97	6.46	5.80	6.03	5.85	5.62	2.61	5.22
April-05	6.30	4.58	4.46	5.50	5.30	6.36	5.84	4.58	4.88	5.02
May-05	5.37	5.94	5.55	5.77	4.69	5.73	5.85	3.33	2.74	4.58
June-05	4.21	3.86	4.05	5.21	3.67	3.90	5.83	3.81	1.19	4.25
July-05	4.97	4.05	3.52	4.59	2.46	3.96	4.46	4.34	5.73	4.35
August-05	5.42	5.23	2.44	3.56	-	-	-	-	-	-
% < 4.0 mg/l ⁻¹	4.0%	12.0%	28.0%	4.0%	33.0%	13.0%	0.0%	16.7%	25.0%	4.3%
% >3.0 but <4.0 mg/l ⁻¹	4.0%	12.0%	24.0%	4.0%	16.7%	13.0%	0.0%	16.7%	8.3%	4.3%
% >2.0 but < 3.0 mg/l ⁻¹	0.0%	0.0%	4.0%	0.0%	8.3%	0.0%	0.0%	0.0%	12.5%	0.0%
% < 2.0 mg/l ⁻¹ or Hypoxic	0.0%	0.0%	0.0%	0.0%	8.3%	0.0%	0.0%	0.0%	4.2%	0.0%

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Table 3.5. Sampling sites listed by month and the duration of time that the 24-Hr Minimum Dissolved Oxygen recorded was <4.0 mg l⁻¹. Numbers in parentheses are military time event began and the concentrations were <4.0 mg/l⁻¹. Numbers in red are the duration and time that values were <2.0 mg/l⁻¹ and considered hypoxic. * No data recorded due to loss of instrument. ** No data – did not meet QA/QC. – No Data required to be collected.

Month	Oso Bay				Upper Laguna Madre			Lower Laguna Madre		
	13442	17118	17119	17120	17121	18188	13445	13449	13447	13446
August-03	0.5 hrs (0731)		4.5 hrs (0431)		9 hrs (0101) 1 hr (0630)			0.5 hrs (0831)	3 hrs (0416) 1 hr (0816) 0.5 hrs (1146)	
September-03		3 hrs (0616)	3.5 hrs (0631) 0.5 hrs (1031)		1 hr (0930) 4.5 hrs (0530)				1 hr (0646)	
April-04			3.5 hrs (0036) 1 hr (0536)		1 hr (0716)					
June-04									4.5 hrs (0541)	
July-04					8.5 hrs (0211) 5.5 hrs (0311)					**
August-04		2.5 hrs (0656)	1 hr (0811)		10.5 hrs (2316)		3.5 hrs (0441)			
September-04							**	2.5 hrs (0626)		
October-04					8.5 hrs (0106)					0.5 hrs (0856) 1.5 hr (0856)
November-04			0.5 hrs (0901)							
March-05	*								1 hr (1006) 2.5 hrs (0606)	
May-05								4 hrs (0446)	3.5 hrs (0551)	
June-05		3.5 hrs (0446)			1.5 hrs (0711)		1 hr (0701)	2 hrs (0551)	5.5 hrs (0316) 1.5 hrs (0616)	
July-05			3.5 hrs (0441)		9 hrs (0146)		0.5 hrs (0811)			
August -05			5.5 hrs (0311)	0.5 hrs (0821)	-	-	-	-	-	-

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Table 3.6. Biological Oxygen Demand (BOD) in mg l⁻¹ recorded at each sampling location and at each array from August 2003 through July 2005. Values derived by the following formula: BOD = DO_I - DO_D where DO_I = dissolved oxygen (mg l⁻¹) in initial bottle and DO_D = dissolved oxygen (mg l⁻¹) in dark bottle (see QAPP for detailed CCS WQA-2 SOP). * = No data (sampling bottle not present on day of retrieval).

		Oso Bay				Upper Laguna Madre			Lower Laguna Madre		
	Month	13442	17118	17119	17120	17121	13445	18188	13449	13447	13446
Array 1	August-03	0.42	0.93	0.77	0.67	*	-0.31	0.16	0.92	1.06	0.38
Array 2	August-03	0.55	0.47	0.69	0.65	0.85	-0.31	0.59	1.15	1.15	0.41
Array 1	September-03	0.58	1.57	1.70	0.17	0.19	1.41	0.97	0.27	0.02	0.44
Array 2	September-03	-0.04	1.05	0.93	0.63	0.11	1.10	0.40	0.44	0.70	0.82
Array 1	October-03	1.16	1.16	1.18	1.09	0.62	1.12	0.29	1.18	1.67	0.24
Array 2	October-03	-0.22	1.34	1.29	0.78	0.45	0.89	0.62	*	1.45	0.33
Array 1	March-04	0.40	0.68	0.68	0.88	1.11	1.38	1.02	1.13	0.56	0.05
Array 2	March-04	0.28	0.47	0.43	0.68	0.41	1.43	0.97	1.50	0.53	0.14
Array 1	April-04	3.18	0.45	-1.55	1.80	1.14	1.29	1.11	0.14	0.64	0.21
Array 2	April-04	1.48	0.94	-0.39	0.53	1.48	0.73	0.73	1.46	0.82	0.04
Array 1	May-04	1.34	0.59	0.52	0.66	0.75	2.35	0.86	1.13	1.93	0.36
Array 2	May-04	1.51	0.77	0.65	0.65	0.35	0.77	1.79	0.91	1.35	0.71
Array 1	June-04	1.23	2.35	1.61	1.50	0.34	1.17	0.85	1.21	0.48	0.14
Array 2	June-04	0.97	2.62	1.88	*	0.43	1.50	0.45	0.75	0.39	0.27
Array 1	July-04	1.25	2.05	1.35	0.95	0.23	0.62	1.12	1.67	0.71	1.41
Array 2	July-04	1.08	1.88	0.80	1.65	0.53	0.72	0.45	1.77	1.18	0.49
Array 1	August-04	0.83	1.10	0.92	0.47	0.54	1.57	1.87	-0.04	1.12	0.69
Array 2	August-04	0.52	1.01	0.58	0.23	0.27	1.57	1.51	0.13	*	0.05
Array 1	September-04	1.60	3.03	0.72	0.54	1.22	0.77	1.15	0.56	1.29	0.40
Array 2	September-04	0.90	2.35	0.83	*	1.11	0.77	0.91	0.66	1.11	0.38
Array 1	October-04	2.75	1.95	1.20	0.80	2.93	2.10	*	2.33	1.11	0.36
Array 2	October-04	2.22	1.60	1.42	1.40	3.70	1.51	2.52	2.15	1.42	0.09
Array 1	March-05	3.20	0.63	1.17	*	2.69	2.20	2.29	2.15	2.67	0.88
Array 2	March-05	*	0.27	0.24	0.69	2.97	1.55	2.66	3.03	2.80	0.02
Array 1	April-05	2.54	2.92	2.04	2.28	1.70	1.51	0.93	4.31	2.29	0.99
Array 2	April-05	2.31	1.94	2.99	2.11	1.34	2.15	1.31	*	2.17	0.26
Array 1	May-05	2.70	4.38	2.77	1.05	2.77	2.72	2.16	3.47	1.23	0.50
Array 2	May-05	1.03	5.48	3.58	3.43	2.81	2.16	1.98	3.12	1.49	0.42
Array 1	June-05	0.24	5.03	3.86	4.43	6.35	3.64	5.36	2.86	1.43	0.45
Array 2	June-05	1.00	4.29	3.86	4.09	6.26	4.89	4.31	2.59	1.47	0.29
Array 1	July-05	1.33	3.89	3.77	*	0.39	0.29	1.97	2.37	0.90	0.77
Array 2	July-05	2.01	4.32	3.89	4.50	0.86	1.87	2.51	2.10	0.66	1.60

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Table 3.7. Nutrient and Chlorophyll *a* concentrations recorded at each sampling location from August 2003 through July 2005. Red number represents a value exceeding the applicable TCEQ Screening Level listed in parentheses below parameter.

OSO BAY STATIONS

Date	Station	Ammonia (0.10 mg/l ⁻¹)	Nitrate + Nitrite (0.26 mg/l ⁻¹)	Ortho-phosphate) (0.16 mg/l ⁻¹)	Total Phosphate (0.22 mg/l ⁻¹)	Chlorophyll <i>a</i> (11.50 µg l ⁻¹)
08/07/2003	13442	0.02	0.05	<0.04	0.06	8.90
09/08/2003	13442	<0.02	<0.04	<0.04	0.08	13.10
10/13/2003	13442	0.17	0.16	<0.04	0.07	9.10
03/09/2004	13442	<0.02	<0.04	<0.04	0.04	4.60
04/07/2004	13442	0.03	0.19	<0.04	0.10	17.80
05/05/2004	13442	<0.02	<0.02	<0.04	0.11	11.20
06/02/2004	13442	0.02	<0.04	<0.04	0.12	12.70
07/07/2004	13442	<0.02	<0.04	<0.04	0.10	11.80
08/04/2004	13442	<0.02	<0.04	<0.04	0.08	6.70
09/09/2004	13442	0.03	0.04	0.04	0.10	11.20
10/18/2004	13442	0.13	<0.04	<0.04	0.43	18.70
03/10/2005	13442	<0.02	0.16	<0.04	0.19	13.00
04/07/2005	13442	0.03	0.04	<0.04	0.18	10.50
05/10/2005	13442	<0.02	<0.04	<0.04	0.06	4.50
06/07/2005	13442	<0.02	<0.04	0.06	0.08	12.60
07/06/2005	13442	0.03	<0.04	<0.04	0.12	9.00
08/07/2003	17118	0.11	0.06	<0.04	0.11	11.60
09/08/2003	17118	0.03	<0.04	<0.04	0.10	15.10
10/08/2003	17118	0.03	<0.04	<0.04	0.13	11.70
03/09/2004	17118	0.10	0.03	<0.04	0.07	9.60
04/07/2004	17118	0.17	0.36	0.08	0.25	18.00
05/05/2004	17118	0.11	0.15	0.06	0.26	6.00
06/02/2004	17118	0.03	<0.04	<0.04	0.20	35.10
07/07/2004	17118	0.02	0.03	0.05	0.25	30.80
08/04/2004	17118	<0.02	<0.04	<0.04	0.10	6.90
09/09/2004	17118	0.04	0.05	<0.04	0.28	32.10
10/18/2004	17118	0.15	<0.04	<0.04	0.16	13.70
03/10/2005	17118	0.07	0.14	<0.04	0.27	10.20
04/07/2005	17118	<0.02	0.03	<0.04	0.19	24.90
05/10/2005	17118	<0.02	0.06	<0.04	0.11	39.50
06/07/2005	17118	<0.02	<0.04	<0.04	0.22	48.20
07/06/2005	17118	<0.02	<0.04	<0.04	1.10	32.60

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Table 3.7 (continued).

OSO BAY STATIONS

Date	Station	Ammonia (0.10 mg/l ⁻¹)	Nitrate + Nitrite (0.26 mg/l ⁻¹)	Ortho-phosphate) (0.16 mg/l ⁻¹)	Total Phosphate (0.22 mg/l ⁻¹)	Chlorophyll <i>a</i> (11.50 µg l ⁻¹)
08/07/2003	17119	0.05	0.06	<0.04	0.08	5.60
09/08/2003	17119	0.04	0.02	<0.04	0.13	19.60
10/08/2003	17119	0.03	0.25	<0.04	0.13	21.50
03/09/2004	17119	0.09	0.02	<0.04	0.09	8.00
04/07/2004	17119	0.24	0.44	0.11	0.27	9.20
05/05/2004	17119	0.08	0.12	<0.04	0.18	4.70
06/02/2004	17119	0.03	<0.04	<0.04	0.18	32.00
07/07/2004	17119	0.10	<0.04	<0.04	0.19	8.20
08/04/2004	17119	0.02	<0.04	<0.04	0.07	15.10
09/09/2004	17119	0.17	0.11	<0.04	0.20	7.00
10/18/2004	17119	0.18	<0.04	<0.04	0.15	9.10
03/10/2005	17119	0.09	0.34	<0.04	0.25	3.90
04/07/2005	17119	<0.02	0.03	<0.04	0.20	8.50
05/10/2005	17119	<0.02	0.54	<0.04	0.60	33.70
06/07/2005	17119	<0.02	<0.04	<0.04	0.23	27.30
07/06/2005	17119	0.26	<0.04	<0.04	0.83	39.60
08/11/2003	17120	0.03	<0.04	<0.04	<0.06	13.80
09/10/2003	17120	0.06	<0.04	<0.04	0.04	6.20
10/20/2003	17120	0.02	<0.04	<0.04	0.06	16.10
03/09/2004	17120	0.02	0.06	<0.04	0.10	13.60
04/07/2004	17120	0.15	0.80	0.17	0.37	5.50
05/05/2004	17120	0.05	0.12	<0.04	0.17	4.20
06/02/2004	17120	0.05	<0.04	<0.04	0.12	14.90
07/07/2004	17120	0.04	<0.04	<0.04	0.10	9.20
08/04/2004	17120	0.02	<0.04	<0.04	0.08	6.00
09/09/2004	17120	0.12	0.10	<0.04	0.20	4.80
10/18/2004	17120	0.09	<0.04	<0.04	0.13	8.10
03/10/2005	17120	0.08	0.37	<0.04	0.23	8.50
04/07/2005	17120	0.03	0.13	<0.04	0.15	20.90
05/10/2005	17120	<0.02	0.91	<0.04	0.29	29.70
06/07/2005	17120	<0.02	<0.04	<0.04	0.18	42.70
07/06/2005	17120	<0.02	<0.04	<0.04	0.71	37.30

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Table 3.7 (continued).

UPPER LAGUNA MADRE STATIONS

Date	Station	Ammonia (0.10 mg/l ⁻¹)	Nitrate + Nitrite (0.26 mg/l ⁻¹)	Ortho-phosphate) (0.16 mg/l ⁻¹)	Total Phosphate (0.22 mg/l ⁻¹)	Chlorophyll <i>a</i> (11.50 µg l ⁻¹)
08/11/2003	17121	0.03	<0.04	<0.04	<0.06	4.40
09/10/2003	17121	0.03	<0.04	<0.04	<0.06	4.10
10/13/2003	17121	0.05	<0.04	<0.04	0.04	8.10
03/17/2004	17121	<0.02	<0.04	<0.04	<0.06	3.10
04/21/2004	17121	0.02	<0.02	<0.04	0.09	13.90
05/19/2004	17121	<0.02	<0.02	<0.04	<0.06	0.08
06/09/2004	17121	<0.02	<0.04	<0.04	0.09	2.30
07/19/2004	17121	0.04	<0.04	<0.04	<0.06	5.00
08/24/2004	17121	<0.02	<0.04	<0.04	0.04	1.20
09/16/2004	17121	<0.02	<0.04	<0.04	0.24	2.40
10/21/2004	17121	<0.02	<0.04	<0.04	0.09	22.00
03/22/2005	17121	<0.02	<0.04	<0.04	0.10	15.20
04/12/2005	17121	<0.02	<0.04	<0.04	<0.06	19.20
05/17/2005	17121	<0.02	<0.04	<0.04	0.16	24.20
06/15/2005	17121	<0.02	<0.04	<0.04	0.11	40.50
07/13/2005	17121	<0.02	<0.04	<0.04	0.04	20.10
08/18/2003	18188	0.02	<0.04	<0.04	0.07	13.30
09/17/2003	18188	<0.02	<0.04	<0.04	0.06	20.20
10/15/2003	18188	<0.02	<0.04	<0.04	<0.06	10.30
03/17/2004	18188	<0.02	<0.04	<0.04	<0.06	23.70
04/21/2004	18188	0.04	<0.02	<0.04	0.07	23.50
05/19/2004	18188	<0.02	<0.02	<0.04	0.10	21.50
06/09/2004	18188	0.06	<0.04	<0.04	0.09	20.40
07/19/2004	18188	0.04	<0.04	<0.04	0.05	8.10
08/24/2004	18188	0.02	<0.04	<0.04	0.07	13.40
09/16/2004	18188	<0.02	<0.04	<0.04	<0.10	8.90
10/21/2004	18188	<0.02	<0.04	<0.04	0.09	29.20
03/22/2005	18188	0.03	<0.04	<0.04	0.07	10.90
04/12/2005	18188	<0.02	<0.04	<0.04	0.05	33.00
05/17/2005	18188	<0.02	<0.04	<0.04	0.13	41.70
06/15/2005	18188	<0.02	<0.04	<0.04	0.09	58.20
07/13/2005	18188	<0.02	<0.04	<0.04	0.04	58.60

Table 3.7 (continued).

UPPER LAGUNA MADRE STATIONS

Date	Station	Ammonia (0.10 mg/l⁻¹)	Nitrate + Nitrite (0.26 mg/l⁻¹)	Ortho-phosphate) (0.16 mg/l⁻¹)	Total Phosphate (0.22 mg/l⁻¹)	Chlorophyll <i>a</i> (11.50 µg l⁻¹)
08/18/2003	13445	0.02	<0.04	<0.04	0.10	2.10
09/17/2003	13445	<0.02	<0.04	<0.04	0.04	13.80
10/15/2003	13445	<0.02	<0.04	<0.04	<0.06	12.40
03/17/2004	13445	<0.02	<0.04	<0.04	0.03	19.40
04/21/2004	13445	0.02	<0.02	<0.04	0.07	15.60
05/19/2004	13445	<0.02	0.02	<0.04	<0.07	13.20
06/09/2004	13445	<0.02	<0.04	<0.04	0.07	15.00
07/19/2004	13445	0.03	<0.04	<0.04	0.03	1.80
08/24/2004	13445	<0.02	<0.04	<0.04	0.05	6.80
09/16/2004	13445	0.03	<0.04	<0.04	0.13	3.60
10/21/2004	13445	<0.02	<0.04	<0.04	0.07	22.20
03/22/2005	13445	<0.02	<0.04	<0.04	0.24	17.00
04/12/2005	13445	<0.02	<0.04	0.08	0.08	25.20
05/17/2005	13445	<0.02	<0.04	<0.04	0.10	25.70
06/15/2005	13445	<0.02	<0.04	<0.04	0.07	30.50
07/13/2005	13445	<0.02	<0.04	<0.04	0.05	27.60

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Table 3.7 (continued).

LOWER LAGUNA MADRE STATIONS

Date	Station	Ammonia (0.10 mg/l ⁻¹)	Nitrate + Nitrite (0.26 mg/l ⁻¹)	Ortho-phosphate) (0.16 mg/l ⁻¹)	Total Phosphate (0.22 mg/l ⁻¹)	Chlorophyll <i>a</i> (11.50 µg l ⁻¹)
08/13/2003	13446	<0.02	<0.04	<0.04	<0.06	1.20
09/25/2003	13446	0.03	<0.04	<0.04	0.05	3.60
10/23/2003	13446	0.02	0.04	0.02	0.06	5.00
03/24/2004	13446	0.03	0.04	<0.04	0.03	1.60
04/28/2004	13446	0.03	<0.04	<0.04	0.07	1.90
05/26/2004	13446	<0.02	<0.04	<0.04	0.03	2.90
06/23/2004	13446	0.02	<0.04	<0.04	0.07	3.30
07/28/2004	13446	<0.02	<0.04	<0.04	0.03	0.80
08/18/2004	13446	0.06	<0.04	<0.04	0.04	1.60
09/22/2004	13446	<0.02	<0.04	<0.04	0.04	1.10
10/27/2004	13446	<0.02	<0.04	<0.04	0.04	1.20
03/30/2005	13446	0.04	<0.04	<0.04	0.08	5.30
04/26/2005	13446	<0.02	<0.04	<0.04	0.05	2.60
05/25/2005	13446	<0.02	<0.04	<0.04	<0.06	1.20
06/22/2005	13446	<0.02	<0.04	<0.04	0.08	1.40
07/26/2005	13446	<0.02	<0.04	<0.04	0.03	1.40
08/13/2003	13447	0.04	<0.04	<0.04	<0.06	4.40
09/25/2003	13447	0.15	0.21	0.18	0.27	5.80
10/23/2003	13447	0.02	0.17	0.02	0.15	39.10
03/24/2004	13447	0.08	0.61	<0.04	0.11	10.40
04/28/2004	13447	0.05	0.25	<0.04	0.09	13.00
05/26/2004	13447	<0.02	0.24	<0.04	0.12	26.10
06/23/2004	13447	0.04	<0.04	<0.04	0.08	12.10
07/28/2004	13447	0.08	<0.04	<0.04	0.12	12.30
08/18/2004	13447	0.07	<0.04	<0.04	0.13	15.50
09/22/2004	13447	0.06	0.15	<0.04	0.13	6.80
10/27/2004	13447	0.02	0.40	0.04	0.16	11.40
03/30/2005	13447	0.05	0.10	<0.04	0.17	87.50
04/26/2005	13447	<0.02	0.28	<0.04	0.13	28.60
05/25/2005	13447	0.05	0.06	<0.04	0.09	6.50
06/22/2005	13447	<0.02	<0.04	<0.04	0.14	25.70
07/26/2005	13447	0.14	0.88	0.06	0.19	13.40

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Table 3.7 (continued).

LOWER LAGUNA MADRE STATIONS

Date	Station	Ammonia (0.10 mg/l ⁻¹)	Nitrate + Nitrite (0.26 mg/l ⁻¹)	Ortho-phosphate) (0.16 mg/l ⁻¹)	Total Phosphate (0.22 mg/l ⁻¹)	Chlorophyll <i>a</i> (11.50 µg l ⁻¹)
08/13/2003	13449	0.03	<0.04	<0.04	<0.06	4.20
09/25/2003	13449	0.02	0.02	<0.04	0.04	2.60
10/23/2003	13449	0.02	0.04	0.02	0.07	11.70
03/24/2004	13449	0.04	<0.04	<0.04	0.13	18.20
04/28/2004	13449	0.02	<0.04	<0.04	0.04	12.70
05/26/2004	13449	<0.02	<0.04	<0.04	0.04	7.70
06/23/2004	13449	<0.02	<0.04	<0.04	0.07	14.10
07/28/2004	13449	<0.02	<0.04	<0.04	0.04	5.00
08/18/2004	13449	0.06	<0.04	<0.04	0.04	2.00
09/22/2004	13449	<0.02	<0.04	<0.04	0.04	2.50
10/27/2004	13449	0.02	<0.04	0.07	0.10	19.80
03/30/2005	13449	0.04	<0.04	<0.04	0.10	36.40
04/26/2005	13449	<0.02	<0.04	<0.04	0.17	30.80
05/25/2005	13449	0.05	0.06	<0.04	0.09	26.20
06/22/2005	13449	<0.02	<0.04	<0.04	0.10	9.10
07/26/2005	13449	<0.02	<0.04	<0.04	0.09	18.50

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Table 3.8. List of the number of exceedances (along with percent of the total number) that the applicable TCEQ Screening Level was exceeded for each station, by parameter, and for area (Oso Bay – 13442, 17118, 17119, and 17120, ULM or Upper Laguna Madre – 17121, 13445, 18188, and LLM or Lower Laguna Madre – 13447, 13446, and 13449). Numbers in red represent values that were exceeded 25.0% or greater.

	Station	Ammonia	Nitrate + Nitrite	Ortho-phosphate	Total Phosphate	Chlorophyll a
	13442	2 (12.5)	-	-	1 (6.3)	7 (43.8)
	17118	5 (31.3)	1 (6.3)	-	7 (43.8)	12 (75.0)
	17119	4 (25.0)	3 (18.8)	-	5 (31.3)	7 (43.8)
	17120	2 (12.5)	3 (18.8)	1 (6.3)	4 (25.0)	8 (50.0)
	17121	-	-	-	1 (6.3)	12 (75.0)
	13445	-	-	-	1 (6.3)	7 (43.8)
	18188	-	-	-	-	12 (75.0)
	13446	-	-	-	-	-
	13447	2 (12.5)	4 (25.0)	1 (6.3)	1 (6.3)	10 (62.5)
	13449	-				9 (56.3)
Parameter (All Stations)		15 (9.4)	11 (6.9)	2 (1.3)	20 (12.5)	84 (52.5)
Oso Bay		13 (20.3)	7 (10.9)	1 (1.6)	18 (28.1)	34 (53.1)
ULM		-	-	-	1 (2.1)	31 (64.6)
LLM		2 (4.2)	4 (8.3)	1 (2.1)	1 (2.1)	19 (39.6)

4.0 SUMMARY

Although not tasked with providing data analysis, the researchers involved with this project felt obligated to provide some feedback concerning the TCEQ dissolved oxygen (DO) criteria. As previously stated in other reports (Nicolau 2001; Nicolau and Nuñez 2004), while DO represents the most essential water quality parameter utilized by TCEQ in assessing the aquatic life use and thereby the health of the water body, or segment, it is apparent that fixed numerical criteria is not applicable in all cases. The inherent problem in applying criteria on a statewide basis should be obvious, as differences in such abiotic factors as rainfall, salinity, water temperature, and amount of freshwater inflows exist in Texas.

As established, each TCEQ classified, tidally-influenced, segment receives an Aquatic Life Use (ALU), and I emphasize, **based on physical, chemical, and biological characteristics of the segment**. Classifications are then assigned using *exceptional, high, or intermediate use* designations, with DO criteria based on meeting 24-hour average concentrations of 5.0, 4.0, and 3.0 mg/l⁻¹, respectively. In addition, the absolute minimum criteria to protect the range of ALUs in tidal waters are 1.0 mg/l⁻¹ less for all categories (TCEQ 2003).

We believe the problem relates directly to the fact that the DO criteria established by TCEQ fails to fully take into account the actual **physical, chemical, and biological characteristics** of the water body. The Laguna Madre (Segment 2491) is one of several unique hypersaline lagoons in the world and exhibits different characteristics between the Upper and Lower portions of this large geographical area.

The Upper Laguna Madre continues to strongly influence Oso Bay (Segment 2485 – Stations 17120, 17119, 17118, and 13442), through the once pass through cooling system of the Barney Davis Power Plant, while the water quality of the Arroyo Colorado (Segments 2202 and 2201) influences much of the central portion (Station 13447 and beyond) of the Lower Laguna Madre. In addition, the Brazos Santiago pass at Port Isabel also exerts a strong influence on the water quality of the extreme lower portion of the Lower Laguna Madre (Station 13449) in a positive way, by keeping the area well flushed, something that may begin to happen in the Upper Laguna Madre (Station 17121) with the opening of Packery Channel. While many similarities exist between the Upper and Lower Laguna Madre there are some physical, chemical, and biological differences and perhaps this extremely large Segment should be treated as such when water quality is evaluated. Just as what is applicable to one water body in the vast State of Texas is not necessarily applicable to all water bodies, what applies for the Upper Laguna Madre may not necessarily apply to the Lower Laguna Madre; a fact seen in some of the data collected through this project.

High emphasis remains on the fact that the relatively shallow, warm water, high salinity bays, typical of South Texas, exert a strong influence on DO, and that collectively all these factors produce water quality conditions that often lead to wide diurnal fluctuations and depressed DO levels (Nicolau 2001). However, these depressed DO levels are often common and routinely expected in such shallow (**physical**), warm water, highly saline (**chemical**) systems and are not necessarily indicative of “impaired” water quality as the biota (**biological**) of the systems are well adapted to dramatically changing conditions.

The exceptional habitat designation for this Segment is justifiable, but it is clear that natural hydrodynamics play a critical part in low DO levels. The data from this project revealed that the 24-Hour DO criteria is the issue, but rather than the minimum criteria for exceptional habitat will never be attainable based on the present fixed numerical value. The criteria must fully take into account the **physical, chemical, and biological characteristics of the segment** to produce an accurate assessment.

Rather than the original idea of looking at a site-specific DO criteria based on the relationship of salinity and temperature, we would propose that TCEQ investigate establishing site-specific criteria based on critical DO ranges for coastal bays and estuaries. While our data collection effort showed that the critical hypoxic point was reached a small percentage of the time, a criteria based on hypoxia ($<2.0 \text{ mg/l}^{-1}$) may be too stressful on the system. An alternative DO criteria, within what EPA in the National Coastal Assessment Program classifies as biologically stressful ($>2.0 \text{ mg/l}^{-1}$ and $<5.0 \text{ mg/l}^{-1}$) might be more applicable. A caveat could be added that DO must remain in this range for some time limit. Both these suggestions might provide a more accurate characterization of the system based on DO concentrations that may or may not directly affect the biota.

Whether TCEQ can make changes to the DO criteria based on data collected from this project, or whether more data collection is required, is uncertain. Perhaps further data collection in critical areas that captures concentrations, event duration, and geographic extent of depressed DO levels; coupled with any possible biological effects observed such as the small fish and crab kill observed at Station 17121 in July 2004 when hypoxic conditions existed for 5.5 hours, would provide a firmer basis for modifying the criteria. What is certain is that until the assessment is based on the actual **physical, chemical, and biological characteristics of the segment** the possibility exists that the criteria may never be met and that there is no TMDL solution for a naturally occurring process.

5.0 REFERENCES

- Center for Coastal Studies. 2003. Quality Assurance Project Plan for the Oso Bay And Laguna Madre Total Maximum Daily Load Project – Phase III. Revision 3. 90 p.
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