Michael F. Easley, Governor

William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director
Division of Water Quality

March 14, 2005

MEMORANDUM

To: Michelle Woolfolk
Narayan Rajbhandari

Through: Jimmie Overton
Dianne Reid

From: Jim Fisher

Subject: Lower Cape Fear River / Estuary TMDL Study

Attached is a report of the data collected in July and August 2004 by the Intensive Survey Unit (ISU) of Environmental Sciences (ESS), in support of the Lower Cape Fear River / Estuary TMDL Study.

The data consists of field measurements and chemical sampling of 12 sites in the river and tributaries over a six weeks period from July 7 to August 11, 2004. Two additional sites are included. They were randomly sampled in conjunction with ISU assisting the US Geological Survey (USGS) in maintaining three continuous monitoring sites for field measurements on the river. The USGS continuous monitoring data is available from their Raleigh Field Office. Contact person Ramona Traynor 919.571.4096.

Additional data collection is ongoing with ISU maintaining three continuous monitoring sites in the river and a time of travel dye study is planned for the summer or early fall.

Please feel free to contact me should you have questions regarding this information – 919.733.6510

cc: Ed Beck, WiRO
Darlene Kucken

Lower Cape Fear River / Estuary TMDL Study
DENR/DWQ ISU Sampling Data
July 7 – August 11, 2004

Introduction

During July and August 2004, the Division of Water Quality conducted a Cape Fear River Estuary field study. The study was to support the development of a model, to estimate the Total Maximum Daily Load (TMDL), for the lower Cape Fear River / Estuary. The study consisted of field measurements and chemical sampling in the river from Lock 1 to Snows Cut and the main tributaries, the Black River, and the Northeast Cape Fear River, plus two tidal swamp streams, Town Creek and Prince George Creek.

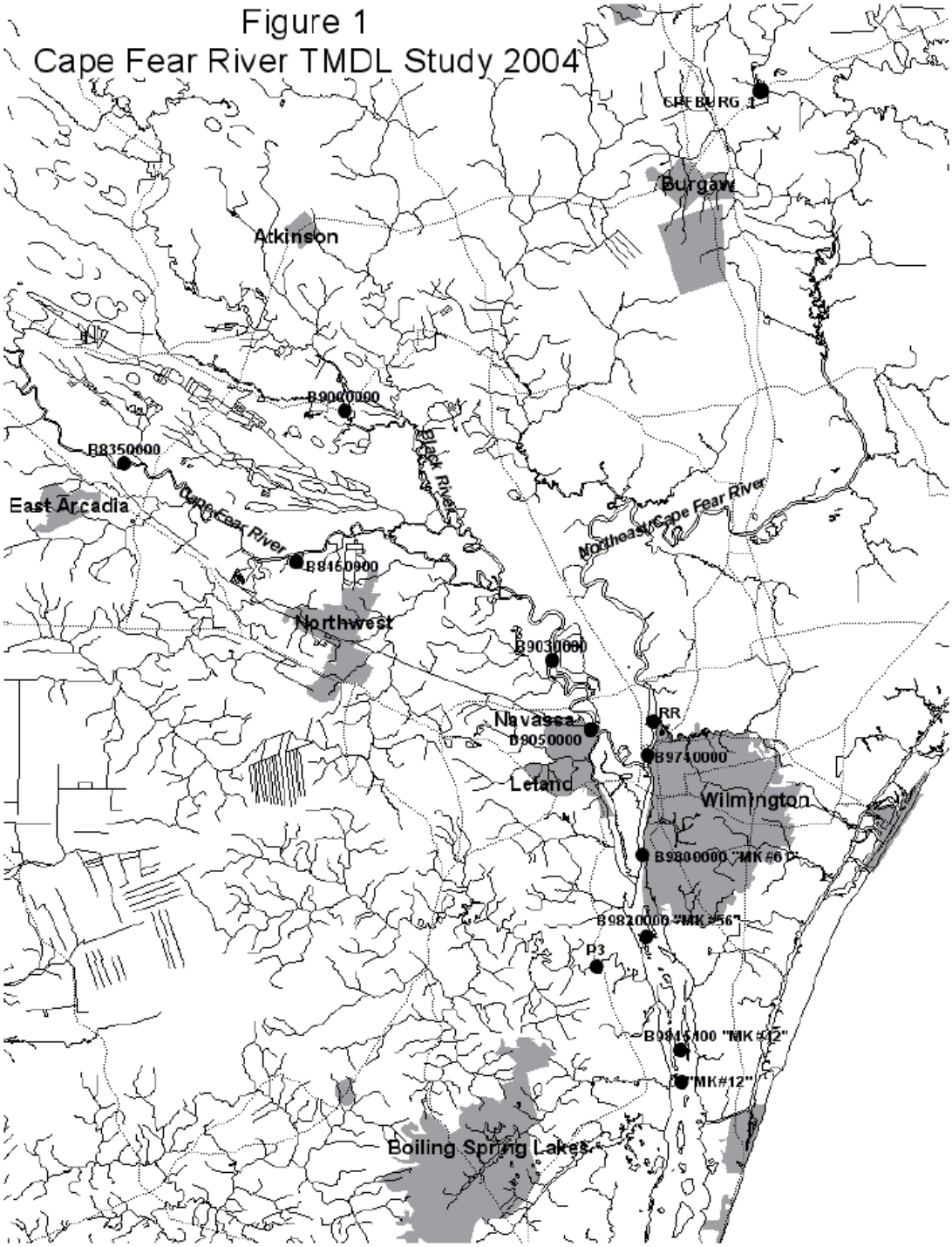
The lower Cape Fear River and estuary are presently on North Carolina's impaired streams list for dissolved oxygen (DO) levels below N.C. stream standards. The DO stream standard is 5.0 mg/l (minimum instantaneous of 4.0 mg/l) or lower values if caused by natural conditions, such as swamp waters, backwaters, lake bottoms, poorly flushed tidal areas, and estuary bottom waters. Wastewater treatment plant expansions and discharge permit renewals in the impaired area require a TMDL for permit approval. TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards.

Sampling Sites (See Figure 1 – Study Area Map)		Lat. Long.
B8349000	Cape Fear River upstream side of Lock #1 at Kings Bluff	34.405, –78.29389
B8450000	Cape Fear River near Neils Eddy Landing	34.35472, -78.18167
B9000000	Black River at NC Highway 210 at Still Bluff	34.43111, –78.14444
B9030000	Cape Fear River upstream Indian Creek off Sutton Lake	34.30333, -78.01333
B9050000	Cape Fear River at Navassa at CSX railroad trestle	34.26003 -77.9875
CPFBURG 1	Northeast Cape Fear River at NC Highway 53 east of Burgaw	34.59806, -77.87528
P14	Prince George Creek near mouth west of Castle Hayne	34.35972, -77.95139
B9740000	Northeast Cape Fear River at NC Highway 133 at Wilmington	34.25861, -77.94889
B9800000	Cape Fear River at Channel Marker #61 off State Port	34.19389, -77.95694
P3	Town Creek at NC Highway 133 at the Gator Hole	34.1325, -77.98306
B9820000	Cape Fear River at Channel Marker #56 below power lines	34.1425, -77.94944
B9845100	Cape Fear River at Channel Marker #42 at Upper Lilliput Range	34.09028, -77.93444

Additional Sampling Sites

RR	Northeast Cape Fear River at CSX railroad trestle at Wilmington	34.25862, -77.94897
MK #12	North Wilmington Shortcut near MK #41 in the Cape Fear River	34.07633, -77.93111

Figure 1
Cape Fear River TMDL Study 2004



Parameters Sampled

Field parameters – Dissolved Oxygen (DO), Temperature (Temp.), Specific Conductance @ 25° C (Sp. Cond.), pH, Salinity, DO % Saturation, Tide cycle observation.
Temperature sensors (Tidbits) at two locations

Chemical parameters - 5 Day Biochemical Oxygen Demand (BOD_5), 30 Day Biochemical Oxygen Demand (BOD_{30}), Total Suspended Solids (TSS), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Chlorophyll, Ammonia Nitrogen (NH_3), Total Kjeldahl Nitrogen (TKN) = ammonia + organic nitrogen, Nitrite + Nitrate Nitrogen ($NO_2 + NO_3$), Total Phosphorus (Tot. P), Orthophorus (PO4)

Collection Methods

Physical and chemical parameters were collected by accepted water data acquisition methods, N. C. DENR, Standard Operating Procedures Manual, Physical and Chemical Monitoring, August 2003. The physical parameters – temperature, dissolved oxygen, specific conductance, pH, salinity, DO % saturation, were measured in-situ. Chemical samples were collected as grab samples, using the actual sample bottle, no intermediated sampler. The exception was filtered samples (DOC & PO_4), which were pulled from a 500 ml disposable bottle that was rinsed before use, filtered on site and the filtrate poured into new bottles. Samples were labeled, preserved, and iced, upon collection as per N.C. DENR Laboratory Section, Guidance for Sample Submission, October 13, 2003.

Field Instruments

Field measurements were taken with Hydrolab Quanta model multiparameter meters with either 15 or 30-meter cables. The sensor components include temp, DO with circulator, pH, specific conductance, and depth. Salinity and DO% saturation are meter calculations. All meters were checked for calibration prior to and post sampling per manufacturers recommendations.

Chemical Analysis

All chemical analyses were performed in the Division of Water Quality Central laboratory in Raleigh, except TSS, which were analyzed in the Division's Washington laboratory, and BOD_{30}, which were run in the Environmental Sciences BOD laboratory. The sampling crews delivered samples directly to the Lab.

Quality Assurance

Physical and chemical data was reviewed as received for obvious errors and outliers were confirmed with the sampling staff and the laboratory for accuracy

Instrument Calibration sheets for the field meters, were reviewed by the Quality Assurance Coordinator, and initial, and final calibrations were found to be within control limits.

An equipment blank for the PO4 filter flask (deionized water used to rinse flask) was analyzed for PO4 on 6/23/04 at station B905 Cape Fear River at Navassa at CSX railroad and reported as below the detection level

There was an issue with glass fiber filters being used at stations B903-, B905-, P14, B974-, B980-, B982-, and B98451-, for the filtration of PO4 and DOC. The required filter for the filtration of PO4 and DOC was a 0.45 µm-pore size paper filter. Improper filters were used for the first two weeks of sampling due to mislabeled filters. This was corrected by July 19. Specific samples processed cannot be identified; so all PO4 and DOC data before the week of July 19 at the above stations should be carefully reviewed before use.

Chemical data review of the Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) values showed values to be the same, and some cases, DOC values were higher than the TOC values, with the DOC being a filtered sample. It was expected that DOC levels would be lower than TOC levels, with particulate organic matter (POC) expected to be the major contributor to TOC (TOC=POC+DOC). The Quality Assurance Coordinator for Environmental Sciences reviewed the TOC and DOC data and found identical medians and almost identical means with nearly the same distribution for the two parameters. A check with the laboratory over the closeness of the numbers resulted in an indication that filter contamination could cause questionable data. QA results and discussion are presented in attachment QA Review: DOC results, Cape Fear River Study (S. Gale)

A Quality Control study was conducted at the end of the 2004 sampling season to check on possible contamination from filtration methods of DOC samples. All blanks came back at < 0.5 mg/l DOC. These blanks were run in the lab and did not account for other sources of contamination such as from vehicle and boat exhaust fumes. Equipment blanks will be performed for future DOC sampling to determine if on-site conditions represent a significant source of concern for sample contamination. Attachment QA Review: DOC results, Cape Fear River Study (S. Gale)

Physical / Chemical Data (Appendix A - Physical / Chemical Data, Lower Cape Fear River / Estuary TMDL Study)

The physical / chemical data collected by the Intensive Survey Unit (ISU) of DWQ are presented in Appendix 1. A key to data qualifier codes for the NC DENR/DWQ Chemistry Lab and data notes are included in the footnotes. The main sampling effort was a six-week period of time, from July 7, 2004 to August 11, 2004, with twice a week sampling for four of those weeks. Hurricanes and tropical storms broke the proposed sampling schedule of twice a week for 6 weeks. The additional data presented is either reconnaissance data or profile data collected as ISU staff helped the USGS service the three datasonde stations in the river (B9050000, RR, MK #12). The dissolved organic carbon (DOC) data is presented for your **review only**; possible contamination problems prevent defensible use of the data.

BOD_{30} Data (Table 1 – Lower Cape Fear River 30 Day BOD Data)

The BOD_{30} data collected and analyzed by the Intensive Survey Unit is presented in Table 1. The data qualifier codes for the NC DENR/DWQ Chemistry Laboratory and data notes are in the footnotes.

Table 1

30 Day BOD
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date	Time	Day	BOD	NH3	TKN	NO2+NO3	Tot. N	Tide
		(yy/mm/dd)	(hrs.)		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(cycle)
B900	Black R.	040707	1545	0	-	0.03	0.67	0.17	0.84	Flow
	at Hwy. 210			5	3.2					downstream
				8	3.4					
				12	3.8					
				19	4.2					
				26	4.5					
		040807	0945	30	4.7	0.27	3.60*	0.25	3.85	
B900	Black R.	040728	1300	0	-	0.05	0.68	0.13	0.81	Flow
	at Hwy. 210			5	1.2					downstream
				12	2.0					
				19	2.8					
				26	3.4					
		040828	1010	30	3.8	0.02 U	0.56	0.28	0.84	
B905	Cape Fear R.	040707	1335	0	-	0.09	0.67	0.49	1.16	Rising Tide
	at Navassa			5	1.4					almost high
				12	2.5					
				14	2.7					
				19	3.2					
				26	3.7					
		040807	1000	30	4.1	0.02 U	0.57	0.74	1.31	
B905	Cape Fear R.	040728	1235	0	-	0.08 J6	1.20 J6	0.59 J6	1.79	Low Tide
	at Navassa			5	1.2					slow
				12	2.4					
				19	3.1					
				26	3.8					
		040828	0905	30	4.1	0.02 U	0.76	0.83	1.59	
CPF	NE Cape Fear R.	040714	1555	0	-	0.07	0.70	0.26	0.96	Flow
BURG 1	at Hwy. 53			5	1.4					downstream
				12	2.4					
				19	3.2					
				26	3.7					
		040814	0945	30	4.0	0.02 U	0.65	0.45	1.10	
CPF	NE Cape Fear R.	040728	1410	0	-	0.07	0.80	1.00	1.80	Flow
BURG 1	at Hwy. 53			5	1.0					downstream
				12	2.1					
				19	2.7					
				26	3.2					
		040828	0935	30	3.4	0.02 U	0.60	1.20	1.80	
P14	Prince George Cr.	040721	1335	0	-	0.02	0.66	0.24	0.90	(Not stated
	near mouth			5	0.8					but probably
				12	1.5					rising tide)
				19	2.1					
				26	2.4					
		040821		30	2.6	0.02 U	0.60	0.31	0.91	
P14	Prince George Cr.	040728	1400	0	-	0.04	0.64	0.08	0.72	Low Tide
	near mouth			5	1.2					slack
				12	2.1					
				19	2.8					
				26	3.3					
		040828	0940	30	3.5	0.02 U	0.55	0.20	0.75	

Station	Location	Date	Time	Day	BOD	NH3	TKN	NO2+NO3	Tot. N	Tide
		(yy/mm/dd)	(hrs.)		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(cycle)
B974	NE Cape Fear R.	040714	1300	0	-	0.13	0.63	0.33	0.96	Falling Tide
	at Hwy. 133/117			5	1.4					
				12	2.4					
				19	3.2					
				26	3.8					
		040814	0955	30	4.0	0.02 U	0.51	0.62	1.13	
B974	NE Cape Fear R.	040728	1300	0	-	0.03	0.56	0.45	1.01	(Not stated
	at Hwy. 133/117			5	0.8					but probably
				12	1.5					low tide)
				19	2.0					
				26	2.4					
		040828	0915	30	2.6	0.02 U	0.49	0.60	1.09	
P3	Town Cr	040721	1010	0	-	0.03	0.61	0.02 U	0.63	Rising Tide
	at Hwy. 133			5	1.3					
				12	1.9					
				19	2.7					
				26	3.2					
		040821	0950	30	3.5	0.02 U	0.42	0.14	0.56	
P3	Town Cr.	040728	1100	0	-	0.05	0.82	0.11	0.93	Falling Tide
	at Hwy. 133			5	1.4					out
				12	2.7					
				19	3.7					
				26	4.4					
		040828	1005	30	4.6	0.02 U	0.63	0.36	0.99	
B98451	Cape Fear R.	040728	1030	0	-	0.02	0.49	0.36	0.85	Falling Tied
	at mk# 42			5	1.4					half out
				12	2.5					fast
				19	3.2					
				26	4.0					
		040828	0955	30	4.2	0.02 U	0.33	0.56	0.89	

* Possible outlier

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab

U - non-detect; value is equal to the laboratory's practical quantitation limit

J6 - Improperly chemically preserved sample - preserved at lab

Data Review

A review of the data collected by ISU staff by parameter follows:

Surface measurements and samples

Summary by parameter

Parameter	N	Percentiles						
		Minimum	10th	25th	Median	75th	90th	Max
Field parameters								
DO saturation (%)	163	37	50	55	64	74	84	108
DO (mg/L)	164	2.7	3.8	4.2	4.95	5.7	6.4	8.3
pH (SU)	164	5.7	6.3	6.6	6.8	7.1	7.4	8
Conductivity (µmhos/cm at 25°C)	164	72	100	141	338	13,520	19,400	28,900
Salinity (ppt)	163	0.01	0.05	0.07	0.19	7.9	11.9	17.7
Temp (ºC)	164	17.5	24.9	27.5	28.8	29.6	30.0	31.5
Lab analyses								
TOC (mg/L)	123	6.5	7.6	9.1	11.0	14.0	16.6	25.0
DOC (mg/L)	123	6.4	7.6	9.0	11.0	14.5	17.0	25.0
BOD, 5-day (Chem Lab) (mg/L)	48	2.0	2.0	2.0	2.0	2.0	4.8	16.0
BOD, 5-day (ISU) (mg/L)	13	0.8	0.8	1.1	1.3	1.4	2.5	3.2
BOD, 30-day (mg/L)	13	2.6	2.6	3.5	4.0	4.2	4.7	4.7
TSS (mg/L)	119	2.5	3	5	11	20	30	100
NH_3 (mg/L)	151	0.02	0.02	0.03	0.06	0.09	0.11	0.19
NO_2+NO_3 (mg/L)	151	0.02	0.11	0.26	0.41	0.61	0.88	1.2
PO_4 (mg/L)	149	0.02	0.02	0.04	0.06	0.08	0.12	1.1
TKN (mg/L)	151	0.46	0.56	0.58	0.66	0.74	0.8	1.2
Total P (mg/L)	151	0.04	0.08	0.10	0.12	0.17	0.20	10.8
Chlorophyll *a* (µg/L)	119	1	1	3	7	10	15	42

Field Measurements

Depths ranged from **3.5** m (11.5 ft) in the upper Cape Fear River and the Black River to **14.7** m (48 ft) in the Ship Channel downstream. Physical parameters were measured at the surface (0.1m), middle, and bottom of the water column. Chemical samples were surface grabs.

Temperature readings ranged from **24.7** °C (76.5°F) to **31** °C (87.8°F).

Dissolved Oxygen (DO) surface readings ranged from a low of 2.7 mg/l at Prince George Creek to a high of 7.9 mg/l at Mk #56, with mid and bottom readings generally lower. For comparison purposes, the median surface values by station ranged from 6.2 mg/l upstream Lock 1 to 3.7 mg/l at Prince George Creek. The median surface DO of the main stem of the river was 5.4 mg/l and the median of all stations was 4.9 mg/l, which is below the Water Quality Standard of a daily mean of 5.0 mg/l. Naturally low DO swamp waters and low DO saline bottom waters are some of the factors contributing to the seasonally lower DO values of the river and estuary. A DO sag was noticed at station B903, Cape Fear River upstream of Indian Creek, where the median surface value was 4.1 mg/l.

7.9 mg/l high DO **5.4** mg/l median surface DO for main stem of the river

2.4 mg/l low DO **4.9** mg/l median surface DO for all stations

Box plots of Cape Fear River main stem surface DO – Upstream to Downstream order

One-way Analysis of result By MainstemSort

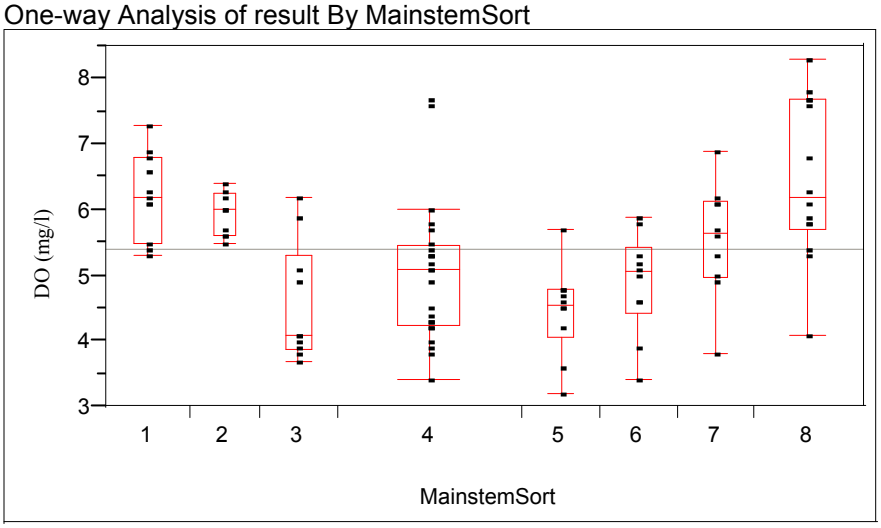


Table of percentiles for D.O. (mg/l)

Main stem Sorting	Station number	Location description	Min	10%	25%	Median	75%	90%	Max
1	B835	Cape Fear R. UPS Lock #1	5.3	5.3	5.5	6.2	6.8	7.2	7.3
2	B845	Cape Fear R. at Neils Eddy Landing	5.5	5.5	5.6	6.0	6.3	6.4	6.4
3	B903	Cape Fear R. UPS Indian Cr	3.7	3.7	3.9	4.1	5.3	6.2	6.2
4	B905	Cape Fear R. at Navassa	3.4	3.9	4.2	5.1	5.5	6.8	7.7
5	B980	Cape Fear R. at CM 61	3.2	3.2	4.1	4.6	4.8	5.6	5.7
6	B982	Cape Fear R. at CM 56	3.4	3.5	4.4	5.1	5.4	5.9	5.9
7	B98451	Cape Fear R. at CM 42	3.8	3.9	5.0	5.7	6.1	6.8	6.9
8	Mk# 12	Cape Fear R. nr CM 41	4.1	4.7	5.7	6.2	7.7	8.1	8.3

Dissolved Oxygen Percent Saturation (% Sat.) values ranged from 7% on the bottom at Mk #56 to 108% on the surface at Mk #12. Median surface values ranged from 48% at Prince George Creek to 82% at upstream Lock #1 and Mk #12. The median surface value for all stations was 64 %DO saturation.

108 % high DO Sat. **64** % median DO Sat. for all stations

7 % low DO Sat

pH values for surface readings ranged from 5.7 SU. at RR to 7.9 SU at Mk #56. Median surface values ranged from 6.3 SU on the Black River to 7.5 SU at Mk #42. WQ Standard 6.0 to 9.0 SU with swamp waters down to 4.3 SU.

7.9 SU. high pH **6.8** SU. median surface pH for all stations

5.7 SU. low pH

Conductivity values and the corresponding **Salinity** values ranged from 39,600 µmhos/cm (25.4 ppt.) at Mk #42 to a low of 72 µmhos/cm (0.04 ppt) on the Black River. Median surface values ranged from 22,650µmhos/cm (13.7 ppt) at Mk #42 to 82 µmhos/cm (0.04 ppt) on the Black River.

39,600 umhos/cm (**25.4** ppt) high cond.& sal.

1098 umhos/cm (**1.0** ppt) median surface cond. & sal. for all stations

72 umhos/cm (**0.04** ppt) low cond. & sal.

Tide (Cycle) Table 2 High / Low Water Level Data
Observed tides were recorded during the sampling runs and a tide table of measured tides from the NOAA Wilmington tide gage for the 6 weeks intensive sampling is presented in table 2. The NOAA tide gage is located at the Corps of Engineers' Docks under the Cape Fear Memorial Bridge. The tide gage is located at the upper end of the estuarine section of the study and there was just about an even distribution of falling tide sampling and rising tide sampling in the lower part of the study except Mk 61. The upper part of the study area, including the tributaries, were sampled more frequently during falling tides because the tide falls out longer up river and in the tributaries than it rises. DWQ staff installed a stage height recorder in the Cape Fear River near Livingston Creek for four days in August '04, to check for tidal differences against the Wilmington gage. The difference in tides was 2.5 hours for high tide and 3.5 hours for low tide. Wind tides and lunar phases change the times and depths of the semi-diurnal tides. Tidal effects on concentration of some constituents are obvious. For example, rising tides sometimes raise surface DO, while more saline bottom waters show lower DO. Solids concentrations sometimes change with the tides, but trends were hard to see as the river and estuary mix, so median values were used as general indicators of water quality.

Analytical Results

5 Day Biochemical Oxygen Demand (BOD5) Chem. Lab. values ranged from 16 mg/l at Mk #56 to <2.0 mg/l at all stations sampled. Median for all stations was <2.0 mg/l. BOD5 values <5 mg/l. are expected in minimally impacted streams.

16 mg/l high BOD5 **<2.0** mg/l median BOD5 for all stations

<**2.0** mg/l low BOD5

Table 2 High / Low Water Level Data

Dec 17 2004 14:28 HIGH/LOW WATER LEVEL DATA July, 2004
National Ocean Service (NOAA)

Station: 8658120 T.M.: 0 W
Name: WILMINGTON, CAPE FEAR RIVER, NC Units: Feet
Type: Mixed Datum: MLLW
Note: > Higher-High/Lower-Low [] Inferred Tide Quality: Verified

	High		Low			High		Low	
Day	Time	Height	Time	Height	Day	Time	Height	Time	Height
1	> 0.9	5.09	8.2	-0.30	16	> 1.3	4.81	8.3	0.36
	13.4	4.30	> 19.8	-0.83		13.2	3.89	> 20.0	0.11
2	> 2.2	5.39	9.1	-0.26	17	> 2.0	4.85	9.0	0.32
	14.1	4.20	> 20.9	-0.80		14.2	4.06	20.7	0.28
3	> 3.0	5.41	10.1	-0.23	18	> 2.9	4.94	> 9.8	0.22
	15.1	4.47	> 21.8	-0.46		14.9	3.80	> 21.2	-0.13
4	> 3.9	5.45	> 11.0	-0.13	[19]	> 3.5	4.64	10.4	0.02
	16.0	4.54	22.7	-0.11		15.4	3.90	21.9	0.00
5	> 4.8	5.54	11.7	0.19	20	> 3.9	4.54	> 10.8	-0.12
	17.0	4.57	> 23.7	0.00		16.1	3.91	22.6	0.11
6	> 5.7	5.22			[21]	> 4.6	4.53	> 11.4	-0.12
	18.1	4.47	> 12.6	-0.02		17.2	3.98	23.4	-0.05
[7*]	> 6.5	5.02	0.3	0.03	22	> 5.1	4.43		
	19.0	4.77	> 13.3	0.05		17.9	4.26	> 12.2	-0.10
8	> 7.2	4.92	1.3	0.65	23	> 6.1	4.48	0.1	0.34
	19.8	4.77	> 14.1	0.14		> 18.9	4.40	> 12.8	0.22
9	8.1	4.59	2.1	0.65	24	6.7	4.27	1.2	0.36
	> 20.8	4.65	> 14.8	0.08		> 19.7	4.27	> 13.7	-0.22
10	9.0	4.21	3.1	0.55	25	7.4	3.71	2.1	0.02
	> 21.6	4.58	> 15.3	0.01		> 20.6	4.31	> 14.4	-0.48
11	9.5	4.00	4.2	0.43	[26]	8.5	3.84	3.1	0.01
	> 22.1	4.49	> 16.1	-0.01		> 21.7	4.67	> 15.3	-0.50
[12]	10.3	3.86	5.1	0.49	27	9.5	3.97	4.4	0.27
	> 23.2	4.68	> 16.8	0.17		> 22.9	4.96	> 16.5	-0.45
13	11.0	3.84	5.9	0.70	[28]	10.6	3.89	5.7	0.13
			> 17.7	0.20		> 23.9	5.02	> 17.7	-0.75
[14]	> 0.2	4.69	6.8	0.48	29	11.8	3.78	6.3	-0.05
	12.5	3.65	> 18.4	0.18				> 18.7	-0.90
15	> 0.9	4.86	7.7	0.48	30	> 0.7	4.94	7.9	-0.43
	12.8	3.81	> 18.8	0.20		12.9	4.11	> 19.6	-0.90
					31	> 1.9	5.21	8.8	-0.28
						13.9	4.47	> 20.8	-0.68

Highest Tide: 5.54 4.8 Hrs Jul 5 2004
Lowest Tide: -0.90 18.7 Hrs Jul 29 2004

Monthly Means:							
MHHW	4.83						
MHW	4.48	DHQ	0.35				
MTL	2.23			GT	5.03	HWI	4.57 H
DTL	2.32			MN	4.50	LWI	26.52 H
MSL	2.39						
MLW	-0.02	DLQ	0.18				
MLLW	-0.20						

*Boxed dates are sampling runs
Shaded areas are High and Low Tides affecting sampling runs usually near midday
Sampling runs were from 1000 to 1500

Dec 17 2004 14:28 HIGH/LOW WATER LEVEL DATA August, 2004
National Ocean Service (NOAA)

Station: 8658120 T.M.: 0 W
Name: WILMINGTON, CAPE FEAR RIVER, NC Units: Feet
Type: Mixed Datum: MLLW
Note: > Higher-High/Lower-Low [] Inferred Tide Quality: Verified

Day	High Time	High Height	Low Time	Low Height	Day	High Time	High Height	Low Time	Low Height
1	> 2.7	5.46	9.7	0.03	16	> 2.0	4.57	9.3	0.01
	15.0	4.70	> 21.7	-0.44		14.2	4.19	> 21.1	-0.47
2	> 3.7	5.38	10.7	-0.08	17	> 2.8	4.74	9.8	-0.20
	15.8	4.73	> 22.5	-0.18		14.9	4.36	> 21.7	-0.12
3	> 4.5	5.46	> 11.6	0.07	18	> 3.5	4.95	10.6	0.03
	16.6	4.81	23.3	0.09		15.6	4.68	22.5	0.31
4*	> 5.2	5.24			19	> 3.9	4.94	> 11.1	-0.07
	17.6	4.84	> 12.0	0.00		> 16.8	4.68	23.3	0.04
5	> 5.8	5.12	0.0	0.40	20	4.5	4.56	> 11.7	-0.27
	18.4	4.97	> 12.8	0.18		> 17.5	4.70		
6	6.8	4.48	1.1	0.67	21	5.4	4.48	0.1	0.16
	> 19.1	4.53	> 13.6	-0.19		> 18.5	4.82	> 12.5	-0.11
7	7.4	4.45	1.6	0.73	22	6.1	4.37	1.1	0.51
	> 20.0	4.81	> 14.1	0.39		> 19.2	4.62	> 13.3	-0.34
8	7.9	4.27	2.5	1.03	23	7.0	4.28	1.8	0.31
	> 20.7	4.41	> 14.5	0.27		> 20.3	5.04	> 13.7	0.16
9	8.6	3.69	3.3	0.53	24	8.2	4.42	2.8	0.65
	> 21.6	4.19	> 15.2	-0.01		> 21.2	4.96	> 15.0	-0.04
10	9.7	3.47	4.2	0.56	25	9.0	4.19	4.1	0.38
	> 22.5	4.21	> 15.9	-0.08		> 22.2	4.82	> 16.2	-0.30
11	10.5	3.47	5.3	0.32	26	10.4	4.27	5.2	0.18
	> 23.4	4.22	> 16.6	0.05		> 23.5	5.20	> 17.2	-0.19
12	11.4	3.30	6.1	0.17	27	11.3	4.43	6.5	0.00
			> 18.3	-0.32				> 18.5	-0.47
13	> 0.2	4.13	6.7	[0.36]	28	> 0.6	5.32	7.6	-0.05
	12.7	3.88	> 19.2	-0.51		12.7	4.62	> 19.7	-0.57
14	> 0.8	3.99	7.8	-0.08	29	> 1.7	5.36	> 8.6	-0.04
	> 18.9	4.86	21.5	0.89		13.8	4.98	20.7	0.04
15	2.6	4.67	> 9.1	0.06	30	> 2.7	5.82	9.5	0.71
	14.6	3.96	> 21.0	-0.18		14.7	4.88	> 21.6	-0.47
					31	> 3.1	4.93	> 10.2	-0.67
						15.5	4.69	22.2	-0.56

Highest Tide: 5.82 2.7 Hrs Aug 30 2004
Lowest Tide: -0.67 10.2 Hrs Aug 31 2004

Monthly Means:							
MHHW	4.85						
MHW	4.61	DHQ	0.24				
MTL	2.33			GT	5.01	HWI	4.73 H
DTL	2.34			MN	4.55	LWI	26.81 H
MSL	2.50						
MLW	0.06	DLQ	0.22				
MLLW	-0.16						

*Boxed dates are sampling runs
Shaded areas are High and Low Tides affecting sampling runs usually near midday
Sampling runs were from 1000 to 1500

30 Day Biochemical Oxygen Demand (BOD30) ISU Lab. values ranged from 4.7 mg/l on the Black River to 2.6 mg/l at Prince George Creek and NE Cape Fear River at NC 133. The median for all stations was 4.1 mg/l.

4.7 mg/l high BOD30 **4.1** mg/l median BOD30 for all stations

2.6 mg/l low BOD30

Total Suspended Solids (TSS) values ranged from 100 mg/l to 2.5 mg/l, both at Navassa, with the median values ranging between 22 mg/l at Mk #42 to 2.5 mg/l at the NE Cape Fear River at Burgaw.

100 mg/l high TSS **18.5** mg/l median TSS for all stations

2.5 mg/l low TSS

Total Organic Carbon (TOC) values ranged from 25 mg/l at Prince George Creek to 6.5 mg/l on the Cape Fear River at Neils Eddy Landing. Median values ranged from 16 mg/l at Prince George Creek and NE Cape Fear River at RR to 8.4 mg/l at Mk #12

25 mg/l high TOC **11.0** mg/l median TOC for all stations

6.5 mg/l low TOC

Dissolved Organic Carbon (DOC) values are suspect because of contamination, but may be of some use if the DOC is lower than the TOC. See attachment QA Review: DOC results, Cape Fear River Study, by S. Gale

Chlorophyll a values ranged from 35 µg/l to 1.0 µg/l both levels occurring in Prince George Creek, and with the Black River and NE Cape Fear River at Burgaw also having lows of 1.0 µg/l. Median values ran from 15.5 µg/l at Mk #42 to 1.0 µg/l on the Black River. The Chlorophyll a WQ standard is 40 µg/l.

35 µg/l high Chlorophyll a **6.25** µg/l median Chlorophyll a for all stations

1.0 µg/l low Chlorophyll a

Ammonia (NH3) values ranged from 0.19 mg/l in the Cape Fear River at Neils Eddy landing to <0.02 mg/l at most sites. The median values ranged from 0.12 mg/l on the Cape Fear River at Neils Eddy Ldg. to 0.02 mg/l at Mk #42. NH3 concentrations of <0.05 mg/l is expected in minimally impacted waters.

0.19 mg/l high NH3 **0.05** mg/l median NH3 for all stations

<**0.02** mg/l low NH3

Total Kjeldahl Nitrogen (TKN) - Kjeldahl nitrogen includes organic nitrogen and ammonia. TKN values ranged from 1.2 mg/l on the Cape Fear River at Navassa to 0.46 at Mk #56. Median values ranged from 0.80 mg/l on Cape Fear River at Neils Eddy Ldg. to 0.57 mg/l at Mk #56 and Mk #42.
TKN concentrations of <0.5 mg/l. are considered normal for minimally impacted waters.

1.2 mg/l high TKN **0.68** mg/l median TKN for all stations

0.46 mg/l low TKN

Nitrite + Nitrate Nitrogen (NO2+NO3) values ranged from 1.2 mg/l at Lock #1 to 0.02 mg/l at Town Creek and Mk #42. Median values ranged from 0.89 mg/l at Neils Eddy to 0.06 mg/l at Town Creek.
NO2+NO3 concentrations of <0.3 mg/l. are considered normal for minimally impacted waters.

1.2 mg/l high NO2+NO3 **0.40** mg/l median NO2+NO3 for all stations

0.02 mg/l low NO2+NO3

Total Phosphorus (Tot. P.) values ranged from 10.8 mg/l at Town Creek to 0.04 mg/l at Town Creek. Median values ranged from 0.21mg/l on the Cape Fear River at Neils Eddy Ldg. to 0.10 mg/l at Mk #12, Mk #42, and Mk #56. Tot. P concentrations of <0.05 mg/l are considered normal for minimally impacted waters.

10.8 mg/l high Tot. P **0.11** mg/l median Tot.P for all stations

0.04 mg/l low Tot. P

Orthophosphate (PO4) values ranged from 1.1 mg/l on the Black River to 0.02 mg/l on the Cape Fear River at Neils Eddy Ldg., Navassa, Town Creek, Mk #42, and Mk #12. Median values ranged from 0.02 mg/l at Town Creek to 0.10 mg/l on the Cape Fear River at Neils Eddy Ldg. and NE Cape Fear River at Burgaw. PO4 concentrations of <0.05 mg/l. are usually considered normal for minimally impacted waters.

1.1 mg/l high PO4 **0.06** mg/l median PO4 at all stations

0.02 mg/l low PO4

QA Review: DOC results, Cape Fear River Study
S. Gale
November 29, 2004

During a special study to collect data for development of the TMDL for the lower Cape Fear River basin, the Study Leader noted that results for Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) samples collected at individual stations were essentially equal, and in some cases DOC was actually higher than TOC. It was expected that the major contribution to TOC would generally be from particulate organic matter (POC), and that DOC would be a minor contributor to TOC (TOC=POC+DOC). Consequently, it was unexpected when DOC and TOC analyses returned essentially comparable numbers. The ESS QA Coordinator undertook a short QC study to determine if field filtration methods may have caused contamination of the DOC samples.

Data review
A basic review of all available TOC and DOC data was made, as shown in the table below. Two measures of central tendency were made for each station, median and mean. Values were extremely close (<1.0mg/L) in almost all cases. DOC is within +/-20%, the accepted precision for laboratory analyses, of TOC values for almost all stations.

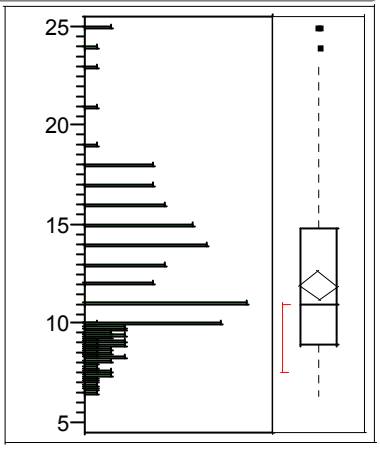
Station	n	Median DOC	Median TOC	Median DOC as % of Median TOC	Mean DOC	Mean TOC	Mean DOC as % of Mean TOC
B835	10	7.8	7.3	106	7.9	7.4	107
B845	9	12.0	11.0	109	11.9	11.5	104
B900	10	16.5	15.0	110	16.2	15.3	106
B903	10	10.0	11.0	91	10.6	11.2	94
B905	22	11.0	11.0	100	10.7	11.5	93
B974	10	10.0	10.5	95	11.9	12.0	100
B980	10	9.3	9.7	96	9.3	9.8	95
B982	10	8.6	9.0	96	8.6	9.0	95
B98451	10	7.7	8.0	96	7.9	8.2	96
CPF BURG 1	10	14.5	13.0	112	14.6	13.6	107
Mk# 12	2	12.2	8.4	145	12.2	8.4	145
P14	10	16.0	16.0	100	17.9	18.2	98
P3	10	14.0	14.0	100	14.7	14.1	104
RR	2	14.5	16.0	91	14.5	16.0	91

Distributions, including box-and-whisker plots, for both TOC and DOC at each station were produced using SAS JMP 5.01 software. The overlap of DOC and TOC for all stations implies a lack of statistical difference between the two values. When results from all stations are combined, both TOC and DOC have nearly identical distributions, as shown on the next page.

DOC and TOC Distributions for all stations

Distributions

DOC



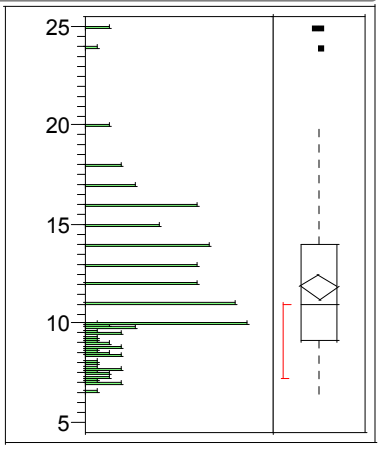
Quantiles

100.0%	maximum	25.000
99.5%		25.000
97.5%		23.975
90.0%		17.000
75.0%	quartile	14.750
50.0%	median	11.000
25.0%	quartile	8.925
10.0%		7.610
2.5%		6.702
0.5%		6.400
0.0%	minimum	6.400

Moments

Mean	11.908333
Std Dev	4.0496827
Std Err Mean	0.3696838
upper 95% Mean	12.640344
lower 95% Mean	11.176323
N	120

TOC



Quantiles

100.0%	maximum	25.000
99.5%		25.000
97.5%		23.600
90.0%		16.600
75.0%	quartile	14.000
50.0%	median	11.000
25.0%	quartile	9.100
10.0%		7.600
2.5%		6.900
0.5%		6.500
0.0%	minimum	6.500

Moments

Mean	11.84878
Std Dev	3.7670131
Std Err Mean	0.3396601
upper 95% Mean	12.521172
lower 95% Mean	11.176389
N	123

Sampling methods

To obtain the DOC samples for analysis, grab surface water samples were collected at each site using a 500mL HDPE bottle. Samples were then filtered in the back of the truck or boat, using a hand-pumped vacuum filtration apparatus that had been rinsed with deionized (DI) water before use. The Cape Fear Study Plan called for the use of filters with 0.45um pore size, as specified by DWQ Laboratory Section guidance and in accordance with the requirements outlined in Standard Methods (18th ed.), method 5310. Two different types of 0.45um filters were used: bulk packed, and sterile individually packed. Approximately 500mL of filtrate were collected, and half was transferred to a clean bottle, preserved with H3PO4, and placed on ice in a cooler, in accordance with DWQ Laboratory Section guidance. (The other half of the filtrate was preserved and submitted for orthophosphate analysis.) Samples were hand-delivered by sampling staff to the Central Chemistry Laboratory the morning following collection.

Sample handling anomalies

In some cases, field staff used glass fiber filters in processing samples, which have a pore size of approximately 0.7um. The larger pore size may have led to elevated DOC concentrations in the samples handled in this way. There is no way to definitively determine exactly which samples were processed

with the incorrect filters, though the error was limited to only stations B903, B905, B974, B980, B982, B98451, and P14. The impact of filter pore size on resulting DOC levels was not addressed in this QC study, but given that all stations appear to have similar DOC/TOC ratios, it is felt that in this particular case this change to standard field methods had minimal impact.

QC sample results

No QC samples were performed during the study period. The ESS QA Coordinator assisted on two sampling runs, and gave recommendations for changes in field methods to minimize contamination concerns. The Cape Fear Study Leader consulted with DWQ Central Laboratory staff, who suggested several possible sources of contamination that may affect results.

After the end of the study, the QA Coordinator ran several different blanks to determine if current methods for cleaning and rinsing of sampling and filtration equipment or mishandling of filters may have caused contamination of DOC samples. All filtrations performed during this QC study were done with individually packaged, sterile 0.45um filters, and the same filtration equipment used by field staff. Results are shown in the following table.

Sample treatment	**Result**
None- unfiltered lab DI water	0.56 mg/L
Lab DI filtered as observed in the field	0.20 mg/L
Wash bottle DI filtered with "clean" methods	0.38 mg/L
Lab DI filtered with "clean" methods	0.08 mg/L
Lab DI collected in sampling container and filtered with "clean" methods	0.35 mg/L[1]

[1] *Average of two results (0.43 and 0.26mg/L); duplicate analysis run by lab*

As seen in the above results, "clean" filtering methods (filtering apparatus cleaned with detergent and rinsed with laboratory DI water, gloves worn, filter handled only with clean forceps) resulted in much lower organic carbon levels. Major sources of contamination appear to be the 500mL HDPE bottle used for obtaining the stream samples and wash bottles used for DI. However, even with "dirty" filtering methods (filtering apparatus only rinsed with DI water, using bare hands to handle filter), contaminant levels were very low. *However, these QC samples were not prepared in a field setting, and therefore do not take into account other possible sources of contamination, such as vehicle exhaust and gasoline fumes from boat motors.*

Conclusions and recommendations

Though certainly not conclusive, the QC samples collected indicate that filtering apparatus and handling may not have been a major source of contamination of DOC samples. However, as noted above, these samples were not set up in a real world setting. It is recommended that future field filtrations be performed with more careful technique:

1. A clean bottle should be used to collect whole water samples for filtering for each station visit.
2. Gloves should be worn while handling and preserving samples. In addition to preventing contamination of samples, this will reduce the likelihood of chemical burns from handling acid used for preservation.
3. Field staff should continue to use individually packaged, sterile 0.45um filters. Glass fiber filters should only be used to pre-filter highly turbid samples to ease final filtration through a 0.45um filter.
4. Filters should be handled with clean forceps, not fingers.
5. The filtering apparatus and DI wash bottle should be regularly cleaned with phosphate-free detergent and completely rinsed with DI water, as is done with all other sampling equipment.
6. Equipment blanks should be run in the field. Two are recommended: one at the beginning of the day before the first water sample is processed, and one at the end of the day after the last water sample is processed. It is recommended that these be performed daily by each team collecting samples. It is also recommended that if any blanks show levels of DOC at or above the usual laboratory reporting limit of 5.0mg/L, the results from samples collected that day either be flagged as suspect or discarded altogether.
7. It is also recommended that blanks be submitted for PO_4 and TP analysis, if these parameters continue to be collected at the same time as DOC/TOC. In addition to concerns of contamination from equipment, the use of H_3PO_4 as a preservative for TOC and DOC samples raises the risk of cross-contamination. It is recommended that if PO_4 or TP blanks show levels above the usual laboratory reporting limit of 0.02mg/L, the results from samples collected that day either be flagged as suspect or discarded altogether.

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B8349	Cape Fear R. upstream Lock #1 34.405 78.29389	040621	1200	0.1	28.3	5.5	6.6	112	0.06	74	Flow				-	-	-	-	-	-	-	-	-
				1.8	28.3	5.0	6.4	112	0.06	63	downstream												
				3.5	28.3	5.0	6.5	112	0.06	64													
		040707	1440	0.1	30.0	6.9	7.3	118	0.06	91	Flow	2.0 U			8	7.6	9.9†	15	0.02	0.53	0.53	0.11	0.05
				1.7	29.6	6.6	7.0	118	0.06	86	downstream												
				3.4	29.5	6.6	7.0	119	0.06	86													
		040712	1250	0.1	30.3	6.3	7.5	132	0.07	82	Flow				11	8.7	8.8†	14	0.03	0.58	0.96	0.16	0.08
				1.7	30.0	5.3	6.9	133	0.07	71	downstream												
				3.4	29.9	5.5	7.0	132	0.07	71													
		040714	1400	0.1	31.0	6.8	6.7	137	0.07	93	Flow	2.0 U G5			10	6.9	8.6†	14	0.02 U	0.64	0.88	0.16	0.14
				1.6	30.8	6.4	6.8	137	0.07	87	downstream												
				3.3	30.6	6.3	6.8	137	0.07	84													
		040719	1225	0.1	30.2	6.1	7.1	152	0.08	85	Flow				12	7.9	8.7†	15	0.03	0.75	1.10	0.17	0.13
				1.5	29.9	5.7	6.8	153	0.08	76	downstream												
				3.0	29.8	5.5	6.7	153	0.08	74													
		040721	1230	0.1	30.3	7.3	7.0	143	0.07	97	Flow	4.0			6	7.0	8.2†	42	0.02	1.00	0.91	0.18	0.10
				1.6	29.7	5.7	6.7	143	0.07	77	downstream												
				3.2	29.6	5.5	6.7	144	0.07	73													
		040726	1240	0.1	30.0	6.2	6.8	140	0.07	80	Flow				10	7.1	7.2†	10	0.06	0.60	1.00	0.21	0.12
				1.6	29.7	5.1	6.5	138	0.07	69	downstream												
				3.2	29.6	5.2	6.5	138	0.07	67													
		040728	1220	0.1	29.7	5.3	6.9	146	0.07	69	Flow	2.0 U			10	7.4	6.8†	7	0.07	0.58	1.00	0.18	0.11
				1.6	29.7	4.7	6.7	145	0.07	63	downstream												
				3.3	29.6	4.6	6.7	146	0.07	62													
		040802	no sample -Hurricane Alex																				
		040804	1235	0.1	28.7	6.1	7.1	135	0.07	78	Flow				9	6.9	6.7†	4	0.08	0.58	0.90	0.16	0.12
				1.7	28.4	5.5	6.6	135	0.07	72	downstream												
				3.5	28.3	5.6	6.7	135	0.07	72													
		040809	1240	0.1	27.7	5.4	7.1	150	0.08	70	Flow				9	7.2	7.0†	9	0.02 U	0.64	1.20	0.19	0.09
				1.7	27.4	5.2	6.8	151	0.08	66	downstream												
				3.5	27.3	5.2	6.8	150	0.08	66													
		040811	1250	0.1	28.4	6.6	6.8	151	0.08	86	Flow				5	7.4	7.3†	15	0.02 U	0.58	1.20	0.21	0.09
				2.2	27.6	5.6	6.7	152	0.08	71	downstream												
				5.5	27.6	5.4	6.5	154	0.08	70													
		040816	no sample - Hurricane Charley																				
			max	5.5	31.0	7.3	7.5	154	0.08	97		4.0			12	8.7	9.9	42	0.08	1.00	1.20	0.21	0.14
			mean	1.8	29.3	5.7	6.8	138	0.07	76		2.5			9	7.4	7.9	14.5	0.04	0.65	0.97	0.17	0.10
			median	1.7	29.6	5.5	6.8	138	0.07	73		2.0			9.5	7.3	7.8	14	0.03	0.59	0.98	0.18	0.11
			min	0.1	27.3	4.6	6.4	112	0.06	62		2.0			5	6.9	6.7	4	0.02	0.53	0.53	0.11	0.05

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B845	Cape Fear R. at Neils Eddy Ldg. 34.35472 78.18167	040707	1325	0.1	29.8	6.2	6.9	121	0.06	82	Rising Tide	2.0 U			2.5 U	8.3	8.5†	7	0.06	0.61	0.62	0.14	0.07
				2.8	29.2	6.0	6.8	118	0.06	78													
				5.7	29.2	5.9	6.8	119	0.06	77													
		040712	1145	0.1	29.8	5.7	7.1	265	0.13	74	Falling Tide				10	14.0	15.0†	5	0.11	0.80	0.81	0.22	0.13
				2.5	29.8	5.2	7.1	265	0.13	70													
				5.1	29.7	5.2	7.1	264	0.13	70													
		040714	1235	0.1	30.3	5.5	7.0	385	0.19	74	Falling Tide	14.0 G5			8	17.0	18.0†	5	0.18	1.10	0.74	0.24	0.15
				2.7	30.3	5.4	7.0	426	0.21	77													
				5.5	30.3	5.4	7.0	425	0.21	73													
		040719	1125	0.1	29.9	5.6	7.0	235	0.11	75	Rising Tide				12	11.0	12.0†	7	0.15	0.80	0.97	0.19	0.12
				2.7	29.7	5.5	7.0	237	0.12	74													
				5.4	29.7	5.6	7.0	233	0.12	75													
		040721	1130	0.1	30.1	6.3	6.8	157	0.08	84	Rising Tide	2.0 U			7	6.5	8.0†	11	0.06	0.81	1.00	0.16	0.02 U
				2.5	29.7	5.9	6.8	152	0.08	79	from low												
				5.0	29.7	5.9	6.7	152	0.08	79	tide												
		040726	1140	0.1	29.9	5.6	6.8	190	0.09	80	Falling Tide				11	9.4	11.0†	7	0.12	0.75	0.89	0.21	0.10
				2.2	29.8	5.7	6.7	184	0.09	76													
				4.5	29.8	5.8	6.7	176	0.09	77													
		040728	no sample - boat trailer broke down																				
		040802	no sample -Hurricane Alex																				
		040804	1135	0.1	28.4	6.4	6.7	128	0.06	82	Falling Tide				10	8.0	7.5†	5	0.09	0.58	0.82	0.16	0.11 Q2
				2.3	28.2	6.0	6.7	131	0.07	78													
				4.7	28.2	6.0	6.6	130	0.07	79													
		040809	1140	0.1	27.3	6.0	7.0	317	0.15	76	Falling Tide				13	14.0	13.0†	6	0.17	0.88	1.10	0.24	0.10
				2.5	27.3	5.8	7.0	299	0.15	85													
				5.0	27.2	5.7	7.0	299	0.14	74													
		040811	1155	0.1	27.7	6.0	7.0	358	0.17	77	Falling Tide	3.8			9	15.0	14.0†	6	0.19	0.99	1.10	0.25	0.10
				2.5	27.7	5.9	7.0	366	0.18	76													
				5.1	27.6	6.0	7.0	370	0.18	78													
			max	5.7	30.3	6.4	7.1	426	0.21	85		14.0			13	17.0	18.0	11	0.19	1.10	1.10	0.25	0.15
			mean	2.6	29.1	5.8	6.9	240.81	0.12	77		5.5			9.2	11.5	11.9	6.6	0.13	0.81	0.89	0.20	0.10
			median	2.5	29.7	5.8	7.0	235	0.12	77		2.9			10	11.0	12.0	6	0.12	0.80	0.89	0.21	0.10
			min	0.1	27.2	5.2	6.6	118	0.06	70		2.0			2.5	6.5	7.5	5	0.06	0.58	0.62	0.14	0.02

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
Q2 - analyzed 15 minutes beyond 48 hr. holding time
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B900	Black R. at NC 210 34.43111 78.14444	040621	1120	0.2	26.9	4.8	6.5	89	0.05	60	Flow				-	-	-	-	-	-	-	-	-
				1.5	-	4.7	6.5	88	0.05	58	downstream												
				3.0	26.9	4.7	6.5	89	0.05	58													
		040707	1545	0.1	30.0	4.5	6.8	80	0.04	59	Flow	2.0 U	3.2	4.7	2.5 U	13.0	15.0†	1 U	0.03	0.67	0.17	0.12	1.10
				1.8	29.1	4.2	6.4	80	0.04	55	downstream												
				3.7	29.1	4.4	6.5	79	0.04	56													
		040712	1345	0.1	27.8	5.0	6.6	72	0.04	61	Flow				5	16.0	17.0†	1	0.04	0.66	0.09	0.12	0.06
				1.5	27.8	4.3	6.4	72	0.04	56	downstream												
				3.1	27.8	4.3	6.5	72	0.04	55													
		040714	1450	0.1	29.1	4.4	6.3	73	0.04	56	Flow	2.0 U G5			3	14.0	17.0†	1	0.03	0.72	0.08	0.13	0.05
				1.6	29.1	4.2	6.3	73	0.04	53	downstream												
				3.2	29.1	4.2	6.3	73	0.04	55													
		040719	1320	0.1	26.7	4.6	6.2	79	0.04	58	Flow				4	15.0	18.0†	3	0.06	0.68	0.12	0.11	0.04
				1.6	26.2	4.3	6.3	79	0.04	55	downstream												
				3.2	26.2	4.3	6.2	79	0.04	54													
		040721	1315	0.1	28.9	4.7	6.2	82	0.05	62	Flow	2.0 U			3	15.0	17.0†	2	0.05	0.76	0.12	0.13	0.05
				1.6	27.5	4.5	6.2	83	0.05	57	downstream												
				3.2	27.5	4.5	6.2	85	0.05	58													
		040726	1330	0.1	27.6	4.6	6.1	80	0.04	59	Flow				3	16.0	15.0†	2	0.06	0.71	0.13	0.13	0.04
				1.3	27.6	4.6	6.0	79	0.04	59	downstream												
				2.6	27.6	4.5	6.0	78	0.04	58													
		040728	1300	0.1	28.5	4.5	6.4	82	0.04	58	Flow	2.0 U	1.2	3.8	5	14.0	14.0†	1	0.05	0.68	0.13	0.18	0.04
				1.3	28.5	4.3	6.2	82	0.04	56	downstream												
				2.6	28.5	4.3	6.2	82	0.04	57													
		040802	no sample -Hurricane Alex																				
		040804	1315	0.1	27.8	4.3	6.0	88	0.05	55	Flow				3	18.0	18.0†	1	0.04	0.70	0.10	0.12	0.04
				1.7	27.6	4.2	6.0	88	0.05	54	downstream												
				3.5	27.6	4.2	6.0	87	0.05	53													
		040809	1335	0.1	24.9	5.3	6.2	91	0.05	65	Flow				4	17.0	16.0†	1	0.02	0.65	0.17	0.11	0.06
				1.5	24.9	5.2	6.1	91	0.05	64	downstream												
				2.9	24.9	5.2	6.1	91	0.05	64													
		040811	1330	0.1	25.7	5.4	6.4	94	0.05	67	Flow				4	15.0	15.0†	1 U	0.03	0.62	0.20	0.13	0.04
				1.5	25.6	5.4	6.2	96	0.05	66	downstream												
				3.0	25.7	5.3	6.2	95	0.05	66													
			max	3.7	30.0	5.4	6.8	96	0.05	67		2.0	3.2	4.7	5	18.0	18.0	3	0.06	0.76	0.20	0.18	1.10
			mean	1.6	27.4	4.6	6.3	83	0.04	58		2.0	2.2	4.2	3.7	15.3	16.2	1.4	0.04	0.69	0.13	0.13	0.15
			median	1.5	27.6	4.5	6.2	82	0.04	58		2.0	2.2	4.2	3.5	15.0	16.5	1	0.04	0.68	0.13	0.13	0.05
			min	0.1	24.9	4.2	6.0	72	0.04	53		2.0	1.2	3.8	2.5	13.0	14.0	1	0.02	0.62	0.08	0.11	0.04

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B903	Cape Fear R. upstream Indian Cr. 34.30333 78.01333	040707	1315	0.1	28.8	5.1	6.3	154	0.08	64	Falling Tide	4.7			8	12.0	11.0†	4	0.10	0.64	0.51	0.16	0.08
				4.7	28.9	4.9	6.3	155	0.08	62													
				9.5	28.8	4.9	6.1	156	0.08	62													
		040712	1345	0.1	29.4	4.1	6.5	148	0.07	56	Falling Tide				10 Q1	13.0	NS	3 J5	0.09 J5	0.6 J5	0.49 J5	0.15 J5	0.44 J5
				2.2	29.4	4.2	6.1	147	0.07	55													
				4.3	29.4	4.7	6.2	149	0.07	57													
		040714	1230	0.1	29.6	4.1	6.9	204	0.10	52	Falling Tide	2.0 G5			13	11.0	11.0†	3	0.10	0.62	0.56	0.16	0.08
				3.7	29.6	3.6	6.6	206	0.10	48													
				7.5	29.6	3.7	6.8	208	0.10	49													
		040719	0940	0.1	29.3	4.0	6.8	217	0.11	52	Rising Tide				11	12.0	13.0†	3	0.08	0.65	0.65	0.16	0.08
				3.0	29.3	3.7	6.7	223	-	-													
				6.0	29.3	3.8	6.8	225	0.11	52													
		040721	1200	0.1	29.7	3.9	6.7	272	0.13	51	Rising Tide	2.0 U			11	10.0	10.0†	4	0.07	0.75	0.64	0.18	0.08
				3.1	29.7	3.7	6.6	271	0.13	49													
				6.1	29.7	3.7	6.7	269	0.13	50													
		040726	1230	0.1	29.8	3.8	6.8	217	0.11	54	Low Tide				11	13.0	9.6†	4	0.11	0.74	0.70	0.18	0.08
				4.6	29.7	3.9	6.5	221	0.11	52	slow out												
				9.3	29.7	4.0	6.8	224	0.11	54													
		040728	1200	0.1	29.6	3.7	7.0	246	0.12	50	Low Tide	2.1			22	11.0	10.0†	3	0.11	0.72	0.67	0.16	0.08
				4.0	29.6	3.6	6.7	256	0.12	49	medium												
				8.0	29.6	3.7	6.8	251	0.12	49	out												
		040802	no sample -Hurricane Alex																				
		040804	1220	0.1	29.0	5.9	6.5	187	0.09	70	Rising Tide				12	9.4	9.7†	5	0.05	0.64	0.84	0.18	0.10
				2.8	28.9	5.0	6.4	185	0.09	66													
				5.7	28.9	4.0	6.5	187	0.09	66													
		040809	1250	0.1	28.1	6.2	6.7	165	0.08	78	Falling Tide				6	10.0	10.0†	10	0.04	0.58	0.62	0.41	0.12
				3.3	27.8	5.5	6.3	166	0.08	70													
				6.6	27.8	5.5	6.3	167	0.08	71													
		040811	1345	0.1	27.7	4.9	6.5	212	0.10	63	Falling Tide				10	11.0	11.0†	7	0.02	0.57	0.87	0.20	0.07
				2.2	27.7	4.8	6.6	213	0.10	61													
				4.4	27.7	4.8	6.6	213	0.10	61													
			max	9.5	29.8	6.2	7.0	272	0.13	78		4.7			22	13.0	13.0	10	0.11	0.75	0.87	0.41	0.44
			mean	3.4	29.1	4.4	6.6	203.8	0.10	58		2.7			11.4	11.2	10.6	4.6	0.08	0.65	0.66	0.19	0.12
			median	3.2	29.4	4.1	6.6	210	0.10	55		2.1			11	11.0	10.0	4	0.09	0.64	0.65	0.17	0.08
			min	0.1	27.7	3.6	6.1	147	0.07	48		2.0			6	9.4	9.6	3	0.02	0.57	0.49	0.15	0.07

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
Q1 - holding time exceeded prior to receipt by lab
J5 - temperature limits exceeded during transport > 6° C
NS - no sample
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B905	Cape Fear R. at Navassa 34.26003 77.9875	040414	1420	0.2	17.7	7.7	7.3	142	0.07	80	Falling Tide								0.06	0.47	0.62	0.12	-
				6.2	17.7	7.6	7.1	143	0.07	79													
				12.4	17.7	7.5	7.1	147	0.07	78													
		040506	1515	0.2	21.0	7.6	5.8	108	0.05	85	Falling Tide								0.07	0.58	0.61	0.21	0.06
		040513	1145	0.2	23.2	5.7	6.4	99	0.05	64	Falling Tide								0.09	0.65	0.37	0.12	0.05
				5.0	23.2	5.0	6.3	99	0.05	59													
				10.0	23.2	5.0	6.3	99	0.05	59													
		040519	1425	0.2	25.0	5.1	6.6	154	0.08	60	Falling Tide								0.09	0.75	0.45	0.13	*
				5.9	24.9	4.9	6.4	154	0.08	59													
				11.8	24.9	4.7	6.5	155	0.08	58													
		040526	1400	0.2	27.7	5.2	6.4	195	0.10	64	Rising Tide								0.10	0.70	0.62	0.12	0.06**
				5.5	27.3	4.9	6.6	268	0.13	61													
				11.0	27.3	4.9	6.5	252	0.13	61													
		040602	1345	0.2	27.9	4.3	6.6	3820	2.00	57	Falling Tide								0.08	0.74	0.69	0.16	0.06
				4.4	27.8	4.3	6.6	3520	2.10	55													
				8.9	27.8	4.3	6.6	4140	2.60	56													
		040608	1340	0.2	28.0	3.9	6.6	633	0.34	50	Rising Tide								0.08	0.72	0.61	0.18	0.06
				5.2	27.9	3.9	6.6	1295	0.69	49													
				10.5	27.9	3.7	6.5	3490	1.80	48													
		040615	1345	0.2	28.0	4.5	6.5	1720	0.82	58	Falling Tide								0.10	0.95	0.66	0.20	0.02 U
				6.0	28.0	4.4	6.5	1690	0.86	56													
				12.0	27.9	4.1	6.5	3100	0.97	55													
		040623	1300	Rinse water blank - dionized water used to rinse filter bottle																			0.02 U
		040623	1320	0.2	29.1	5.4	6.4	200	1.09	69	Rising Tide								0.11	0.77	0.75	0.17	0.05
				5.1	28.6	4.2	6.4	464	2.80	55													
				10.3	28.4	4.1	6.5	11760	6.70	53													
		040630	1345	0.2	28.8	4.9	6.7	221	0.11	63	Falling Tide					12.0	12.0†		0.06	0.68	0.71	0.25	0.08
				5.2	28.8	4.7	6.7	222	0.11	61													
				10.5	28.8	4.7	6.7	223	0.11	60													
		040707	1335	0.1	29.3	5.3	6.7	2730	1.80	66	Rising Tide	2.0 U	1.4	4.1	14	10.0	10.0†	7	0.09	0.67	0.49	0.15	0.07
				3.2	29.0	4.5	6.7	3450	2.40	61	almost high												
				6.5	29.0	4.2	6.8	10540	5.80	57													
		040712	1315	0.1	29.4	4.2	6.5	194	0.01	56	Falling Tide				18 Q1	13.0	NS	3 J5	0.09 J5	0.69 J5	0.45 J5	0.16 J5	0.26 J5
				2.8	29.4	4.2	6.2	178	0.09	56													
				5.6	29.4	4.5	6.3	196	0.10	57													
		040714	1200	0.1	29.7	4.4	7.2	2530	1.38	54	Falling Tide	2.0 U G5			18	12.0	11.0†	3	0.11	0.68	0.49	0.15	0.08
				3.3	29.5	3.5	7.0	5770	3.07	47													
				6.7	29.5	3.4	7.0	8770	4.65	47													
		040719	1005	0.1	29.2	3.4	6.8	3390	1.77	52	Rising Tide				16	11.0	11.0†	5	0.08	0.75	0.59	0.15	0.07
				3.8	29.1	3.3	6.9	7220	3.81	44													
				7.5	29.1	3.4	6.9	10190	5.79	44													

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (°C)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B905	Cape Fear R.																						
	at Navassa	040721	1215	0.1	30.0	4.2	6.6	5240	2.83	53	Rising Tide	2.0 U			18	10.0	10.0†	6	0.07	0.75	0.60	0.15	0.07
	34.26			7.2	29.3	3.1	6.7	12450	7.20	43													
	77.9875			14.3	29.2	3.0	6.7	14120	8.24	41													
		040726	1305	0.1	30.6	4.0	6.6	277	0.13	55	Low Tide				9	10.0	10.0†	5	0.09	0.65	0.73	0.17	0.09
				4.7	29.7	3.6	6.6	261	0.13	49	slack												
				9.3	29.8	3.7	6.7	304	0.14	49													
		040728	1235	0.1	29.6	3.8	6.9	1261	0.61	53	Low Tide	2.0 U	1.2	4.1	100	17.0	11.0†	7	0.08 J6	1.2 J6	0.59 J6	0.38 J6	0.08
				2.9	29.6	3.5	6.9	1343	0.67	46	slow												
				5.8	29.6	2.8	6.9	1690	0.84	44													
		040802	no sample -Hurricane Alex																				
		040804	1245	0.1	29.6	5.5	6.7	938	0.45	73	Rising Tide				12	10.0	9.3†	5	0.05	0.75	0.88	0.19	0.10
				3.4	29.0	4.2	6.7	6340	6.53	51													
				6.9	29.7	3.6	6.7	12030	6.94	51													
		040809	1235	0.1	28.1	5.1	6.9	175	0.09	-	Falling Tide				4	10.0	10.0†	8	0.05	0.57	0.61	0.13	0.07
				2.7	27.9	5.0	6.5	175	0.09	66	slowly												
				5.4	27.9	5.4	6.6	178	0.09	70													
		040811	1315	0.1	27.9	5.3	6.8	871	0.42	65	Falling Tide				18	11.0	11.0†	8	0.02 U	0.66	0.74	0.20	0.07
				3.6	27.9	4.8	6.7	989	0.49	64													
				7.3	27.9	5.2	6.7	918	0.46	66													
		Post Hurricane Charley																					
		040818	1525	0.1	24.9	6.0	6.4	122	0.06	73	Falling Tide				-	14.0	12.0†	-	0.03	0.62	0.55	0.21	0.07
				4.1	24.8	5.9	6.4	121	0.06	72													
				8.2	24.9	5.9	6.4	122	0.06	72													
		040825	1400	0.1	25.9	4.3	6.2	110	0.06	53	Low Tide				-	-	-	-	-	-	-	-	-
				5.9	25.8	4.2	6.3	110	0.06	52	falling												
				11.8	25.8	4.2	6.2	110	0.06	47	out												
		040922	1340	0.1	22.7	5.3	6.2	92	0.05	69	Rising Tide				-	-	-	-	-	-	-	-	-
				6.0	22.3	5.1	6.1	91	0.05	55	from												
				12.1	22.3	5.1	6.0	92	0.05	60	low												
		041020	1350	0.1	21.0	5.8	6.7	630	0.40	64	Rising Tide				-	-	-	-	-	-	-	-	-
				5.3	21.0	5.5	6.6	3270	1.50	63													
				11.4	21.0	5.4	6.5	3420	1.90	62													
			max	14.3	30.6	7.7	7.3	14120	8.24	85		2.0	1.4	4.1	100	17.0	12.0	8	0.11	1.20	0.88	0.38	0.26
			mean	4.7	26.9	4.7	6.6	2307	1.36	59		2.0	1.3	4.1	22.7	11.7	10.7	5.7	0.08	0.71	0.61	0.18	0.08
			median	4.9	27.9	4.5	6.6	384	0.37	58		2.0	1.3	4.1	17	11.0	11.0	5.5	0.08	0.69	0.61	0.16	0.07
			min	0.1	17.7	2.8	5.8	91	0.01	41		2.0	1.2	4.1	4	10.0	9.3	3	0.02	0.47	0.37	0.12	0.02

* Chem. Lab not analyzing PO4 due to instrument training
** glass fiber filter used - 0.7µm
NS - no sample
Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
Q1 - holding time exceeded prior to receipt by lab
J5 - temperature limits exceeded during transport > 6° C
J6 - improperly chemically preserved sample - preserved at lab
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (°C)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
CPF BURG 1	NE Cape Fear R. at NC 53 34.59806 77.87528	040621	1030	0.2	26.5	5.5	6.7	95	0.05	68	Flow downstream				-	-	-	-	-	-	-	-	-
		040707	1655	0.1	29.5	5.2	6.8	108	0.06	67	Flow	2.0 U			2.5 U	16.0	21.0†	1 U	0.04	0.75	0.27	0.16	0.08
				1.7	29.4	4.8	6.7	108	0.06	63	downstream												
				3.9	29.3	4.9	6.7	108	0.06	63													
		040712	1500	0.1	29.8	4.6	6.9	134	0.07	60	Flow				2.5	14.0	16.0†	2	0.08	0.80	0.27	0.17	0.13
				1.9	28.9	4.2	6.8	134	0.07	55	downstream												
				3.8	28.9	4.2	6.9	134	0.07	55													
		040714	1555	0.1	31.5	4.3	6.7	135	0.07	58	Flow	2.0 U G5	1.4	4.0	2.5 U	13.0	15.0†	3	0.07	0.70	0.26	0.18	0.09
				1.9	29.5	3.7	6.6	137	0.07	49	downstream												
				3.9	29.5	3.6	6.6	137	0.07	48													
		040719	1430	0.1	29.3	4.3	6.8	137	0.07	57	Flow				2.5 U	12.0	13.0†	2	0.08	0.67	0.42	0.19	0.08
				1.7	28.3	4.0	6.8	138	0.07	51	upstream												
				3.4	28.3	3.9	6.7	138	0.07	51													
		040721	1425	0.1	29.3	4.0	6.6	142	0.07	53	Flow	2.0 U			3	12.0	14.0†	2	0.08	0.70	0.49	0.21	0.24
				1.7	28.5	3.4	6.6	143	0.07	48	downstream												
				3.5	28.3	3.1	6.6	146	0.07	40													
		040726	1445	0.1	30.0	4.6	6.7	199	0.10	61	Flow				11	11.0	10.0†	3	0.06	0.60	0.81	0.23	0.09
				1.9	29.0	4.3	6.7	199	0.10	58	downstream												
				3.8	29.0	4.3	6.7	198	0.10	57													
		040728	1410	0.1	29.2	4.7	6.8	190	0.09	63	Flow	2.0 U	1.0	3.4	2.5 U	11.0	11.0†	4	0.07	0.80	1.00	0.20	0.10
				1.9	28.9	3.9	6.7	190	0.09	51	downstream												
				3.9	28.9	3.9	6.7	190	0.09	52													
		040802	no sample -Hurricane Alex																				
		040804	1425	0.1	28.5	5.0	6.7	163	0.08	65	Flow				2.5 U	13.0	12.0 J6†	1	0.06	0.68	0.51	0.20	X2
				1.9	28.2	4.8	6.7	163	0.08	63	downstream												
				3.9	28.1	4.7	6.7	163	0.08	62													
		040809	1445	0.1	24.9	5.4	6.6	117	0.06	66	Flow				4	18.0	18.0†	1 U	0.07	0.91	0.37	0.17	0.10
				2.0	24.8	5.4	6.6	117	0.06	66	downstream												
				4.1	24.8	5.3	6.5	117	0.06	65													
		040811	1445	0.1	25.9	5.5	6.5	116	0.06	68	Flow				2.5 U	16.0	16.0†	1	0.06	0.82	0.27	0.16	0.07
				1.9	25.1	5.4	6.5	116	0.06	66	downstream												
				3.8	25.0	5.4	6.4	116	0.06	66													
			max	4.1	31.5	5.5	6.9	199	0.10	68		2.0	1.4	4.0	11	18.0	18.0	4	0.08	0.91	1.00	0.23	0.24
			mean	1.9	28.2	4.5	6.7	143	0.07	59		2.0	1.2	3.7	3.7	13.3	13.9	2.1	0.07	0.74	0.49	0.19	0.11
			median	1.9	28.9	4.6	6.7	137	0.07	60		2.0	1.2	3.7	2.5	13.0	14.0	2	0.07	0.70	0.42	0.19	0.10
			min	0.1	24.8	3.1	6.9	95	0.05	40		2.0	1.0	3.4	2.5	11.0	10.0	1	0.06	0.60	0.26	0.16	0.07

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
J6 - improperly chemically preserved sample - preserved at lab
X2 - sampled, but analysis lost or not performed - field error - sample not chemically preserved properly
† - Possible contamination, for information only

P14	Prince George Cr. near mouth 34.35972 77.95139	040708	1155	0.1	29.5	4.2	6.5	136	0.06	55	Low Tide	2.0 U			6	15.0	15.0†	1	0.04	0.72	0.23	0.15	0.11
				5.3	29.5	4.0	6.4	136	0.06	53													
				10.5	28.4	4.0	6.3	135	0.06	53													
		040712	1500	0.1	27.6	3.6	6.3	130	0.07	44	Low Tide				3	14.0	14.0†	35	0.04	0.60	0.12	0.09	0.05
				2.8	27.5	3.3	6.1	132	0.07	42	still												
				5.7	27.5	3.0	6.1	132	0.07	40													
		040714	1345	0.1	30.0	3.9	6.8	152	0.08	51	Falling Tide	2.0 U G5			4	14.0	14.0†	9	0.04	0.64	0.26	0.13	0.06
				3.0	29.7	3.7	6.6	152	0.08	48													
				6.1	29.7	3.8	6.7	152	0.08	49													
		040719	0900	0.1	27.9	3.5	6.6	150	0.08	43	Falling Tide				3	16.0	16.0†	3	0.03	0.64	0.15	0.10	0.05
				3.2	27.0	3.3	6.7	152	0.08	43	half tide												
				6.3	27.3	3.2	6.6	152	0.08	43													
		040721	1335	0.1	29.9	5.4	6.7	141	0.07	63	(Not stated	2.0 U	0.8	2.6	4	16.0	16.0†	2	0.02	0.66	0.24	0.13	0.03
				1.8	29.7	3.9	6.6	140	0.07	50	but probably												
				3.5	29.7	3.8	6.6	141	0.07	50	rising)												
		040726	1415	0.1	28.3	2.7	6.5	171	0.08	37	Low Tide				5	16.0	15.0†	8	0.05	0.75	0.07	0.10	0.03
				2.3	27.5	2.6	6.4	173	0.09	33	slow in												
				4.6	27.5	2.7	6.5	174	0.09	35													
		040728	1400	0.1	27.8	3.4	6.7	156	0.08	46	Low Tide	2.0 U	1.2	3.5	4	17.0	17.0†	5	0.04	0.64	0.08	0.09	0.04
				2.5	27.7	2.9	6.6	157	0.08	37	slack												
				5.0	27.8	2.9	6.6	157	0.08	45													
		040802	no sample -Hurricane Alex																				
		040804	1400	0.1	29.1	4.4	6.1	112	0.06	55	Rising Tide				9	25.0	23.0†	1	0.02 U	0.72	0.11	0.11	0.04
				2.0	29.0	3.9	5.9	110	0.06	52													
				4.1	29.0	3.4	6.0	110	0.06	51													
		040809	1415	0.1	26.3	4.1	6.1	99	0.05	50	Rising Tide				4	25.0	25.0†	2	0.04	0.68	0.06	0.08	0.04
				2.9	24.8	3.6	6.0	114	0.06	43													
				3.8	24.7	3.6	6.1	114	0.06	46													
		040811	1445	0.1	26.5	3.4	6.3	128	0.06	42	Falling Tide				5 U	24.0	24.0†	2	0.03	0.76	0.08	0.08	0.03
				1.6	26.0	3.2	6.3	133	0.07	38													
				3.2	25.8	3.3	6.2	136	0.07	39													
			max	10.5	30.0	5.4	6.8	174	0.09	63		2.0	1.2	3.5	9	25.0	25.0	35	0.05	0.76	0.26	0.15	0.11
			mean	2.7	28.0	3.5	6.4	139.23	0.07	46		2.0	1.0	3.1	4.7	18.2	17.9	6.8	0.04	0.68	0.14	0.11	0.05
			median	2.7	27.8	3.5	6.5	138	0.07	45		2.0	1.0	3.1	4	16.0	16.0	2.5	0.04	0.67	0.12	0.10	0.04
			min	0.1	24.7	2.6	5.9	99	0.05	33		2.0	0.8	2.6	3	14.0	14.0	1	0.02	0.60	0.06	0.08	0.03

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
RR	NE Cape Fear R. at CSX RR Trestle 34.25862 77.94897	040414	1315	0.2	18.1	7.2	7.3	3870	2.00	76	Falling Tide								0.12	0.73	0.35	0.11	X2
				3.3	18.1	7.2	7.3	3770	1.97	77													
				6.6	18.1	7.0	7.2	3716	1.94	73													
		040506	1330	0.2	21.8	6.5	6.1	307	0.15	74	Falling Tide								0.07	0.66	0.37	0.11	0.04
				4.2	21.5	6.5	5.9	319	0.15	74													
				8.4	21.2	6.4	5.9	319	0.15	72													
		040513	1050	0.2	23.0	4.7	6.2	101	0.05	54	Falling Tide								0.07	0.84	0.41	0.13	0.05
				3.5	23.0	4.5	6.1	101	0.05	52													
				7.0	23.0	4.5	6.1	101	0.05	53													
		040519	1215	0.2	25.4	5.1	6.7	5670	3.15	61	High Tide								0.11	0.78	0.38	0.09	*
				3.9	24.7	4.5	6.5	6820	3.61	56	slack												
				7.8	24.7	4.5	6.6	7200	3.95	54													
		040526	1300	0.2	27.4	5.8	6.4	6490	3.60	75	Rising Tide								0.11	0.79	0.41	0.14	0.04**
				3.5	27.1	5.5	6.5	7110	4.30	69													
				7.0	26.6	5.2	6.5	8720	4.90	67													
		040602	1240	0.2	27.5	4.7	6.9	16400	9.70	63	Falling Tide								0.13	0.75	0.46	0.11	0.05
				4.3	27.5	4.6	6.9	16700	9.90	62													
				8.5	27.5	4.5	6.9	17000	10.00	60													
		040608	1245	0.2	28.0	4.5	6.9	12840	7.40	59	Rising Tide								0.10	0.84	0.45	0.17	0.04
				3.6	27.8	4.2	6.8	14030	8.30	56													
				7.3	27.7	4.1	6.9	14830	8.60	55													
		040615	1245	0.2	28.3	5.2	6.7	11020	6.10	69	Falling Tide								0.09	0.79	0.38	0.11	0.05
				4.1	28.3	5.0	6.7	11710	6.80	67													
				8.2	28.1	4.8	6.8	13660	7.60	63													
		040623	1220	0.2	28.9	5.1	6.6	11820	6.80	70	Rising Tide								0.08	0.72	0.35	0.11	0.03 Q2
				3.6	28.3	4.3	6.7	15200	9.20	59													
				7.3	28.2	4.2	6.7	16500	9.80	57													
		040630	1245	0.2	28.9	4.6	6.7	13600	7.80	61	Falling Tide					12.0	11.0†		0.11	0.68	0.40	0.12	0.05
				4.0	28.8	4.1	6.8	13840	8.10	55													
				8.0	28.7	4.0	6.8	14100	8.20	55													

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
RR	NE Cape Fear R.	Post Hurricane Charley																					
	at CSX RR Trestle	040818	1435	0.1	24.8	5.2	6.1	125	0.06	63	Falling Tide					20.0	18.0†		0.04	0.69	0.25	0.13	0.05
	34.25862			4.6	24.8	5.1	6.2	126	0.06	62													
	77.94897			9.2	24.6	5.0	6.2	126	0.06	61													
		040825	1310	0.1	25.3	3.0	5.7	82	0.04	37	Falling Tide								-	-	-	-	-
				3.9	25.2	2.8	5.7	82	0.04	34													
				7.8	25.2	2.8	5.7	82	0.04	34													
		040922	1220	0.1	22.6	4.3	5.7	121	0.06	50	Falling Tide								-	-	-	-	-
				3.5	22.5	4.0	5.8	127	0.06	46													
				6.9	22.5	4.0	5.7	157	0.08	47													
		041020	1230	0.2	21.9	5.2	6.6	6070	3.30	62	Low Tide								-	-	-	-	-
				3.7	21.7	5.1	6.6	7000	3.90	61	coming in												
				7.1	21.6	5.0	6.6	8350	4.60	59													
			max	9.2	28.9	7.2	7.3	17000	10.00	77						20.0	18.0		0.13	0.84	0.46	0.17	0.05
			mean	3.9	25.0	4.9	6.5	6912	3.97	60						16.0	14.5		0.09	0.75	0.38	0.12	0.04
			median	3.8	25.2	4.7	6.6	6655	3.61	61						16.0	14.5		0.10	0.75	0.38	0.11	0.05
			min	0.1	18.1	2.8	5.7	82	0.04	34						12.0	11.0		0.04	0.66	0.25	0.09	0.03

* Chem. Lab not analyzing PO4 due to instrument training
** glass fiber filter used - 0.7µm

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
X2 - sampled, but analysis not performed - field error - sampled preserved with H3PO4
Q2 - 48 hr. holding time exceeded following receipt by lab by 12 minutes
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B974	NE Cape Fear R. at NC 133 34.25861 77.94889	040707	1245	0.1	29.3	5.5	6.9	11300	6.10	71	Rising	5.7			16	10.0	11.0†	7	0.12	0.69	0.44	0.12	0.06
				5.7	29.0	4.2	7.0	16400	9.70	57	Tide												
				11.5	28.9	4.2	7.0	18700	11.20	57													
		040712	1250	0.1	29.7	4.3	6.9	10500	5.98	55	Falling				12 Q1	11.0	NS	6 J5	0.11 J5	0.66 J5	0.35 J5	0.11 J5	0.1 J5
				5.3	29.3	3.8	6.9	12700	7.37	52													
				10.6	29.3	3.8	7.0	16900	9.90	52													
		040714	1300	0.1	30.1	4.4	6.9	14000	8.17	59	Falling	2.0 U G5	1.4	4.0	24	9.8	9.2†	8	0.13	0.63	0.33	0.10	0.14
				5.3	29.6	3.4	7.1	15900	9.20	48	Tide												
				10.7	29.6	3.0	7.1	21100	11.90	42													
		040719	1230	0.1	29.3	3.2	7.2	11300	9.84	48	High				27	9.9	9.1†	7	0.11	1.10	0.39	0.10	0.05
				5.8	29.1	2.9	7.2	14600	11.64	41	Tide												
				11.6	29.2	3.0	7.2	21600	13.08	43	dead slack												
		040721	1245	0.1	29.6	4.3	6.8	17500	10.35	55	Rising	2.0 U			26	8.9	9.2†	9	0.06	0.68	0.46	0.11	0.05
				5.5	29.2	3.1	7.0	20200	12.03	44	Tide												
				11.0	29.2	3.1	7.0	23100	14.01	45													
		040726	1330	0.1	30.4	4.0	6.8	6550	3.58	57	Low Tide				14	13.0	13.0†	5	0.03	0.68	0.35	0.15	0.06
				5.0	29.5	3.2	6.9	12290	7.15	44	slow in												
				10.0	29.4	2.8	6.9	16400	9.58	40													
		040728	1300	0.1	29.3	3.4	7.0	14600	8.50	48	(Not stated	2.0 U	0.8	2.6	25	11.0	10.0†	4	0.03	0.56	0.45	0.12	0.06
				5.7	29.3	3.1	7.0	15000	8.76	44	but probably												
				10.5	29.3	3.2	7.0	15200	8.82	44	Low Tide)												
		040802	no sample -Hurricane Alex																				
		040804	1315	0.1	29.7	4.1	6.8	13460	7.87	61	Rising Tide				30	10.0	9.7†	6	0.05	0.67	0.61	0.12	0.06
				5.6	29.2	3.3	6.8	17000	9.45	51													
				11.1	29.1	3.6	6.9	13900	11.19	51													
		040809	1310	0.1	28.2	4.7	6.6	2110	1.08	62	Falling Tide				6	20.0	19.0†	7	0.02	0.68	0.19	0.10	0.06
				4.6	28.0	4.2	6.6	4730	2.47	56	still falling												
				9.2	28.0	3.6	6.8	15100	4.87	56	slowly												
		040811	1550	0.1	28.1	4.2	6.9	7620	4.17	55	Rising Tide				8	16.0	17.0†	5	0.02 U	0.61	0.26	0.10	0.05
				4.7	28.1	3.6	7.1	10590	6.01	49													
				9.4	27.9	3.5	7.1	21000	12.54	46													
			max	11.6	30.4	5.5	7.2	23100	14.01	71		5.7	1.4	4.0	30	20.0	19.0	9	0.13	1.10	0.61	0.15	0.14
			mean	5.3	29.1	3.7	6.9	14378	8.55	51		2.9	1.1	3.3	18.8	12.0	11.9	6.4	0.07	0.70	0.38	0.11	0.07
			median	5.4	29.3	3.6	7.0	14800	9.01	51		2.0	1.1	3.3	20	10.5	10.0	6.5	0.06	0.68	0.37	0.11	0.06
			min	0.1	27.9	2.8	6.6	2110	1.08	40		2.0	0.8	2.6	6	8.9	9.1	4	0.02	0.56	0.19	0.10	0.05

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
Q1 - holding time exceeded prior to receipt by lab
J5 - temperature limits exceeded during transport > 6° C
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (°C)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B980	Cape Fear R. at Mk# 61 34.19389 77.95694	040707	1225	0.1	30.2	5.7	7.1	13300	7.70	79	Rising	2.0 U			18	10.0	9.6†	12	0.09	0.65	0.43	0.14	0.06
				6.8	28.9	4.3	7.0	17100	10.10	59	Tide												
				13.6	29.0	4.6	7.4	27800	17.00	66													
		040712	1230	0.1	29.9	4.5	7.1	14800	8.57	62	Low Tide				9	10.0	11.0†	10	0.13	0.60	0.40	0.11	0.14
				6.6	29.4	3.5	7.2	21300	12.20	51	falling												
				13.6	29.8	3.7	7.5	32900	20.60	56													
		040714	1130	0.1	30.0	4.8	7.4	13540	7.80	66	Falling	2.0 U G5			17	9.7	9.4†	9	0.09	0.56	0.35	0.10	0.21
				7.0	29.7	3.7	7.6	24800	14.20	54	Tide												
				14.0	29.7	3.1	7.7	30000	18.60	52													
		040719	1200	0.1	29.3	4.2	7.3	18600	11.06	64	Falling				53 J3	8.7	8.3†	17	0.05	0.58	0.36	0.10	0.04
				7.1	29.0	4.0	7.5	27600	17.00	58	Tide												
				14.2	29.0	3.9	7.5	28200	17.50	57													
		040721	1140	0.1	29.1	4.5	7.2	17900	10.60	70	Rising	15.0			22	9.0	8.4†	11	0.03	0.68	0.47	0.10	0.04
				7.1	29.1	3.7	7.5	25600	15.07	55	Tide												
				14.2	29.1	3.6	7.5	29500	18.32	54													
		040726	1200	0.1	29.9	3.2	7.0	17100	10.10	45	Low				44	9.7	9.3†	6	0.02	0.54	0.45	0.12	0.06
				6.5	29.4	2.7	7.1	21100	12.80	40	Tide												
				13.3	29.4	2.8	7.3	29400	18.18	44	slow out												
		040728	1120	0.1	29.3	3.6	7.2	18900	11.25	55	Low Tide	2.0 U			17	9.2	8.9†	13	0.03	0.57	0.49	0.10	0.06
				6.8	29.5	3.0	7.2	20400	12.23	43	out medium												
				13.6	29.5	3.0	7.4	26600	16.35	44													
		040802	no sample -Hurricane Alex																				
		040804	1130	0.1	29.8	4.8	7.1	17300	10.42	75	Rising Tide				27	9.7	8.8†	8	0.02 U	0.58	0.54	0.11	0.05 Q2
				7.3	29.1	4.3	7.3	26800	1648.00	61													
				14.7	29.1	4.2	7.3	27300	16.81	62													
		040809	1205	0.1	28.1	4.7	6.9	13010	6.99	63	Low Tide				20	11.0	9.7†	6	0.02	0.52	0.56	0.12	0.06
				6.6	28.0	3.4	7.1	18100	10.78	45	slack												
				13.2	28.0	3.5	7.4	33200	20.77	54													
		040811	1230	0.1	28.2	4.6	7.0	14000	8.26	69	Low Tide				23	11.0	-	10	0.02 U	0.54	0.47	0.11	0.05
				7.1	27.9	4.0	7.1	24300	15.00	54	slack												
				14.3	27.7	3.8	7.3	30200	18.83	57													
			max	14.7	30.2	5.7	7.7	33200	20.77	79		15.0			53	11.0	11.0	17	0.13	0.68	0.56	0.14	0.21
			mean	7.0	29.1	3.9	7.3	22688	13.72	57		5.3			25	9.8	9.3	10.2	0.05	0.58	0.45	0.11	0.08
			median	6.9	29.2	3.8	7.3	22800	13.50	56		2.0			21	9.7	9.3	10	0.03	0.58	0.46	0.11	0.06
			min	0.1	27.7	2.7	6.9	13010	6.99	40		2.0			9	8.7	8.3	6	0.02	0.52	0.35	0.10	0.04

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
J3 - sample matrix interfered with the ability to make any accurate determination
Q2 - 48 hr.holding time exceeded following receipt by lab by 15 minutes
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
P3	Town Cr. at NC 133 34.1325 77.98306	040707	1120	0.1	29.8	4.1	6.6	7690	4.30	56	Rising Tide	2.0 U			17	12.0	13.0†	12	0.04	0.64	0.13	0.07	0.02 U
				3.4	29.6	4.0	6.8	8100	4.50	55													
				6.8	29.6	4.0	6.8	8210	4.60	53													
		040712	1010	0.1	28.9	3.8	6.9	8650	4.80	51	Falling Tide				20	13.0	14.0†	9	0.06	0.68	0.17	0.07	X2
				3.4	28.9	3.7	7.0	8550	4.80	50	out												
				6.9	28.9	3.6	7.0	8650	4.80	49													
		040714	1035	0.1	28.3	3.4	6.6	3510	1.83	45	Falling Tide	2.0 U G5			24	14.0	12.0†	8	0.07	0.77	0.08	10.80	0.02 U
				3.6	28.3	3.3	6.7	3530	1.81	44	out												
				7.3	28.3	3.2	6.7	3760	1.86	43													
		040719	1000	0.1	27.0	4.0	6.9	283		49	Rising				15	13.0	14.0†	5	0.02	0.56	0.03	0.05	0.02 U
				4.0	27.0	3.9	6.9	291		48	tide												
				8.0	26.9	3.9	6.9	281		47													
		040721	1010	0.1	28.0	3.8	6.6	170	0.08	49	Rising	2.0 U	1.3	3.5	5	12.0	14.0†	5	0.03	0.61	0.02 U	0.04	0.07
				4.1	27.7	3.6	6.6	168	0.08	46	tide												
				8.3	27.7	3.7	6.6	169	0.08	46													
		040726	1020	0.1	28.0	3.9	6.7	262	0.13	50	Falling Tide				35	15.0	25.0†	6	0.04	0.75	0.04	0.10	0.02
				2.2	28.3	3.9	6.7	257	0.12	50	out												
				4.5	28.3	3.5	6.7	260	0.13	50													
		040728	1100	0.1	28.9	3.8	6.6	6790	3.70	52	Falling Tide	2.0 U	1.4	4.6	36	14.0	13.0†	12	0.05	0.82	0.11	0.11	0.02
				3.5	28.9	3.8	6.7	6550	3.60	51	out												
				7.0	28.9	3.7	6.7	6710	3.70	51													
		040802	no sample -Hurricane Alex																				
		040804	1010	0.1	28.7	3.9	6.6	9730	5.50	52	High Tide				18	14.0	12.0†	5	0.02 U	0.66	0.13	0.06	0.03 Q2
				2.9	28.7	3.8	6.6	10040	5.70	49	Slack												
				5.9	28.7	3.6	6.6	10190	5.80	49													
		040809	1015	0.1	25.5	4.2	6.7	203	0.10	52	Falling Tide				30	18.0	16.0†	6	0.02 U	0.72	0.02 U	0.07	0.02
				4.0	25.5	4.1	6.7	204	0.10	51													
				8.0	25.5	4.1	6.6	207	0.10	50													
		040811	1030	0.1	26.3	4.3	6.7	384	0.19	54	Falling Tide				23	16.0	14.0†	9	0.03	0.71	0.03	0.09	0.02
				2.5	26.3	4.2	6.7	381	0.19	53	out												
				5.0	26.3	4.2	6.7	392	0.19	53													
			max	8.3	29.8	4.3	7.0	10190	5.80	56		2.0	1.4	4.6	36	18.0	25.0	12	0.07	0.82	0.17	10.80	0.02
			mean	3.4	27.9	3.8	6.7	3819	2.33	50		2.0	1.3	4.1	22.3	14.1	14.7	7.7	0.04	0.69	0.08	1.15	0.02
			median	3.5	28.3	3.8	6.7	1951	1.83	50		2.0	1.3	4.1	21.5	14.0	14.0	7	0.04	0.70	0.06	0.07	0.02
			min	0.1	25.5	3.2	6.6	168	0.08	43		2.0	1.3	3.5	5	12.0	12.0	5	0.02	0.56	0.02	0.04	0.02

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
X2 - sampled, but not analyzed
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
Q2 - 48 hr.holding time exceeded following receipt by lab by 1 hr. 40 minutes
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B982	Cape Fear R. at Mk# 56 34.1425 77.94944	040707	1200	0.1	29.3	5.8	7.2	19900	12.00	77	Rising Tide about High Tide	2.0 U			30	9.4	9.6†	12	0.08	0.57	0.38	0.09	0.08
				7.0	29.1	4.9	7.5	29200	18.10	70													
				13.9	29.1	4.9	7.5	31100	19.30	71													
		040712	1200	0.1	29.7	4.6	7.2	16900	10.60	66	Low Tide				10	8.9	9.0†	9	X3	0.63	0.36	0.10	0.09
				6.6	29.7	4.0	7.4	29800	18.10	59	rising												
				13.6	29.9	3.9	7.6	34800	22.00	61													
		040714	1115	0.1	30.0	5.9	7.7	18700	11.10	83	Rising Tide	2.4 G5			20	8.6	8.0†	19	0.11	0.61	0.32	0.10	0.04
				6.9	29.7	3.7	7.9	30900	19.36	55													
				14.0	29.6	3.9	7.9	32400	20.50	56	almost high												
		040719	1130	0.1	28.9	5.3	7.5	21700	13.14	76	Rising Tide				33	7.7	7.3†	22	0.04	0.58	0.29	0.09	0.03
				7.2	28.8	4.5	7.7	30000	18.50	66													
				14.5	28.9	4.2	7.7	31500	19.60	66													
		040721	1120	0.1	29.3	5.1	7.4	22200	13.35	71	Rising Tide	16.0			5 U	8.3	7.9†	11	0.04	0.61	0.41	0.09	0.03
				7.0	29.1	4.0	7.7	31000	19.41	59													
				14.0	28.9	2.4	7.6	26800	18.31	7													
		040726	1130	0.1	29.8	3.4	7.0	18000	10.61	49	Low Tide				27	9.8	9.0†	7	0.02	0.53	0.44	0.12	0.05
				6.5	29.4	3.0	7.3	26200	15.88	44													
				13.0	29.3	3.3	7.5	31100	17.93	50	going out												
		040728	1100	0.1	29.4	3.9	7.3	21100	12.69	56	Low Tide	2.0 U			2.5 U	8.5	8.2†	7	0.03	0.46	0.46	0.10	0.05
				6.5	29.3	4.0	7.4	23200	14.14	57	out fast												
				13.1	29.6	4.1	7.6	21500	13.42	54													
		040802	no sample -Hurricane Alex																				
		040804	1115	0.1	29.5	5.2	7.2	18500	11.26	69	Rising Tide				20	9.1	8.2†	8	0.02	0.56	0.52	0.11	0.06 Q2
				6.7	29.0	4.4	7.3	22200	13.14	64													
				13.4	29.0	4.3	7.4	28700	17.70	59													
		040809	1145	0.1	28.3	5.0	7.1	13110	7.58	68	Falling Tide				20	9.5	9.3†	9	0.02	0.54	0.55	0.10	0.06
				6.3	28.0	4.4	7.1	23900	14.90	58	almost slack												
				12.6	27.9	4.1	7.4	33800	21.18	60	low												
		040811	1200	0.1	28.1	4.6	7.1	14200	8.52	64	Falling Tide				14	10.0	9.0†	10	0.02 U	0.56	0.48	0.11	0.05
				7.1	27.8	4.0	7.3	25000	15.10	54													
				14.2	27.7	3.9	7.5	30300	18.70	56													
			max	14.5	30.0	5.9	7.9	34800	22.00	83		16.0			33	10.0	9.6	22	0.11	0.63	0.55	0.12	0.09
			mean	6.8	29.1	4.3	7.4	25257	15.54	60		5.6			18.15	9.0	8.6	11.4	0.04	0.57	0.42	0.10	0.05
			median	6.8	29.2	4.2	7.4	25600	15.49	60		2.2			20	9.0	8.6	9.5	0.03	0.57	0.43	0.10	0.05
			min	0.1	27.7	2.4	7.0	13110	7.58	7		2.0			2.5	7.7	7.3	7	0.02	0.46	0.29	0.09	0.03

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
X3 - sampled, but sampled discarded before analyzed
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
Q2 - 48 hr.holding time exceeded following receipt by lab by 30 minutes
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
B98451	Cape Fear R. at Mk# 42 34.09028 77.93444	040707	1130	0.1	29.7	6.1	7.6	24700	15.10	90	Rising	2.0 U			30	7.5	7.6†	19	0.03	0.56	0.31	0.08	0.02
				5.5	29.2	5.5	7.7	30600	19.00	79	Tide												
				10.9	29.2	5.2	7.8	36000	22.70	78													
		040712	1130	0.1	29.8	5.6	7.3	11800	11.70	74	Low Tide				11	8.4	8.8†	13	X3	0.60	0.34	0.10	0.12
				6.6	29.8	4.4	7.7	33200	21.00	65	rising												
				13.6	29.9	4.5	7.8	39600	25.40	70													
		040714	1045	0.1	29.6	6.9	7.9	22200	13.40	97	Rising	2.4 G5			16	7.6	7.1†	22	0.08	0.57	0.28	0.08	0.03
				6.7	29.5	4.5	8.0	32800	20.60	68	Tide												
				13.6	29.4	4.5	8.0	35700	22.60	67													
		040719	1100	0.1	29.0	6.2	7.5	27200	16.71	87	Rising				40	6.9	6.4†	18	0.02 J6	0.52 J6	0.20 J6	0.08 J6	0.03
				6.8	28.6	5.1	7.8	33400	20.89	70	Tide												
				13.6	28.7	4.4	7.5	35400	22.31	67													
		040721	1045	0.1	29.3	5.0	7.7	25400	15.48	74	Rising	2.2			5	7.2	6.6†	18	0.03	0.62	0.34	0.10	0.03
				6.9	29.1	4.9	7.9	32000	19.62	71	Tide												
				13.8	29.1	4.9	7.9	35200	22.31	71													
		040726	1100	0.1	29.6	3.8	7.2	21600	13.02	54	Low				29	8.3	8.4†	10	0.02	0.58	0.39	0.11	0.05
				5.7	29.3	3.6	7.4	28300	17.43	52	Tide												
				11.6	29.2	3.7	7.6	33900	21.36	56	going out												
		040728	1030	0.1	29.2	4.9	7.6	25400	15.54	73	Falling Tide	2.0 U	1.4	4.2	22	7.6	7.5†	10	0.02	0.49	0.36	0.09	0.04
				6.5	29.5	4.3	7.6	30700	19.22	23	Half out												
				13.1	29.4	3.7	7.8	33400	21.57	22	fast												
		040802	no sample -Hurricane Alex																				
		040804	1040	0.1	29.4	5.7	7.5	23100	14.01	79	Rising Tide				31	9.7	7.7†	12	0.02 U	0.57	0.44	0.18	0.08 Q2
				6.9	28.9	4.6	7.6	27700	16.82	68													
				13.5	29.0	4.8	7.7	32800	20.50	77													
		040809	1115	0.1	28.1	5.3	7.2	17400	10.46	68	Falling Tide				22	8.7	8.6†	11	0.02	0.48	0.51	0.10	0.07
				6.0	27.8	4.3	7.5	28200	17.60	62													
				12.0	27.6	4.2	7.6	33700	21.10	64													
		040811	1100	0.1	28.2	6.1	7.5	17900	10.59	82	Falling Tide				18	10.0	10.0†	30	0.02 U	0.67	0.34	0.11	0.04
				6.7	27.7	4.9	7.7	30800	19.10	69													
				13.4	27.6	4.9	7.8	34800	21.87	72													
			max	13.8	29.9	6.9	8.0	39600	25.40	97		2.4	1.4	4.2	40	10.0	10.0	30	0.08	0.67	0.51	0.18	0.12
			mean	6.5	29.0	4.9	7.6	29163	18.30	68		2.2	1.4	4.2	22.4	8.2	7.9	16.3	0.03	0.57	0.35	0.10	0.05
			median	6.6	29.2	4.9	7.7	30750	19.16	70		2.1	1.4	4.2	22	8.0	7.7	15.5	0.02	0.57	0.34	0.10	0.04
			min	0.1	27.6	3.6	7.2	11800	10.46	22		2.0	1.4	4.2	5	6.9	6.4	10	0.02	0.48	0.20	0.08	0.02

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
X3 - sampled, but sampled discarded before analyzed
G5 - Glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L
J6 - improperly chemically preserved sample - preserved at lab
Q2 - 48 hr.holding time exceeded following receipt by lab by 1 hr.
† - Possible contamination, for information only

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
Mk# 12	Cape Fear R. near Mk# 41	040414	1030	0.2	17.5	8.3	7.9	15700	8.96	90	Falling Tide								0.13	0.55	0.38	0.10	-
	34.07633	040506	1100	0.2	22.3	7.8	7.3	13700	7.90	93	High Tide								0.11	0.55	0.40	0.08	0.03
	77.93111			3.4	21.0	7.3	7.4	21300	12.60	87	Slack												
				6.9	20.8	7.2	7.5	26400	16.20	89													
		040513	1405	0.2	24.3	6.1	6.5	4290	2.30	74	Rising Tide								0.10	0.76	0.41	0.11	0.04
				3.0	23.9	5.7	6.6	6580	3.60	69													
				6.0	23.6	5.5	6.3	11220	6.36	66													
		040519	1055	0.2	25.2	6.3	7.3	18400	10.90	81	High Tide								0.07	0.62	0.30	0.08	*
				3.2	24.5	5.7	7.5	25800	15.70	74													
				6.4	24.5	5.6	7.5	28700	17.70	74													
		040526	1145	0.2	27.1	7.6	7.3	15600	9.10	102	Falling Tide								0.07	0.63	0.36	0.11	0.03**
				3.0	26.5	6.7	7.2	19000	11.20	89	Low slack												
				5.9	26.4	6.3	7.4	26100	15.90	84													
		040602	1115	0.2	27.1	6.8	7.8	28900	17.70	95	Falling Tide								0.03	0.53	0.23	0.08	0.02
				3.2	26.7	6.0	7.8	32000	20.70	86	from High												
				6.4	26.7	5.9	7.9	36900	23.40	83													
		040608	1130	0.2	27.9	5.8	7.6	24300	14.80	80	Rising Tide								0.06	0.57	0.32	0.12	0.04
				3.1	27.4	5.5	7.6	26300	16.30	77	from Low												
				6.3	27.6	6.0	7.7	27500	16.90	83													
		040615	1130	0.2	27.6	7.7	8.0	24100	14.60	106	Falling Tide								0.02 U	0.74	0.25	0.07	0.02
				3.0	27.2	6.5	7.9	27400	16.80	91													
				6.1	27.1	6.1	7.9	31500	19.70	85													
		040623	1115	0.2	28.8	7.7	7.6	24200	14.70	108	Rising Tide								0.02 U	0.59	0.26	0.10	0.02 Q2
				3.1	28.2	6.5	7.6	25400	15.50	92													
				6.3	28.2	6.1	7.5	29000	17.70	86													
		040630	1130	0.2	28.8	5.9	7.4	23600	14.30	83	Falling Tide					8.4	9.4†		0.06	0.59	0.28	0.10	0.02
				3.0	28.5	5.2	7.5	25700	15.60	77													
				6.0	28.3	5.0	7.6	29700	18.30	73													

Appendix A

Physical / Chemical Data
Lower Cape Fear River / Estuary TMDL Study

Station	Location	Date yy/mm/dd	Time (hrs.)	Depth (m)	Temp. (ºC)	DO (mg/L)	pH (su)	Cond. (µmhos)	Salinity (ppt)	%Sat. (%)	Tide (cycle)	BOD5 (mg/L) Chem Lab	BOD5 (mg/L) ISU	BOD30 (mg/L) ISU	TSS (mg/L)	TOC (mg/L)	DOC (mg/L)	Chlorophyll (µg/L)	NH3 (mg/L)	TKN (mg/L)	NO2+NO3 (mg/L)	Tot. P (mg/L)	PO4 (mg/L)
Mk# 12	Cape Fear R.	Post Hurricane Charley																					
	near Mk# 41	040818	1300	0.1	26.7	5.3	6.6	5430	2.93	67	Falling Tide						15.0†		0.03 J6	0.68 J6	0.31 J6	0.10	0.05
	34.07633			3.3	25.8	4.7	6.8	8100	4.54	60	from High												
	77.93111			6.7	26.4	4.4	7.0	20500	12.27	65													
		040825	1140	0.1	26.0	4.1	6.3	3800	2.00	51	Falling Tide								-	-	-	-	-
				2.8	25.9	3.8	6.4	5270	2.90	47	to Low												
				5.7	25.8	3.8	6.4	5420	2.93	47													
		040922	1045	0.1	22.5	5.4	6.5	9960	5.60	67	Falling Tide								-	-	-	-	-
				3.0	22.4	5.3	6.7	11760	6.80	65													
				6.0	23.3	5.1	6.7	18800	11.10	64													
		041020	1050	0.2	21.9	5.8	7.1	17700	10.50	73	Low Tide								-	-	-	-	-
				3.1	21.9	5.8	7.2	21100	12.60	72	coming in												
				5.9	21.9	5.7	7.2	22400	13.40	72													
			max	6.9	28.8	8.3	8.0	36900	23.40	108						8.4	15.0		0.13	0.76	0.41	0.12	0.05
			mean	3.1	25.4	5.9	7.3	19988	12.07	78						8.4	12.2		0.06	0.62	0.32	0.10	0.03
			median	3.1	26.2	5.8	7.4	21850	13.00	79						8.4	12.2		0.06	0.59	0.31	0.10	0.03
			min	0.1	17.5	3.8	6.3	3800	2.00	47						8.4	9.4		0.02	0.53	0.23	0.07	0.02

* Chem. Lab not analyzing PO4 due to instrument training
** glass fiber filter used - 0.7µm

Data Qualifier Codes - NC DENR/DWQ Chemistry Lab.
U - non-detect; value is equal to the laboratory's reporting limit
Q2 - 48 hr.holding time exceeded following receipt by lab by 1 hr. 11 minutes
J6 - improperly chemically preserved sample - preserved at lab
† - Possible contamination, for information only