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Richard D. Stockwell
Eastern Kentucky University

Walter S. Borowski
Eastern Kentucky University

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Seasonal Changes in a Eutrophic Lake (Wilgreen Lake, Madison County, Kentucky) from Summer Stratification through Fall Turnover

Richard Drew Stockwell

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Professor: Dr. Walter S. Borowski

Richard Drew Stockwell

Eastern Kentucky University

Introduction:

Eutrophic is defined as rivers and lakes rich in organisms and organic material (eu = truly; trophic =nutrious)(Cunningham, Cunningham, & Saigo 2007). Eutrophication is an increase in nutrient levels and biological productivity. Some amount of eutrophication is a normal part of successional changes in most lakes. Tributary streams bring in sediments and nutrients that stimulate plant growth. Over time, ponds or lakes may fill in , eventually becoming marshes. The rate of eutrophication and succession depends on water chemistry and depth, volume and inflow, mineral content of the surrounding watershed, and the biota of the lake itself (Cunningham, Cunningham, & Saigo 2007).

Increased productivity in an aquatic system can be beneficial. Fish and other desirable species may grow faster, providing a welcome food source. Often, however, eutrophication has undesirable results. Elevated phosphorous and nitrogen levels stimulate "blooms" of algae or thick growth of aquatic plants. Bacterial populations also increase, fed by larger amounts of organic matter. The water often becomes cloudy or turbid and has unpleasant tastes and odors (Cunningham, Cunningham, & Saigo 2007). Such odors are often caused by the release of hydrogen sulfide gas, a byproduct of anaerobic respiration & decomposition. During the processes of oxidative phosphorylation and the electron transport chain, glucose and sulfur are converted by organisms in anaerobic conditions, to carbon dioxide, hydrogen sulfide gas, and ATP. (C.C.S 2007) In extreme cases, plants and algae die and decomposers deplete oxygen in the water. Total collapse of the aquatic ecosystem can result. Beyond aesthetics and water quality, eutrophic lakes often have a greatly lessened recreational value (Cunningham, Cunningham, Saigo 2007).

Lake Wilgreen in Madison County Kentucky is a man made reservoir. Lake Wilgreen, a 169-acre moderately sized body of water, was dammed in 1966. (Jolly 2007). Wilgreen drains a watershed with residential developments, modified woodlands, cattle pasture, and some industrial/urban usage in the city of Richmond (Borowski & Aguiar 2008). Wilgreen has been deemed as nutrient impaired, in this case fully eutrophic, by the EPA. Wilgreen appears on the EPA's 303(d) list of lakes exceeding their Total Maximum Daily Load of nutrients (TMDL), along with 38 other bodies of water in the state of Kentucky. Wilgreen displays many common characteristics of eutrophic water bodies. Aesthetics such as water appearance and odor are less than desirable and algal blooms and thick vegetation are common along the shorelines. Past studies have shown that Wilgreen goes anoxic under 4 meters, yet fish thrive under these high nutrient conditions in the surface section of the lake (Borowski, Aguiar, Jolly, Hunter 2006-2007-2008).

In this study, goals include providing cap-stone data for the previous 3 years work, as well as more precisely, following the seasonal changes in a eutrophic lake (Wilgreen lake, Madison County, Kentucky) from summer stratification through fall overturn. Such a study will reveal information about nutrient stratification as well as information about oxygen availability in not only lake Wilgreen but perhaps similar eutrophic lakes as well.

Stratification and concentration of Phosphate, Ammonium, and Nitrate will be determined over 4 months of sampling, August 2008 through October of 2008. As well as taking water samples for lab analysis from 1 meter intervals throughout multiple sampling stations strategically located along the entire length of lake Wilgreen as well as its tributaries, integral biological parameters such as dissolved oxygen, temperature, conductivity and pH will also be determined at 1 meter intervals using an YSI multi-probe (Borowski, Hunter 2008). Such analysis should reveal key stratification characteristics and will likely follow a predictable summer stratification pattern turning towards a more homogeneous mixture as the surface waters turn colder and thus become more-dense than the warmer water below. This phenomenon causes the lake to de-stratify, and display more uniform mixed characteristics (Borowski, Hunter, Jolly, 2007-2008).

Methods:

Lake Wilgreen is easily accessible via the lake Marina. A ten foot long, gas powered, aluminum john boat was used to access 19 sampling stations located along not only Taylor Fork, Old Towne Branch, and Pond Cove, but at all of the lakes water input locations. Sampling was done once a month for four months, August through October, of 2008. At each station, an YSI multi-probe was used to take samples at 1 meter depth intervals, from surface to bottom, as allowed by the characteristics of each station. The YSI multi probe measures integral parameters such as temperature, conductivity, pH and the most important biological factor, dissolved oxygen. Oxygen is the most fundamental parameter of lakes, aside from water itself. DO is obviously essential to the metabolism of all aquatic organisms that process aerobic respertory biochemistry. Hence, the properties of solubility, and especially the dynamics of oxygen distribution in lakes, are basic to the understanding of the distribution, behavior, and physiological growth of aquatic organisms (C.C.S, 2007).

Water samples were also taken at 1 meter depth intervals as previously stated for the multi-probe readings. A traditional Van Horn sampler was used to access pure samples at given depths. These water samples where later analyzed in the laboratory for eutrophication causing nutrients such as Phosphate, Ammonium and Nitrate. Ammonium was determined using the phenol-hypochlorite, colormetric method (Solorzano, 1969) as modified by Gieskes et al. (1991). We used cadmium reduction, another colormetric method, to measure nitrate, using Hach NitraVer 5 reagent packets as outlined by Eaton et al. (2005). Phosphate was measured using the ammonium molybdate, colormetric method (Strickland and Parsons, 1968) as modified by Gieskes et al. (1991). Such data will allow for the creation of Stratification graphs of the previously mentioned parameters, likely revealing important data about the locations of clines, and locations of over abundant nutrients and hopefully their origins. Integration of multiple years' worth of data should provide a clearer picture of what is causing Wilgreens impairment.

Results:

In August, the surface temperature near Wilgreen's dam at station TF-6 was 26.3˚C. Conductivity was measured there to be 417µS. Surface waters were saturated with oxygen (6.5ppm) and sustained a normal pH of about 7.5. Samples from depth intervals 0 to 4 meters were homogenous. Below the thermocline (5m), temperature drops off rapidly to 7.3˚C at the lake bottom (15.1m), as well as oxygen content which was determined to be disoxic below 4 meters. The other stations with depths greater than 4 meters showed similar characteristics. Shallower stations were also similar, but even more saturated with oxygen. (Table 1)

In September, the surface temperature at TF-6 was a bit cooler at 25.5˚C. Conductivity was also lower, 353µS. Surface oxygen content increased to 8.6ppm and the pH remained normal at 7.5. The thermo-cline and picnocline were determined to be between 5 and 6 meters. Below this depth, temperature and oxygen content drop of steadily until to the bottom (7.56˚C & .90ppm oxygen)Similar characteristics were seen throughout the lake, except for an increased pH of above 8 at all sites up lake of the dam. Also, as in August, shallower sites with more vegetation were usually super saturated with oxygen (up to 12.1ppm). (Table 2)

In October, the surface temperature at TF-6 was much lower than in the previous two months at 19.37˚C. Conductivity continued to decrease in October (293µS). Oxygen levels in the surface remained saturated (7ppm), and pH continued to hover in the 7+ realm. Probe data showed the thermo-cline and picno-cline distinctly at 7 meters. The bottom temperature was 7.8˚C, conductivity was 333µS, pH was 6.93, and DO levels were disoxic (.41ppm). (Table 3)

Beyond the probe data, water samples were analyzed for specific nutrients. In the laboratory, standard curves were performed before analysis, with R^2 values greater than .98. In August, surface phosphate concentration at TF-6 was .05ppm, and values increased towards the bottom (2.18ppm). In September and October, surface phosphate was determined to be 0ppm, and bottom readings were near 2ppm. Ammonium concentration in August at the surface was .23ppm, with an increasing trend, towards the bottom (2.44ppm). September and October ammonium values were very similar to the values from August. The last major nutrient we sampled for was Nitrate. August Nitrate concentrations at TF-6 were 0ppm at the surface trending up to nearly 2ppm at greater depth. In September and October, surface values were still 0ppm, but concentrations near 3ppm were determined from the deepest samples (~14M). (Table 4)

Discussion:

During the hot summer months, lakes with great enough depth, show distinct stratification. This stratification is caused by solar heating of surface waters with minimal surface mixing. The result is a lake that shows an upper layer with warmer temperatures that is mostly homogenous. As you look deeper into the lakes cross-section, a distinct thermo-cline can be seen, below which, temperatures steadily decrease. Temperature seems to have the greatest impact of all of the lakes parameters. This is because temperature ultimately impacts most if not all of the lake chemical and biological processes. Other readings vary mostly because of differences in temperature. The data showed that DO in general was lower in the summer, likely due to increased microbial activity in the warmest months. (USGS 2004)

One thing that really stuck out was the fact that this lake which is historically anoxic at depth, was determined to be merely disoxic. Spring weather patterns likely played a major role in this surprising discovery. Cold, heavy rainfall in the spring likely helped to mix surface waters, but terrestrial sheet run-off likely followed the contours of the lake bottom inserting itself into the deeper portion of the lake, with its insertion location being based on water density (temperature). This odd event likely was the factor that influenced the lakes more oxygenated characteristics. (USGS 2004)

Stratification of the lake and density explain why deeper sites had higher nutrient concentration than shallower ones in general. Also, Input sites showed heightened concentrations; possibly do to the ultimate source of such nutrients. This greater abundance of dissolved ions in the deeper portions of the lake is the reason why conductivity readings were higher at depth as well. Heightened nutrient loads cause an influx in plant growth. Increase photosynthesis during the summer months only oxygenates the surface portion of the lake. As these chemoautotroph's die, their bodies are decomposed by microbes; this activity literally sucks the oxygen right out of the lake. This is the process known as eutrophication. Which is common in lakes, but not to the severity that is seen in Wilgreen (nutrient impaired EPA). (USGS 2004)

As the August rolled into September, atmospheric conditions remained steady, if the temperature stays the same, and the precipitation stays the same, water parameters will also remain steady. On the other hand as September turned to October, air temperatures during the day may still be the same, but night time temperatures are drastically cooler and winds are increasing which in turn, begins the density dance known as fall overturn. These breezy days begin to physically mix the surface portion of the lake, followed by cooler air temperatures which begin to cool the surface of the water. This trend continues in the upper portion throughout October. (USGS 2004)

This process actually stretches out the warmer region above the thermo cline to about 7m. The data shows that at the end of October, turnover had not yet occurred, but the lakes characteristics indicated that overturn was near. In November, continued cooling and surface mixing, will eventually cause a density deficit in the bottom portion of the lake. Cooler, more dense surface water rushes towards the bottom, displacing the deep water, forcing this warmer, less dense water to the surface, thus turning over. It is during this time where the entire lake would be more or less homogenous until the thermal heating of the spring and summer sun will once again stratify Lake Wilgreen. (USGS 2004)

APPENDICES

Appendix A

Location of Sampling Stations

			LATITUDE				LONGITUDE		
Tributary	Station	Degrees	Minutes	Seconds		Degrees	Minutes	Seconds	
Taylor Fork	TF in	37	43	13.0	N	84	19	34.3	W
	M1	37	43	7.4	N	84	19	35.8	W
	TF-1	37	43	11.1	N	84	19	51.8	W
	M2	37	43	5.7	N	84	19	54.1	W
	TF-1d	37	43	5.8	N	84	20	5.6	W
	M3	37	43	8.0	N	84	20	6.4	W
	TF-2	37	42	57.9	N	84	20	12.6	W
	TF-2d	37	42	53.7	N	84	20	20.8	W
	TF-3	37	42	50.6	N	84	20	39.7	W
	TF-4	37	42	38.0	N	84	20	50.5	W
	TF-4d	37	42	31.3	N	84	21	1.1	W
	TF-5	37	42	19.0	N	84	21	9.1	W
	TF-5d	37	42	17.6	N	84	21	17.7	W
	TF-6	37	42	10.1	N	84	21	23.8	W
Old Town Branch	OTB in	37	42	10.4	N	84	19	55.3	W
	M4	37	42	11.0	N	84	20	1.7	W
	OTB-1u	37	42	20.2	N	84	20	7.6	W
	OTB-1	37	42	29.1	N	84	20	10.0	W
	OTB-1d	37	42	37.8	N	84	20	17.7	W
	OTB-2	37	42	44.8		84	20	26.3	W
Pond Cove	PD-in								
	M5	37	42	22.5	N	84	20	41.3	W
	PD-iu	37	42	25.7	N	84	20	45.9	W
	PD-1	37	42	31.8	N	84	20	52.7	W

Appendix B

Probe Data

August 2008	Station M1	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
	12-Aug-08	0	22.36	0.602	10.04	8.18
		0.75	18.52	0.851	8.74	7.97

TF-1	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
12-Aug-08	0	22.72	0.624	10.55	8.35
	0.75	21.41	0.656	9.61	8.21

M2	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
12-Aug-08	0	23.94	0.577	10.2	8.3
	0.75	22.52	0.614	9.23	8.22

TF-1d	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
12-Aug-08	0	24.24	0.521	10.13	8.11
	0.75	23.92	0.521	9.58	8.07

M3	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
12-Aug-08	0	26.09	0.444	8.88	8.15

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
	0	26.21	0.418	7.93	8.12
TF-2	1	26.09	0.419	7.24	8.05
	2	25.83	0.419	6.44	7.99
	3	25.2	0.423	5.22	7.81

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
	0	26.23	0.419	7.02	8.01
TF-2d	1	26.17	0.418	6.58	7.98
	2	25.95	0.417	5.96	7.91
12-Aug-08	3	25.83	0.42	5.05	7.83
	4	25.5	0.422	4.57	7.74

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-3	0	26.17	0.415	7.03	8.08
	1	26.13	0.415	7.00	8.06
12-Aug-08	2	25.98	0.413	7.17	8.08
	3	25.93	0.414	6.46	8.02
	4	25.71	0.419	5.00	7.86
	5	23.78	0.458	0.60	7.42
	6	19.13	0.489	0.47	7.39
	6.75	18.37	0.504	0.46	7.39

	(meters)	(oC)	(mS/cm2)	(mL/L)	
TF-4	0	26.03	0.410	7.46	8.14
	1	26.02	0.411	6.93	8.12
12-Aug-08	2	25.99	0.411	6.97	8.1
	3	25.97	0.411	6.74	8.09
	4	25.95	0.411	7.12	8.09
	5	23.26	0.454	0.63	7.48
	6	18.94	0.480	0.52	7.36
	7	15.35	0.531	0.47	7.32
	7.75	13.41	0.550	0.49	7.48

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-5	0	26.33	0.408	6.90	8.14
	1	26.36	0.408	6.90	8.13
12-Aug-08	2	26.35	0.408	6.59	8.11
	3	26.31	0.409	6.44	8.09
	4	25.85	0.414	3.67	7.81
	5	23.59	0.444	0.83	7.52
	6	19.20	0.464	0.71	7.41
	7	15.18	0.499	0.66	7.39
	8	12.14	0.547	0.60	7.43
	9	10.13	0.578	0.56	7.55

	10	8.94	0.597	0.58	7.58
	11	8.09	0.620	1.40	7.52
	12	7.77	0.627	1.22	7.48
	13	7.56	0.633	1.23	7.49
	13.75	7.47	0.641	1.3	7.47

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-6	0	26.31	0.407	6.5	7.52
	1	26.33	0.407	6.32	7.95
12-Aug-08	2	26.33	0.407	6.4	8.01
	3	26.31	0.407	6.20	8.02
	4	25.90	0.413	3.69	7.73
	5	23.59	0.436	0.74	7.39
	6	18.70	0.463	0.70	7.27
	7	15.50	0.488	0.71	7.26
	8	11.87	0.545	0.97	7.26
	9	10.02	0.571	1.11	7.33
	10	8.71	0.582	1.13	7.36
	11	8.08	0.591	1.16	7.37
	12	7.72	0.613	1.21	7.31
	13	7.52	0.626	1.72	7.35
	14	7.39	0.637	1.62	7.31
	15	7.36	0.641	1.59	7.24
	15.1	7.36	0.668	1.74	7.07

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
M5	0.0	26.34	0.706	7.02	8.06
12-Aug-08					

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
M4	0.0	22.5	0.496	9.2	7.99
	1.0	20.87	0.505	3.81	3.81
12-Aug-08					

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-1u	0.0	23.99	0.486	10.90	8.14
	0.8	21.83	0.492	6.80	7.90

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-1	0.0	26.6	0.416	8.9	8.25
	1.0	25.98	0.417	6.78	8.04
12-Aug-08	1.4	25.6	0.421	6.63	7.94

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-1d	0.0	26.53	0.699	8.31	8.22
	0.5				
12-Aug-08	1.0	26.09	0.704	6.86	8.08
	1.5				
	2.0	24.36	0.706	4.50	7.79
	2.5				
	3.0	22.35	0.71	1.82	7.62
	4	18.48	0.733	0.17	7.52
	4.75	17.06	0.738	0.12	7.47

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-2	0.0	27.06	0.415	9.50	8.39
	1.0	26.70	0.415	8.97	8.31
12-Aug-08	2.0	25.94	0.416	6.15	8.04
	3.0	25.83	0.417	5.15	7.95
	4.0	25.52	0.426	2.25	7.70
	5.0	23.50	0.466	0.23	7.42
	5.8	20.35	0.509	0.17	7.26

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
PD-1	0.0	27.38	0.407	9.77	8.54
	1.0	26.85	0.408	9.35	8.48
12-Aug-08	2.0	26.46	0.407	8.94	8.45
	3.0	26.23	0.408	8.15	8.38
	4.0	26.04	0.408	7.90	8.30
	5.0	24.41	0.423	4.15	7.86
	6.0	19.13	0.479	0.51	7.53
	7.0	15.48	0.511	0.21	7.52
	7.8	13.12	0.553	0.18	7.53

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH

12-Aug-08	0.0	27.34	0.405	10.6	8.67
	1.0	26.8	0.406	10.01	8.6
	1.4	26.58	0.407	9.48	8.51

M5	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
M5	0.0	27.57	.405.	11.24	8.7
12-Aug-08					

Sept 2008

Station M1	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
13-Sep-08	0	21.94	0.888	6.5	8.09
	0.75				

TF-1	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
13-Sep-08	0	23.53	0.733	8.19	8.24
	0.5	23	0.757	7.12	8.13

M2	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
13-Sep-08	0	24.75	0.659	8	8.24
	0.5	24.38	0.679	7.27	7.98

TF-1d	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
13-Sep-08	0	25.6	0.493	8.8	8.38
	0.5	25.44	0.516	8.5	8.31

M3	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
13-Sep-08					

no data - water too shallow to access

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
	0	26.06	0.356	8.57	8.72
TF-2	1	26.05	0.356	8.45	8.73
	2	26	0.357	8.4	8.69
13-Sep-08	3	25.72	0.370	7.42	8.26

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-3	0	26.03	0.353	9.70	8.82
	1	26.04	0.353	9.30	8.84
13-Sep-08	2	25.96	0.354	9.00	8.80
	3	25.15	0.359	4.94	8.23
	4	24.83	0.59	2.21	7.75
	5	24.35	0.365	0.25	7.60
	6	22.17	0.401	0.17	7.32
	7	16.32	0.479	0.21	7.22
	7.4	14.94	0.508	0.38	7.24

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-4	0	25.97	0.352	9.29	8.88
	1	25.90	0.353	8.45	8.83
13-Sep-08	2	25.75	0.352	8.70	8.79
	3	25.21	0.358	5.32	8.27
	4	24.84	0.361	2.58	8.01
	5	24.22	0.367	0.65	7.85
	6	21.74	0.405	0.34	7.45
	7	16.14	0.459	0.29	7.31
	7.4	15.22	0.488	0.24	7.23

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-5	0	25.65	0.351	9.10	8.73
	1	25.68	0.351	8.85	8.79
13-Sep-08	2	25.67	0.351	8.80	8.76
	3	25.35	0.355	6.74	8.62
	4	24.98	0.360	2.58	8.00
	5	24.41	0.367	0.43	7.69
	6	20.11	0.412	0.29	7.31
	7	16.74	0.433	0.23	7.21
	8	13.06	0.489	0.31	7.27
	9	10.32	0.510	0.34	7.35
	10	10.22	0.513	0.49	7.40
	11	8.56	0.548	0.56	7.37
	12	8.03	0.560	0.00	7.35

	13	7.74	0.568	0.00	7.36

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-6	0	25.52	0.35	8.6	7.51
	1	25.53	0.35	8.82	8.36
13-Sep-08	2	25.53	0.35	8.99	8.49
	3	25.51	0.35	8.79	8.5
	4	24.98	0.359	4.35	7.99
	5	24.46	0.365	1.80	7.73
	6	20.43	0.406	0.60	7.25
	7	16.76	0.43	0.44	7.1
	8	13.45	0.472	0.37	6.99
	9	10.30	0.504	0.32	7.05
	10	9.00	0.513	0.32	7.23
	11	8.27	0.529	0.35	7.2
	12	7.85	0.549	0.40	7.18
	13	7.68	0.56	0.67	7.12
	14	7.59	0.569	0	7.16
	14.67	7.56	0.572	0	7.17

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
M5	0.0	28.08	0.35	12.1	9.14
13-Sep-08					

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-1d	0.0	26.13	0.356	7.01	8.46
	0.5				
13-Sep-08	1.0	25.35	0.358	4.90	8.15
	1.5	25.25	0.359	3.25	7.66

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-2	0.0	26.75	0.351	10.14	8.99
	1.0	26.62	0.351	9.91	8.97
13-Sep-08	2.0	25.78	0.354	8.55	8.70
	3.0	25.13	0.357	5.40	8.28
	4.0	24.84	0.359	3.25	8.04

	Depth	Temperature	Conductivity	[Oxygen]	pH
	5.0	24.59	0.361	0.76	7.76
	6.0	24.13	0.368	0.29	7.64

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
PD-1	0.0	26.95	0.350	10.06	9.09
	1.0	26.21	0.35	9.67	9.05
13-Sep-08	2.0	26.06	0.349	9.73	9.03
	3.0	25.69	0.349	8.70	8.98
	4.0	24.81	0.359	3.20	8.23
	5.0	23.30	0.379	1.30	7.79
	6.0	20.90	0.409	1.00	7.64
	7.0	16.93	0.448	0.36	7.42

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
PD-1u	0.0	27.38	0.35	9.95	9.05
	1.0	26.25	0.349	9.87	9.06
13-Sep-08	2.0	25.99	0.349	10.07	9.05
	3.0	25.89	0.35	9.75	8.97
	3.8	25.88	0.354	7.85	8.97

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
M5	0.0	28.08	0.35	12.1	9.14
13-Sep-08					

Oct 2008

Station	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
NEAR TF-1d	0	15.68	0.648	9.98	7.75
18-Oct-08					

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
	0	19.1	0.353	6.25	7.64
TF-2	1	18.84	0.352	5.9	7.60
	2	18.55	0.352	5.45	7.57
18-Oct-08	2.5	18.19	0.354	5.32	7.54

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-3	0	19.34	0.351	3.92	7.58

	1	19.26	0.349	3.88	7.55
18-Oct-08	2	19.23	0.348	3.92	7.53
	3	19.20	0.347	3.98	7.53
	4	19.17	0.348	3.93	7.53
	5	19.10	0.352	3.08	7.47
	6	19.01	0.353	3.00	7.45
	6.2	18.99	0.361	2.60	7.17

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-4	0	19.30	0.344	5.24	7.68
	1	19.31	0.344	4.85	7.64
18-Oct-08	2	19.30	0.344	4.61	7.62
	3	19.30	0.344	4.52	7.61
	4	19.29	0.344	4.24	7.6
	5	19.28	0.345	4.29	7.56
	6	19.20	0.348	3.73	7.51
	7	18.53	0.366	1.20	7.3

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-5	0	19.32	0.339	6.32	7.77
	1	19.40	0.339	6.00	7.76
18-Oct-08	2	19.39	0.339	5.98	7.75
	3	19.40	0.339	5.96	7.74
	4	19.39	0.339	5.83	7.74
	5	19.39	0.340	5.99	7.73
	6	19.39	0.340	5.88	7.74
	7	18.11	0.367	4.54	7.29
	8	10.66	0.451	0.78	7.13
	9	9.90	0.471	0.69	7.00
	10	9.21	0.402	0.45	7.10
	11	8.56	0.410	0.33	7.05
	11.85	8.20	0.417	0.31	7.05

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
TF-6	0	19.37	0.328	7	7.04
	1	19.40	0.327	6.78	7.24
18-Oct-08	2	19.40	0.327	6.72	7.35
	3	19.40	0.328	6.76	7.43
	4	19.39	0.328	6.61	0.748
	5	19.39	0.329	6.40	7.52
	6	19.36	0.33	6.37	7.53
	7	18.51	0.344	3.03	7.19
	8	13.04	0.416	0.70	7.02
	9	10.68	0.428	0.49	7.03

	10	9.69	0.436	0.39	7.05
	11	8.57	0.453	0.36	7.01
	12	8.18	0.468	0.35	6.99
	13	7.92	0.485	0.35	6.92
	14	7.84	0.488	0.36	9.92
	14.5	7.80	0.496	0.41	6.93

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
M5	0.0	28.08	0.35	12.1	9.14
18-Oct-08					

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-1	0.0	19.66	0.348	10.04	8.50
	0.5	19.63	0.349	10.08	8.52
18-Oct-08					

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-1d	0.0	19.42	0.354	7.55	8.15
	1.0	19.43	0.353	7.35	8.13
18-Oct-08	2.0	19.26	0.352	6.97	8.07
	3.0	19.18	0.352	6.73	7.93

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
OTB-2	0.0	19.34	0.352	5.62	7.78
	1.0	19.31	0.351	5.25	7.74
18-Oct-08	2.0	19.22	0.35	5.27	7.71
	3.0	19.14	0.349	5.05	7.68
	4.0	19.03	0.349	5.20	7.68
	5.0	18.52	0.348	5.26	7.69
	5.2	18.54	0.348	5.11	7.59

	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
PD-1	0.0	19.86	0.353	7.13	7.95
	1.0	19.50	0.353	6.36	7.90
18-Oct-08	2.0	19.36	0.353	5.85	7.81
	3.0	19.32	0.352	5.65	7.79
	4.0	19.30	0.351	5.64	7.73
	5.0	19.29	0.351	5.66	7.70
	6.0	19.19	0.351	5.89	7.86

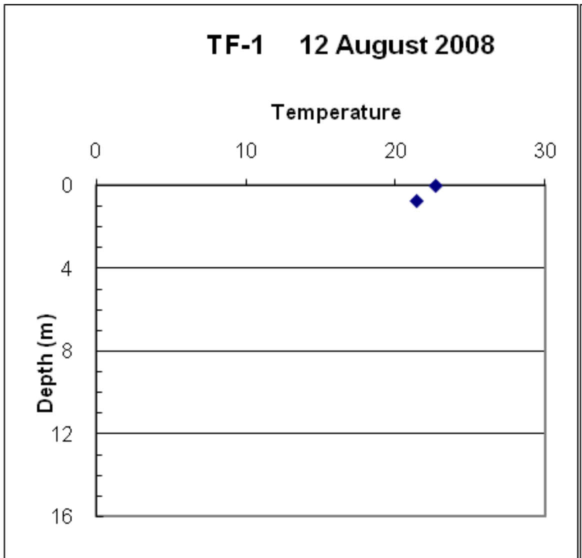
	7.0	18.33	0.365	5.70	7.55

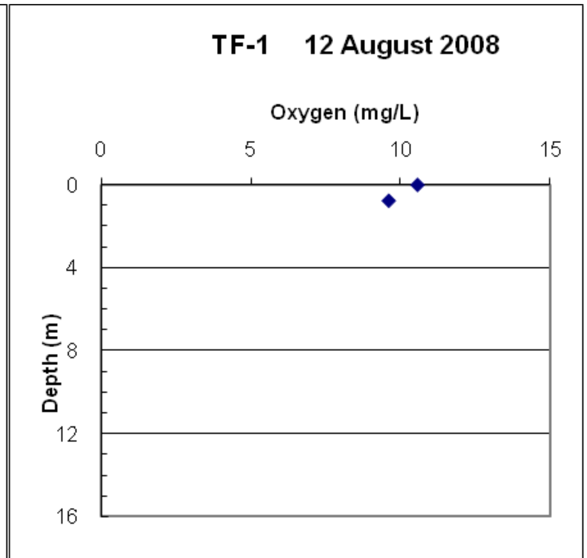
	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
PD-1u	0.0	19.79	0.309	8.1	8.2
	1.0	19.56	0.308	8.23	8.24
18-Oct-08	2.0	19.44	0.308	7.8	8.17
	3.0	19.36	0.307	7.94	8.18
	3.4	19.36	0.307	7.86	8.06

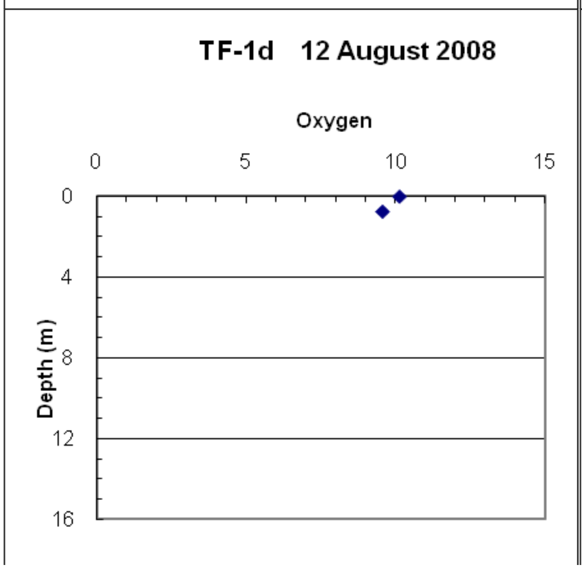
	Depth (meters)	Temperature (oC)	Conductivity (mS/cm2)	[Oxygen] (mL/L)	pH
NEAR M5	0.0	20.3	0.309	8.45	8.23
18-Oct-08					

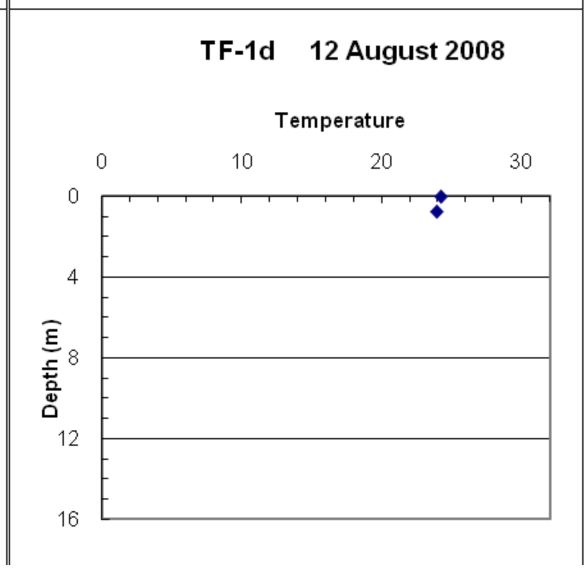
Appendix C:

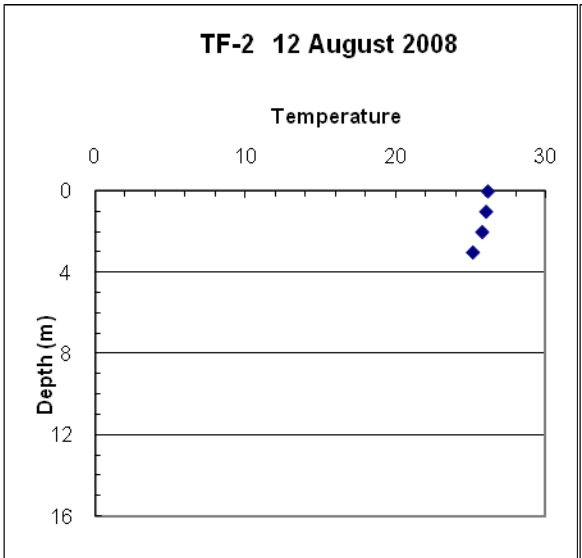
Probe Data Graphs

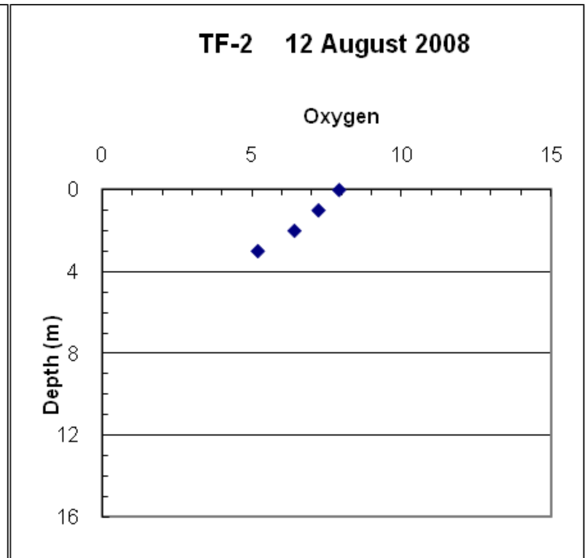


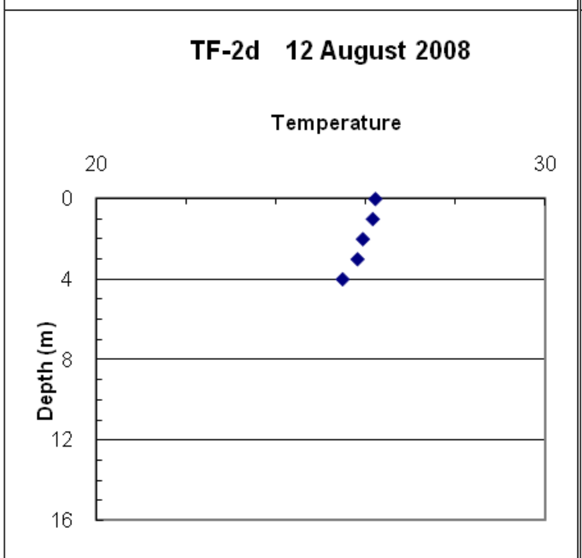


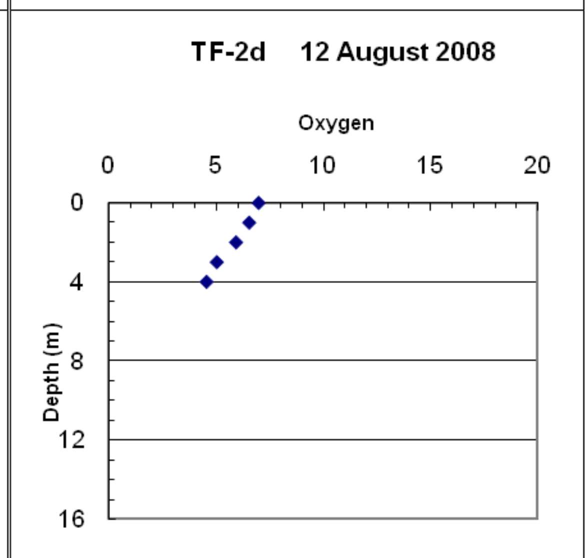


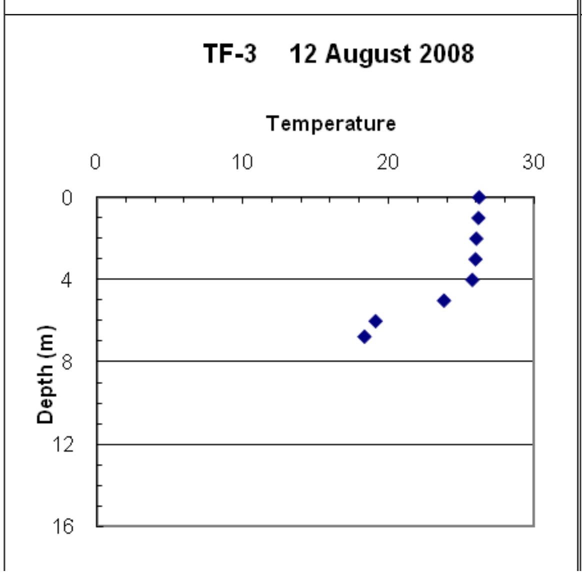


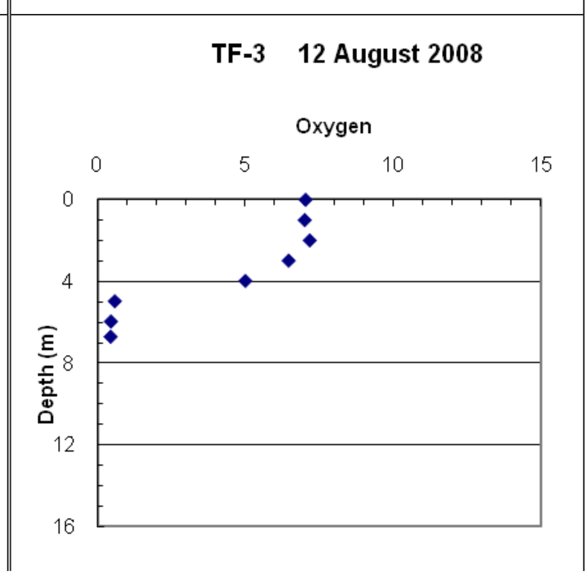

TF-2 12 August 2008
Temperature
0
10
20
30
Depth (m)
0
4
8
12
16

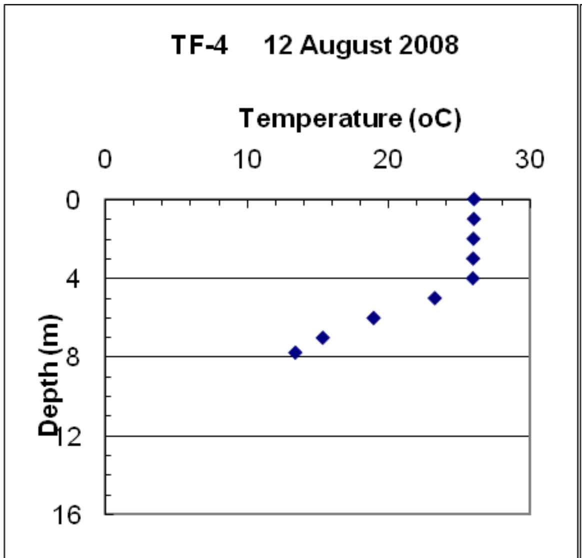

TF-2 12 August 2008
Oxygen
0
5
10
15
Depth (m)
0
4
8
12
16

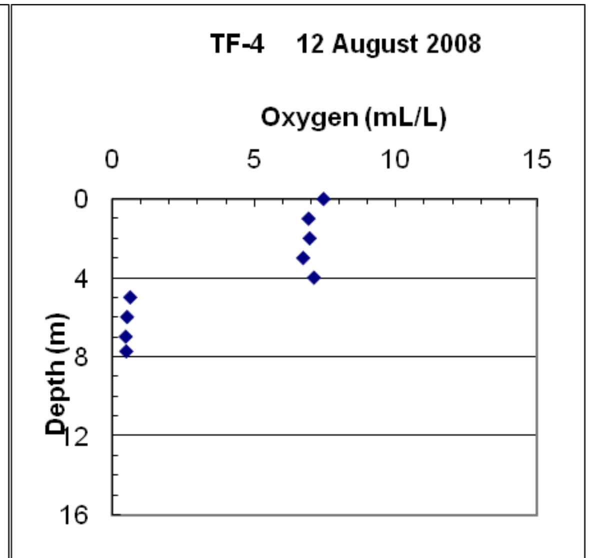

TF-2d 12 August 2008
Temperature
20
30
Depth (m)
0
4
8
12
16

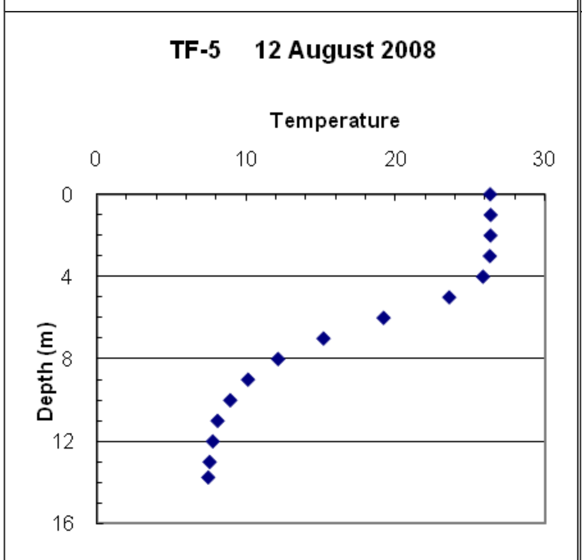

TF-2d 12 August 2008
Oxygen
0
5
10
15
20
Depth (m)
0
4
8
12
16

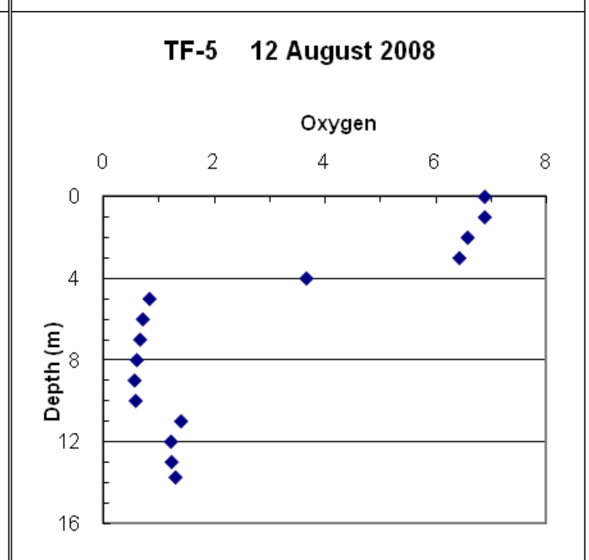

TF-3 12 August 2008
Temperature
0
10
20
30
Depth (m)
0
4
8
12
16

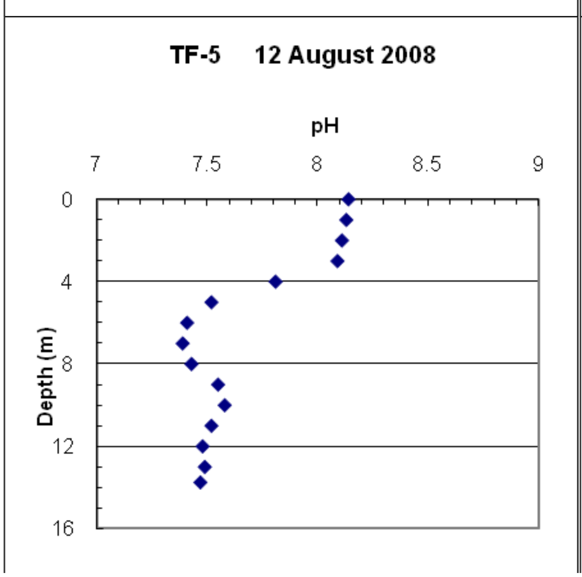

TF-3 12 August 2008
Oxygen
0
5
10
15
Depth (m)
0
4
8
12
16

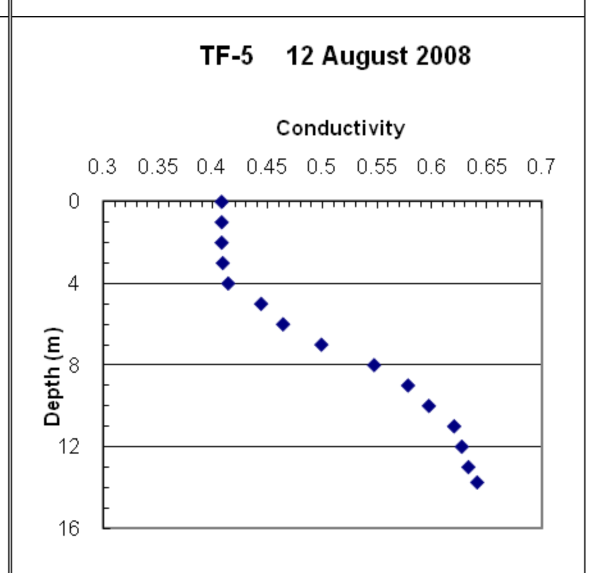

TF-4 12 August 2008
Temperature (oC)
0 10 20 30
Depth (m)
0 4 8 12 16

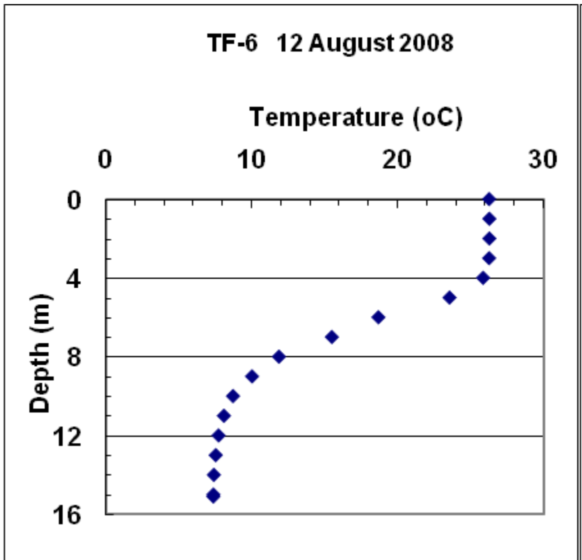

TF-4 12 August 2008
Oxygen (mL/L)
0 5 10 15
Depth (m)
0 4 8 12 16

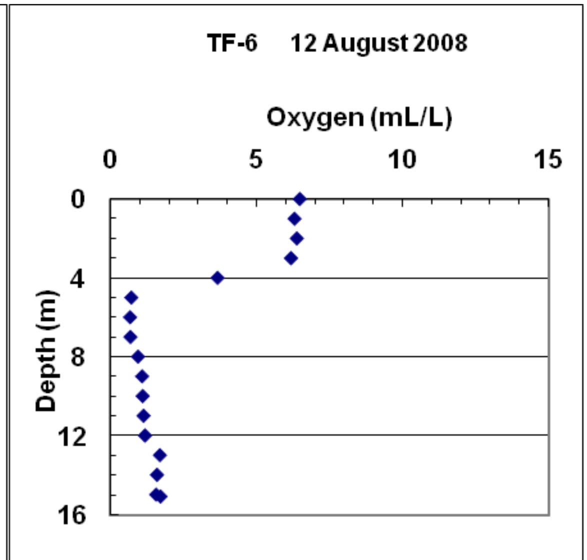

TF-5 12 August 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

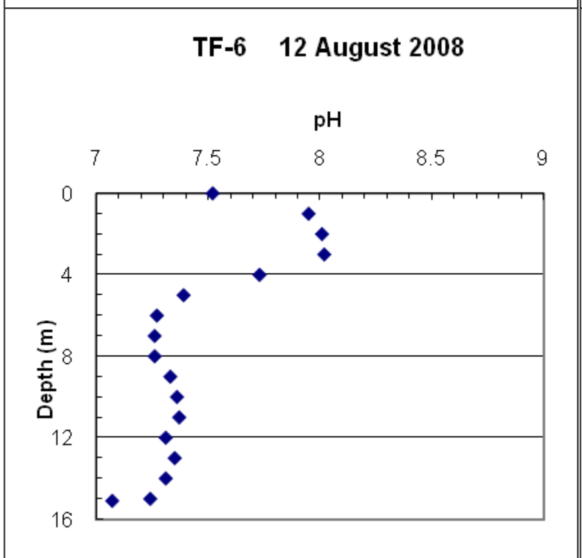

TF-5 12 August 2008
Oxygen
0 2 4 6 8
Depth (m)
0 4 8 12 16

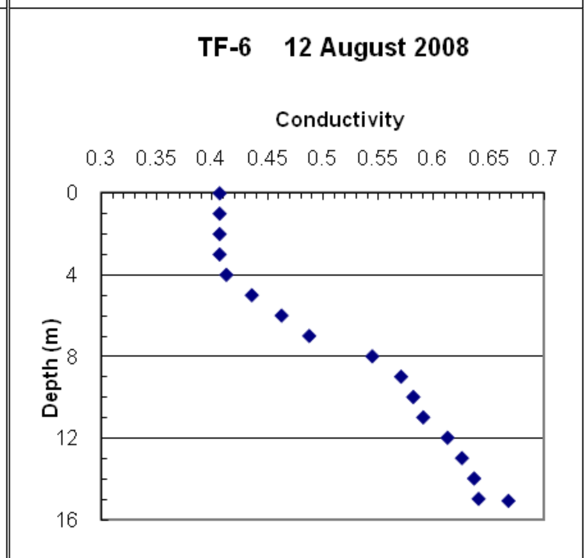

TF-5 12 August 2008
pH
7 7.5 8 8.5 9
Depth (m)
0 4 8 12 16

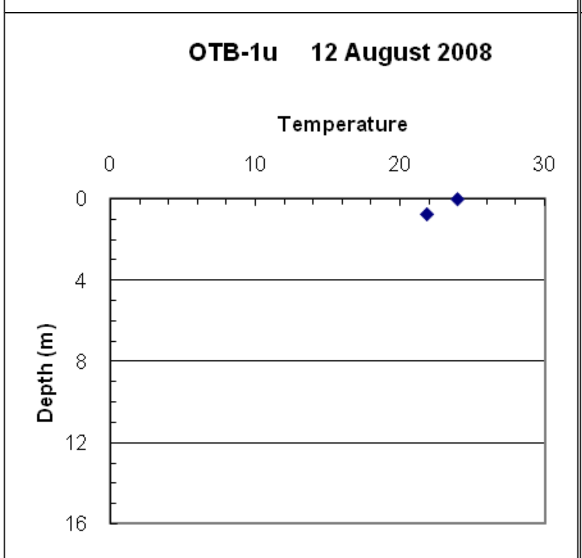

TF-5 12 August 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
Depth (m)
0 4 8 12 16

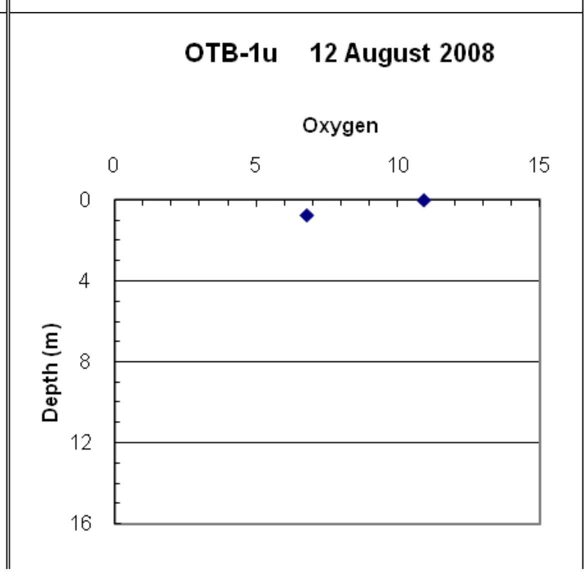

TF-6 12 August 2008
Temperature (oC)
0
10
20
30
Depth (m)
0
4
8
12
16

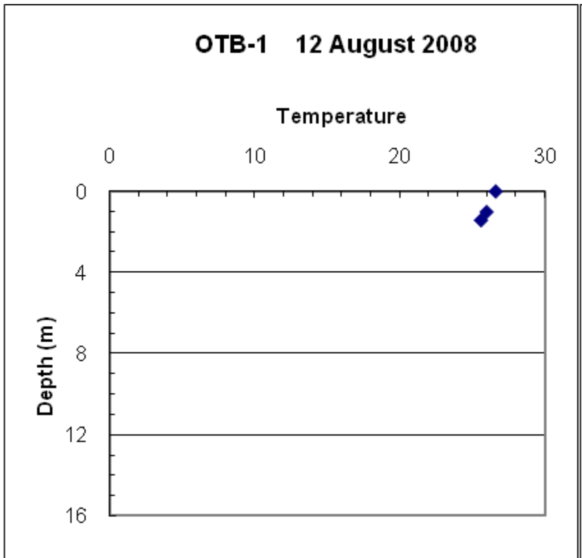

TF-6 12 August 2008
Oxygen (mL/L)
0
5
10
15
Depth (m)
0
4
8
12
16

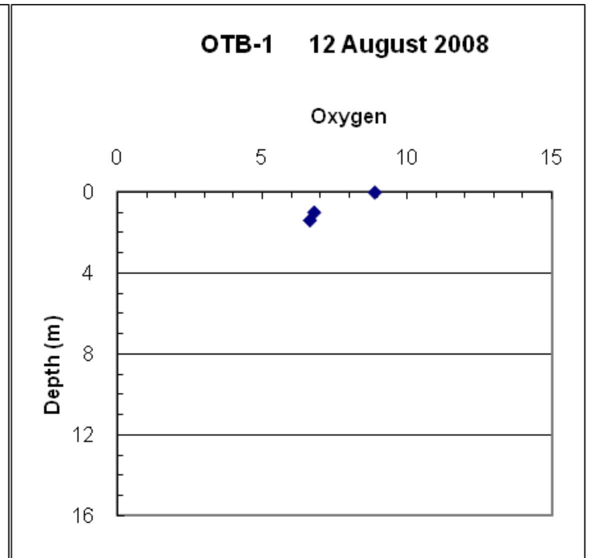

TF-6 12 August 2008
pH
7
7.5
8
8.5
9
Depth (m)
0
4
8
12
16

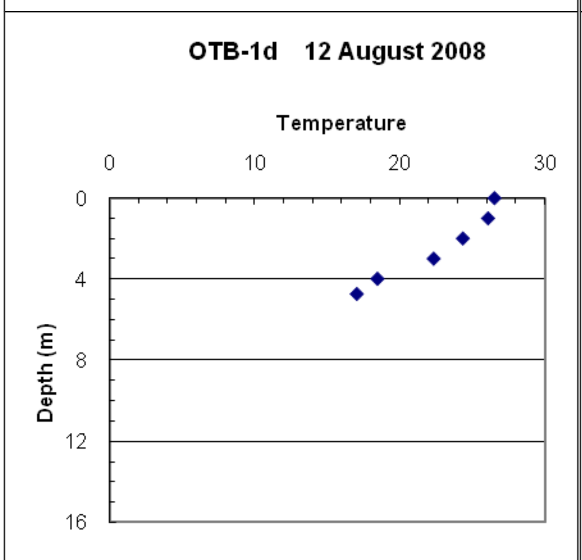

TF-6 12 August 2008
Conductivity
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
Depth (m)
0
4
8
12
16

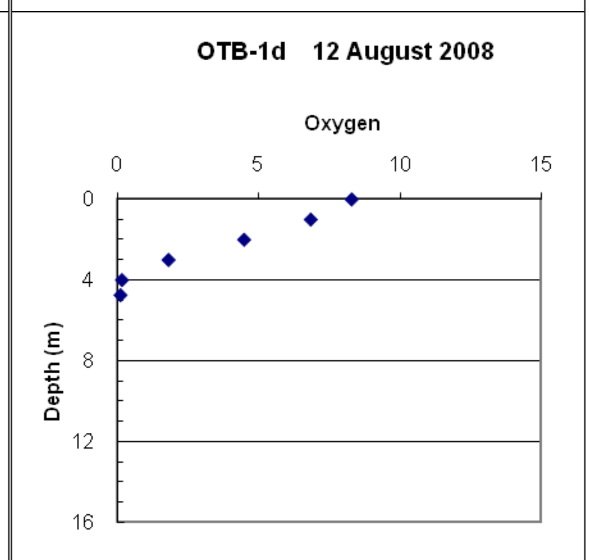

OTB-1u 12 August 2008
Temperature
0
10
20
30
Depth (m)
0
4
8
12
16

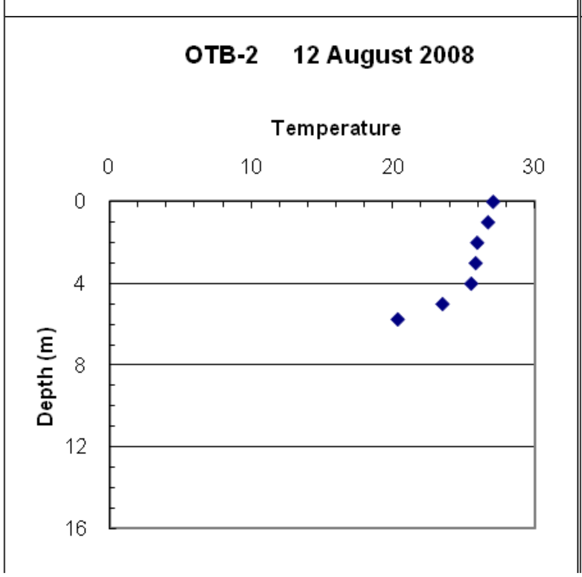

OTB-1u 12 August 2008
Oxygen
0
5
10
15
Depth (m)
0
4
8
12
16

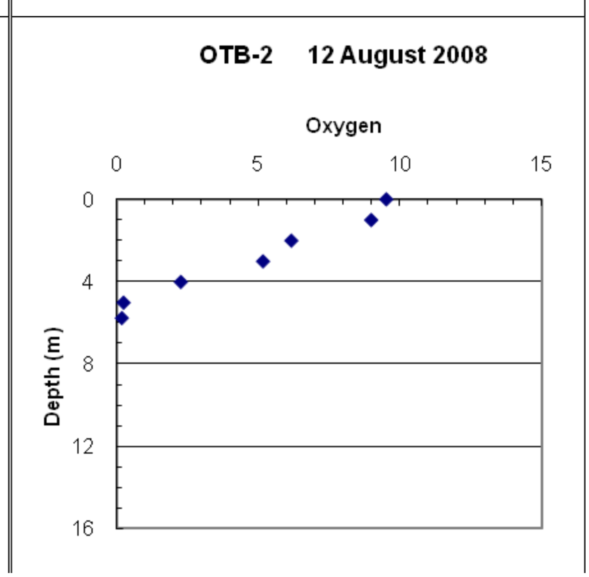

OTB-1 12 August 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

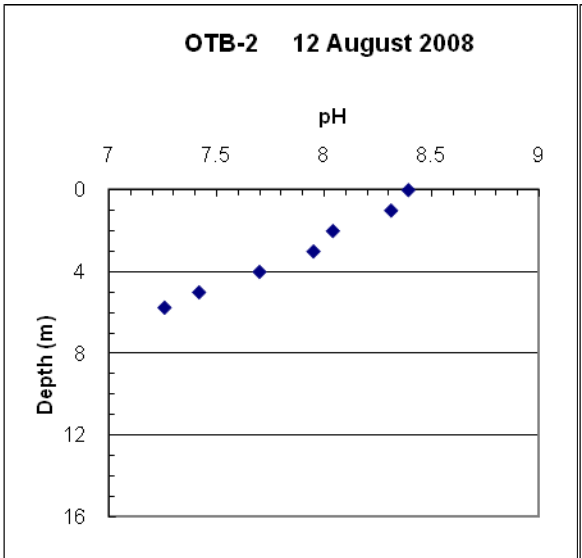

OTB-1 12 August 2008
Oxygen
0 5 10 15
Depth (m)
0 4 8 12 16

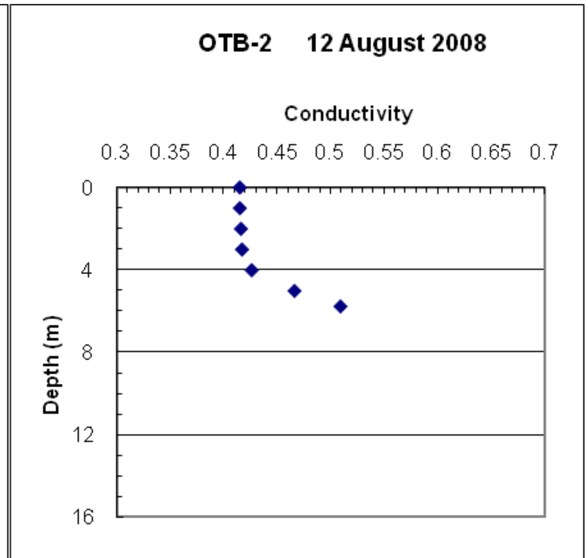

OTB-1d 12 August 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

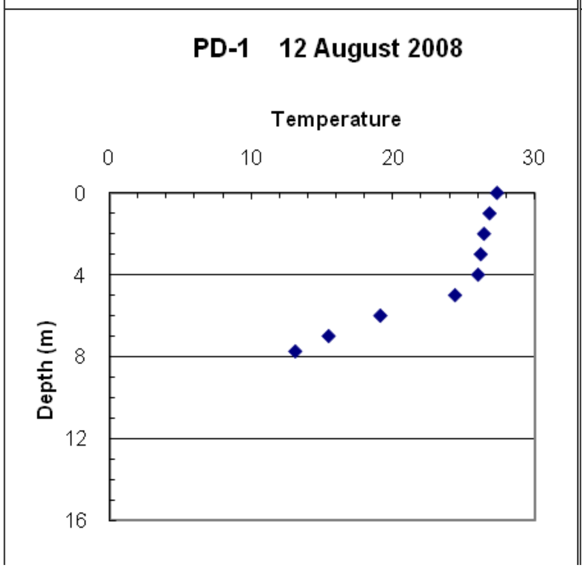

OTB-1d 12 August 2008
Oxygen
0 5 10 15
Depth (m)
0 4 8 12 16

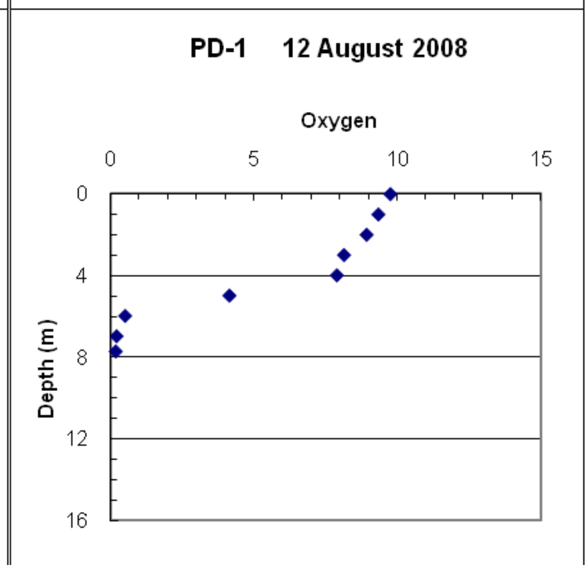

OTB-2 12 August 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

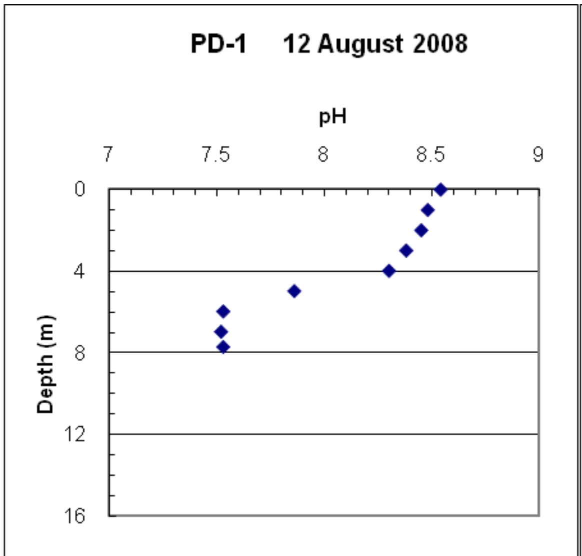

OTB-2 12 August 2008
Oxygen
0 5 10 15
Depth (m)
0 4 8 12 16

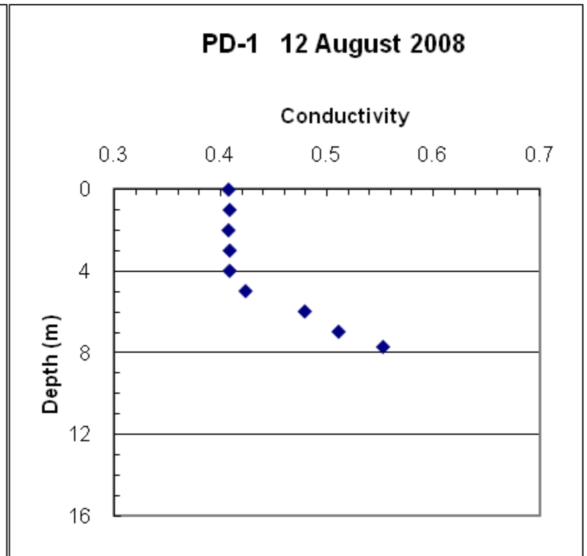

OTB-2 12 August 2008
pH
7 7.5 8 8.5 9
Depth (m)
0 4 8 12 16

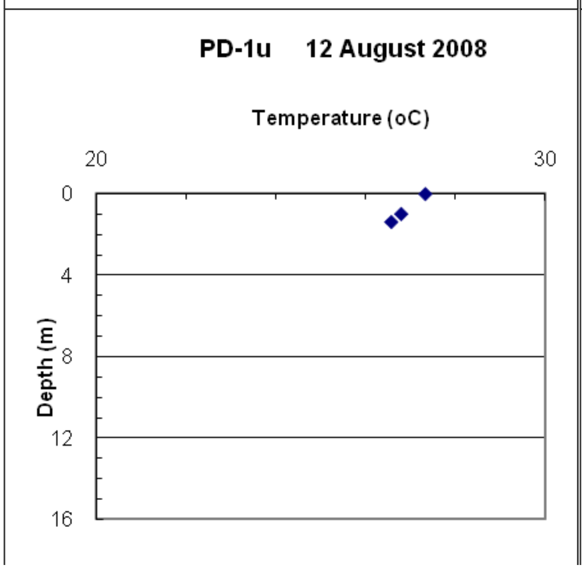

OTB-2 12 August 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
Depth (m)
0 4 8 12 16

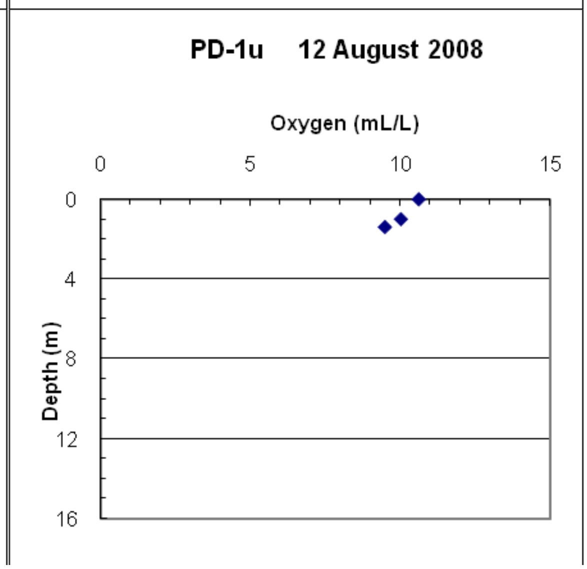

PD-1 12 August 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

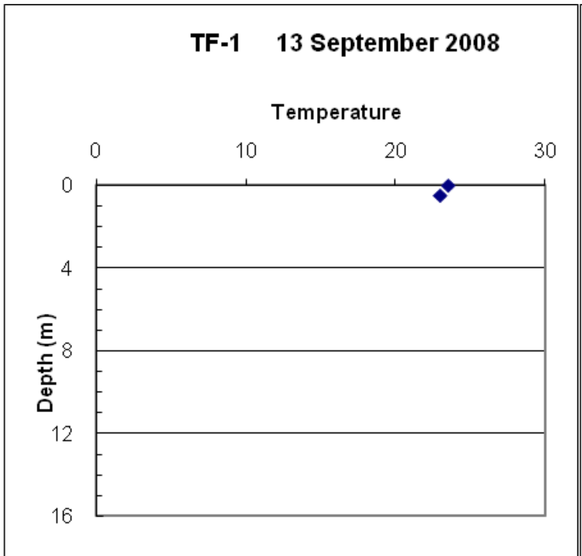

PD-1 12 August 2008
Oxygen
0 5 10 15
Depth (m)
0 4 8 12 16

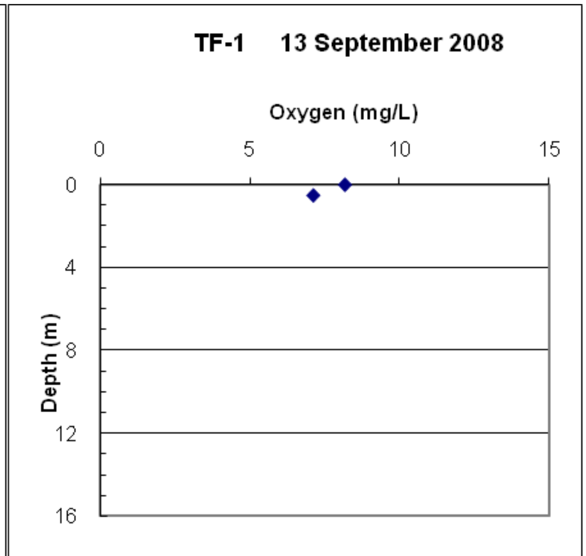

PD-1 12 August 2008
pH
7
7.5
8
8.5
9
0
4
8
12
16
Depth (m)

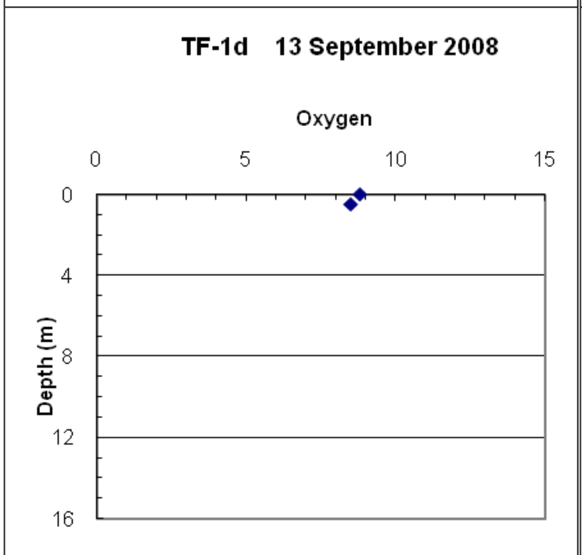

PD-1 12 August 2008
Conductivity
0.3
0.4
0.5
0.6
0.7
0
4
8
12
16
Depth (m)

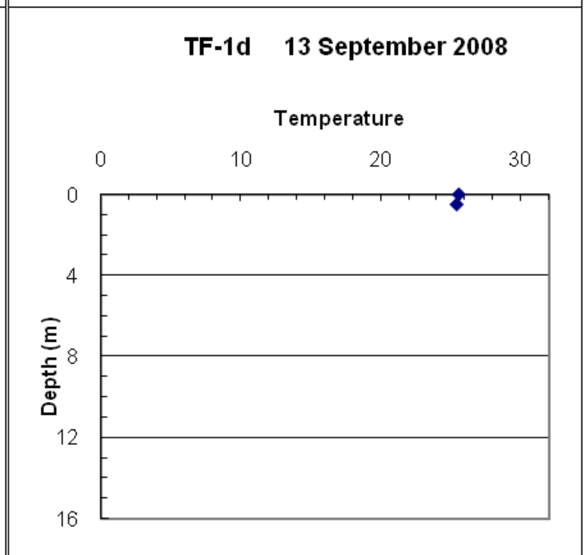

PD-1u 12 August 2008
Temperature (oC)
20
30
0
4
8
12
16
Depth (m)

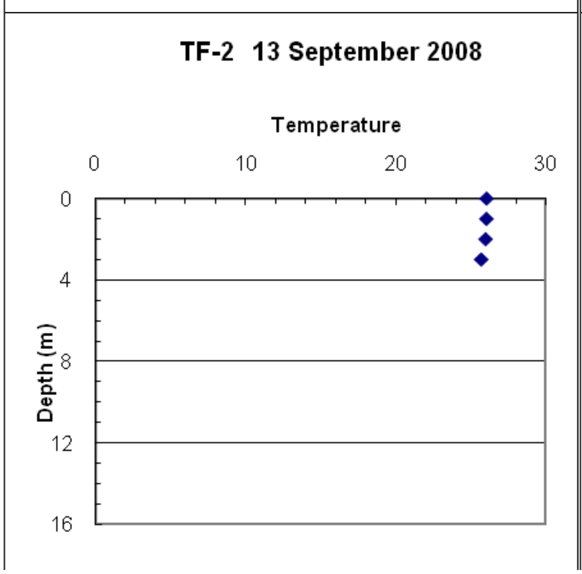

PD-1u 12 August 2008
Oxygen (mL/L)
0
5
10
15
0
4
8
12
16
Depth (m)

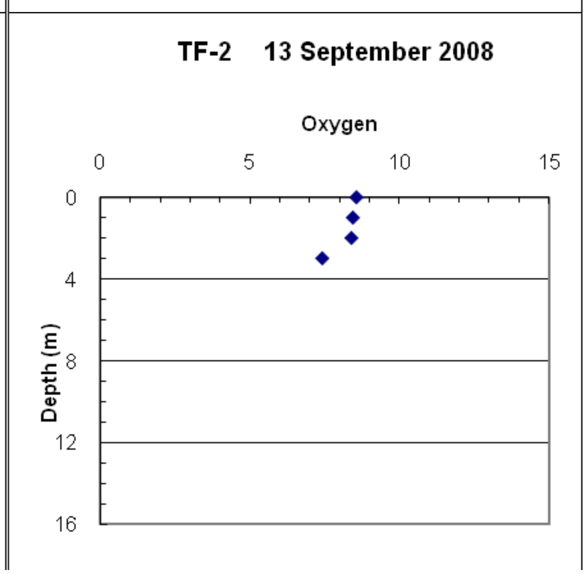

TF-1 13 September 2008
Temperature
0 10 20 30
0 4 8 12 16
Depth (m)

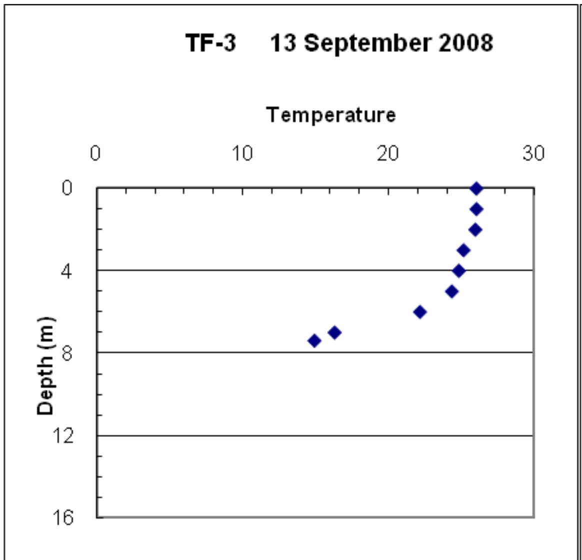

TF-1 13 September 2008
Oxygen (mg/L)
0 5 10 15
0 4 8 12 16
Depth (m)

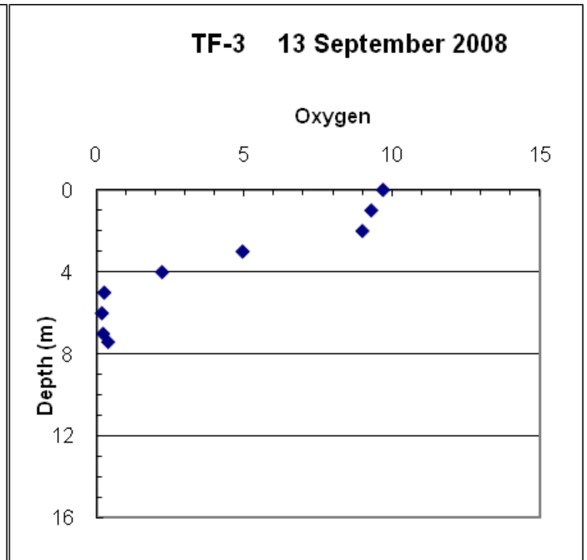

TF-1d 13 September 2008
Oxygen
0 5 10 15
0 4 8 12 16
Depth (m)

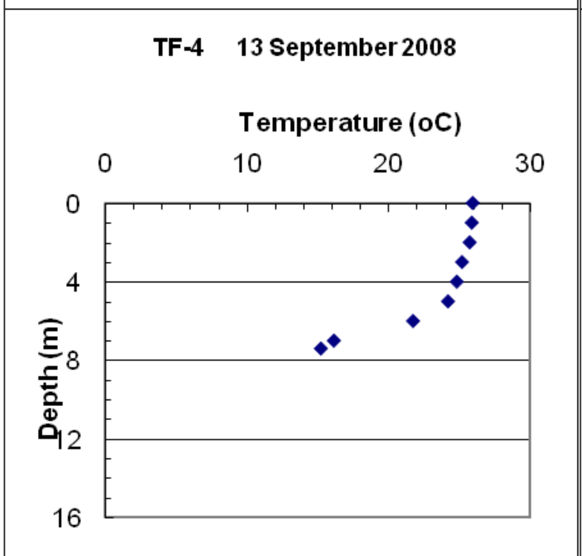

TF-1d 13 September 2008
Temperature
0 10 20 30
0 4 8 12 16
Depth (m)

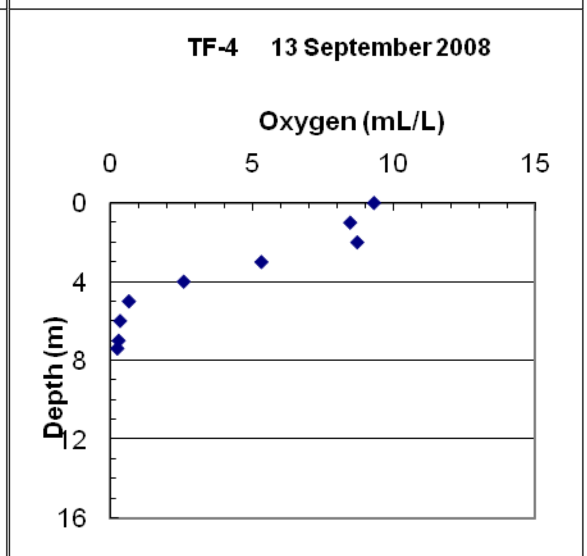

TF-2 13 September 2008
Temperature
0 10 20 30
0 4 8 12 16
Depth (m)

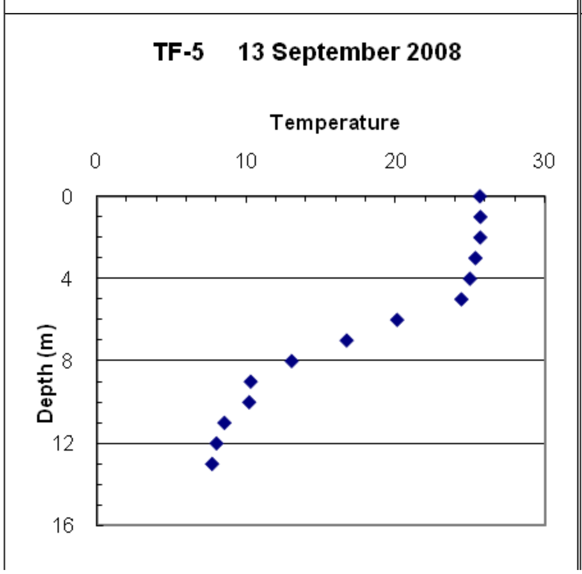

TF-2 13 September 2008
Oxygen
0 5 10 15
0 4 8 12 16
Depth (m)

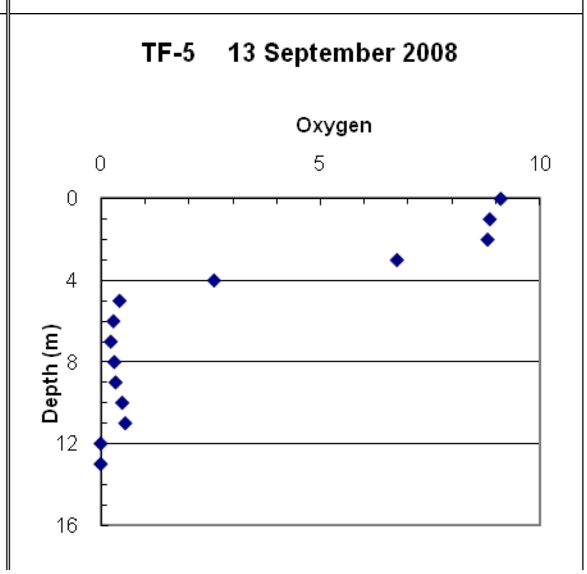

TF-3 13 September 2008
Temperature
0
10
20
30
0
4
8
12
16
Depth (m)

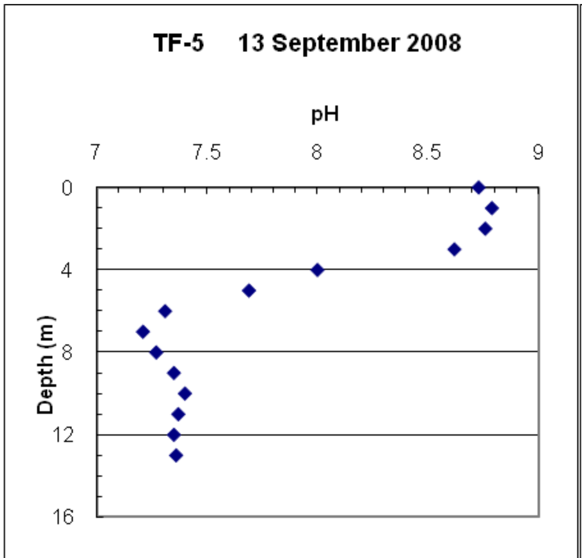

TF-3 13 September 2008
Oxygen
0
5
10
15
0
4
8
12
16
Depth (m)

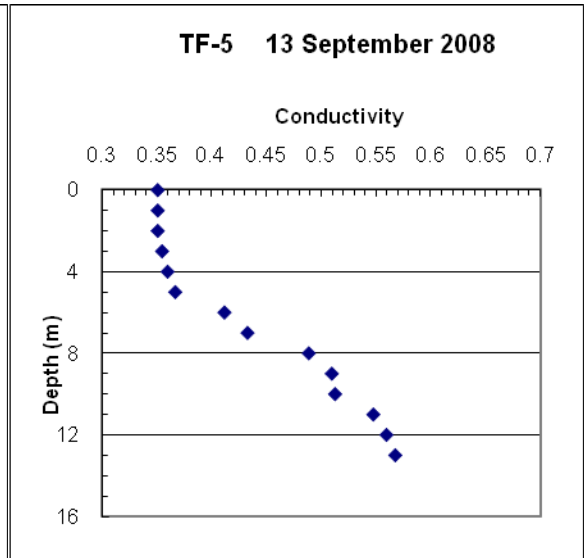

TF-4 13 September 2008
Temperature (oC)
0
10
20
30
0
4
8
12
16
Depth (m)

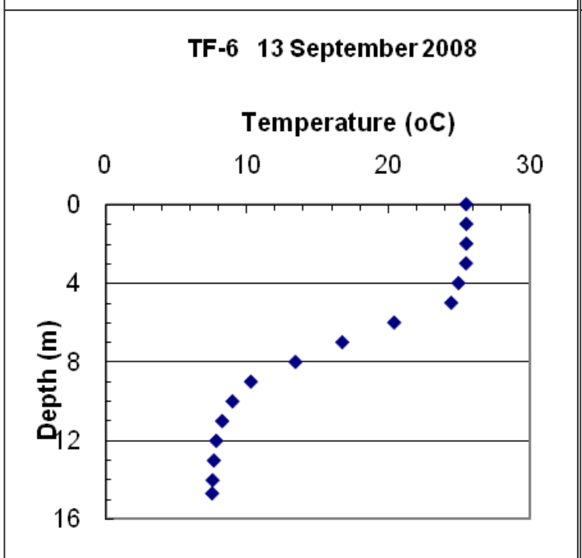

TF-4 13 September 2008
Oxygen (mL/L)
0
5
10
15
0
4
8
12
16
Depth (m)

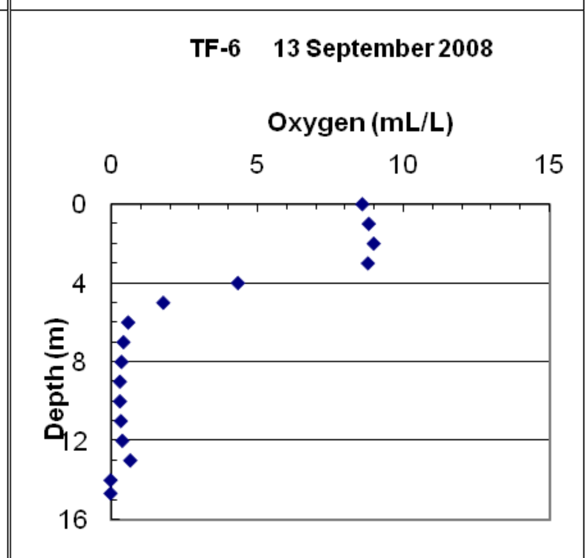

TF-5 13 September 2008
Temperature
0
10
20
30
0
4
8
12
16
Depth (m)

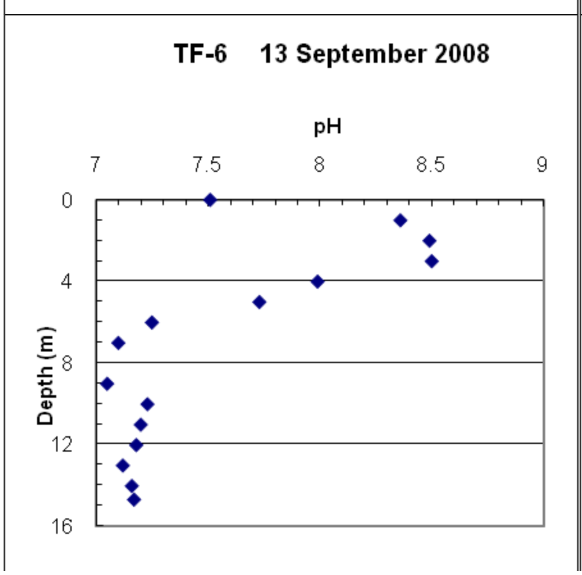

TF-5 13 September 2008
Oxygen
0
5
10
0
4
8
12
16
Depth (m)

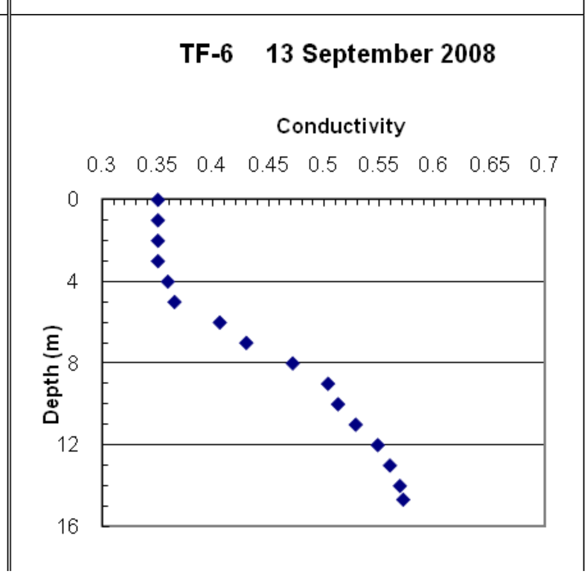

TF-5 13 September 2008
pH
7 7.5 8 8.5 9
Depth (m)
0 4 8 12 16

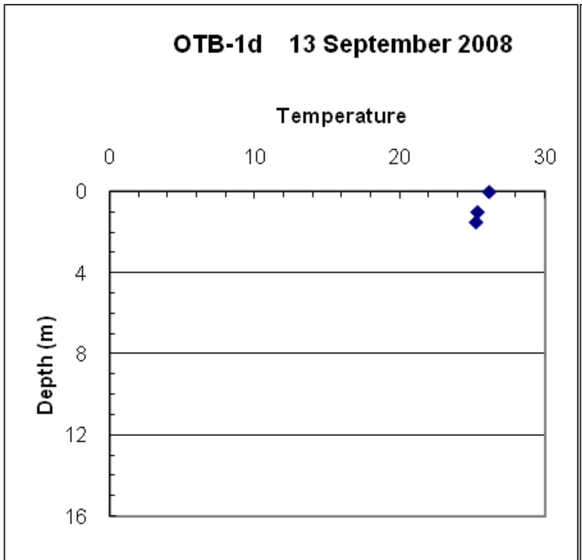

TF-5 13 September 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
Depth (m)
0 4 8 12 16

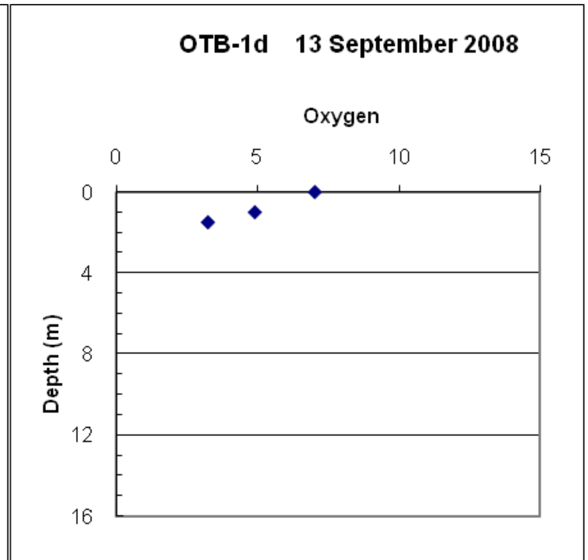

TF-6 13 September 2008
Temperature (oC)
0 10 20 30
Depth (m)
0 4 8 12 16

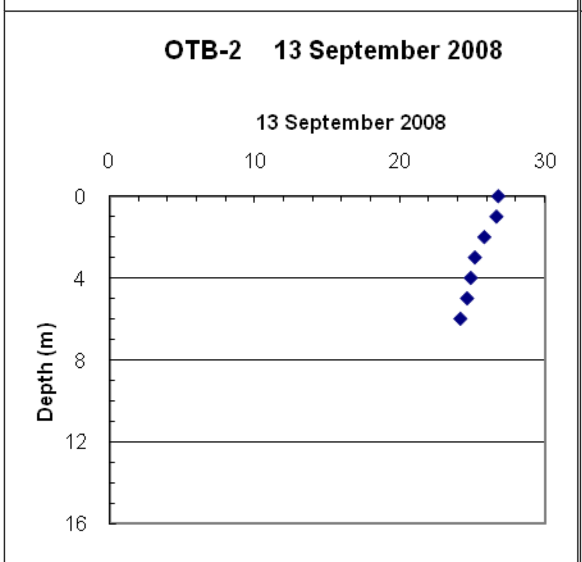

TF-6 13 September 2008
Oxygen (mL/L)
0 5 10 15
Depth (m)
0 4 8 12 16

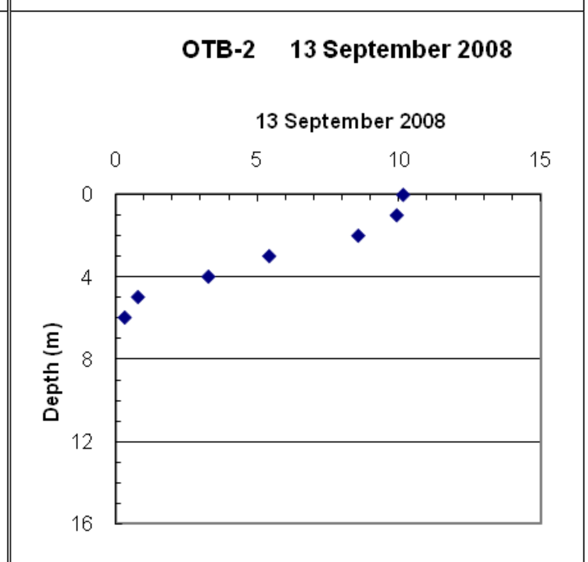

TF-6 13 September 2008
pH
7 7.5 8 8.5 9
Depth (m)
0 4 8 12 16

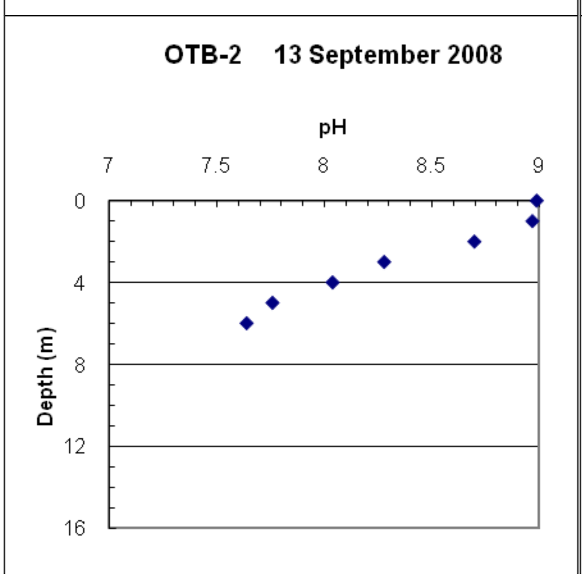

TF-6 13 September 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
Depth (m)
0 4 8 12 16

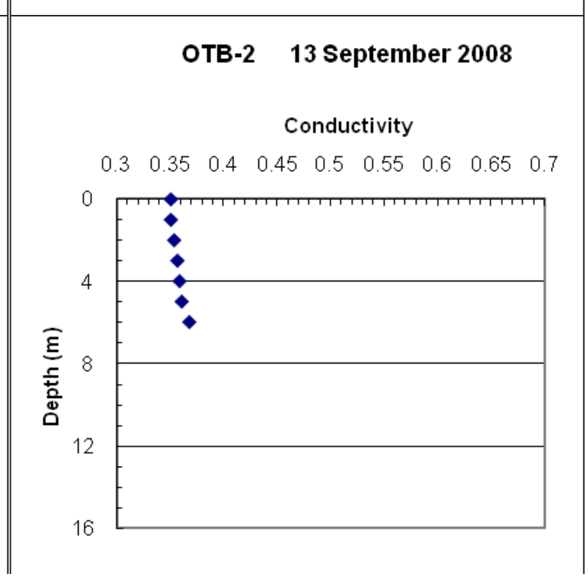

OTB-1d 13 September 2008
Temperature
0 10 20 30
0 4 8 12 16
Depth (m)

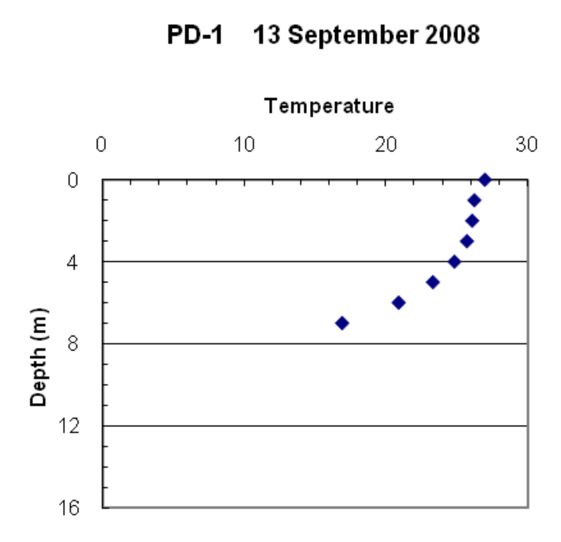

OTB-1d 13 September 2008
Oxygen
0 5 10 15
0 4 8 12 16
Depth (m)

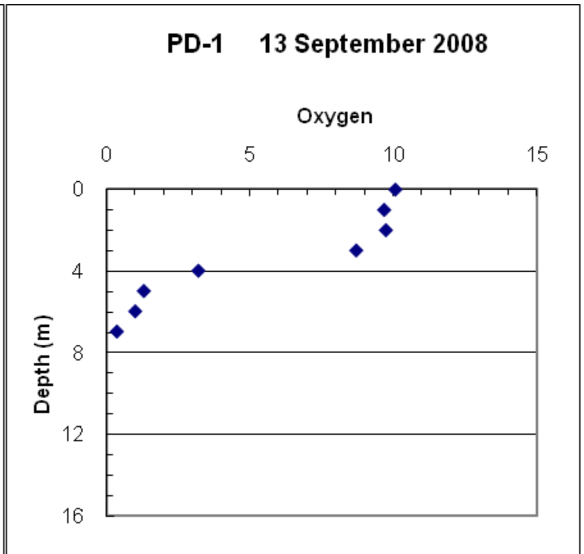

OTB-2 13 September 2008
13 September 2008
0 10 20 30
0 4 8 12 16
Depth (m)

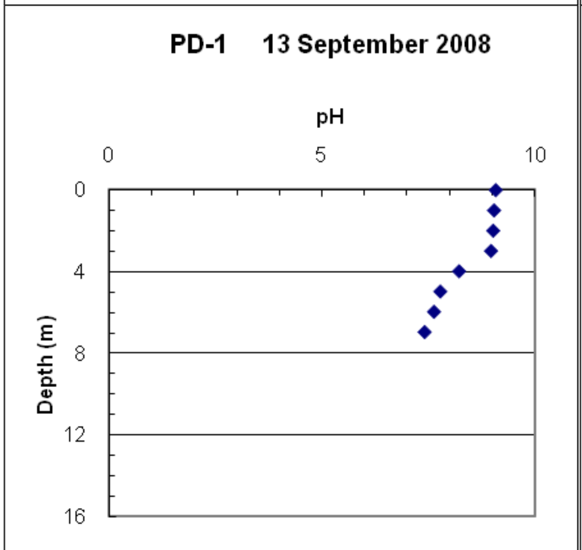

OTB-2 13 September 2008
13 September 2008
0 5 10 15
0 4 8 12 16
Depth (m)

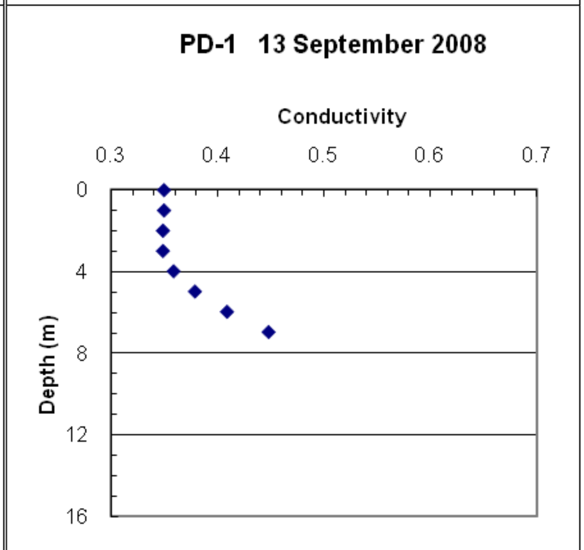

OTB-2 13 September 2008
pH
7 7.5 8 8.5 9
0 4 8 12 16
Depth (m)

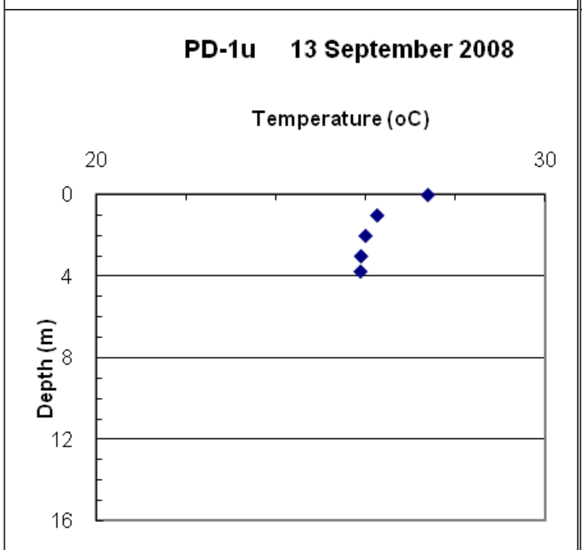

OTB-2 13 September 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
0 4 8 12 16
Depth (m)

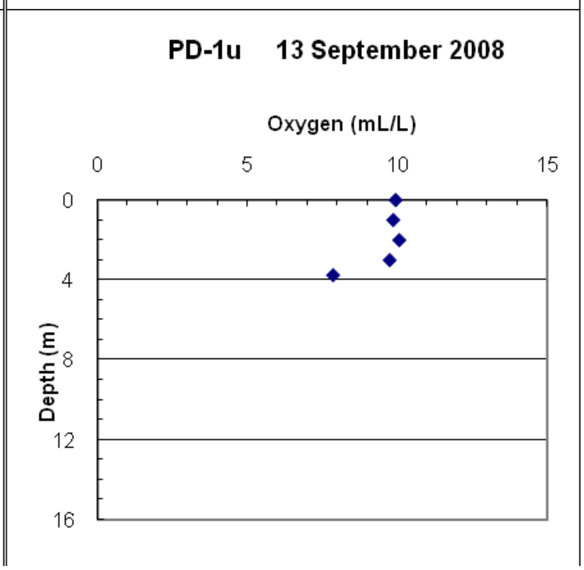

PD-1 13 September 2008
Temperature
0
10
20
30
0
4
8
12
16
Depth (m)

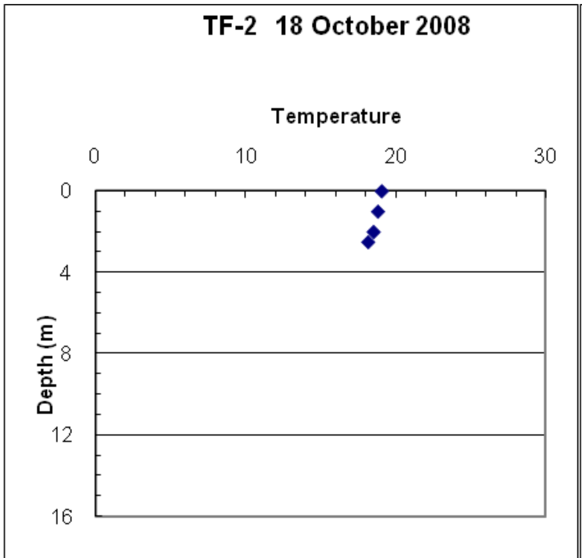

PD-1 13 September 2008
Oxygen
0
5
10
15
0
4
8
12
16
Depth (m)

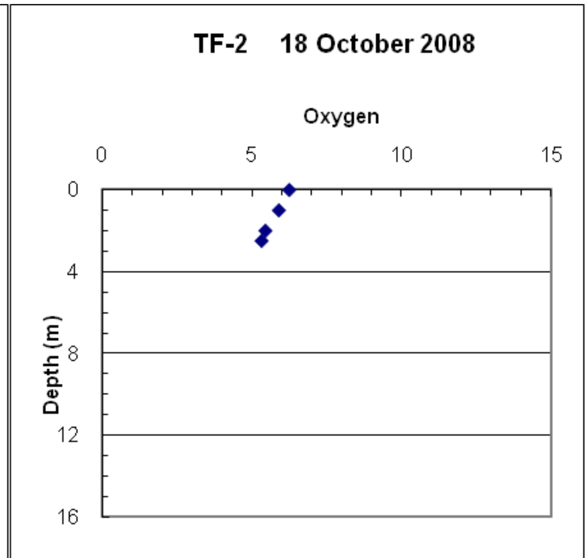

PD-1 13 September 2008
pH
0
5
10
0
4
8
12
16
Depth (m)

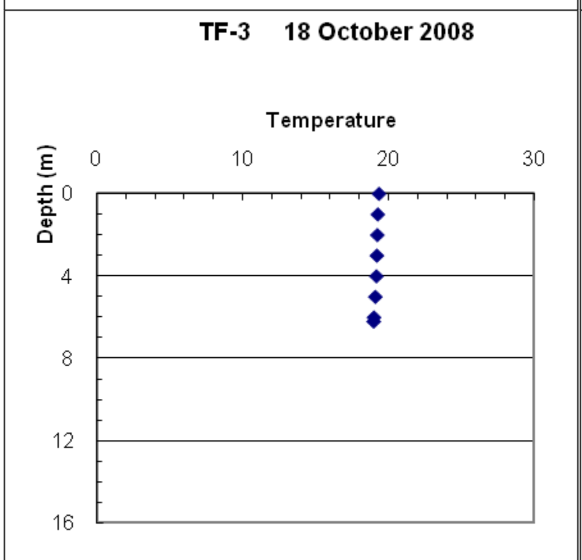

PD-1 13 September 2008
Conductivity
0.3
0.4
0.5
0.6
0.7
0
4
8
12
16
Depth (m)

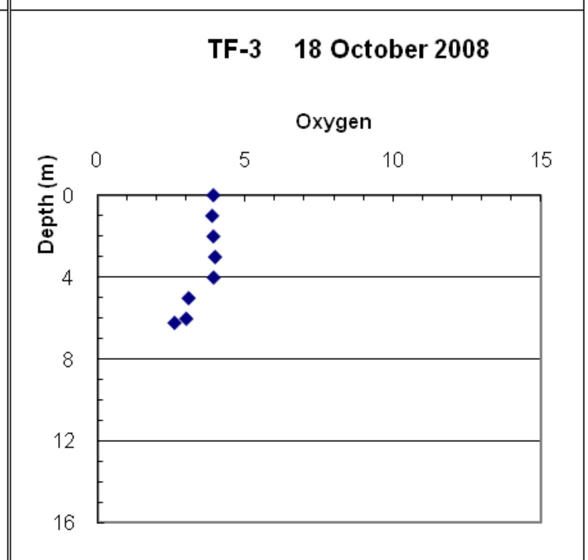

PD-1u 13 September 2008
Temperature (oC)
20
30
0
4
8
12
16
Depth (m)

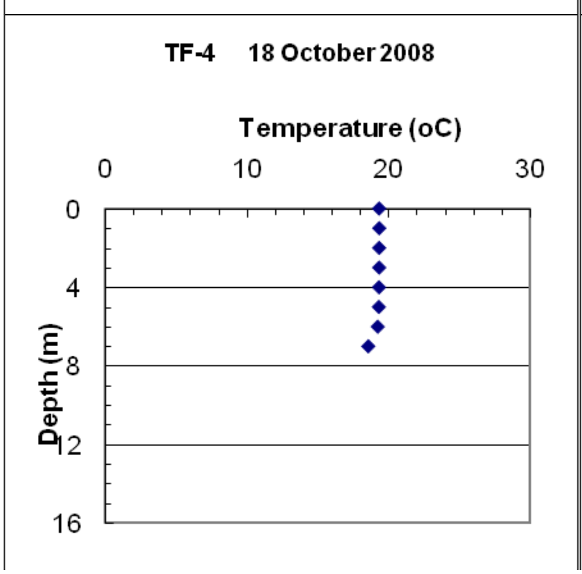

PD-1u 13 September 2008
Oxygen (mL/L)
0
5
10
15
0
4
8
12
16
Depth (m)

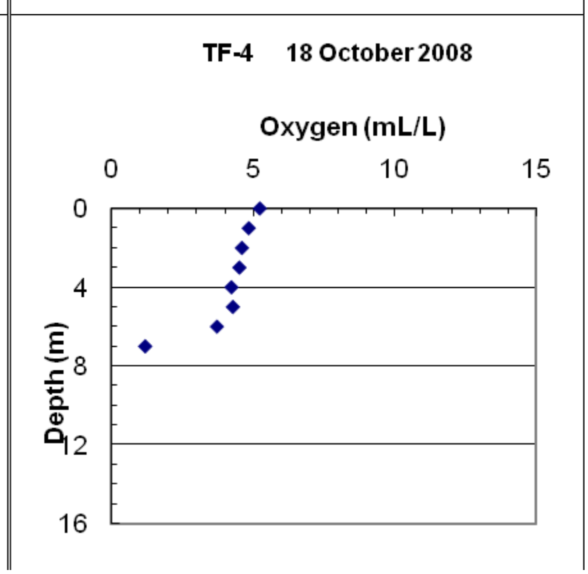

TF-2 18 October 2008
Temperature
0
10
20
30
0
4
8
12
16
Depth (m)

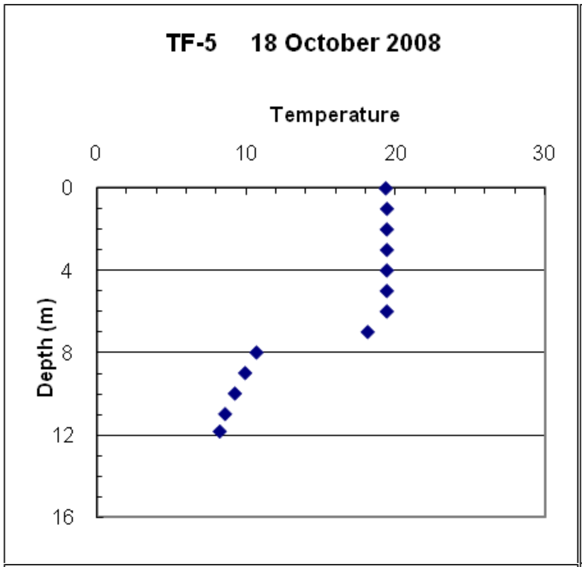

TF-2 18 October 2008
Oxygen
0
5
10
15
0
4
8
12
16
Depth (m)

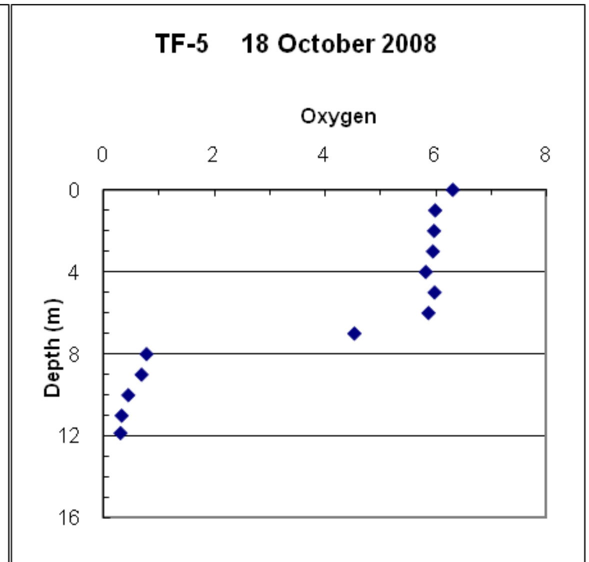

TF-3 18 October 2008
Temperature
0
10
20
30
0
4
8
12
16
Depth (m)

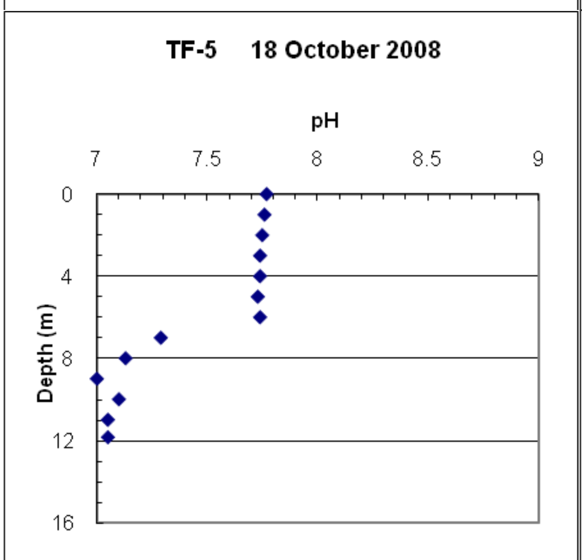

TF-3 18 October 2008
Oxygen
0
5
10
15
0
4
8
12
16
Depth (m)

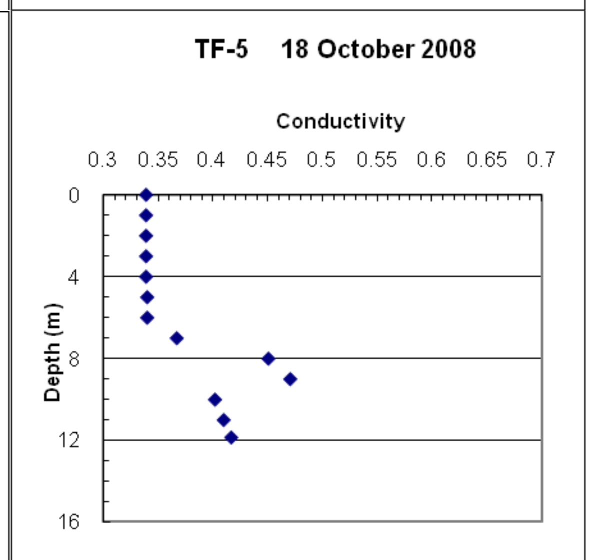

TF-4 18 October 2008
Temperature (oC)
0
10
20
30
0
4
8
12
16
Depth (m)

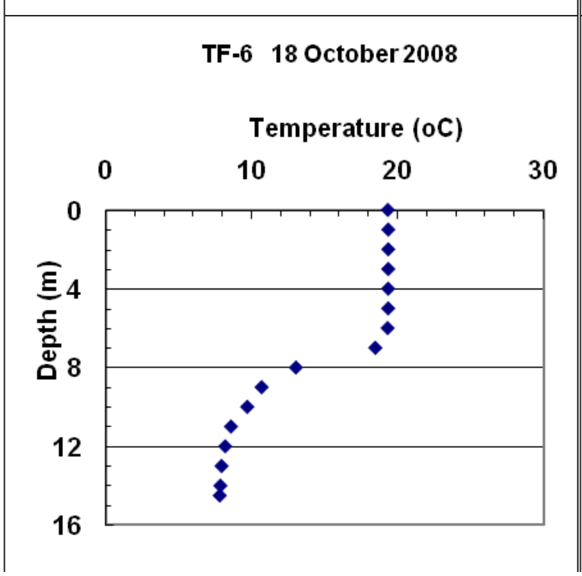

TF-4 18 October 2008
Oxygen (mL/L)
0
5
10
15
0
4
8
12
16
Depth (m)

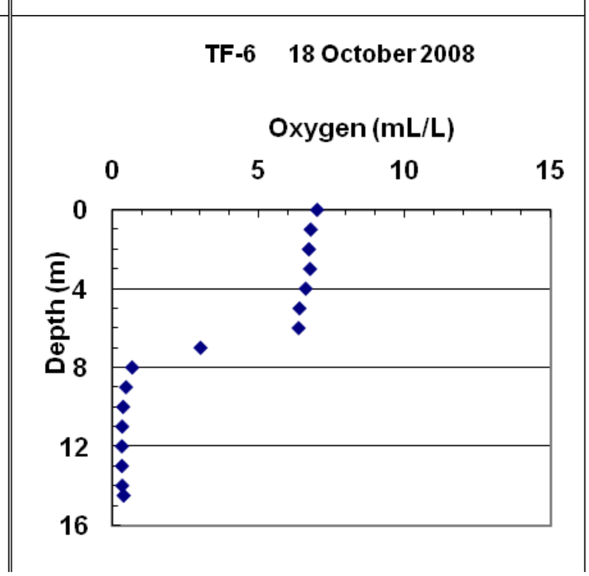

TF-5 18 October 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

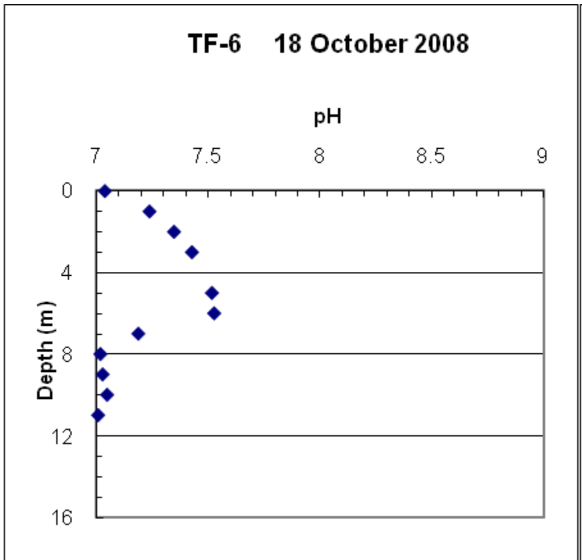

TF-5 18 October 2008
Oxygen
0 2 4 6 8
Depth (m)
0 4 8 12 16

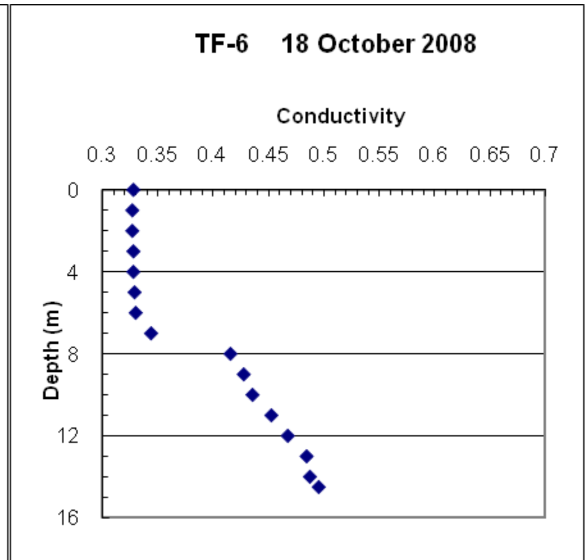

TF-5 18 October 2008
pH
7 7.5 8 8.5 9
Depth (m)
0 4 8 12 16

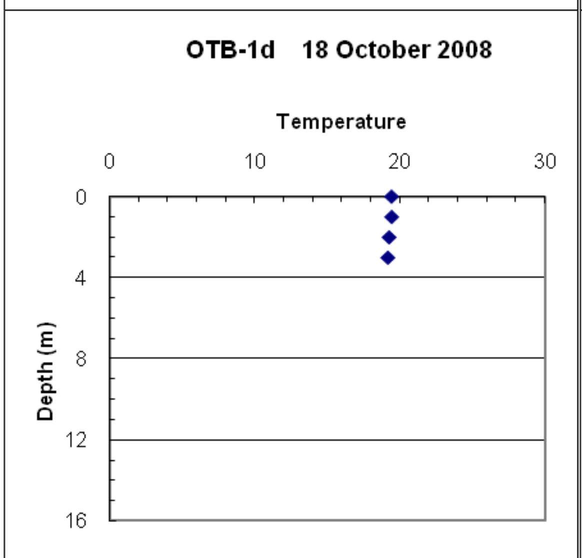

TF-5 18 October 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
Depth (m)
0 4 8 12 16

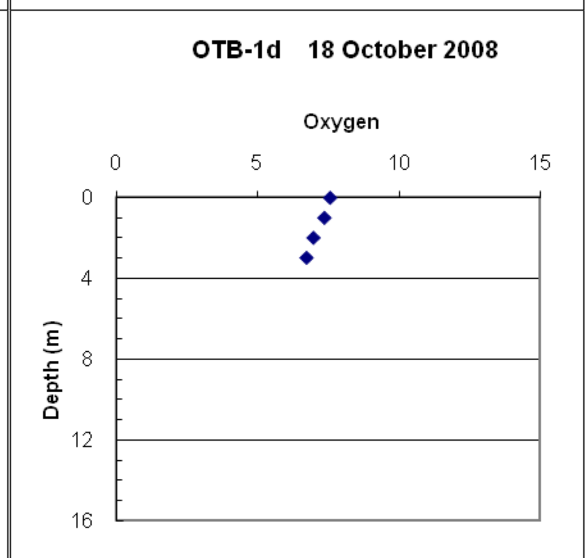

TF-6 18 October 2008
Temperature (oC)
0 10 20 30
Depth (m)
0 4 8 12 16

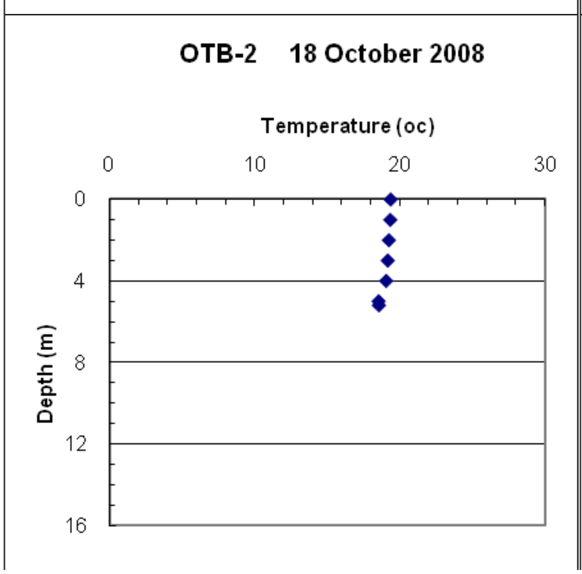

TF-6 18 October 2008
Oxygen (mL/L)
0 5 10 15
Depth (m)
0 4 8 12 16

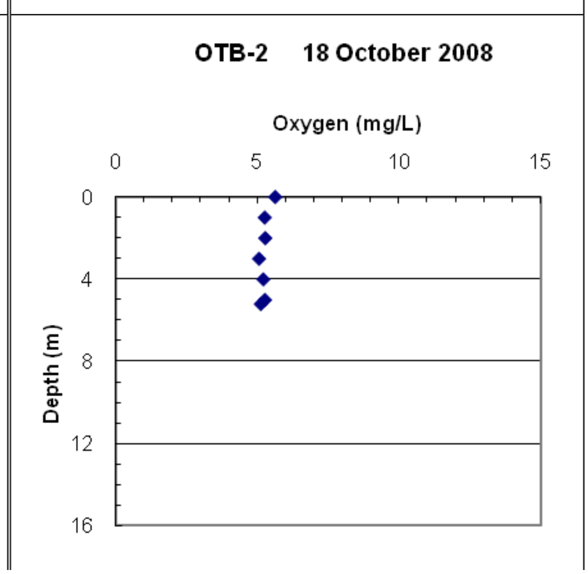

TF-6 18 October 2008
pH
7 7.5 8 8.5 9
Depth (m)
0 4 8 12 16

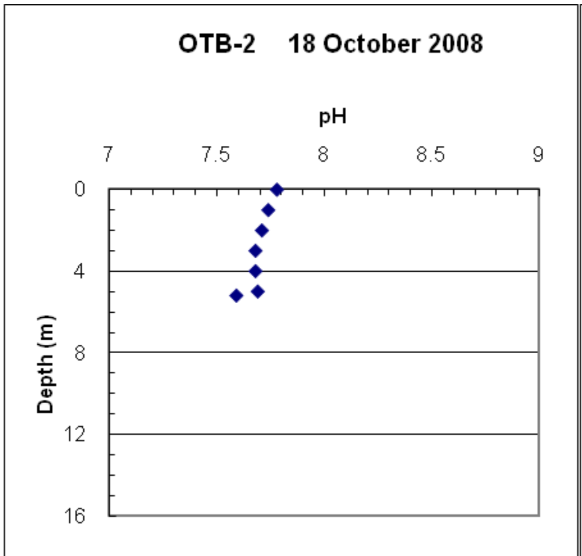

TF-6 18 October 2008
Conductivity
0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
Depth (m)
0 4 8 12 16


OTB-1d 18 October 2008
Temperature
0 10 20 30
Depth (m)
0 4 8 12 16

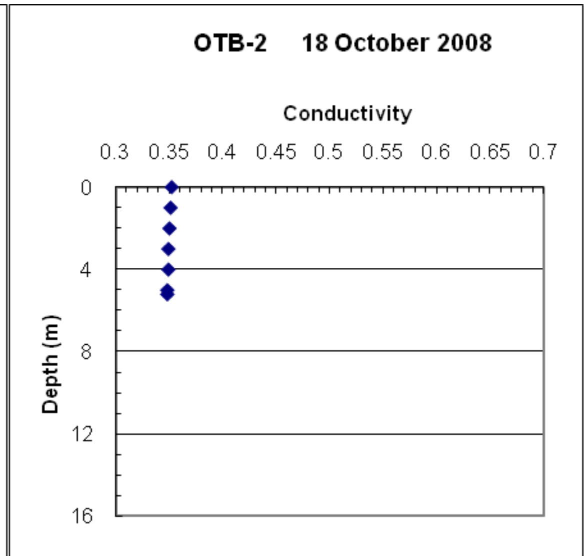

OTB-1d 18 October 2008
Oxygen
0 5 10 15
Depth (m)
0 4 8 12 16


OTB-2 18 October 2008
Temperature (oc)
0 10 20 30
Depth (m)
0 4 8 12 16

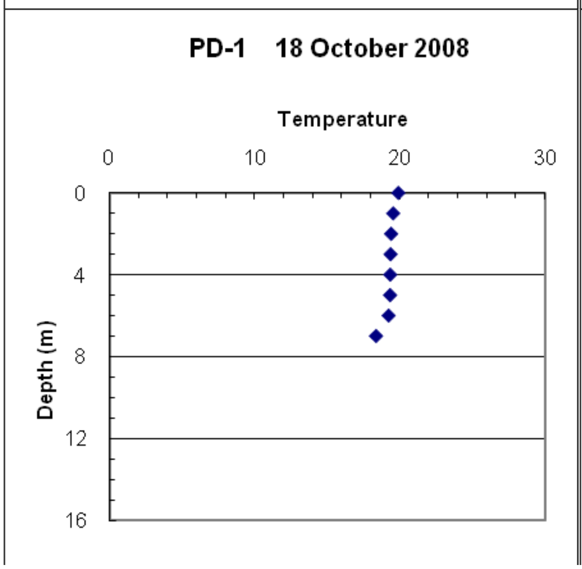

OTB-2 18 October 2008
Oxygen (mg/L)
0 5 10 15
Depth (m)
0 4 8 12 16



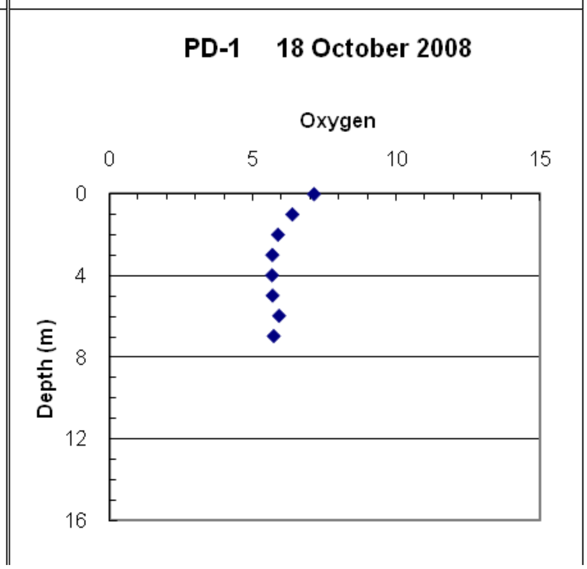
OTB-2 18 October 2008
pH
7
7.5
8
8.5
9
0
4
8
12
16
Depth (m)



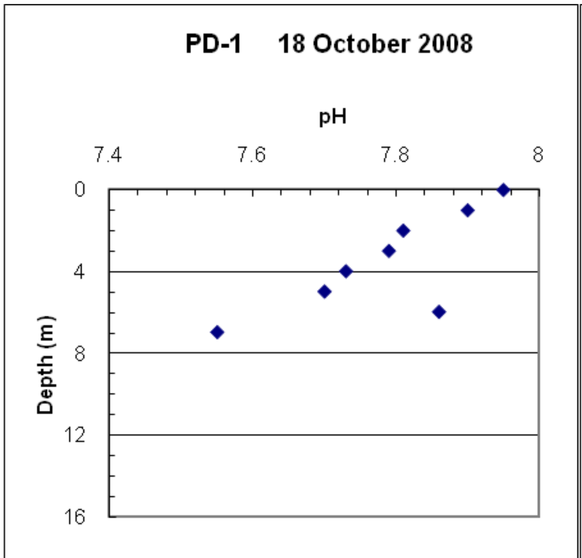
OTB-2 18 October 2008
Conductivity
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0
4
8
12
16
Depth (m)

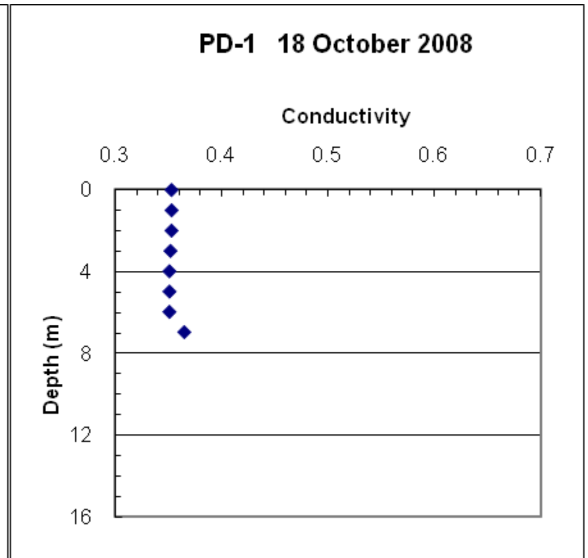


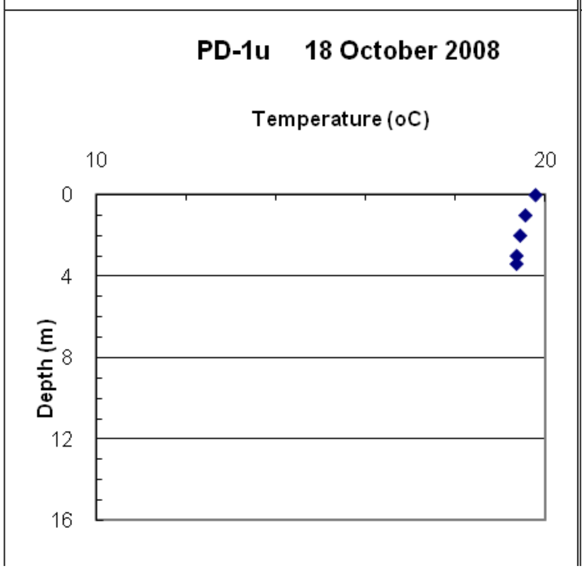
PD-1 18 October 2008
Temperature
0
10
20
30
0
4
8
12
16
Depth (m)

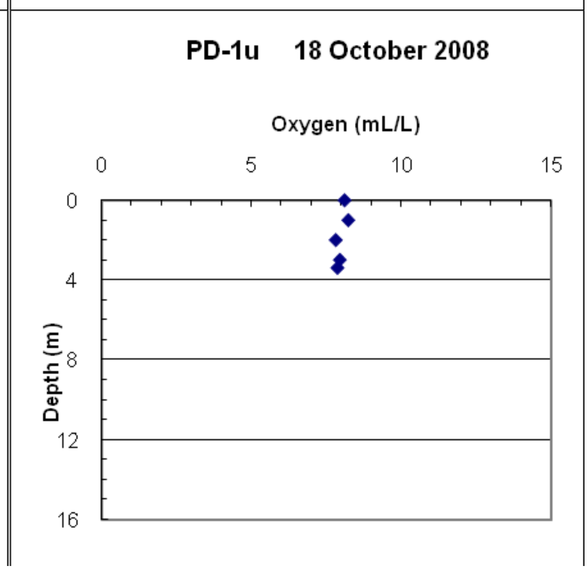


PD-1 18 October 2008
Oxygen
0
5
10
15
0
4
8
12
16
Depth (m)


PD-1 18 October 2008
pH
7.4
7.6
7.8
8
Depth (m)
0
4
8
12
16

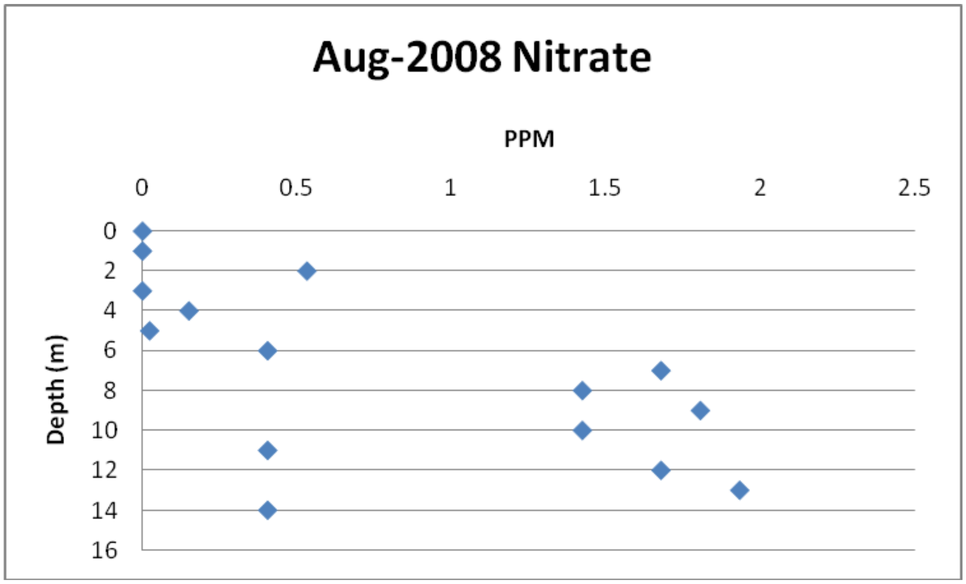

PD-1 18 October 2008
Conductivity
0.3
0.4
0.5
0.6
0.7
Depth (m)
0
4
8
12
16

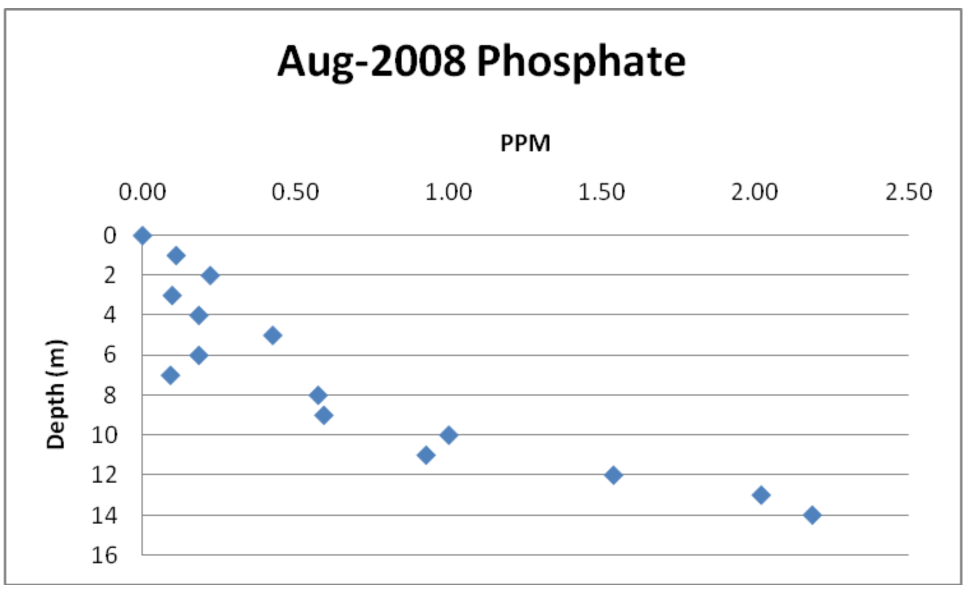

PD-1u 18 October 2008
Temperature (oC)
10
20
Depth (m)
0
4
8
12
16

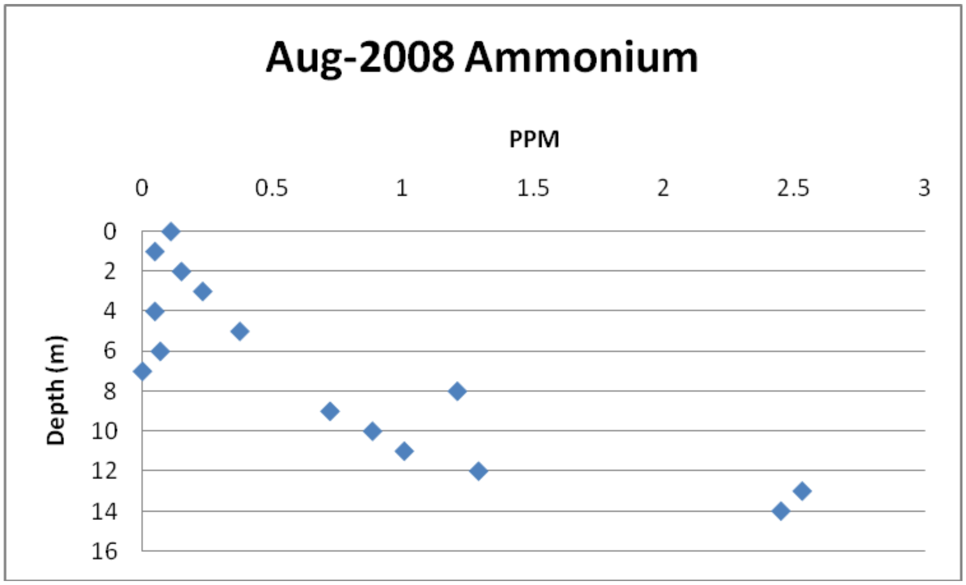

PD-1u 18 October 2008
Oxygen (mL/L)
0
5
10
15
Depth (m)
0
4
8
12
16

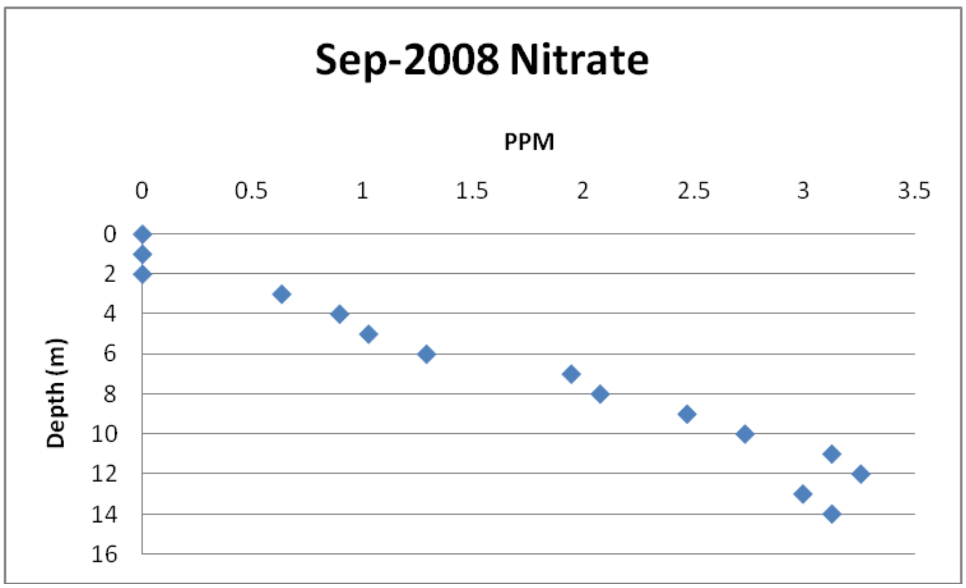
Appendix D

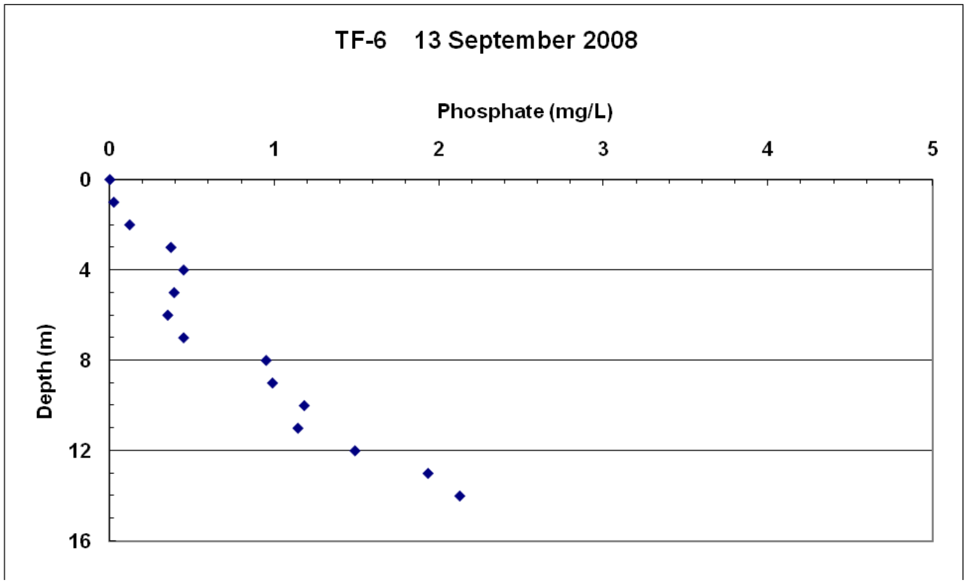
TF-6 Nutrient Data

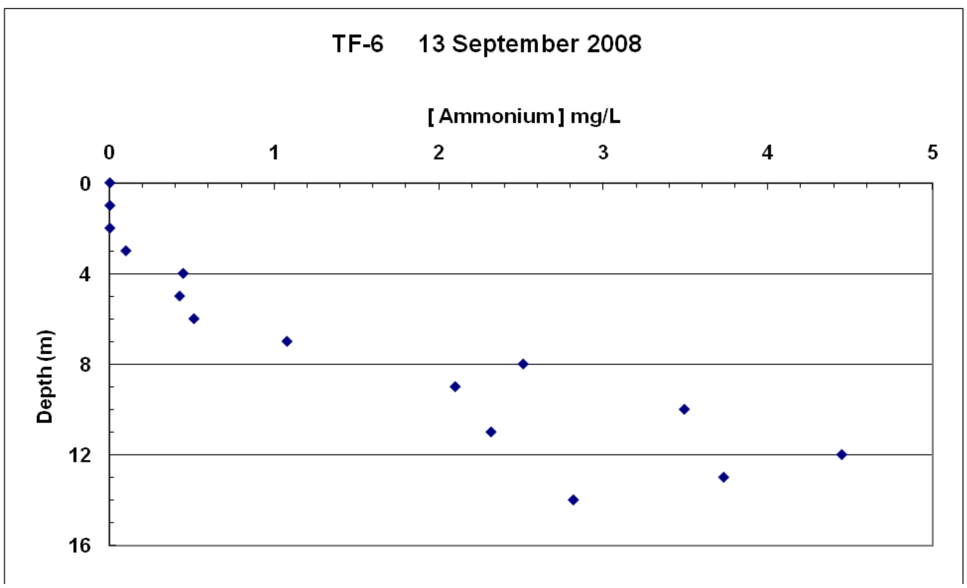


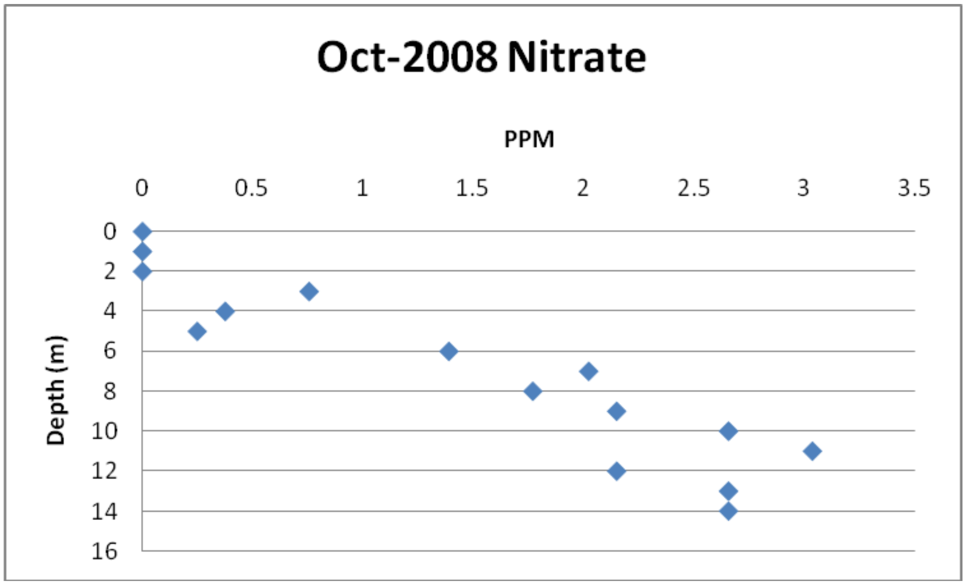


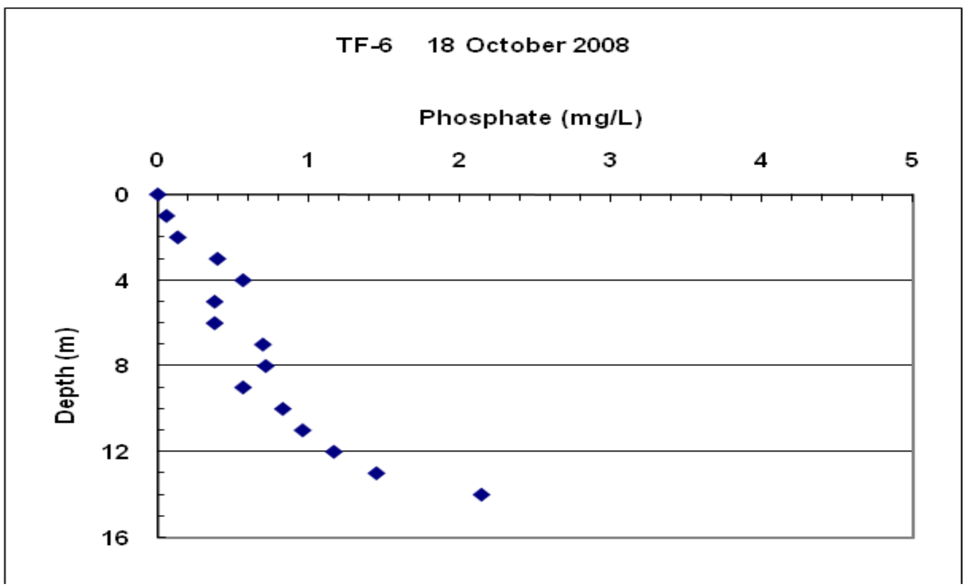

Aug-2008 Ammonium
PPM
0
0.5
1
1.5
2
2.5
3
Depth (m)
0
2
4
6
8
10
12
14
16

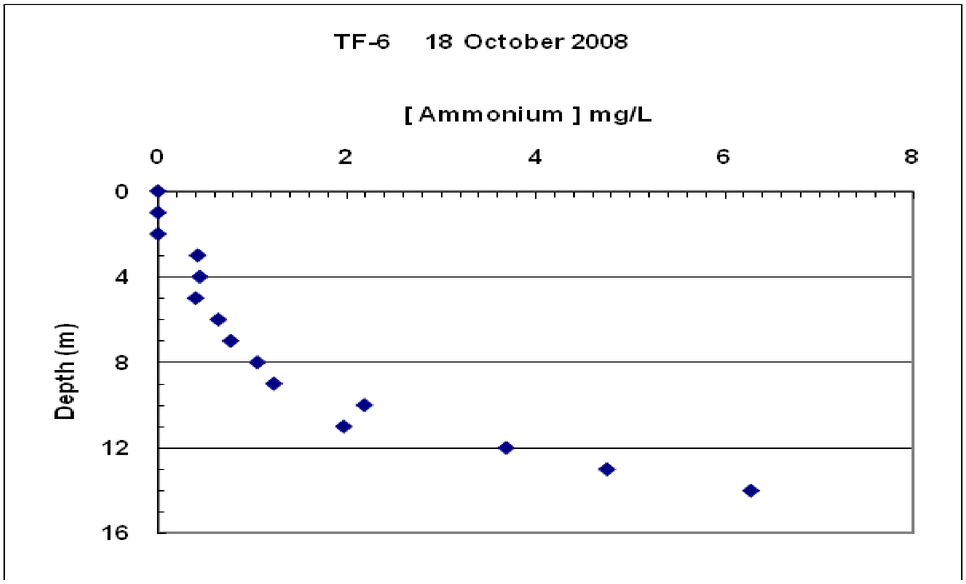

Sep-2008 Nitrate
PPM
0
0.5
1
1.5
2
2.5
3
3.5
Depth (m)
0
2
4
6
8
10
12
14
16


TF-6 13 September 2008
Phosphate (mg/L)
0 1 2 3 4 5
0 4 8 12 16
Depth (m)


TF-6 13 September 2008
[Ammonium] mg/L
0 1 2 3 4 5
0 4 8 12 16
Depth (m)

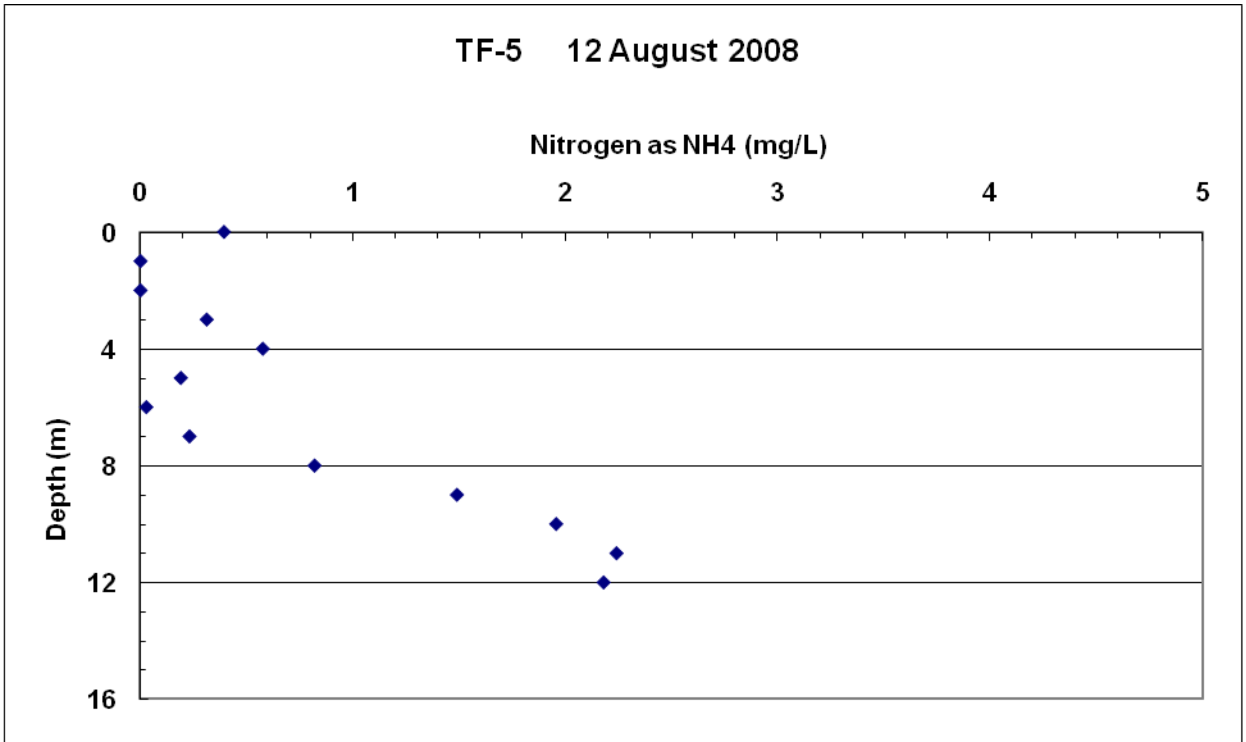

Oct-2008 Nitrate
PPM
0
0.5
1
1.5
2
2.5
3
3.5
Depth (m)
0
2
4
6
8
10
12
14
16

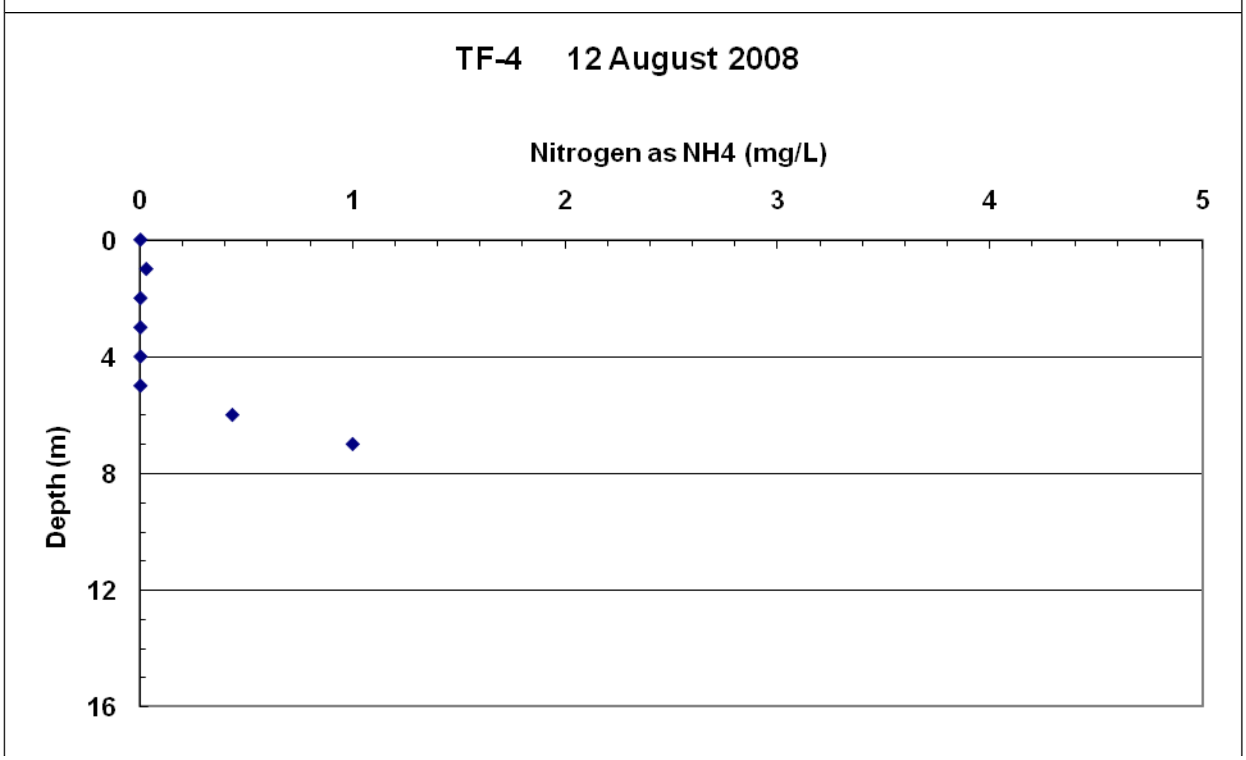

TF-6 18 October 2008
Phosphate (mg/L)
0
1
2
3
4
5
Depth (m)
0
4
8
12
16

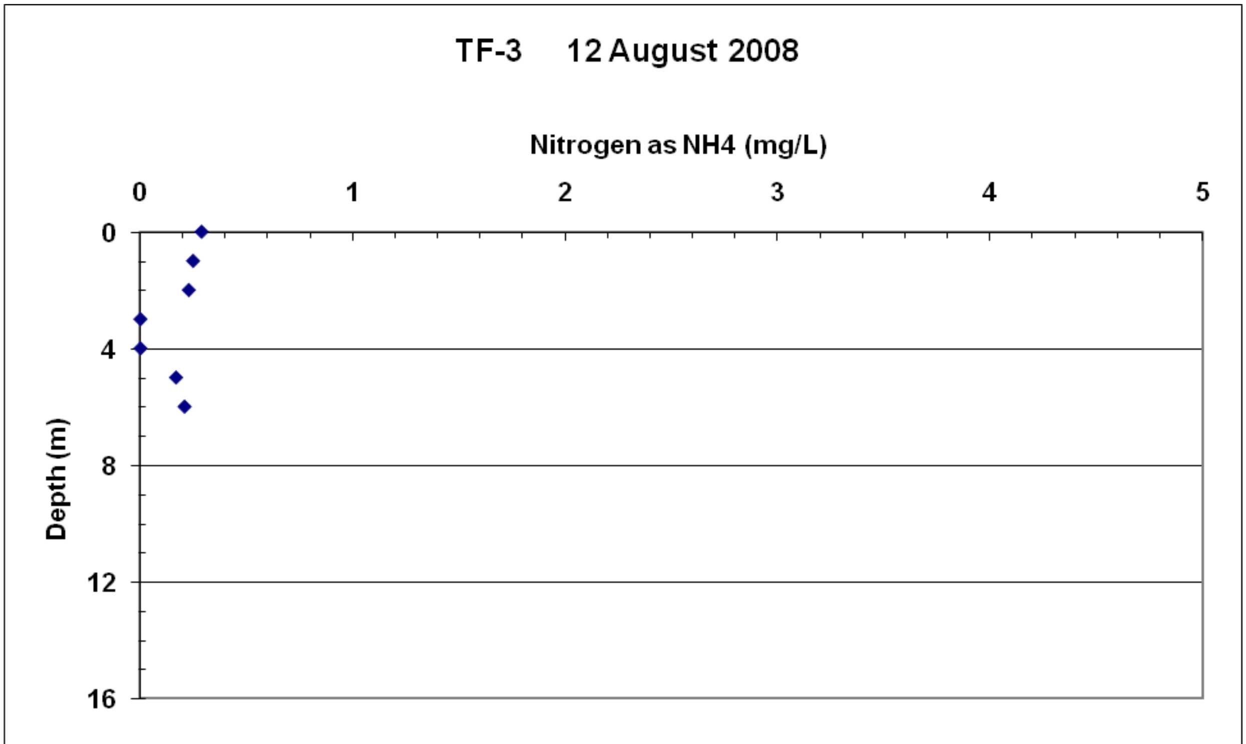

TF-6 18 October 2008
[Ammonium] mg/L
0
2
4
6
8
0
4
8
12
16
Depth (m)

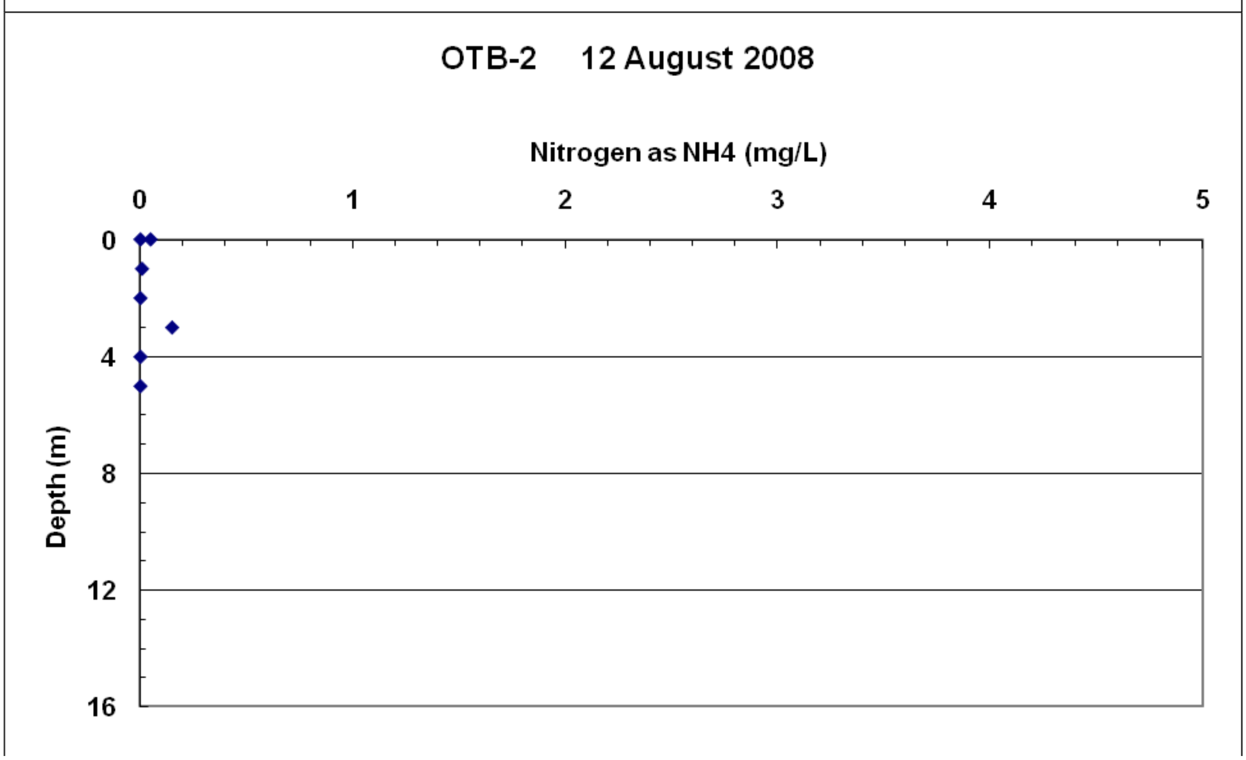
Appendix E

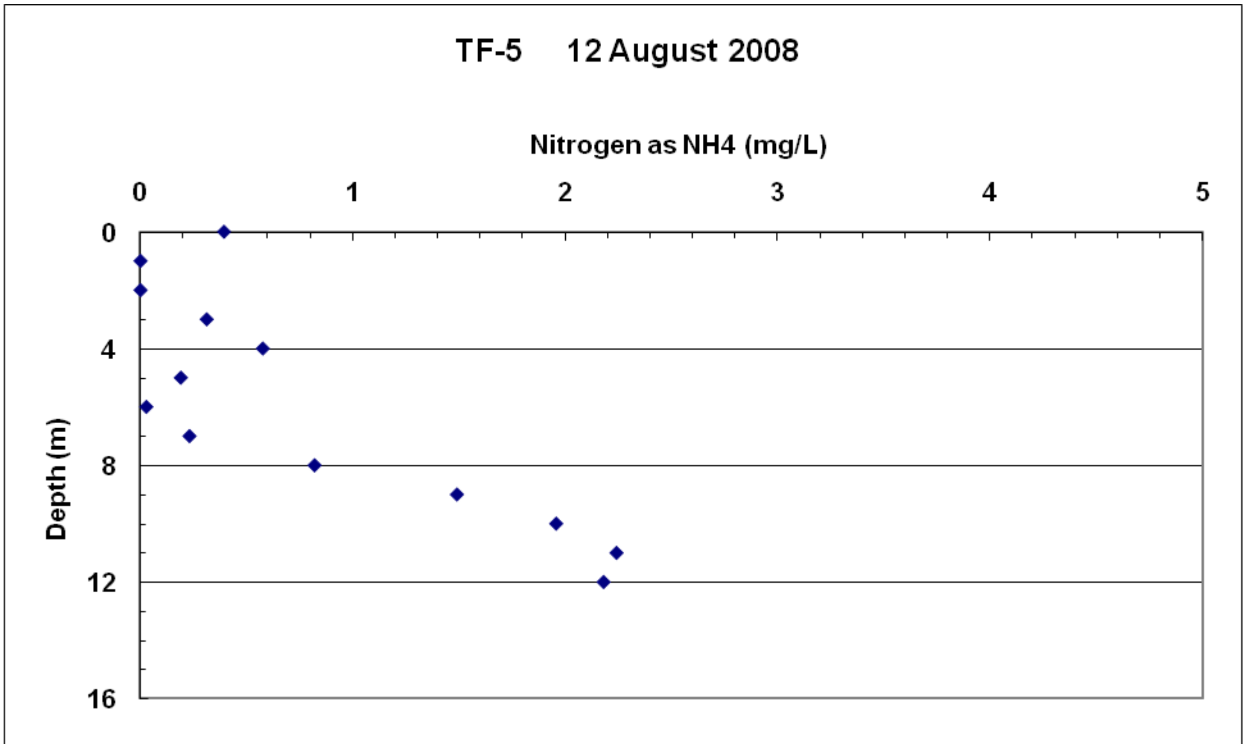
Various Nutrient Graphs

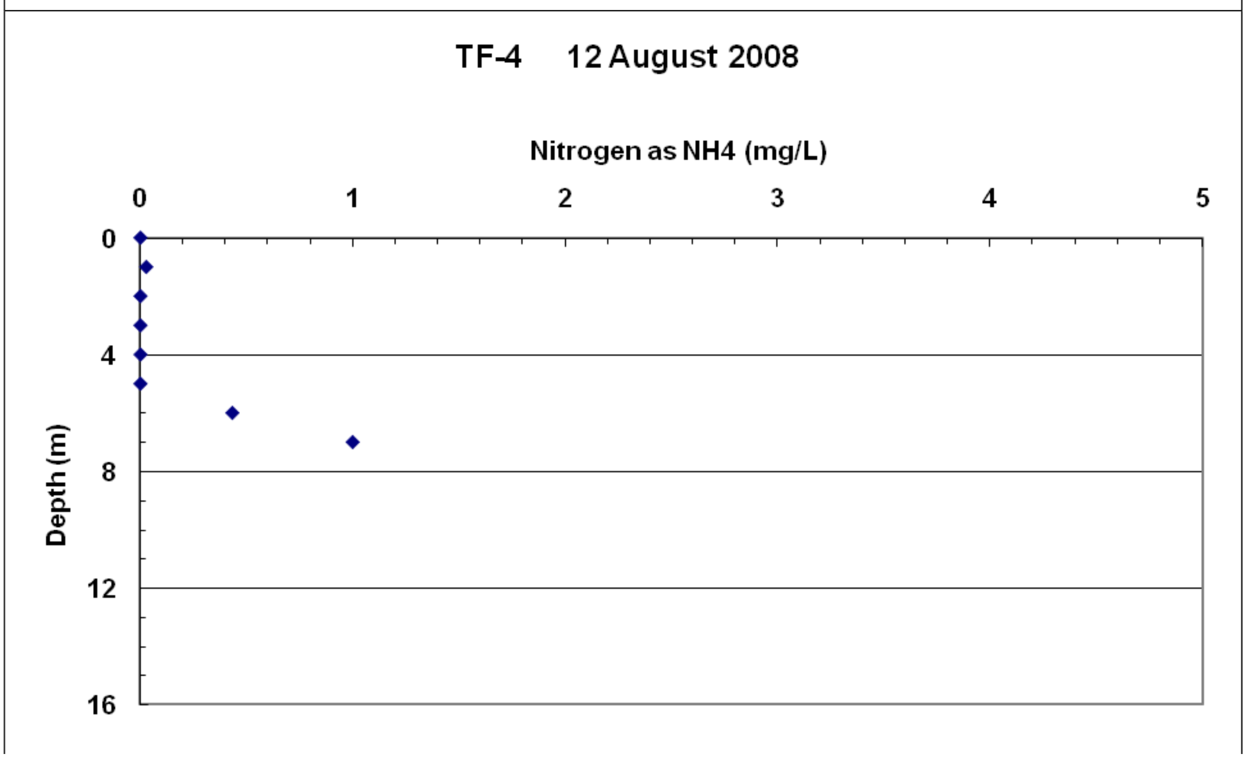


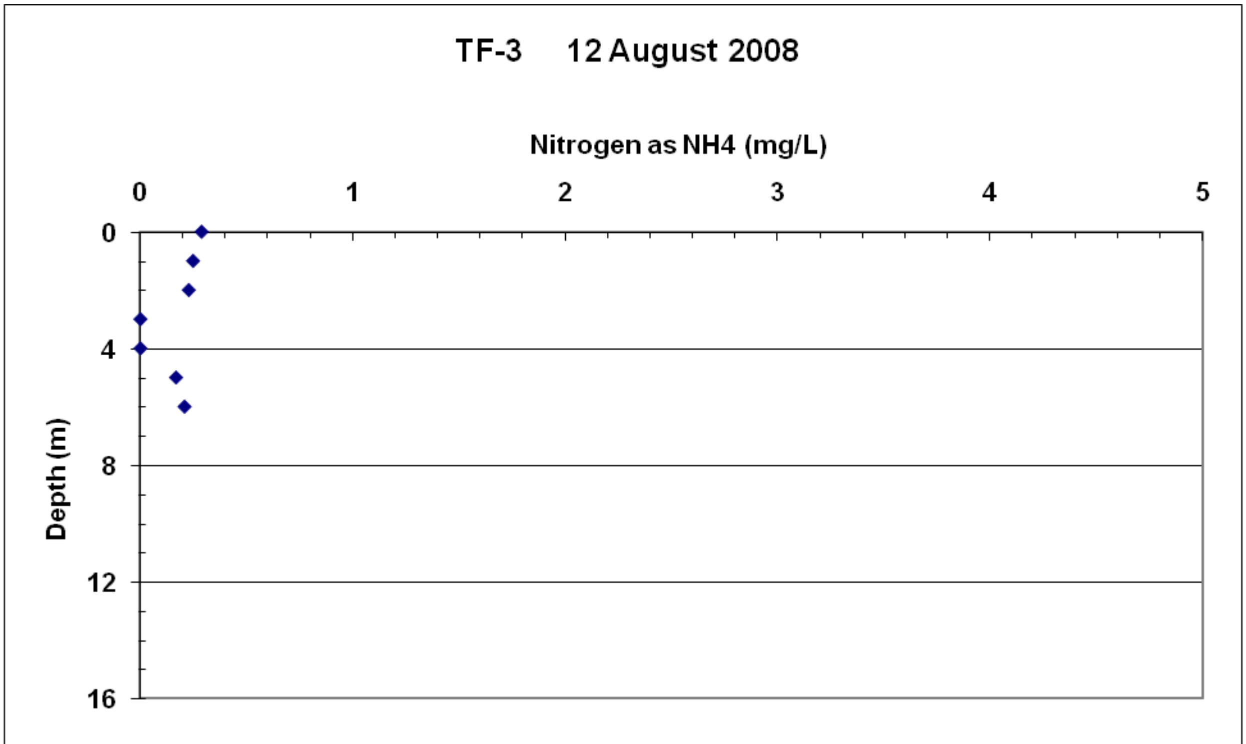


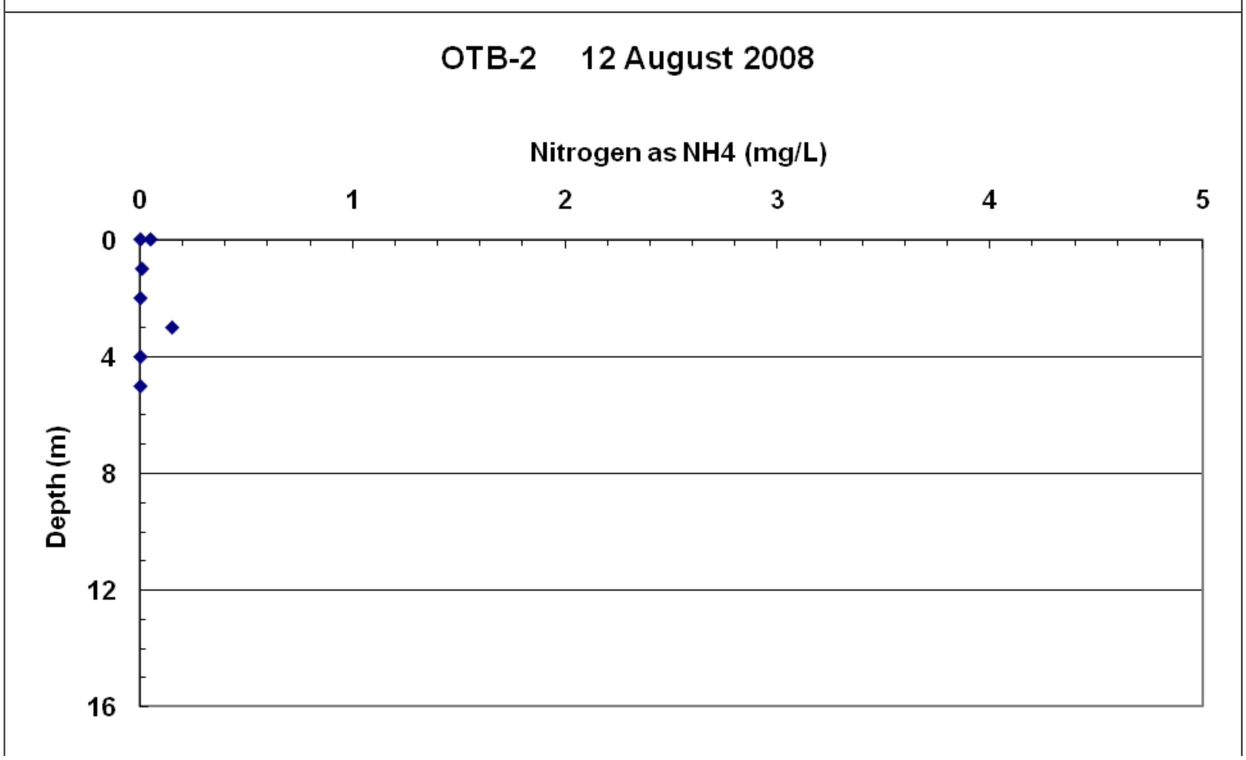

TF-3 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

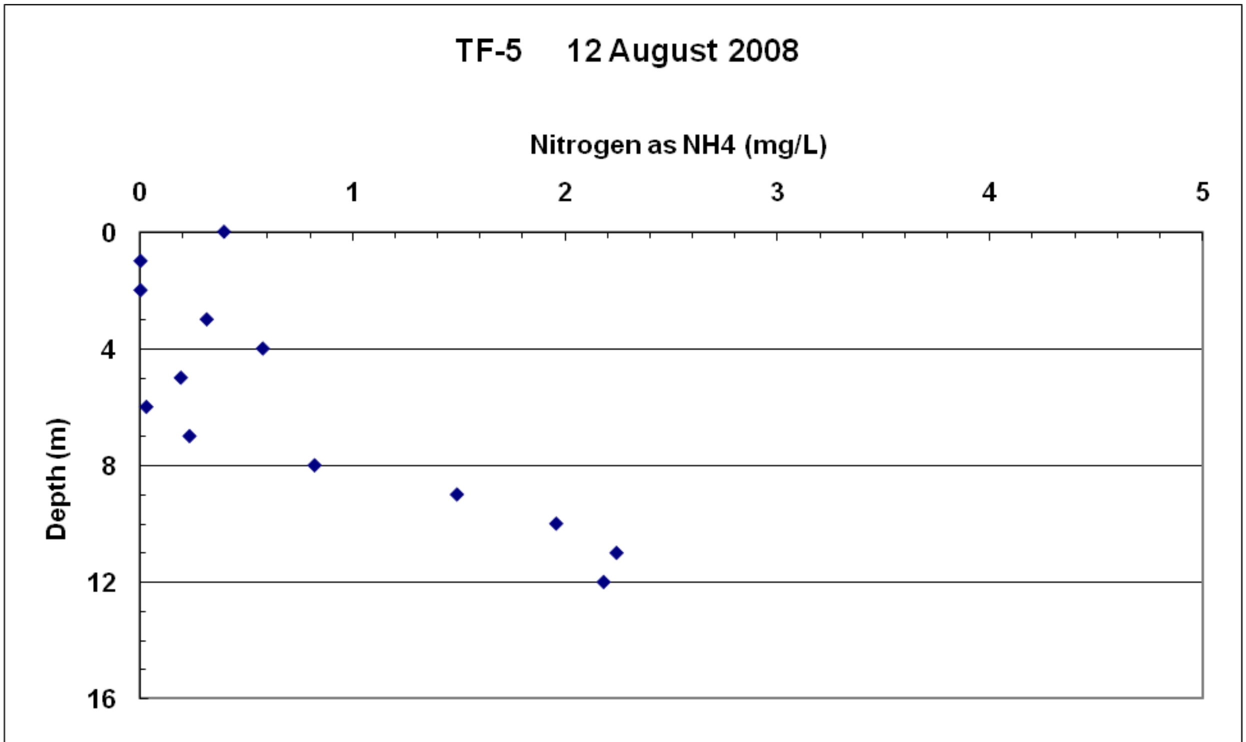

OTB-2 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

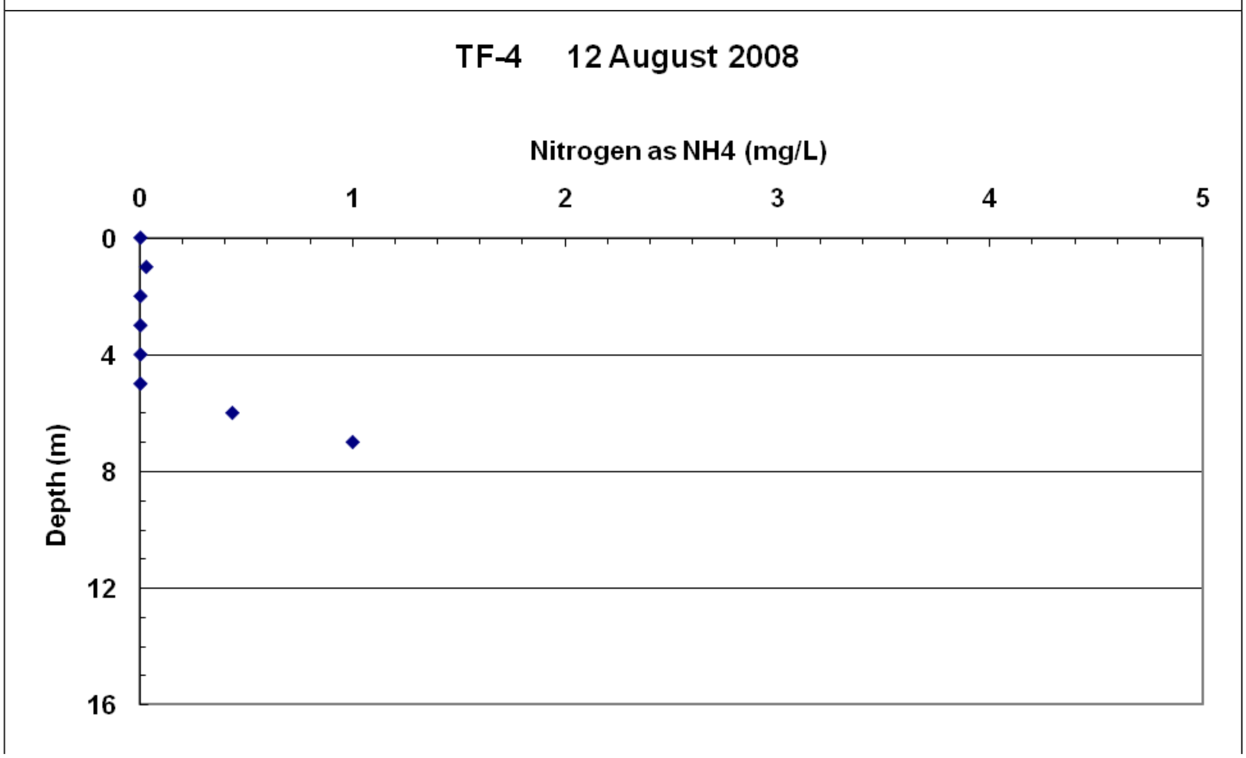

TF-5   12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
Depth (m)
0
4
8
12
16

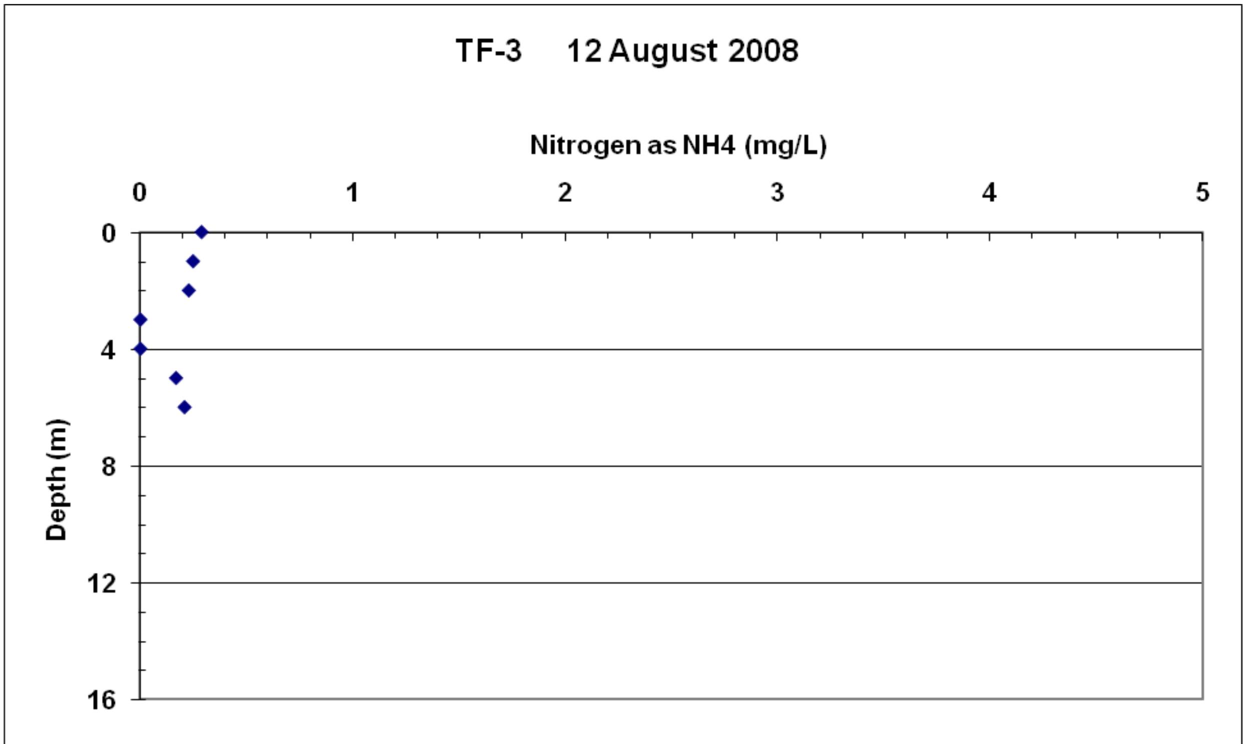

TF-4   12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
Depth (m)
0
4
8
12
16

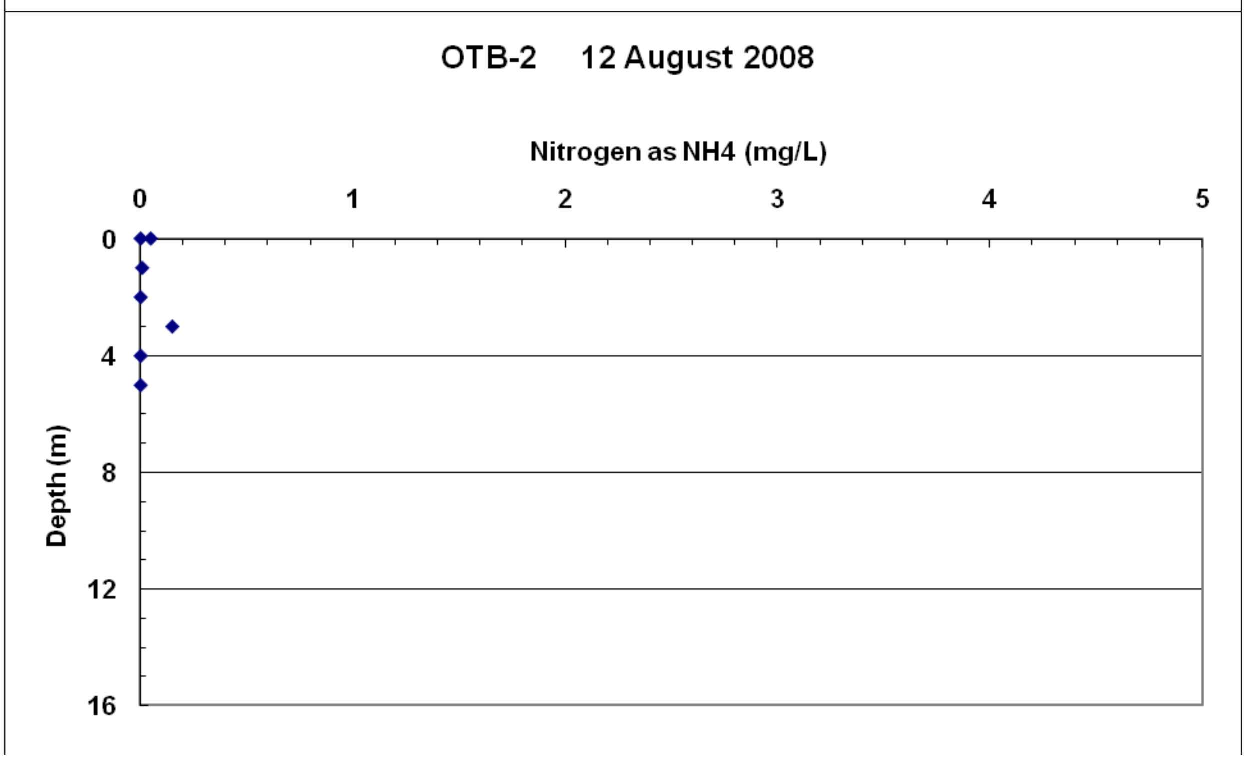

TF-3 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

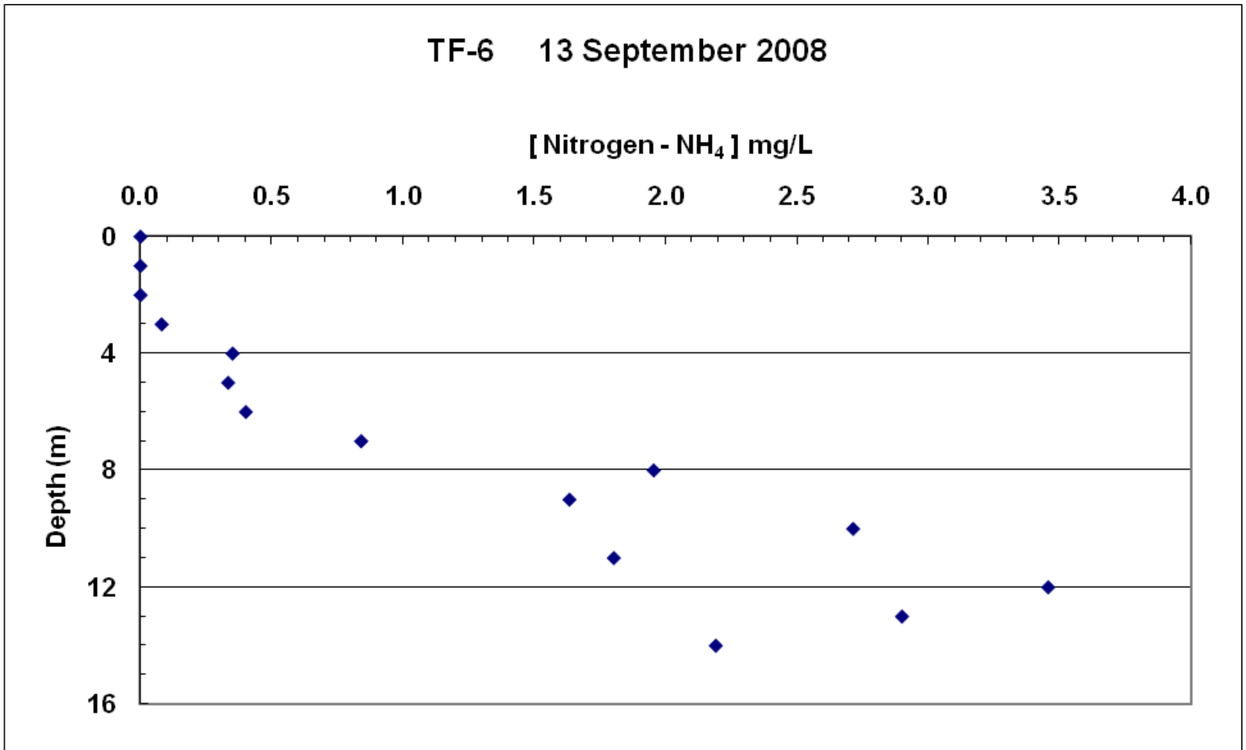

OTB-2 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

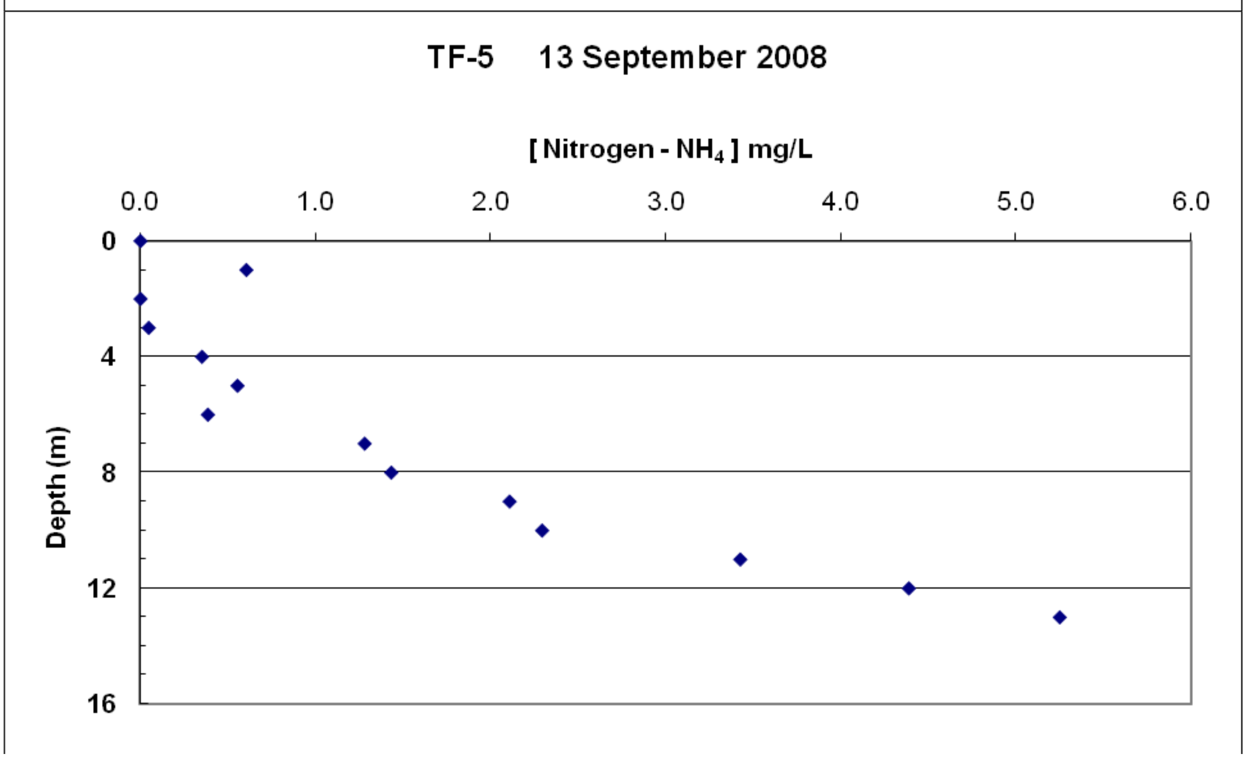

TF-5 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

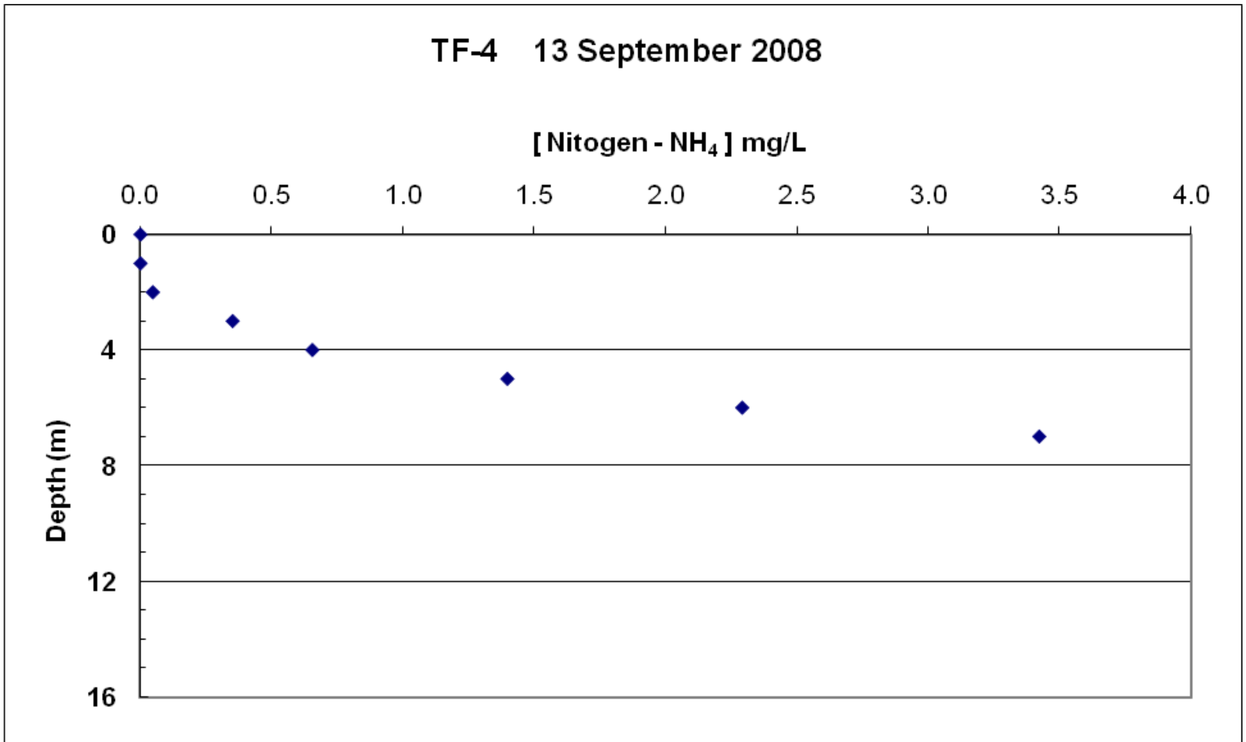

TF-4 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

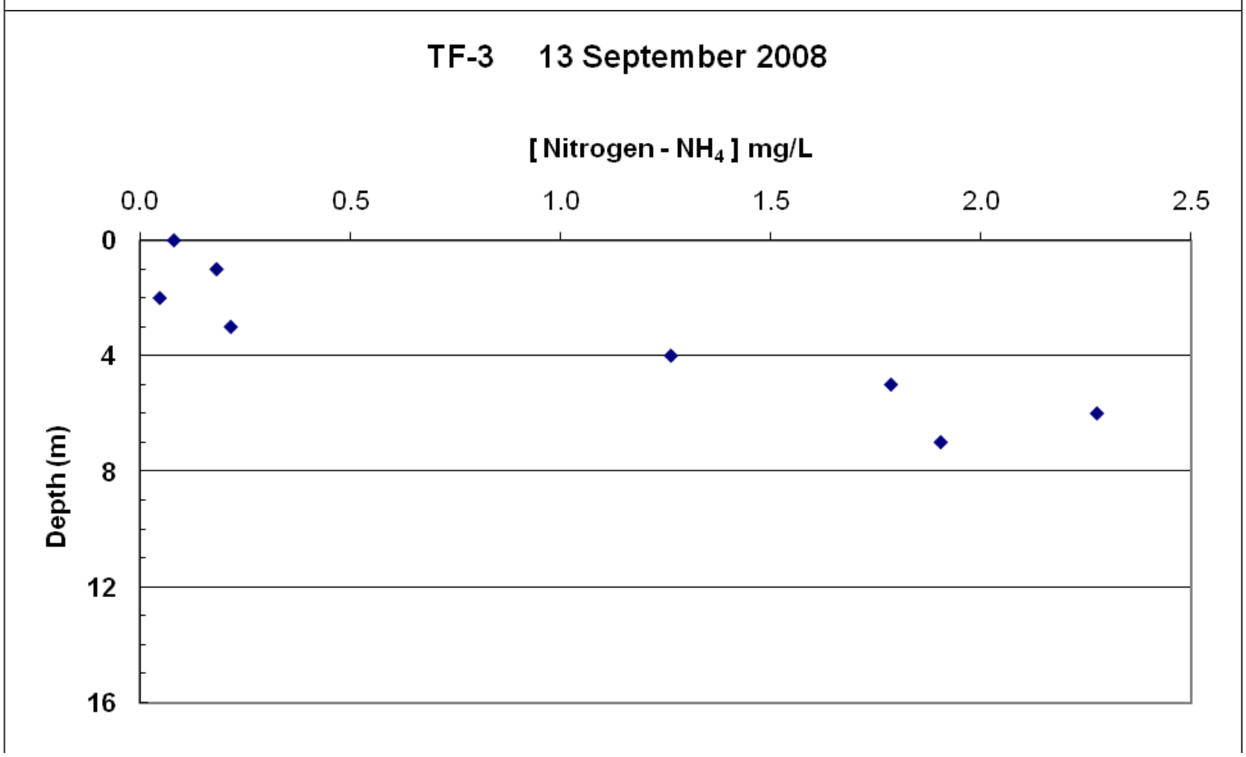

TF-3 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

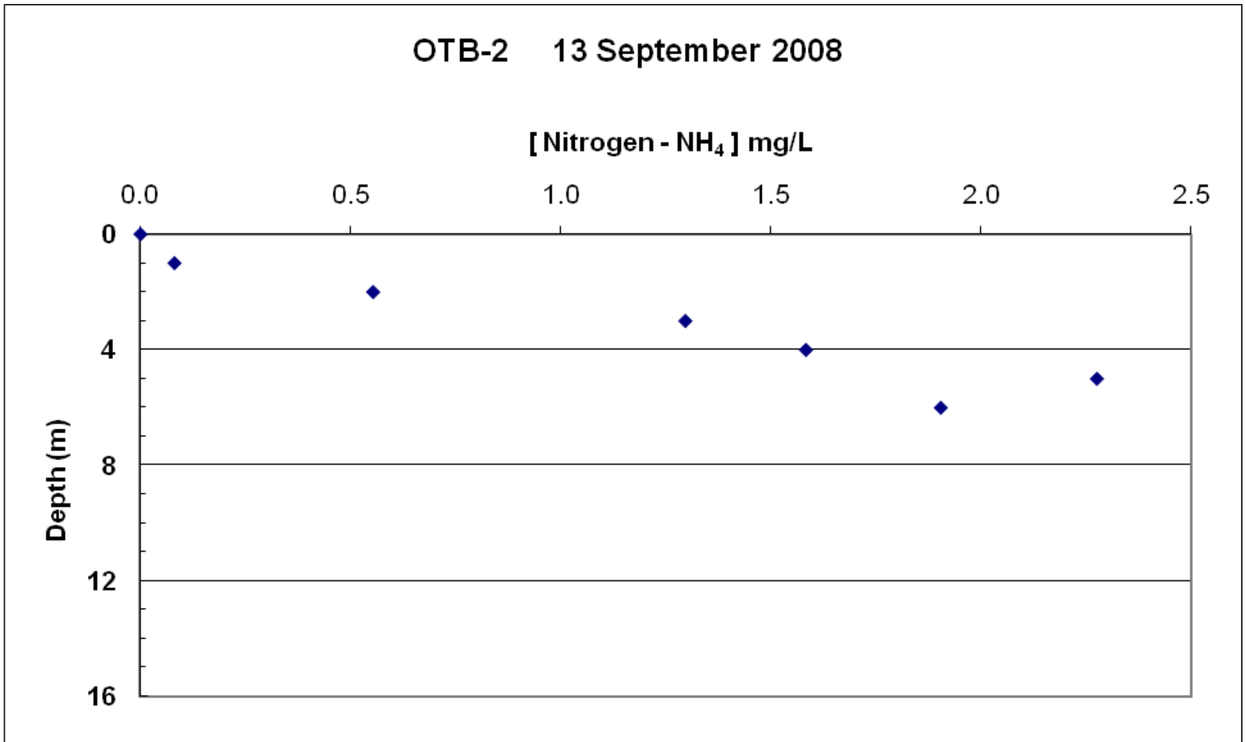

OTB-2 12 August 2008
Nitrogen as NH4 (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)


TF-6 13 September 2008
[Nitrogen - NH4] mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Depth (m)
0
4
8
12
16

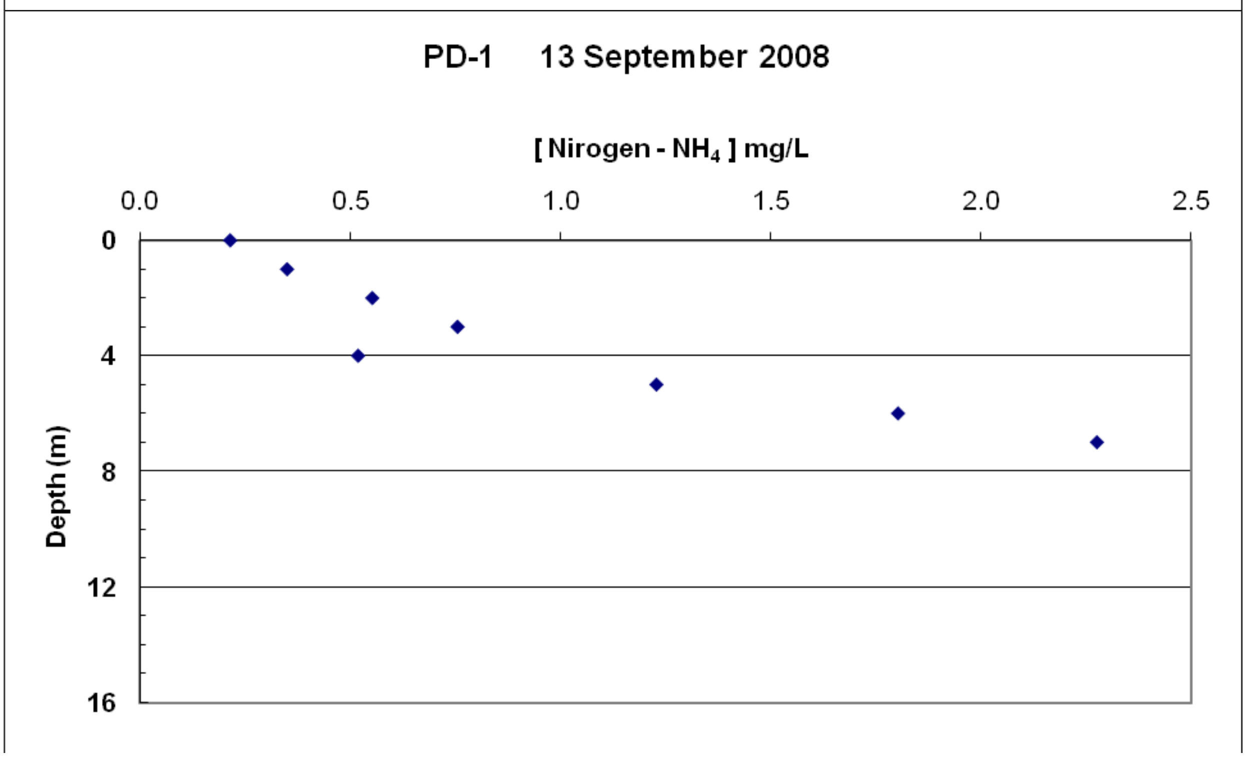

TF-5 13 September 2008
[Nitrogen - NH4] mg/L
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Depth (m)
0
4
8
12
16


TF-4 13 September 2008
[Nitogen - NH4] mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Depth (m)
0
4
8
12
16

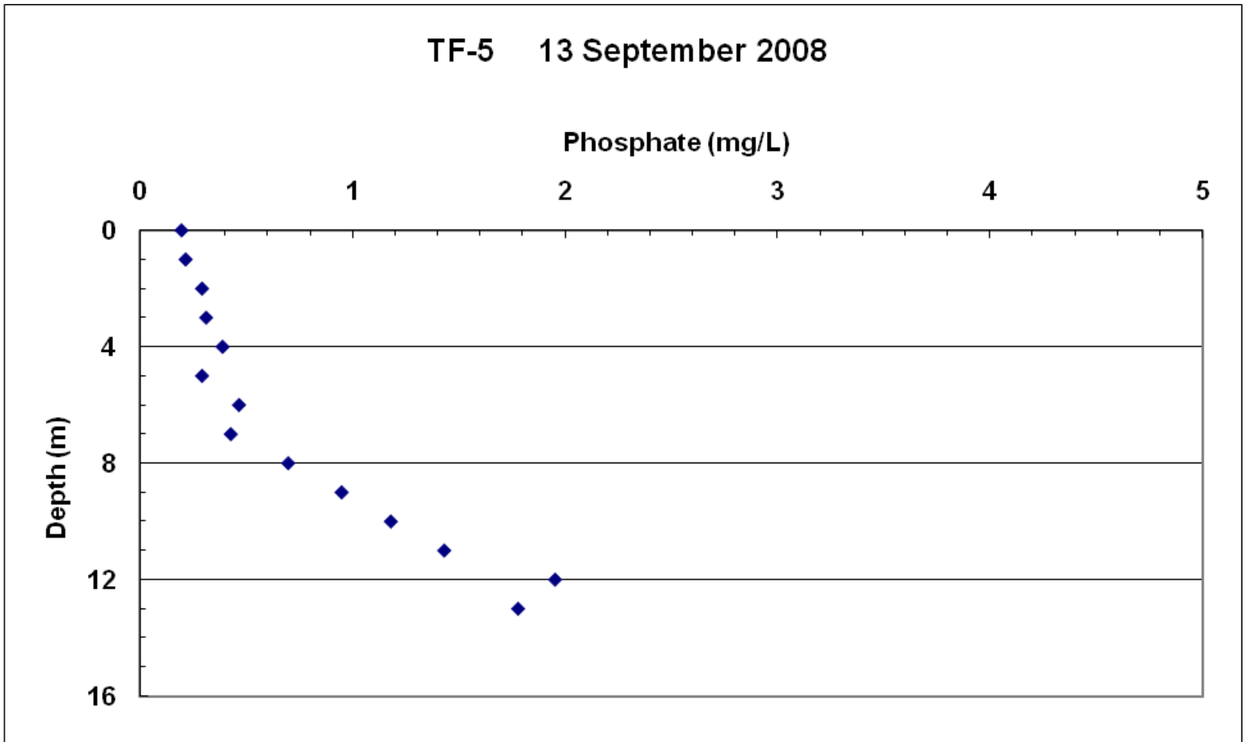

TF-3 13 September 2008
[Nitrogen - NH4] mg/L
0.0
0.5
1.0
1.5
2.0
2.5
Depth (m)
0
4
8
12
16

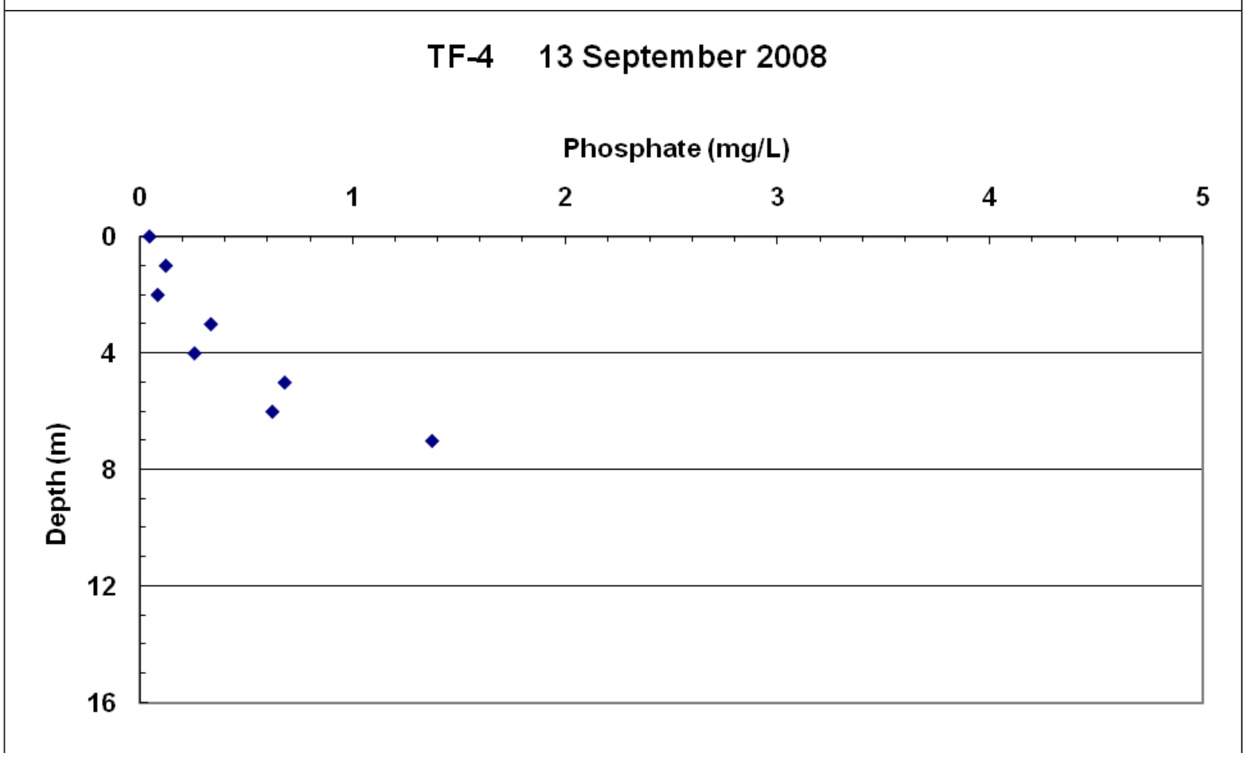


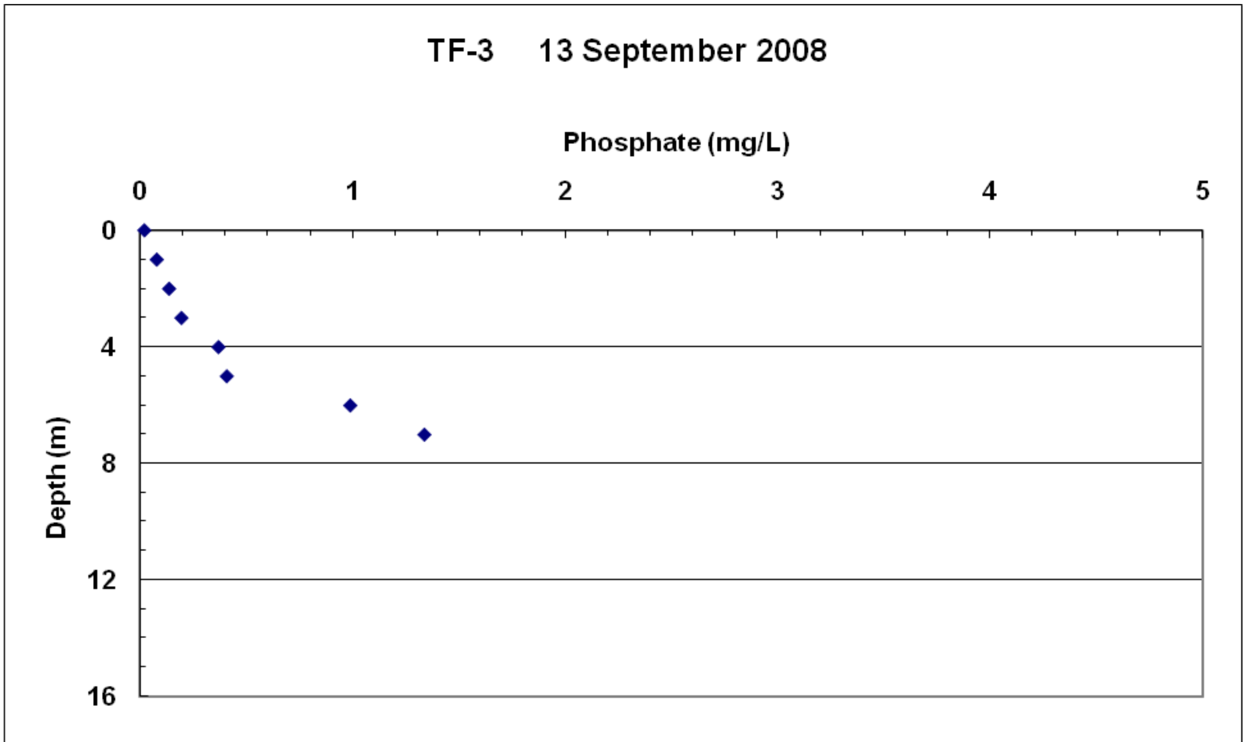
OTB-2 13 September 2008
[Nitrogen - NH4] mg/L
0.0
0.5
1.0
1.5
2.0
2.5
0
4
8
12
16
Depth (m)

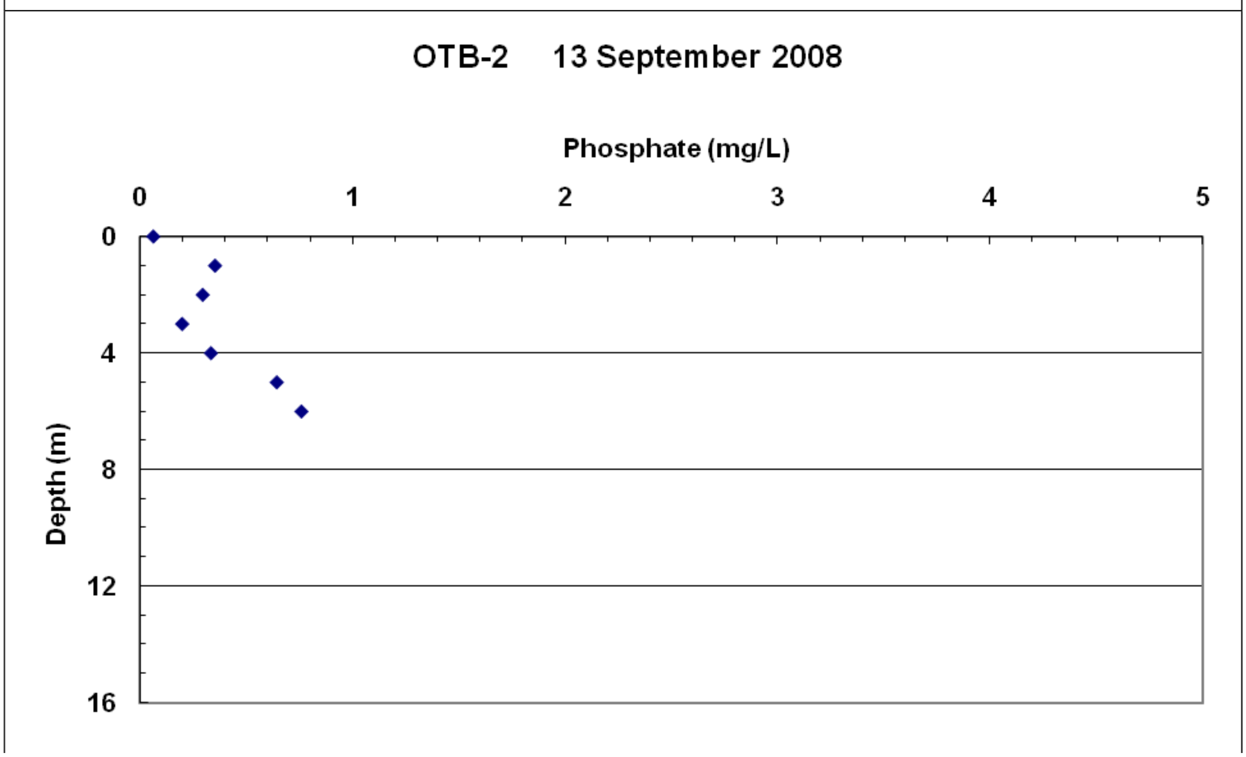


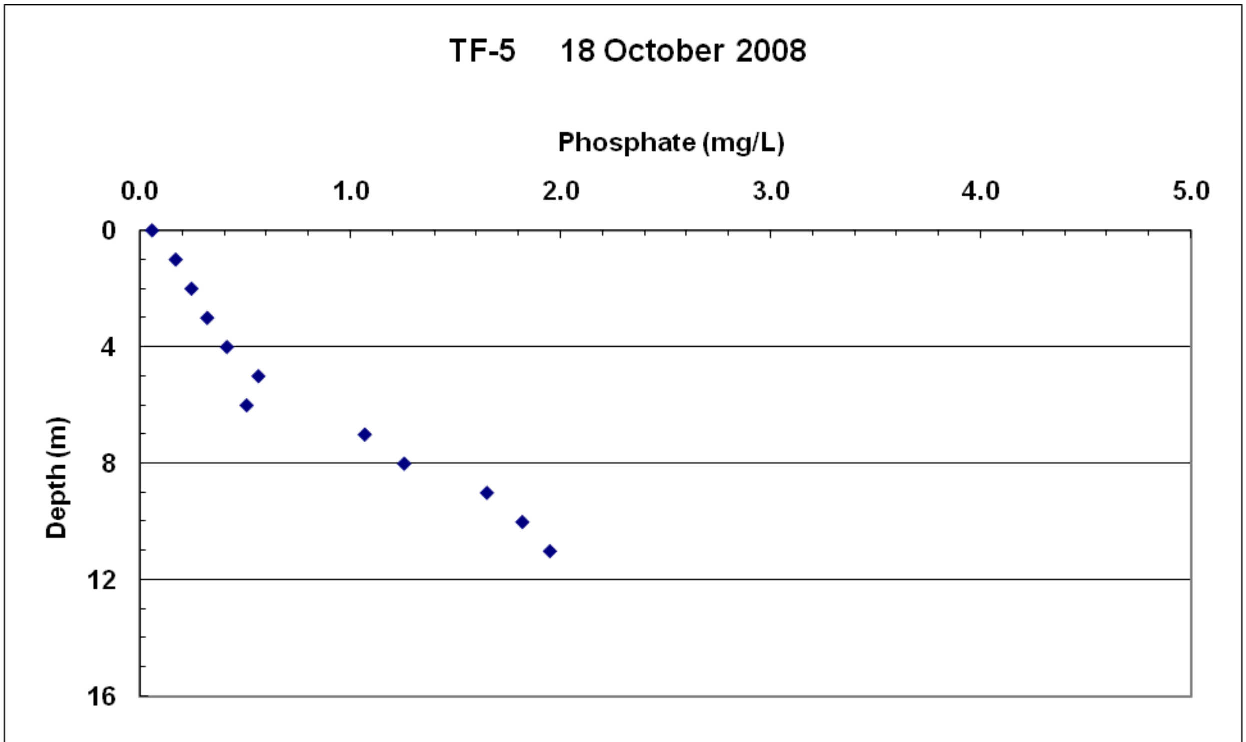
PD-1 13 September 2008
[Nirogen - NH4] mg/L
0.0
0.5
1.0
1.5
2.0
2.5
0
4
8
12
16
Depth (m)

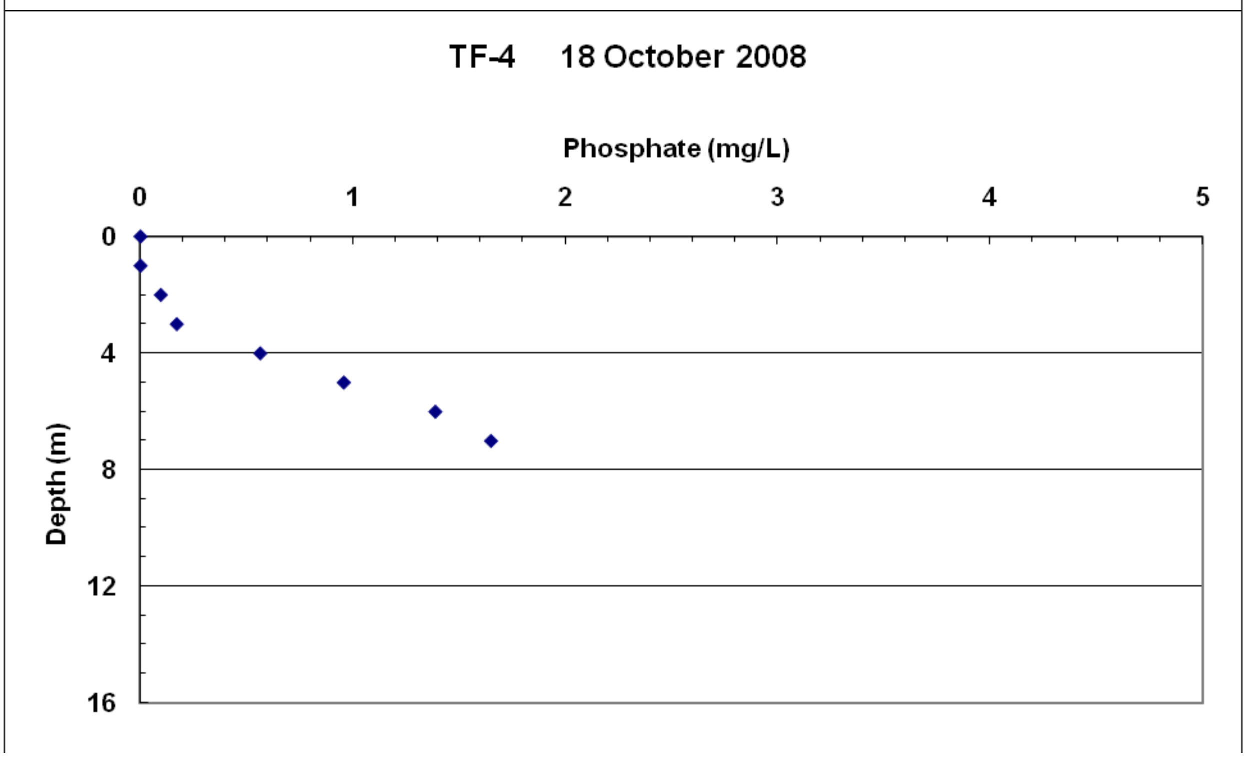

TF-5 13 September 2008
Phosphate (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

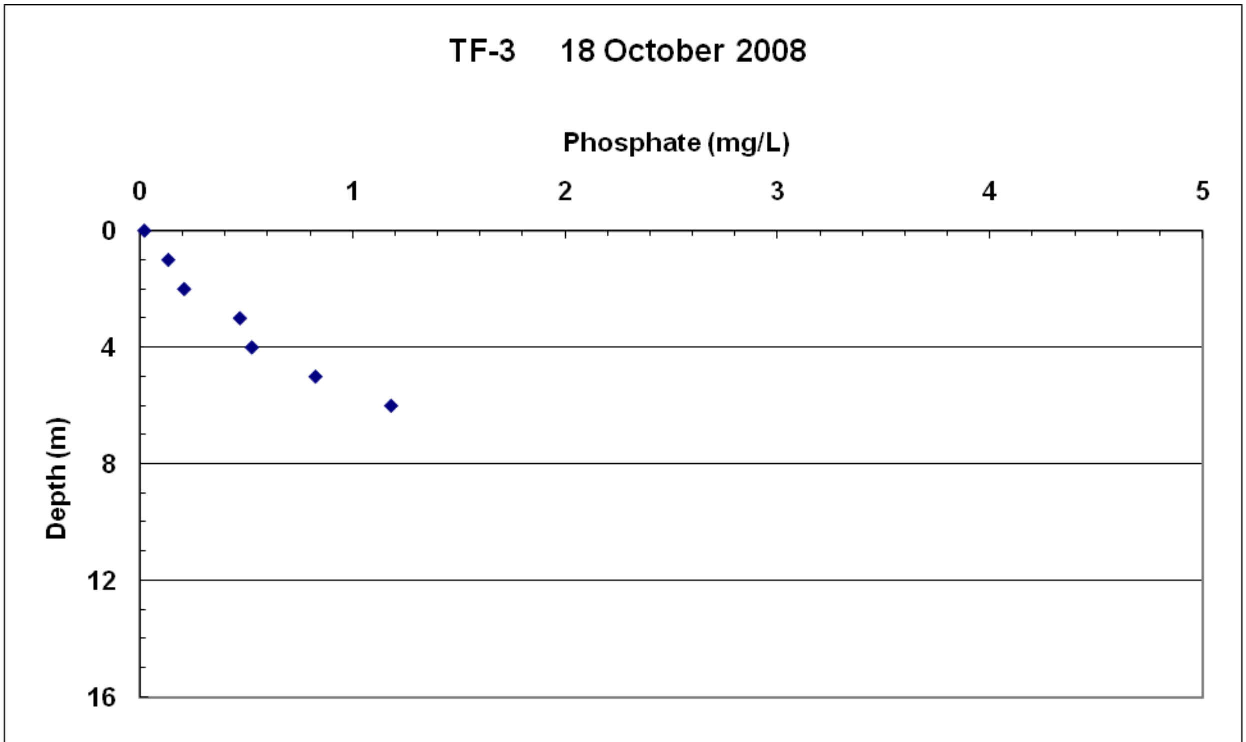

TF-4 13 September 2008
Phosphate (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

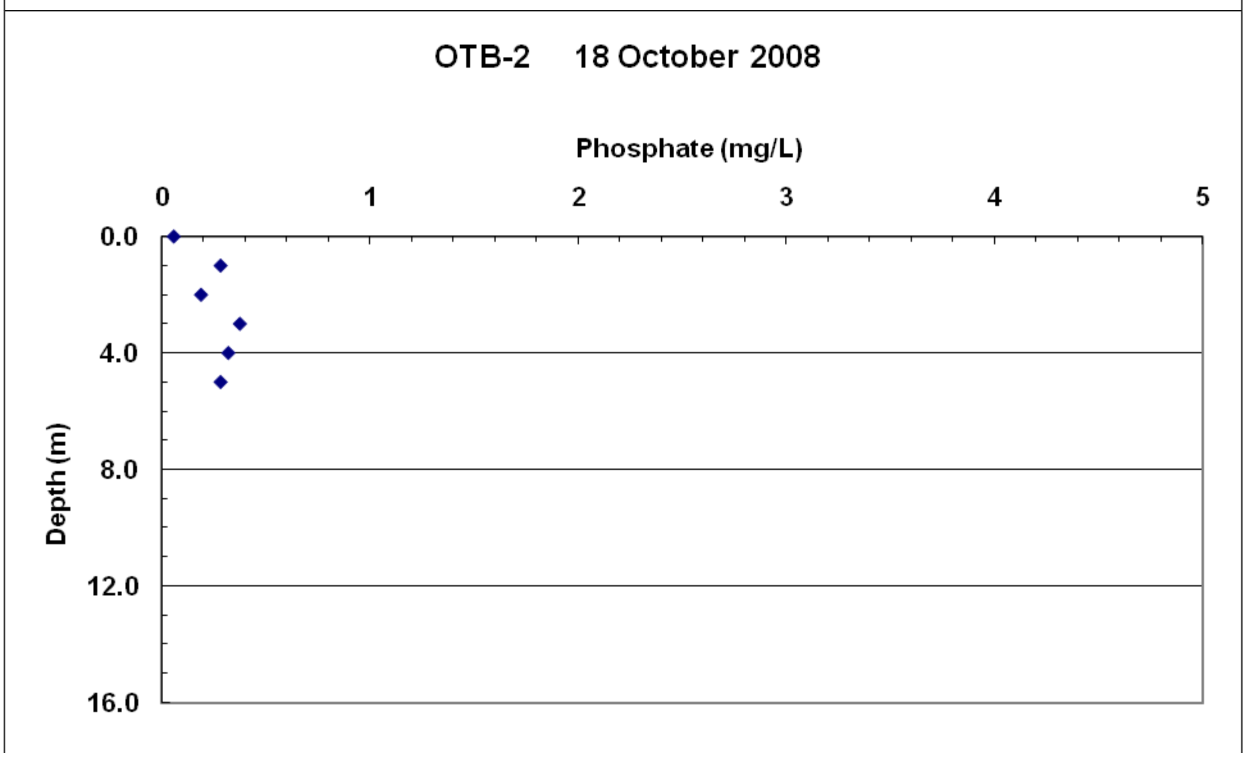

TF-3 13 September 2008
Phosphate (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

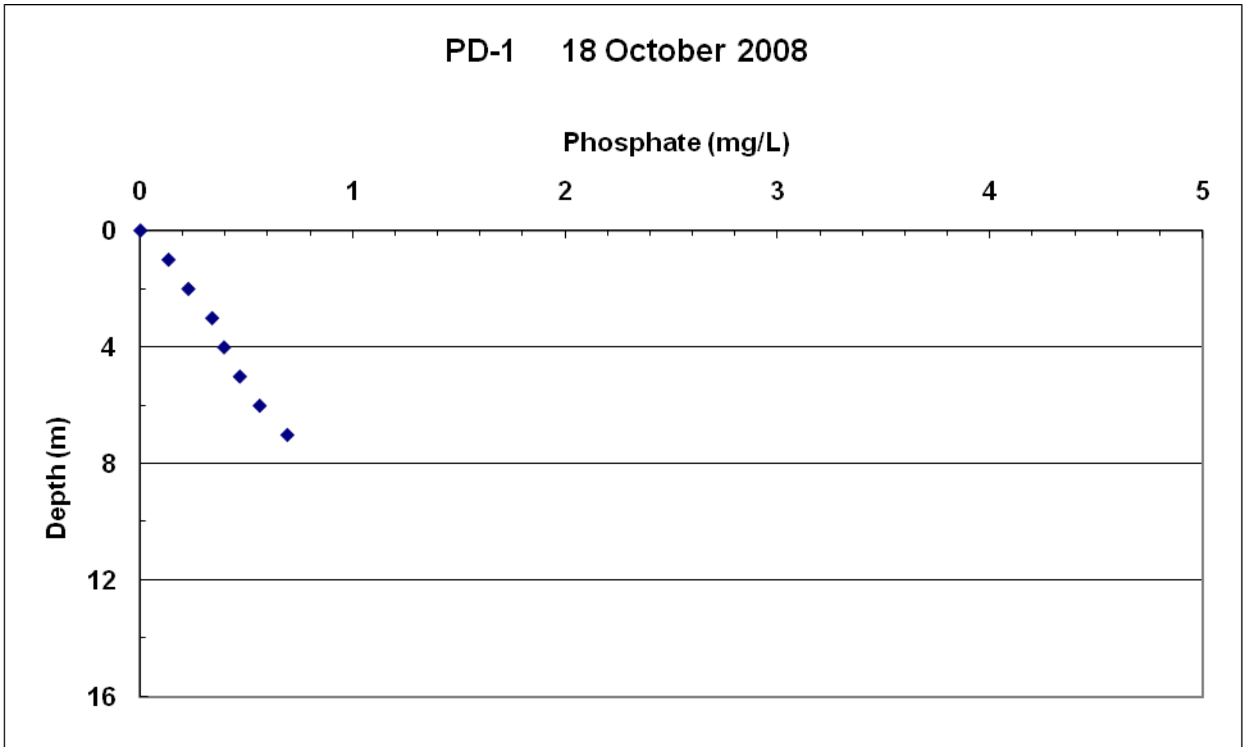

OTB-2 13 September 2008
Phosphate (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)


TF-5 18 October 2008
Phosphate (mg/L)
0.0
1.0
2.0
3.0
4.0
5.0
Depth (m)
0
4
8
12
16


TF-4 18 October 2008
Phosphate (mg/L)
0
1
2
3
4
5
Depth (m)
0
4
8
12
16


TF-3 18 October 2008
Phosphate (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

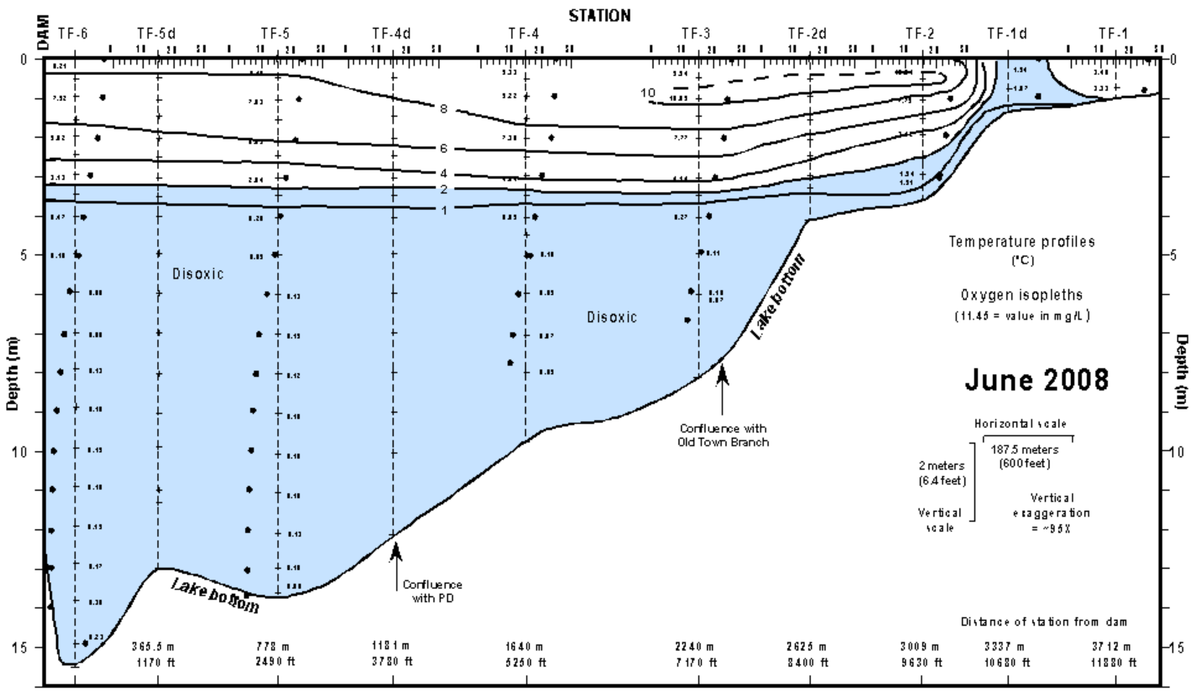

OTB-2 18 October 2008
Phosphate (mg/L)
0
1
2
3
4
5
0.0
4.0
8.0
12.0
16.0
Depth (m)

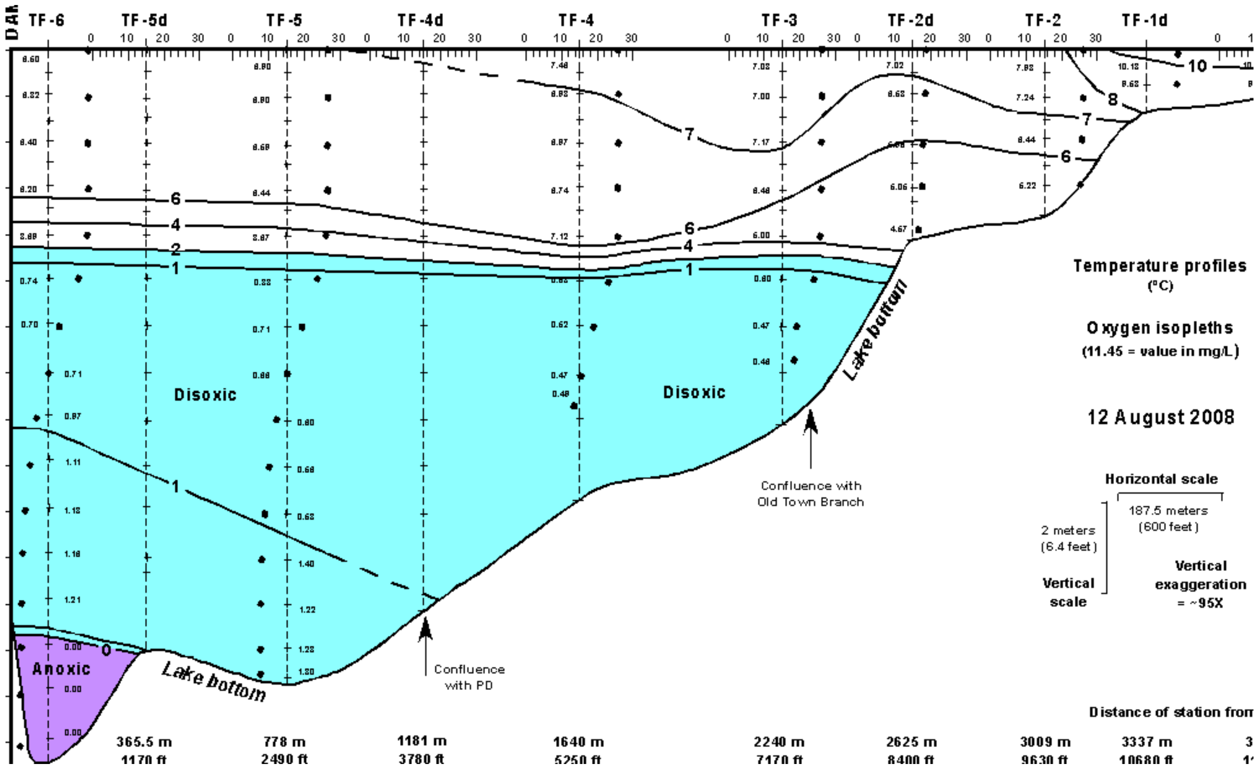


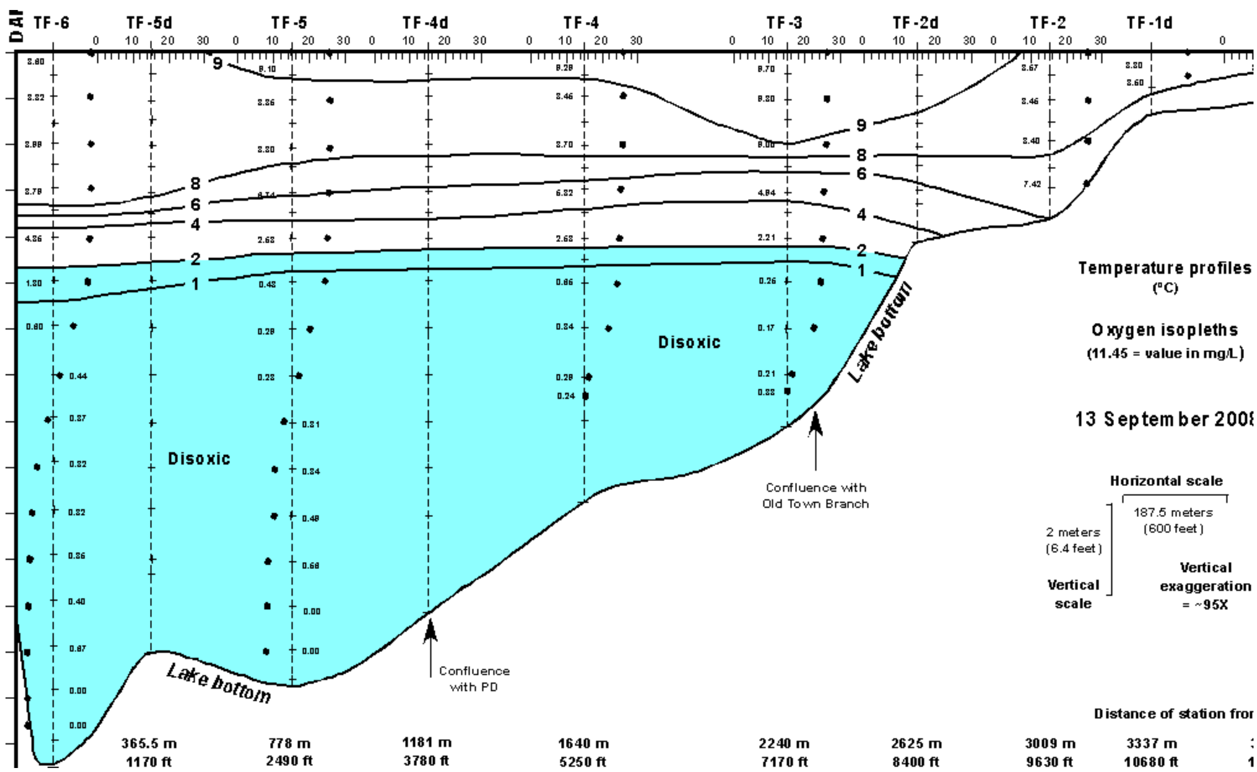
PD-1 18 October 2008
Phosphate (mg/L)
0
1
2
3
4
5
0
4
8
12
16
Depth (m)

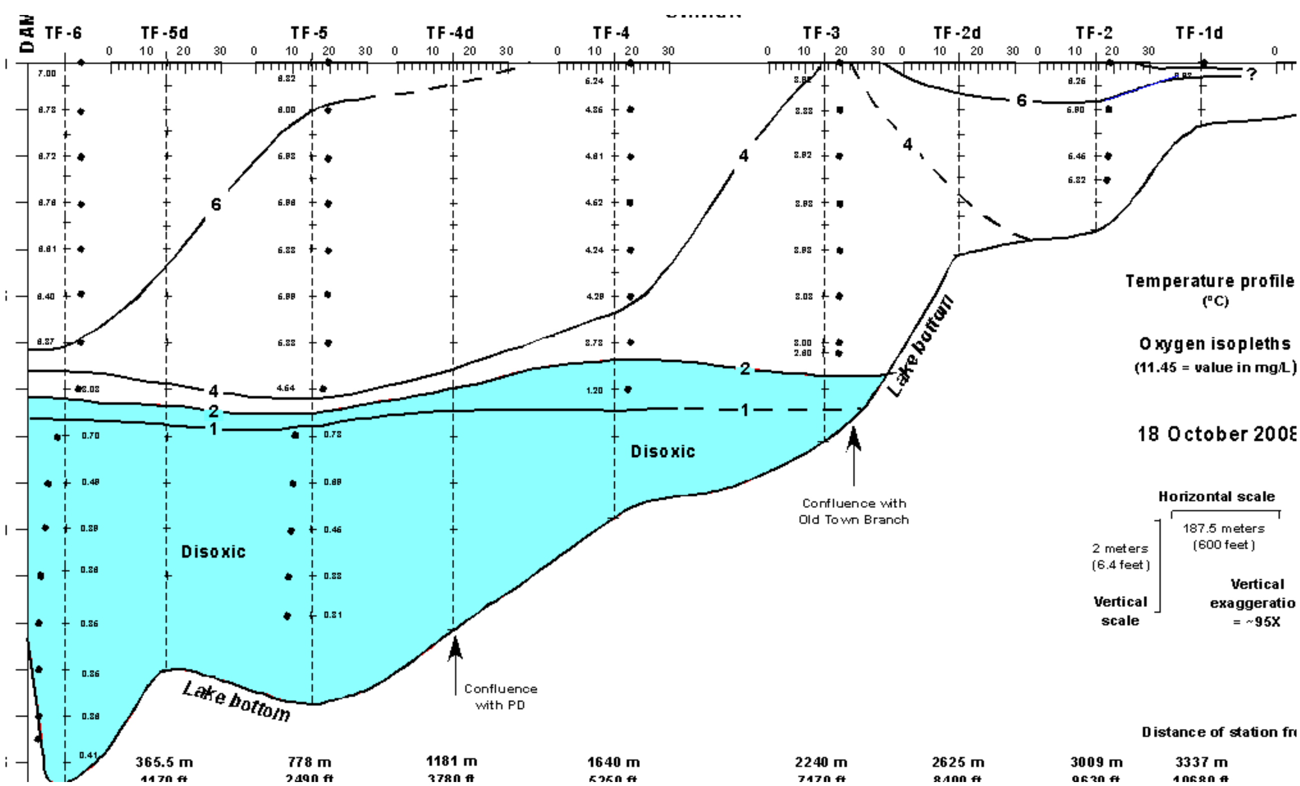
Appendix F

Lake Cross-Sections




TF-6
TF-5d
TF-5
TF-4d
TF-4
TF-3
TF-2d
TF-2
TF-1d
Disoxic
Disoxic
Anoxic
Lake bottom
Lake bottom
Confluence with Old Town Branch
Confluence with PD
Temperature profiles (°C)
Oxygen isopleths (11.45 = value in mg/L)
12 August 2008
Horizontal scale
187.5 meters (600 feet)
2 meters (6.4 feet)
Vertical scale
Vertical exaggeration = ~95X
365.5 m 1170 ft
778 m 2490 ft
1181 m 3780 ft
1640 m 5250 ft
2240 m 7170 ft
2625 m 8400 ft
3009 m 9630 ft
3337 m 10680 ft


TF-6
TF-5d
TF-5
TF-4d
TF-4
TF-3
TF-2d
TF-2
TF-1d
Disoxic
Disoxic
Lake bottom
Lake bottom
Confluence with Old Town Branch
Confluence with PD
Temperature profiles (°C)
Oxygen isopleths (11.45 = value in mg/L)
13 September 2008
Horizontal scale
187.5 meters (600 feet)
2 meters (6.4 feet)
Vertical scale
Vertical exaggeration = ~95X
365.5 m 1170 ft
778 m 2490 ft
1181 m 3780 ft
1640 m 5250 ft
2240 m 7170 ft
2625 m 8400 ft
3009 m 9630 ft
3337 m 10680 ft


TF-6
TF-5d
TF-5
TF-4d
TF-4
TF-3
TF-2d
TF-2
TF-1d
Temperature profile
(°C)
Oxygen isopleths
(11.45 = value in mg/L)
18 October 2008
Disoxic
Disoxic
Lake bottom
Lake bottom
Confluence with
Old Town Branch
Confluence
with PD
Horizontal scale
187.5 meters
(600 feet)
2 meters
(6.4 feet)
Vertical
scale
Vertical
exaggeration
= ~95X
Distance of station fr
365.5 m
778 m
1181 m
1640 m
2240 m
2625 m
3009 m
3337 m

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