Water Quality Data Report
For
The Norwalk River Watershed
May 2010 through September 2010

Excessive nutrients cause unwanted algal growth on impoundments such as Factory Pond

Submitted by:

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Long Island Sound Futures Fund, Connecticut Light and Power, The Norwalk Mayor's Water Quality Committee, The Wilton Inland Wetlands Commission, King Industries, Norwalk River Watershed Association, Inc., NRG-Manresa, Town of Ridgefield, Norm Bloom, Leslie Miklovich, and Trout Unlimited

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Acknowledgements

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Organizations:

Long Island Sound Futures Fund

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Individuals:

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We are pleased with the support offered by these individuals, and their willingness to go the extra mile to get the job done. Finding leaks in the infrastructure is only one aspect of pollution control. Fixing the system is beyond what HW/RW can accomplish, and this is where the above-mentioned people play a very valuable role.

To: The Norwalk Mayor's Water Quality Committee**,** The Wilton Inland Wetlands Commission, King Industries, Norwalk River Watershed Association, Inc., NRG-Manresa, Town of Ridgefield, Norm Bloom, Leslie Bloom-Miklovich, and Trout Unlimited-Mianus River Chapter

From: Dick Harris, Principal Investigator, Earthplace, Harbor Watch/River Watch Program

Date: December 10, 2010

Subject: The Norwalk River Watershed Project Water Quality Report for the period of May 2010 through October 7, 2010

I. Introduction:

Purpose of Study: The Earthplace Harbor Watch/River Watch (HW/RW) Program was funded by the Connecticut Department of Environmental Protection (CT DEP) to conduct water quality monitoring on the Norwalk River for six years, June 1998 through June 2005. HW/RW initially collected and analyzed water samples for fecal coliform bacteria at 21 sites, eleven of them along the main stem of the Norwalk River and one on the Silvermine River (Figure A2).

Background: From June 1998 through May 1999, HW/RW conducted a first-year water quality monitoring study in the Norwalk River Watershed. This study was funded by the CT DEP and was intended to provide water quality information in support of the Norwalk River Watershed Initiative. The purpose of the study was to obtain data on the levels of fecal coliform bacteria, dissolved oxygen, and conductivity at selected locations in the Norwalk River and in its major tributaries (Silvermine River, Comstock Brook and Cooper Brook). The study indicated that fecal coliform bacteria levels frequently exceeded the state's water quality criterion for Class B water at a number of sites along the Norwalk River. Most sites met the dissolved oxygen level CT DEP criterion for Class B waters. The first year study also showed that conductivity levels were consistently higher in the upper reaches of the watershed than in the lower watershed. Based upon the water quality data collected, HW/RW determined that the water quality in the Norwalk River Watershed was moderately impaired.

The CT DEP and HW/RW executed a contract for a second year funding in September 1999 (from September 1, 1999 through November 30, 2000). HW/RW was authorized to begin testing for *E. coli* bacteria in November 1999. Sampling then took place at 12 of the 21 most impacted sites along the Norwalk River. Monthly reports were prepared and submitted to the CT DEP and disseminated to the seven towns comprising the Norwalk River Watershed as well as the Norwalk River Watershed Initiative Advisory Committee.

Funding was then made available by the CT DEP to continue testing on the Norwalk River for a third summer (April 1 to September 30, 2001) based on a continuing interest by Norwalk River Watershed Advisory Committees and the CT DEP. The same testing protocols used in 2000 by HW/RW were again used under the original QAPP, which was extended on April 25, 2001 to September 30, 2001 by the EPA's Office of Environmental Measurement and Evaluation.

During 2002, the CT DEP switched to *E. coli* bacteria as the "preferred" indicator species for freshwater, as it is a more specific indicator of fecal material arising from humans and other warm-blooded animals. For recreational waters, the US EPA recommends the use of *E. coli* because it is a better indicator of a human health risk from water contact than fecal coliform bacteria (Table 1).

Additional 319 funding was allocated to continue the HW/RW testing regime on the Norwalk River for twenty-three months beginning July 2002 and ending June 30, 2004. The last contract with the CT DEP expired on 6/30/05. HW/RW again renewed testing of the Norwalk River and its tributaries by HW/RW began again on May 1, 2005 thanks to the interest and generosity of the Town of Wilton, The Norwalk River Watershed Association, King Industries, and NRG Inc. at Manresa Island in Norwalk. Going

forward, The Norwalk Mayor's Water Quality Committee, The Wilton Inland Wetlands Commission, King Industries, Norwalk River Watershed Association, Inc., NRG-Manresa, Town of Ridgefield, Norm Bloom, Leslie Miklovich, and Trout Unlimited have collectively continued to provide additional funds to support the 2009/2010 monitoring season.

Although these monthly reports are submitted to the CT DEP for review and comment, Harbor Watch/River Watch is solely responsible for the collection, analysis and interpretation of the water quality data.

II. Methods and Procedures:

Water monitoring is carried out under protocols of an EPA approved and revised EPA Quality Assurance Project Plan (QAPP RFA#10160 approved by the EPA on 9/16/10). Monitoring teams leave Earthplace in Westport between 9:30AM and 10:00AM, and return in early afternoon. Each team is comprised of an experienced leader and one or two trained volunteers. Water samples are collected at 12 (Figure A2) monitoring sites within the watershed (QAPP Appendix A1.1). These sites, which represent the more impacted areas, were selected in concert with the CT DEP, because results from the first year's study consistently demonstrated elevated fecal coliform bacteria counts at these locations. In addition to focusing monitoring efforts at these sites, it was determined to analyze for both fecal coliform and *E. coli* bacteria.

The following tests are run *in situ*: dissolved oxygen (QAPP Appendix A3.3) and conductivity (QAPP Appendix A3.8). Water and air temperatures, as well as general observations and storm events are also recorded at each site visit. Observations are recorded (QAPP Appendix 5) on the HW/RW Data Sheet according to the quality control requirements (QAPP Appendix 3.1).

Upon return to the lab, fecal coliform and *E. coli* bacteria membrane filtration tests (QAPP Appendix A3.13) are performed and analyzed according to Standard Methods, 21st edition (9222D & 9222G) and recorded (QAPP Appendix 5) on the HW/RW bacteria log. The frequency of which water quality monitoring for bacteria concentrations occurs is separated into two seasonal testing periods. For the period when the three wastewater treatment plants (WTP) are required to disinfect their wastewater effluent (May 1st to September 30th) monitoring is done four times per month. For the period when effluent disinfection is not required (October 1st to April 30th) monitoring is done monthly.

E. coli bacteria will be evaluated using the criteria published in the CT DEP Surface Water Quality Standards, 12/17/02. The CT DEP *E. coli* criteria for Class AA, A, and B water are established at three levels (Table 1).

Table 1CT DEP criterion for *E. coli* bacteria levels as applied to recreational use, effective 12/17/02

Designated Use Recreation	**Class**	**Indicator**	**Criteria**
Designated Swimming	AA, A, B	*Escherichia coli*	Geometric Mean less than 126 CFUs/100mLs; Single Sample Maximum 235 CFUs/100mLs
Non-designated Swimming	AA, A, B	*Escherichia coli*	Geometric Mean less than 126 CFUs/100mLs; Single Sample Maximum 410 CFUs/100mLs
All Other Recreational Uses	AA, A, B	*Escherichia coli*	Geometric Mean less than 126 CFUs/100mLs; Single Sample Maximum 576 CFUs/100mLs

The Norwalk River is classified by the CT DEP for "all other recreational uses" because the river is too shallow with the exception of a few impoundments. The report will focus on *E. coli* bacteria levels,

because it is the indicator bacteria of choice by the CT DEP. Fecal coliform bacteria levels are reported on Table B1 only as additional data for those who may be interested.

Limited nutrient research for total nitrogen (TN) and total phosphorus (TP) was initiated by HW/RW on four Norwalk River tributaries on 6/23 and 8/9. The tributaries were Steep Brook, Cooper Brook, Bennett's Brook and Comstock Brook (Figure A3). Nutrient concentrations were also assessed on 6/23, 7/20 and 8/9 on the discharge effluent at the three waste water treatment plants in Ridgefield (2) and Georgetown (Figure A4).

Samples were collected by HW/RW using QAPP protocols (Appendix A1.1) kept in a chilled cooler and delivered to York Analytical Laboratories in Stratford, CT within 24 hours. TN samples were processed under SM4500-N with a minimum detection level of 0.00700 mg/L, and a precision level of ±15%. TP samples were processed under EPA-365.3 with a minimum detection level of 0.020 mg/L, and a precision level of ±15%. Sterile collection bottles were provided by York. All TP bottles contained 1 mLs of concentrated H_2SO_4 as a preservative.

III. Results

Table 2 May 2010 through October 7, 2010 *E. coli* bacteria concentrations, geometric means and % frequency exceeding 576 colonies/100 mLs at 12 sampling sites in the Norwalk River Watershed for the period of time when the two Ridgefield and the Georgetown wastewater treatment facilities are required by NPDES permits to disinfect effluent discharges

	Dates												
Sites	5/6/2010	5/12/2010	5/20/2010	5/27/2010	6/3/2010	6/10/2010	6/17/2010	6/24/2010	7/1/2010	7/7/2010	7/15/2010	7/22/2010	7/28/2010
NR23	24	1380	100	96	132	550	100	2800	10	130	300	700	56
NR22	0	1	1	0	0	0	0	170	0	0	0	3	0
NR21	120	1160	212	136	204	680	400	4100	140	400	370	450	240
NR20	240	360	188	228	720	400	192	5900	44	340	290	300	80
NR15	80	340	148	132	184	770	188	1300	60	200	308	210	120
NR13	60	120	108	400	272	250	256	2600	168	740	820	390	380
NR9.5	30	60	148	260	64	20	n/a	260	84	124	330	70	52
NR9	66	140	154	180	420	2100	n/a	920	240	380	400	470	420
NR6	140	680	228	228	144	350	n/a	440	120	400	670	800	156
NR4	110	460	600	196	272	380	n/a	500	156	228	14000	2400	212
SM3	60	340	168	152	156	240	n/a	156	132	80	580	1400	96
NR1	80	600	152	144	128	160	n/a	380	228	240	770	800	120
Rainfall (in.)	0.98	0.38	0.95	0.08	0.38	0.53	0.01	0.77	0.37	0.00	1.62	1.16	0.11
Days prior	3	0	2	3	2	1	3	2	3	7	1	1	3

	Date									
Sites	8/5/2010	8/11/2010	8/19/2010	8/25/2010	9/2/2010	9/8/2010	9/22/2010	10/7/2010	**Geomean**	%frequency over 576 colonies/100mLs
NR23	204	420	188	460	208	340	144	56	**185**	14.29%
NR22	0	0	0	0	0	0	0	0	**1**	0.00%
NR21	360	176	220	272	380	196	152	104	**298**	9.52%
NR20	168	104	112	104	80	84	36	52	**183**	9.52%
NR15	64	244	88	164	116	96	44	140	**162**	9.52%
NR13	620	400	600	240	136	1240	108	88	**302**	19.05%
NR9.5	420	204	104	260	60	156	68	204	**111**	0.00%
NR9	600	880	720	400	340	300	160	188	**348**	25.00%
NR6	260	168	300	720	152	144	100	108	**251**	20.00%
NR4	440	172	88	560	320	300	260	204	**362**	15.00%
SM3	116	44	440	236	72	48	124	88	**153**	10.00%
NR1	240	200	220	340	72	132	140	104	**205**	15.00%
Rainfall (in.)	0.02	0.00	0.47	1.91	0.02	0.01	0.79	0.04		
Days prior	7	7	3	2	7	5	6	2		

Table 3 Monitoring dates and water temperatures when dissolved oxygen concentrations were observed to be below 5 mg/L at Sites NR21 and NR20

Site	Date	DO Concentration	Water Temperature ^{o}C
NR21	6/24/2010	3.4	20.8
	7/15/2010	3.5	22.0
	7/22/2010	3.6	21.6
	7/28/2010	4.4	21.6
	8/25/2010	4.4	18.5
NR20	7/15/2010	4.6	22.6
	8/25/2010	4.0	18.3

Table 4 Maximum, minimum, mean and site range conductivity values (µS) at 12 monitoring sites on the Norwalk River from May 2010 to October7, 2010

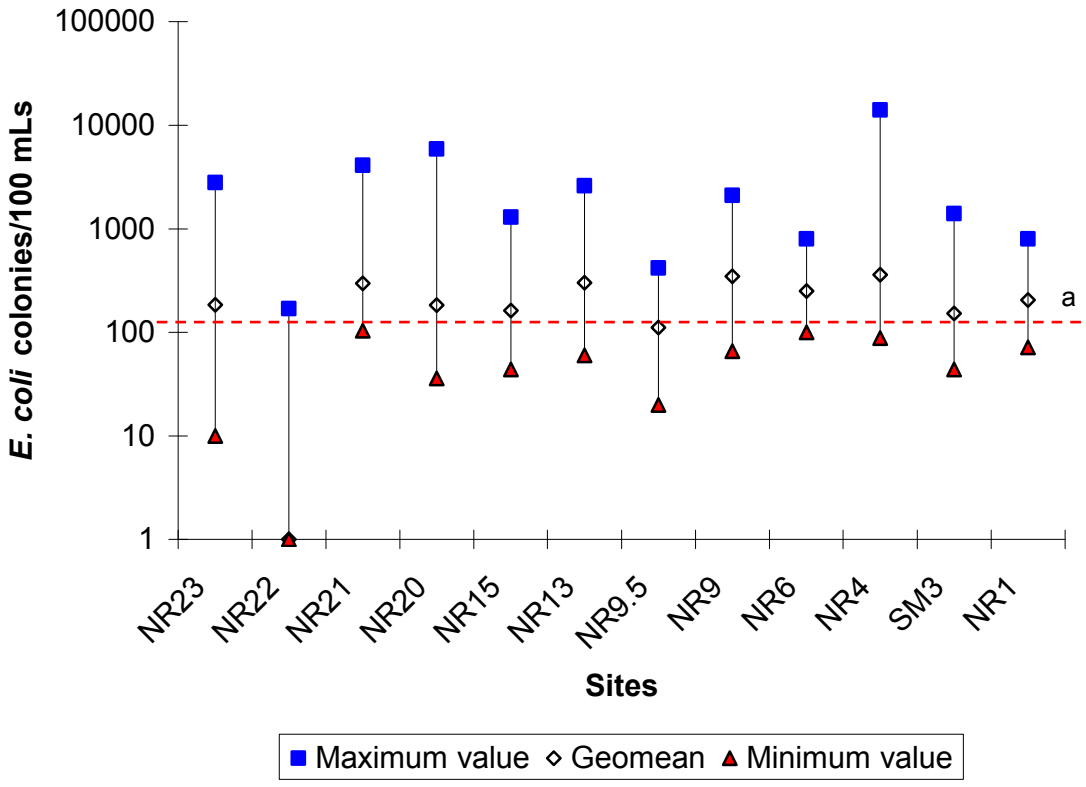
Site	NR23	NR22	NR21	NR20	NR15	NR13	NR9.5	NR9	NR6	NR4	SM3	NR1
Maximum value	1330	928	947	906	756	581	511	431	432	446	299	551
Minimum value	385	527	512	451	410	347	330	322	289	233	174	250
mean	928	800	770	720	625	458	425	370	374	381	259	391
Range	945	401	435	455	346	234	181	109	143	213	125	301

All monitoring sites with the exception of Site NR22 (the main Ridgefield Wastewater Treatment Plant) and Site NR 9.5 exceeded the CT DEP Class B river geomean criterion for *E. coli* bacteria of <126 CFUs/100 mLs (Table1, Table 2, Figure 1, and Figure A2). Five of these sites (NR22, NR21, NR20, NR15, and NR 9.5) did meet the secondary criterion, the Single Sample Maximum (SSM), which is <10% of that site's samples for *E. coli* bacteria exceeding the 576 CFUs/100 mLs level (Table 1, Table 2, and Figure 1). Site NR22 and Site NR 9.5 met both the geomean and SSM criteria for *E. coli* bacteria levels (Table 2 and Figure 1).

All sampling sites met the CT DEP dissolved oxygen (DO) mean criterion of 5 mg/L, however, individual DO values less than 5 mg/L were observed at Site NR21 and NR 20 on several occasions (Figure 2, Table3).

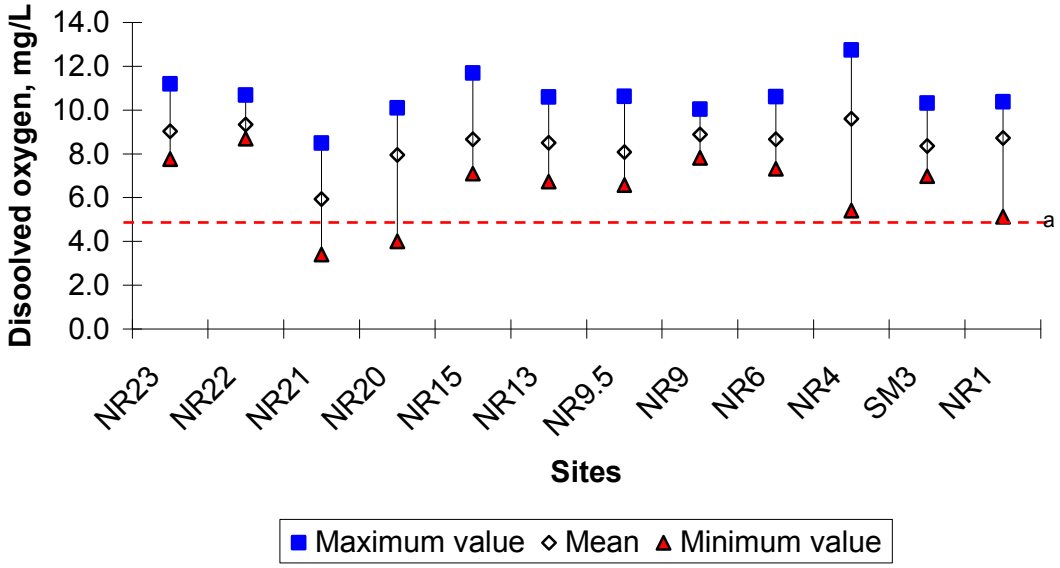
Observed conductivity means ranged from 928 µS in the upper watershed at Site NR23 to a minimum of 259 µS at Site SM3 on the Silverrmine River (Figure 3, Table 4). Observed individual site ranges are at a maximum of 945 µS at Site NR23 on Steep Brook and are at a minimum of 109 µS at site NR9 (Table 4).

Figure 1 Maximum, geometric means, and minimum values of *E. coli* bacteria concentrations at 12 monitoring sites in the Norwalk River Watershed from May 2010 through October 7, 2010 when the two Ridgefield and one Georgetown wastewater treatment facilities are required by NPDES permits to disinfect sewage effluent



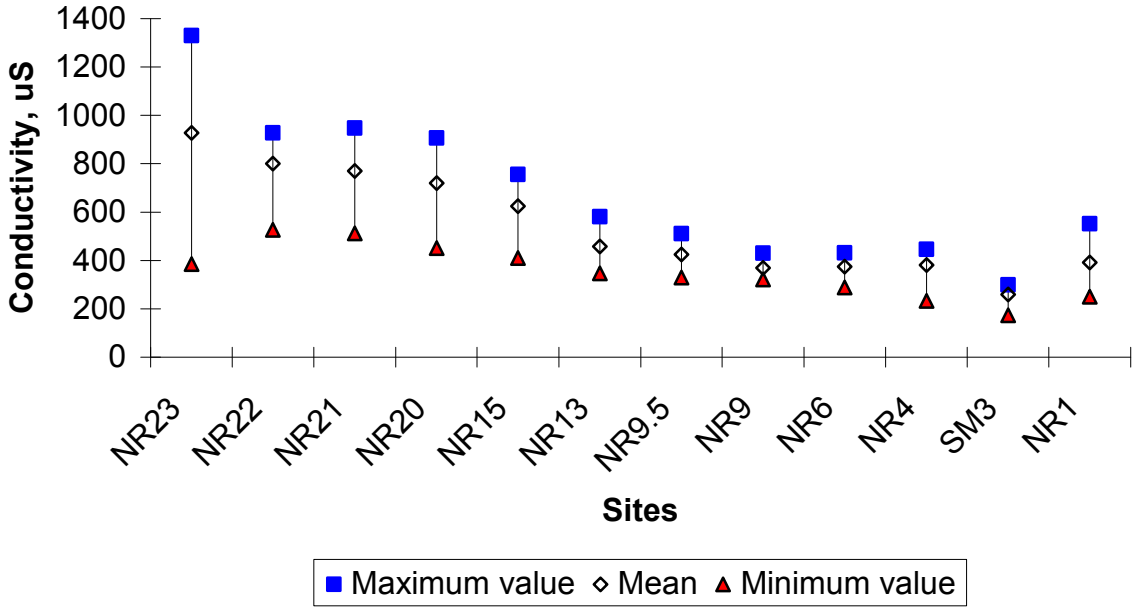
[a]CT DEP geomean maximum value for a Class B river

Figure 2 Maximum, mean and minimum values for dissolved oxygen at 12 sampling sites on the Norwalk River Watershed from May 2010 through October 7, 2010



[a]CT DEP minimum value for a Class B river

Figure 3. Maximum, mean and minimum value for conductivity at 12 sampling sites in the Norwalk River Watershed from May 2010 through October 7, 2010



Nutrient studies for total nitrogen (TN) and total phosphorus (TP) were completed during the summer months of 2010. TN and TP levels were observed at four tributaries, i.e., Steep Brook, Cooper Brook, Bennett's Brook and Comstock Brook, on 6/23 and 8/9 (Figure 4, Figure 5, Figure A4) and on the discharge to the Norwalk River of three waste water treatment plants (Figure 6, Figure 7) on 6/23, 7/20 and 8/9. The three WTP's are located at Site NR22 (Ridgefield, South Street), NR16 (Ridgefield, Route 7) and Site NR9.8 (Georgetown) (Figure A3, Table 5). During the summer months, NPDES seasonal (May through September) criteria are in effect for treatment of TP, effluent disinfection (UV lights) and monthly limits for ammonia-nitrogen (NH_3-N). These last systems are either turned off or are not applicable to winter months.

The only guidelines for TN and TP approved by the CT DEP apply to standing water in lakes and impoundments (Appendix E). No CT DEP approved criteria for TN or TP in moving water presently exist. Nutrient samples collected by HW/RW in moving streams and processed by York Laboratories (Methods and Procedures Section 2) may be of limited value. First, the method of sampling used by HW/RW is the grab method as opposed to the better suited composite method for this type of sampling. Second, there is no approved CT DEP TN or TP criteria for moving water for a true comparison. However, nutrient research in numerous pristine reference streams in Maine have shown that TP levels of 0.020 mg/L and TN levels of 0.60 mg/L are realistic values for moving water (Danielson).

Nevertheless, the samples are useful. For TN for the tributaries, they point to the extreme fluctuations in the observed values (Figure 4, Figure 5) where TN values are observed as low as 0.208 mg/L for Cooper Brook on 6/23 and as high as 2.020 mg/L on 8/9. In this one instance the Brook waters nearly meet the TN oligotrophic guidelines of 0.20 "high potential for contact recreation" and then exceed the other end of the scale where they are twice (2.080 mg/L) the "highly eutrophic" level of 1.00 mg/L (Figure 4, Appendix E). All the observed tributaries except BB1 have one observed TN level that exceeds the CT DEP "highly eutrophic" guideline (Figure 4, Appendix E). Rainfall of 0.77 was recorded one day prior to monitoring on 6/23 and zero for seven days prior to monitoring on 8/9. The TP values for the four tributaries show the same wide fluctuation. On 6/23 elevated TP values of 1.65 mg/L and 1.48 mg/L were observed at the Site BB1 and Site NR23 respectively (Figure 5). These values greatly exceed the "highly eutrophic" value of 0.050 mg/L shown on the CT DEP guidelines for lakes (Appendix E). On 8/9, the same two monitoring sites show observed values below the MDL, which meets the "oligotrophic" level of 0.010 mg/L The rainfall is the same as recorded for observed TN levels (Figure 5).

Nutrient levels observed in the three WTP discharges on 6/23, 7/20 and 8/9 are useful as compared against the approved NPDES permit criteria for each plant (Table 5).

Table 5 Waste water treatment plant type, design flow, actual flow, seasonal permit criteria for disinfection (UV lights), total phosphorus and ammonia-nitrogen and annual permit criteria for total nitrogen.

Location	Type	MGD Design	MGD actual	NPDES Seasonal 5/1-9/30 Limits	NPDES Annual Limits
Ridgefield South Street Site NR22	AS* AdvTr* Nitr* DNitr* PRem* Sfilt* UV Lights*	1.00	0.70	Phosphorus 1mg/L[a] UV lights Ammonia-Nitrogen[b]	TN< 6 mg/L
Ridgefield Route 7 Site NR16	RBC* Nitr* UV Lights*	0.12	0.050	UV Lights Ammonia-Nitrogen[b]	
Redding @[d] Georgetown Site NR9.8	Zenon ®[c] Zeeweed ® AdvTr* Nitr* DNitr* PRem* UV Lights*	0.245	0.055	Phosphorus 2mg/L[a] UV Lights Ammonia-Nitrogen[b]	TN 8 mg/L

a) Phosphorus limits noted are an average over a period of 30 days

b) Ammonia-nitrogen levels are regulated April through October

c) General Electric registered trade marks

d) Redding has bettered the NPDES permit levels by leaving phosphorus removal and UV lights on all year much to the town's credit

*

AS	Activated Sludge
RBC	Rotating biological contractor system
UV	Ultraviolet disinfection
AdvTr	Advanced treatment
Nitr	Nitrification
DNitr	Denitrification
PRem	Phosphorus removal
Sfilt	Sand filter

Based on the NPDES criteria shown in Table 5, both the main Ridgefield WTP and the Georgetown WTP are shown to be operating within NPDES permit levels for both total nitrogen and total phosphorus (Figure 6, Figure 7). The one exception is an observed phosphorus level of 2.4 mg/L in the Georgetown effluent on 6/23 (Figure 7). Due to lack of appropriate technology,

there are no TN or TP discharge levels established for the Route 7 WTP and there are consequently no NPDES permit violations (Figure 6, Figure 7).

Figure 4 Total Nitrogen (mg/L) observed at four tributaries of the Norwalk River on 6/23/10 and 8/9/10

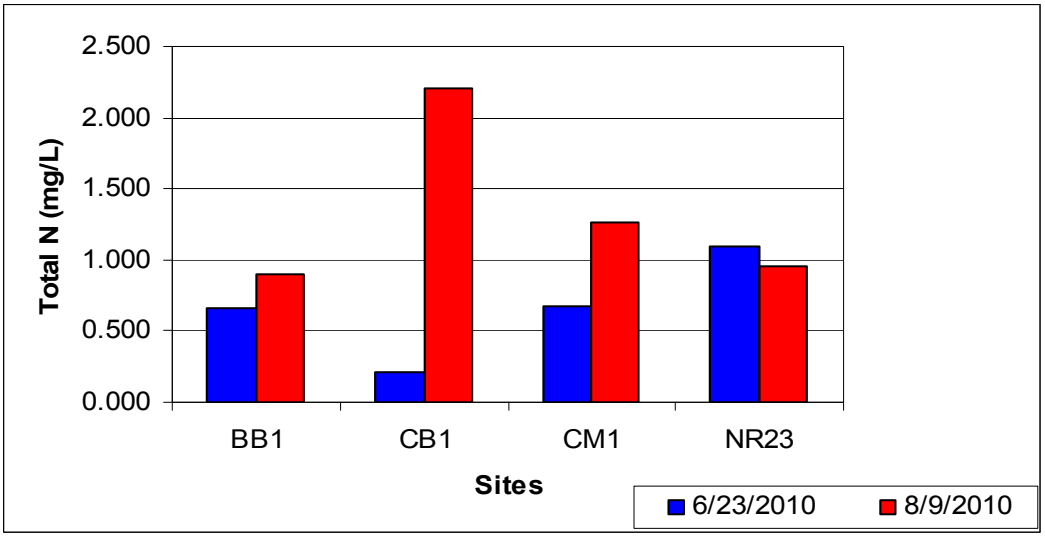
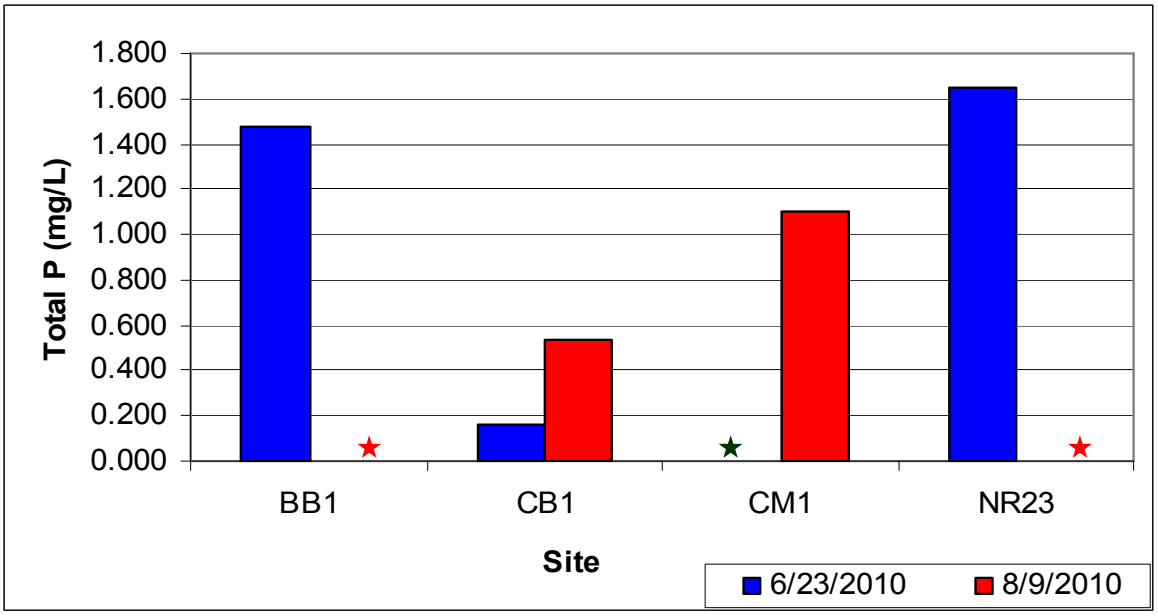
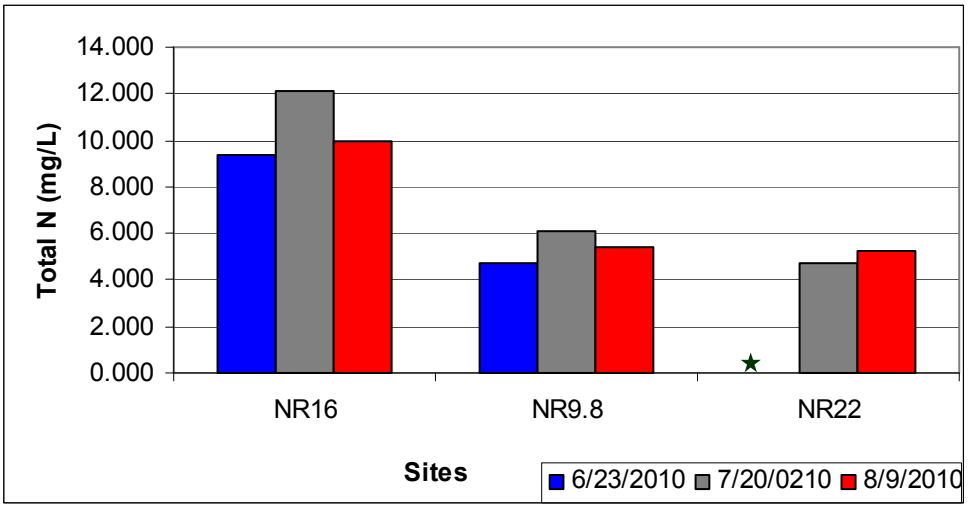


Figure 5 Total phosphorus (mg/L) observed at four tributaries to the Norwalk River on 6/23 and 8/9/10



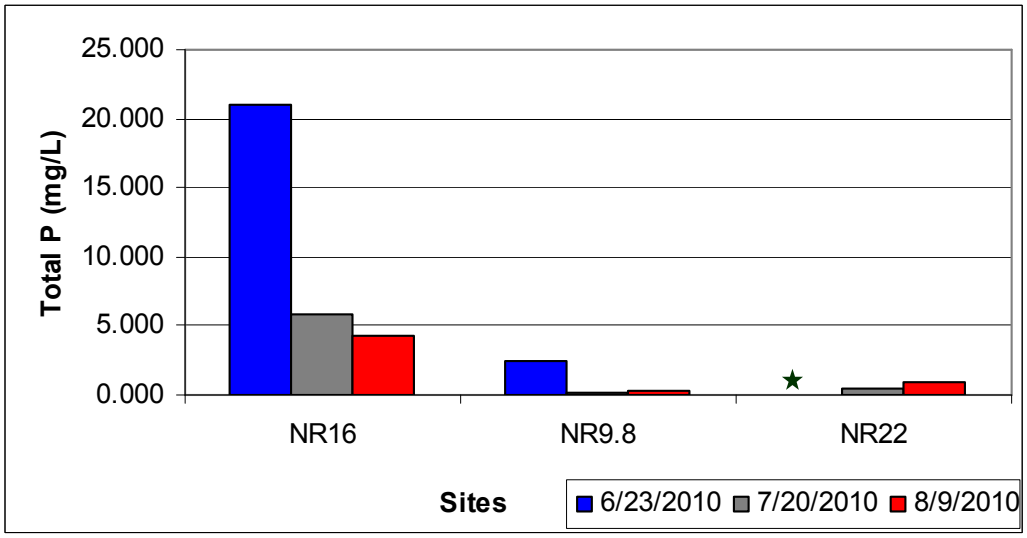
* sample not taken * ND levels

Figure 6 Total Nitrogen (mg/L) observed in the effluent from three waste water treatment plants discharging to the Norwalk River on 6/23/10, 7/9/10, and 8/9/10



* sample not taken

Figure 7 Total phosphorus (mg/L) observed in the effluent from three waste water treatment plants discharging to the Norwalk River on 6/23, 7/9 and 8/9/10.

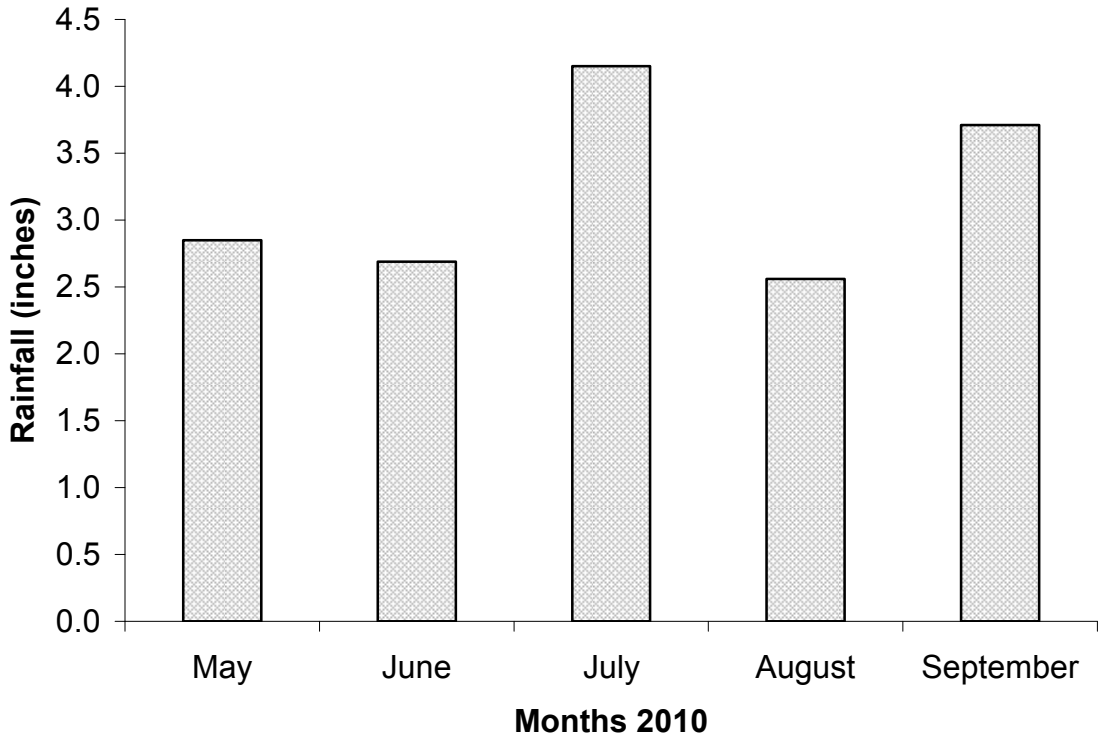


* sample not taken

IV. Discussion

Rainfall during the period of May 1 through September 30 was well below the normal average of 4.5 inches per month.[1] The average was 3.2 inches per month which resulted in a dry, hot season (Figure 8). The result was reduced flow and rising water temperatures in the Norwalk River Watershed. Some of the minor tributaries to include Bennett's Brook and two small un-named brooks feeding into Factory Pond dried up (Figure A2). Bacteria counts observed on monitoring days where rainfall occurred either on the sampling day or one to two days prior to the sampling day are noted on Table 2. These dates are 5/12, 6/10, 6/24, 7/15, 7/22, and 8/5, where increases in *E. coli* bacteria were observed (Table 2). In some cases bacteria counts did not increase uniformly along the length of the river as observed on 7/15 and 7/22 (Table2). This suggests that rainfall was localized in there instances (Table 2).

Figure 8 Monthly rainfall (inches) from May 2010 to September 2010



The highest geometric mean (348 CFUs/100 mLs) and SSM (25%) were observed at Site NR9, which is usually one of the less polluted sites in the river (Figure A2, Table 2). On 6/10, immediately after 0.53 inches of rain fall, an *E. coli* count of 2100 CFU was observed at the site (Table 2). Point sources for this bacteria input cannot be identified.

[1] Rainfall numbers provided by the Norwalk Health Department.

Another site with an elevated *E. coli* count is site NR4 which is located downstream from the Merritt Seven office building complex (Figure A2). Site NR4 has been a long term pollution problem over the years and many attempts by HW/RW to locate bacteria sources have not succeeded. During the month of July, elevated bacteria counts of 14000 and 2400 CFU/100mLs were observed on 7/15 and 7/22 respectively (Table 2). The source of these inputs could not be identified. There were heavy rains one day prior to testing on 7/15 and 7/22 (Table 2).

The staff of the Ridgefield WTP performed their usual efficient job in reducing bacteria to zero for most of the summer months and the UV lights were kept on well into October (Table 2, Figure 1). [2]

All observed DO means meet the CT DEP DO criterion of 5 mg/L or greater for a Class B river. DO single values of less than 5 mg/L were observed on Sites NR21 and NR20 (Table 3). Water arriving at Site NR21 has been standing for some time in the Great Swamp wetlands (Figure A2) and possibly loses some DO in the hot sun. Site NR20 downstream from Site NR21 occasionally shows the residual effects of this with DO depletion on the same days (Table 3).

Observed conductivity means show the usual seasonal profile for the river with elevated values at the headwater sites (Site NR23 downstream to NR15) being diluted to progressively lower values at Cooper Brook (confluence with the river just north of Site NR13), Bennett's Brook (confluence just north of Site NR9.5), Comstock Brook (confluence just north of Site NR6) and the Silvermine River (confluence just north of Site NR1) all with lower conductivity means serve to lower the conductivity of the Norwalk River before it reaches Site NR1 (Figure 3). There are some notable differences observed during the summer of 2010.

First, all conductivity means on the Norwalk River are elevated in relation to those observed for a similar period in 2009 (Table 6). Silverrmine River (Site SM3) shows a decrease in the conductivity levels for 2010 (Table 6).

Table 6 Comparison of conductivity means (μS) at 12 sites on the Norwalk River, May through September, 2009 vs. 2010

	Sites											
Year	NR23	NR22	NR21	NR20	NR15	NR13	NR9.5	NR9	NR6	NR4	SM3	NR1
2009	751	771	617	619	536	373	380	349	341	357	272	344
2010	928	800	770	720	625	458	425	370	374	381	259	391
Change	177	29	153	101	89	85	45	20	33	23	-13	47

The difference in the conductivity means is possibly due to reduced flow in the dry months of 2010 when the ionic strength of the water increased with evaporation (Table 4, Table 5).

Second, the individual site range on Site NR23 (Steep Brook, Ridgefield) is extreme at 945 μS or more than twice the ranges at other monitoring sites (Table 4). Steep Brook is a headwater stream to the Norwalk River from Ridgefield. A separate analysis will be forthcoming from HW/RW on Steep Brook which addresses the range in conductivity.

Nutrients

Based on the limited nutrient testing accomplished at the tributaries it would appear that TN and TP values can be highly variable (Figure 4, Figure 5). The observed phosphorus values are a good example of extreme variability with elevated values at Site BB1 and NR23 on 6/23 followed by below MDL values for TP on 6/23and 8/9. Heavy rain of 0.77 inches one day before the monitoring on 6/23 may have partially caused the elevated TP values in the storm water runoff (Figure 5). Nevertheless, the rain on 6/23 does not appear to have affected TN values excessively except for Site NR23 (Figure 4).

[2] The NPDES permit for the Ridgefield WTP does not require UV lights to be kept on after 9/30/10.

In any case, many of the observed nutrient concentrations greatly exceed the "oligotrophic" values of 0.010 mg/L (TP) and 0.20 mg/ L (TN). This is particularly true with phosphorus (Figure 5). The problems caused by "highly eutrophic" levels of TN and TP create excessive algae blooms (Appendix F). Impoundments in the Norwalk River have experienced mats of floating algae as well as prolific bottom growth due to excessive nutrient levels during spring and summer months. Our example of this growth can be observed on Factory Pond during August (Appendix F). The excessive nutrients come from the overuse of fertilizers, septic systems that are built too close to the Norwalk River or those that have created channels through the river banks (non-point sources). Pet wastes and wastes from wild animals are also contributors to the nutrient sources (Danielson).

In addition to the excessive nutrients found in streams are nutrients from the effluents in the WTP discharge (Figure 6, Figure 7). Two enrichment problems exist here that can be corrected. First, TP removal at all the WTPs should be in effect annually. TP removal is efficient and cost effective, and should be run continually as is done in the Georgetown plant.[3] Phosphorus is a conservative pollutant that is it doesn't degrade or go away (Danielson). It is either assimilated by plants to accelerate the growth cycle or is absorbed by the sediments to accelerate plant growth the following spring. The Route 7 WTP (Site NR16) has no TN or TP removal. The plant is old technology and urgently needs upgrading (Figure 6, Figure 7). Observed TP levels were as high as 21 mg/L on 6/23 (Figure 7) and TN levels ranged from 9.38 to 12 mg/L to 12.1 mg/L (Figure 6).

The excessive impact of TP from tributaries and WTPs is the most troublesome nutrient in the attempt to restore water quality in the Norwalk River because it takes very little phosphorus in combination with TN to produce plant growth. With a ratio of 1 part phosphorus to 18 parts nitrogen, phosphorus is the "limiting nutrient" to plant growth (Howes). During the growth cycle the excessive amounts of phosphorus are "assimilated" to cause an overproduction of aquatic algae in the impoundments. These same aquatic plants release the phosphorus in a process called "regeneration" at the end of their life cycle in August or September to help restart the growth cycle during the following spring (Howes). The excessive amount of biological decomposition produced uses dissolved oxygen (DO) in the process and the ammonia-nitrogen released during biological decomposition tries to become nitrates using the available DO in the process (Howes). The result is to strip DO from the bottom of the impoundments during August and September rendering them uninhabitable for larger fish trying to find cooler bottom water during the hot summer months.

V. Conclusion

Bacteria accumulations in the Norwalk River are not going away and apparently will not be mitigated by natural processes until the sources of input are reduced. It is difficult to say (after 12 years of HW/RW research) whether the situation is getting worse or remaining at the same levels without additional, comparative research by analysts with model building skills. Leaving UV lights on annually at all the WTPs will partially help reduce bacteria loading and is an early first step with relatively little expense.

Excessive nutrient concentrations in the Norwalk River Watershed can be partially reduced if attention is paid by the home owners to reduce fertilization cycles and if the public take an interest in improving WTP operating cycles. Phosphorus removal unit should be run on an annual basis.[3] Obviously a full upgrade to the Route 7 WTP (NR16) is a needed step in any plan to reduce nutrient input to the Norwalk River.

[3] This pertains to the large WTP in Ridgefield of 0.700 mg/L. The equipment to remove phosphorus works well and should be used during the winter months.

VI. Regrets

It was the intention of HW/RW to determine nutrient loading in pounds from the major tributaries to the Norwalk River. Unfortunately the Swoffer current meter chosen for the task was very difficult to use in the uneven stream bottom and completely failed after very little usage.

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Appendix B

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Table B2 Results of fecal coliform bacteria counts (colonies/100 mLs H_2O) inter-laboratory services with the Norwalk Public Health Laboratory (NPHL)

Appendix C

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VIII. References

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US Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Bacteria, US EPA 440/5-84-002, Washington, DC.

IX. Reporting Period

Summary report for a seven month monitoring period, October 2009 through April 2010

Monthly and Quarterly progress reports are available from June 1998 through September 2009

cc: Norwalk River Watershed Initiative Committee Co-Chairs
Norwalk River Watershed Association
Norwalk River Watershed Towns- Conservation Commissions- Norwalk, Wilton, Ridgefield, and Redding

Appendix A

Table A1 Site number identification, site location and town for sampling and testing (headwaters to mouth), *=tributary to the Norwalk River

Site No.	Site Area	Town	GPS Coordinates
NR21	Farmingville Road at the Great Swamp outlet	Ridgefield	Latitude: N 41° 17' 40.2" Longitude: W 73° 29' 18.5"
NR20	Route 35 at Fox Hill Condos	Ridgefield	Latitude: N 41° 17' 52.1" Longitude: W 73° 29' 32.2"
NR15	Stonehenge Road at the top of the dam	Ridgefield	Latitude N 41° 18' 32.0" Longitude: W 73° 28' 8.3"
NR13	Branchville at the railroad station (Route 7)	Ridgefield/Wilton	Latitude: N 41° 15' 55.8" Longitude: W 73° 26' 27.2"
NR 9.5	Downstream of the Georgetown Wastewater Treatment Plant -- Old Mill Road	Wilton	Latitude: N 41° 14' 46.0" Longitude: W 73° 26' 2.5"
NR9	School Road	Wilton	Latitude: N 41° 12' 15.3" Longitude: W 73° 25' 51.6"
NR6	Near Wolfpit Road in back of the Wilton Corporate Office Complex	Wilton	Latitude: N 41° 11' 0.1" Longitude: W 73° 25' 18.4"
NR4	Upstream of Route 15 (Glover Avenue) and downstream of the Merritt 7 Office Complex	Norwalk	Latitude: N 41° 8' 3.5" Longitude: W 73° 25' 35.8"
SM3*	James Street (on the Silvermine River)	Norwalk	Latitude: N 41° 8' 10.3" Longitude: W 73° 26' 4.0"
NR1	Post Road (US Route 1) adjacent to the Ash Creek Grille Restaurant	Norwalk	Latitude: N 41° 7' 10.8" Longitude: W 73° 25' 1.3"

Site No.	Site Area	Town	GPS Coordinates
NR23	Steep Brook next to South Street WTP	Ridgefield	Latitude: N 41° 17' 24.3" Longitude: W 73° 29' 35.6"
NR22	South Street WTP outfall	Ridgefield	Latitude: N 41° 17' 26.8" Longitude: W 73° 29' 29.6"

Figure A2 Location of sampling sites located in the Norwalk River Watershed

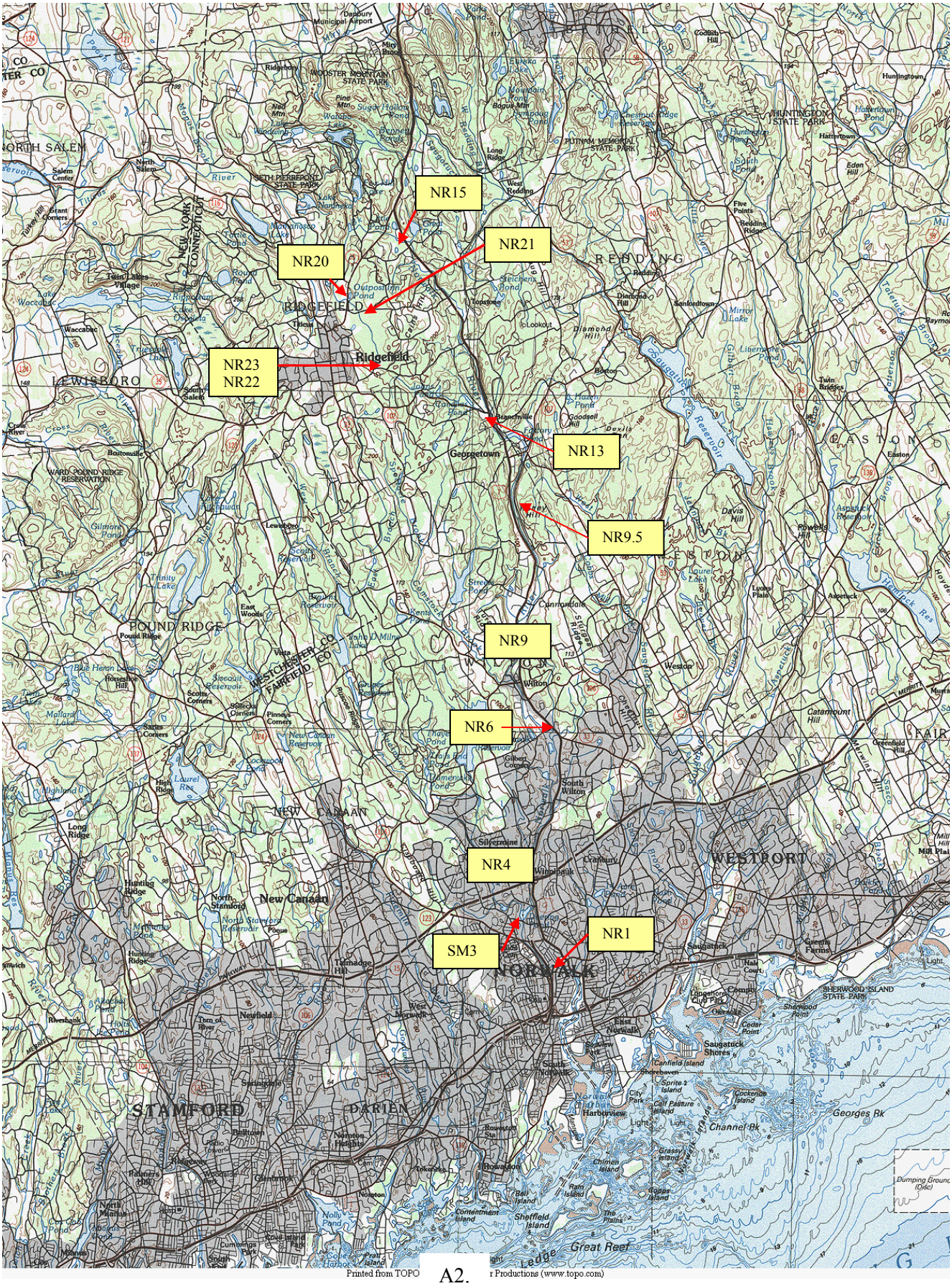


Figure A3 Location of waste water treatment plants located in the Norwalk River Watershed

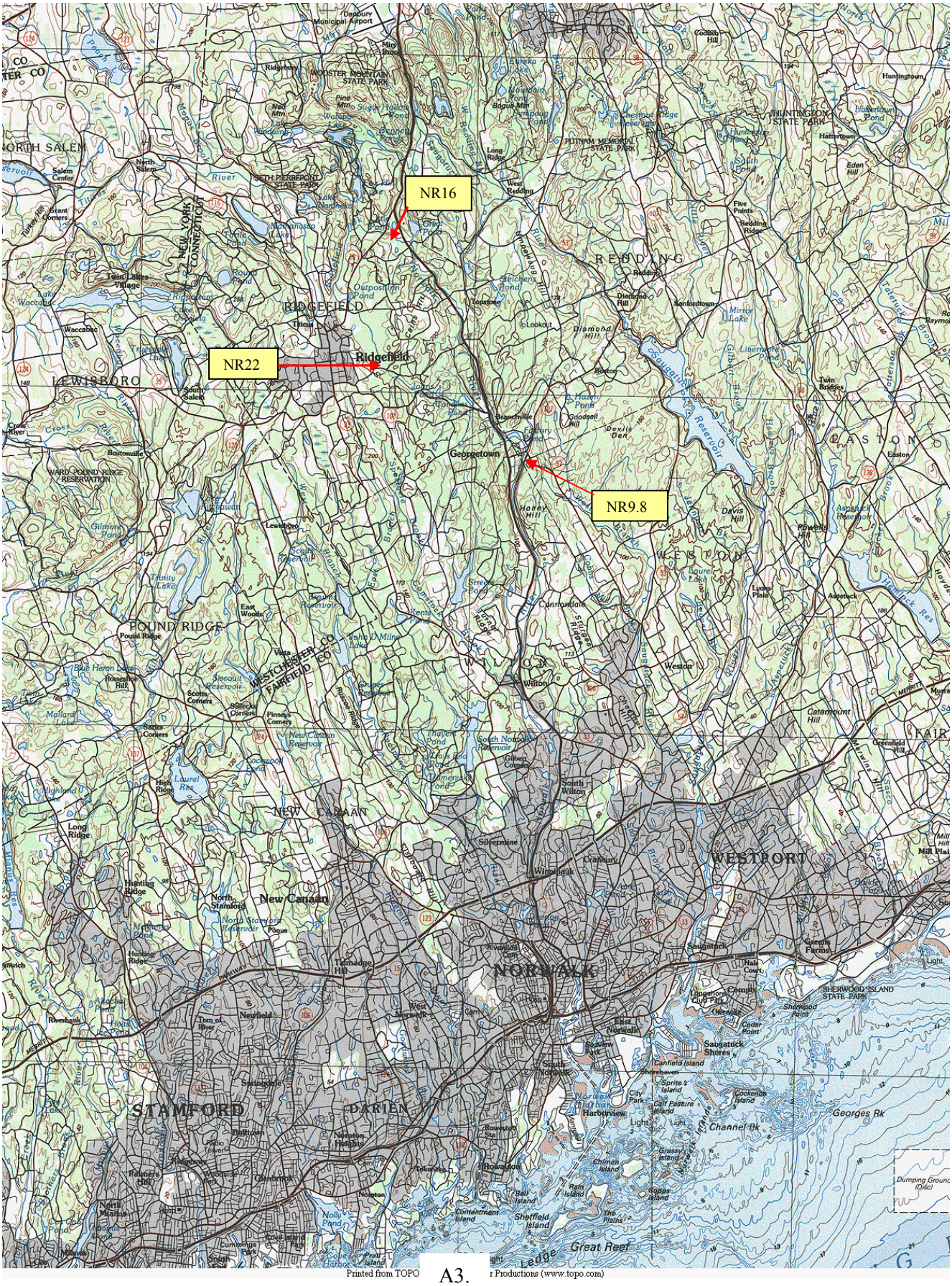
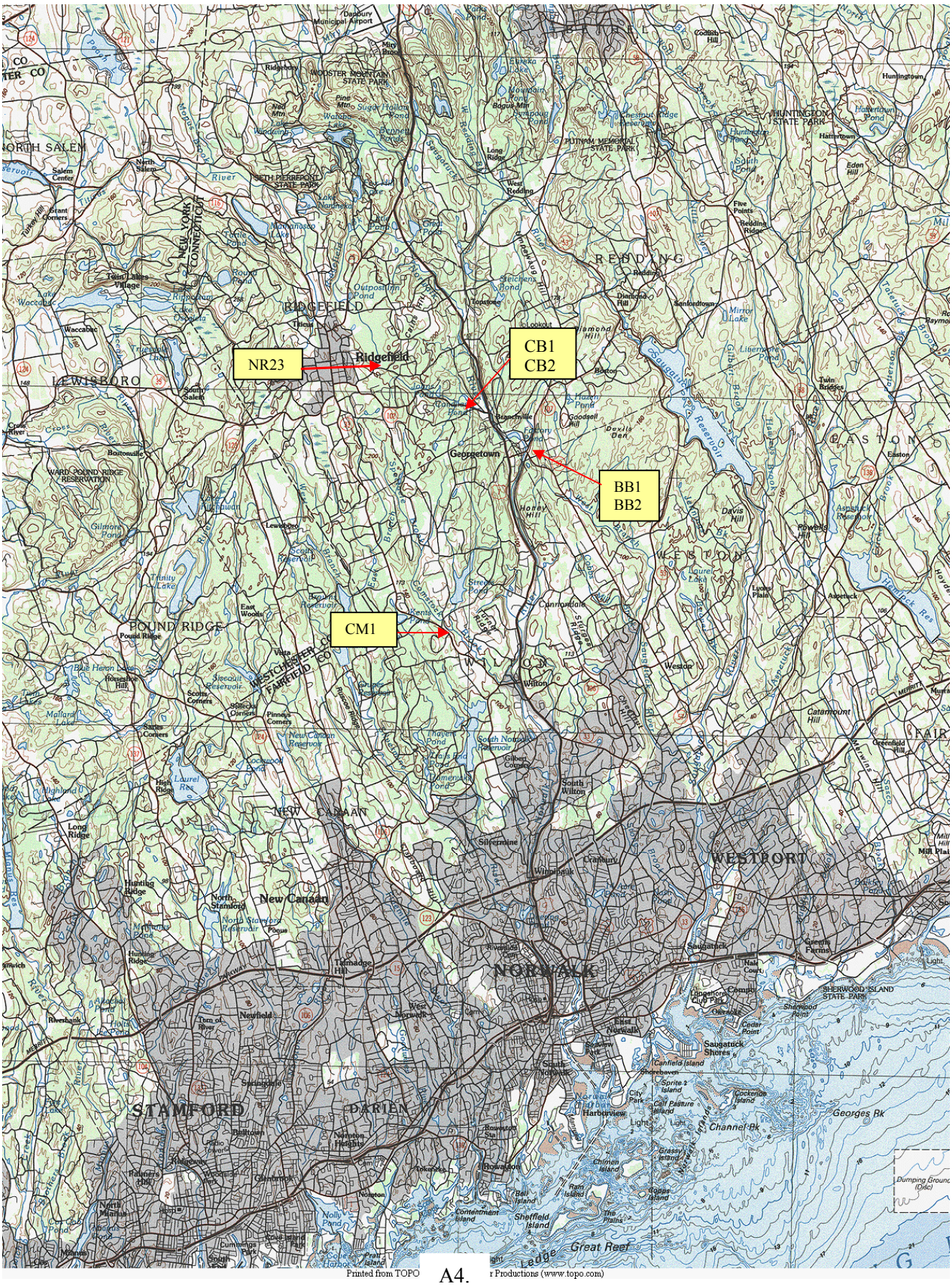


Figure A4 Location of testing sites on Steep Brook, Cooper Brook, Bennett's Brook and Comstock Brook



Appendix B

Table B1 Sampling site, date, time, air& water temperature, dissolved oxygen, conductivity, fecal coliform bacteria, *E. coli* bacteria, rainfall, days prior to sampling, and QA/QC activity for monitoring events in the Norwalk River Watershed May 2010 through September 2010 (plus one sampling date in October)

Site	Date	Time	Air Temp. ° C	Water Temp. ° C	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFU/100 mL	E. coli CFU/100 mL	Amount of rain (in)	Days prior to sampling	QA/QC	Fecal Coliform. CFU/100 mL
NR 23	5/6/2010	1042	24.0	14.2	9.5	745	24	24	0.98	3	Duplicate	34
NR 22	5/6/2010	1055	25.0	15.3	10.6	600	0	1	0.98	3	Field Blank	0
NR 21	5/6/2010	1101	28.0	16.2	5.2	529	120	120	0.98	3	Replicate	128
NR 20	5/6/2010	1108	27.0	16.1	7.7	573	240	240	0.98	3		
NR 15	5/6/2010	1118	25.0	17.5	9.3	466	80	80	0.98	3		
NR 13	5/6/2010	1130	26.0	17.7	9.0	347	60	60	0.98	3		
NR 9.5	5/6/2010	1145	22.0	18.0	9.2	390	30	30	0.98	3		
NR 9	5/6/2010	1129	22.0	16.7	9.3	359	66	66	0.98	3		
NR 6	5/6/2010	1114	21.0	16.3	9.7	336	160	140	0.98	3	Field Blank	0
NR 4	5/6/2010	1055	21.0	6.4	9.7	353	110	110	0.98	3		
SM 3	5/6/2010	1040	21.0	16.8	9.2	235	60	60	0.98	3	Replicate	80
NR 1	5/6/2010	1028	22.0	17.0	9.5	326	80	80	0.98	3	Duplicate	80
NR 23	5/12/2010	1052	8.0	9.9	11.2	385	1740	1380	0.38	0		
NR 22	5/12/2010	1102	9.0	13.2	10.7	779	1	1	0.38	0		
NR 21	5/12/2010	1110	7.0	9.6	8.5	581	1500	1160	0.38	0	Duplicate	1116
NR 20	5/12/2010	1124	7.0	9.7	9.2	618	420	360	0.38	0	Replicate	468
NR 15	5/12/2010	1134	8.0	10.6	10.7	607	360	340	0.38	0	Field Blank	0
NR 13	5/12/2010	1029	8.0	10.8	10.5	379	160	120	0.38	0		
NR 9.5	5/12/2010	1207	11.0	11.5	10.6	367	140	60	0.38	0		
NR 9	5/12/2010	1146	11.0	10.7	10.1	331	160	140	0.38	0	Field Blank	0
NR 6	5/12/2010	1130	11.0	10.6	10.6	322	700	680	0.38	0		
NR 4	5/12/2010	1113	10.0	10.7	9.2	345	620	460	0.38	0	Replicate	640
SM 3	5/12/2010	1055	12.0	11.0	10.3	266	440	340	0.38	0	Duplicate	520
NR 1	5/12/2010	1036	12.0	11.3	10.4	339	860	600	0.38	0		
NR 23	5/20/2010	1040	24.0	13.7	10.3	886	100	100	0.95	2		
NR 22	5/20/2010	1050	24.0	15.4	10.3	749	1	1	0.95	2	Field Blank	0
NR 21	5/20/2010	1100	24.0	15.5	7.0	648	260	212	0.95	2		
NR 20	5/20/2010	1115	23.5	16.2	8.7	608	216	188	0.95	2		
NR 15	5/20/2010	1125	24.5	15.1	9.6	545	148	148	0.95	2	Duplicate	108
NR 13	5/20/2010	1140	26.0	15.5	9.7	449	124	108	0.95	2	Replicate	152
NR 9.5	5/20/2010	1137	23.0	15.0	9.4	385	150	148	0.95	2	Duplicate	180
NR 9	5/20/2010	1120	23.0	14.4	9.7	344	154	154	0.95	2	Replicate	180
NR 6	5/20/2010	1105	22.0	14.5	10.2	340	228	228	0.95	2		
NR 4	5/20/2010	1055	26.0	15.2	10.7	353	600	600	0.95	2	Field Blank	0
SM 3	5/20/2010	1037	21.0	13.8	9.7	240	172	168	0.95	2		
NR 1	5/20/2010	1021	22.0	15.0	9.8	352	204	152	0.95	2		
NR 23	5/27/2010	1054	28.0	18.2	9.0	1070	96	96	0.08	3		
NR 22	5/27/2010	1104	28.0	18.4	9.6	822	0	1	0.08	3	Field Blank	0
NR 21	5/27/2010	1130	29.0	21.4	6.3	821	212	136	0.08	3		
NR 20	5/27/2010	1116	28.0	22.2	8.4	775	272	228	0.08	3		
NR 15	5/27/2010	1023	26.0	19.4	8.4	659	140	132	0.08	3	Replicate	124
NR 13	5/27/2010	1149	26.0	20.7	9.0	430	820	400	0.08	3	Duplicate	n/g
NR 9.5	5/27/2010	1005	28.0	19.9	8.3	427	260	260	0.08	3		
NR 9	5/27/2010	1026	28.0	17.9	9.4	372	280	180	0.08	3		
NR 6	5/27/2010	1037	28.5	18.6	9.1	380	240	228	0.08	3	Duplicate	248
NR 4	5/27/2010	1054	29.0	20.3	11.3	402	204	196	0.08	3	Replicate	176
SM 3	5/27/2010	1107	27.5	18.4	9.1	272	152	152	0.08	3	Field Blank	0
NR 1	5/27/2010	1127	32.5	21.8	8.9	385	172	144	0.08	3		
NR 23	6/3/2010	1040	29.0	19.5	9.5	1032	132	132	0.38	2		
NR 22	6/3/2010	1059	29.0	19.5	9.8	848	0	1	0.38	2	Field Blank	0
NR 21	6/3/2010	1100	29.0	21.0	6.8	814	204	204	0.38	2		
NR 20	6/3/2010	1108	28.0	22.5	9.4	796	720	720	0.38	2	Duplicate	440
NR 15	6/3/2010	1124	26.0	21.8	8.4	706	184	184	0.38	2	Replicate	172
NR 13	6/3/2010	1137	25.0	21.9	8.8	488	272	272	0.38	2		
NR 9.5	6/3/2010	1110	25.0	22.0	7.2	440	64	64	0.38	2		
NR 9	6/3/2010	1057	25.0	19.3	8.6	388	440	420	0.38	2	Field Blank	0
NR 6	6/3/2010	1045	25.0	19.9	8.4	371	196	144	0.38	2	Duplicate	220
NR 4	6/3/2010	1027	24.0	20.4	9.8	386	292	272	0.38	2	Replicate	284
SM 3	6/3/2010	1011	23.5	20.2	8.2	174	220	156	0.38	2		
NR 1	6/3/2010	955	27.0									

Table B1 (continued)

Site	Date	Time	Air Temp. ° C	Water Temp. ° C	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFU/100 mL	E. coli CFU/100 mL	Amount of rain (in)	Days prior to sampling	QA/QC	Fecal Coliform. CFU/100 mL
NR 23	6/10/2010	1004	18.5	15.0	9.7	625	550	550	0.53	1	Duplicate	420
NR 22	6/10/2010	1014	19.0	17.4	9.5	829	0	0	0.53	1		
NR 21	6/10/2010	1031	20.5	15.0	6.1	608	680	680	0.53	1	Field Blank	0
NR 20	6/10/2010	1020	19.0	15.5	7.7	571	400	400	0.53	1		
NR 15	6/10/2010	952	20.0	16.2	9.4	663	770	770	0.53	1	Replicate	700
NR 13	6/10/2010	1043	19.0	16.1	9.1	453	250	250	0.53	1		
NR 9.5	6/10/2010	1118	19.0	17.7	9.0	n/a	20	20	0.53	1		
NR 9	6/10/2010	1104	18.0	16.6	9.4	n/a	2100	2100	0.53	1	Duplicate	1600
NR 6	6/10/2010	1050	20.0	16.7	9.8	n/a	410	350	0.53	1		
NR 4	6/10/2010	1034	22.0	17.2	10.5	n/a	460	380	0.53	1	Field Blank	0
SM 3	6/10/2010	1024	22.0	16.8	9.6	n/a	240	240	0.53	1		
NR 1	6/10/2010	1010	23.0	18.0	10.3	n/a	170	160	0.53	1	Replicate	170
NR 23	6/17/2010	1010		17.5	8.7	1102	100	100	0.01	3		
NR 22	6/17/2010	1020		19.1	9.2	865	0	1	0.01	3	Duplicate	4
NR 21	6/17/2010	1042		19.3	6.3	838	420	400	0.01	3	Field Blank	0
NR 20	6/17/2010	1032		19.9	9.0	845	192	192	0.01	3		
NR 15	6/17/2010	955		18.6	8.2	682	212	188	0.01	3	Replicate	208
NR 13	6/17/2010	1056		19.2	8.2	507	268	256	0.01	3		
NR 9.5	6/17/2010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.01	3		
NR 9	6/17/2010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.01	3		
NR 6	6/17/2010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.01	3		
NR 4	6/17/2010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.01	3		
SM 3	6/17/2010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.01	3		
NR 1	6/17/2010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.01	3		
NR 23	6/24/2010	1053	26.0	20.7	8.7	651	3500	2800	0.77	2		
NR 22	6/24/2010	1105	28.0	20.8	9.1	818	200	170	0.77	2	Field Blank	0
NR 21	6/24/2010	1129	29.0	21.3	3.4	512	5900	4100	0.77	2		
NR 20	6/24/2010	1114	27.0	22.2	6.8	522	6400	5900	0.77	2	Duplicate	6100
NR 16	6/24/2010	SAMPLE ONLY					8	8	0.77	2		
NR 15	6/24/2010	1039	25.0	21.8	8.4	683	1300	1300	0.77	2		
NR 13	6/24/2010	1146	27.0	22.1	8.3	491	3100	2600	0.77	2		
NR 9.5	6/25/2010	1111	25.0	23.4	7.6	463	260 (pink)	260	0.77	2	Duplicate	360
NR 9	6/25/2010	1057	26.0	21.7	8.5	418	980	920	0.77	2		
NR 6	6/25/2010	1045	25.0	22.1	8.0	398	480	440	0.77	2		
NR 4	6/25/2010	1029	30.0	23.6	7.5	407	680	500	0.77	2		
SM 3.1 P	6/25/2010	SAMPLE ONLY					4		0.77	2	Field Blank	0
SM 3	6/25/2010	1016	25.5	22.2	7.0	275	188	156	0.77	2		
NR 1	6/25/2010	1000	24.5	23.2	8.3	356	480	380	0.77	2		
NR 23	7/1/2010	1052	21.0	17.1	9.1	1009	76	10	0.37	3		
NR 22	7/1/2010	1105	20.5	19.9	8.8	809	0	n/a	0.37	3	Replicate	0
NR 21	7/1/2010	1115	22.0	19.3	6.7	846	184	140	0.37	3	Field Blank	0
NR 20	7/1/2010	1123	22.5	19.2	10.0	812	52	44	0.37	3		
NR 15	7/1/2010	1134	22.0	17.7	8.5	662	60	60	0.37	3		
NR 13	7/1/2010	1145	22.0	19.8	8.0	516	180	168	0.37	3	Duplicate	NG
NR 9.5	7/1/2010	1100	19.0	19.7	7.6	503	84	84	0.37	3	Duplicate	96
NR 9	7/1/2010	1050	22.0	17.0	9.1	431	240	240	0.37	3		
NR 6	7/1/2010	1040	22.0	17.7	8.7	432	132	120	0.37	3		
NR 4	7/1/2010	1020	24.5	20.0	11.2	439	200	156	0.37	3	Replicate	228
SM 3	7/1/2010	1000	19.5	20.3	7.8	285	132	132	0.37	3	Field Blank	0
NR 1	7/1/2010	1010	23.0	20.6	8.8	427	260	228	0.37	3		
NR 23	7/7/2010	1035	33.0	23.3	7.8	1187	140	130	0.00	7		
NR 22	7/7/2010	1046	34.0	22.4	8.8	820	0	n/a	0.00	7		
NR 21	7/7/2010	1108	33.0	22.9	5.9	915	400	400	0.00	7	Field Blank	0
NR 20	7/7/2010	1057	32.0	24.9	6.3	864	340	340	0.00	7	Duplicate	280
NR 15	7/7/2010	1020	33.0	23.7	7.1	730	210	200	0.00	7		
NR 13	7/7/2010	1138	36.0	24.8	7.2	494	820	740	0.00	7	Replicate	700
NR 9.5	7/7/2010	1100	31.0	24.9	7.1	511	132	124	0.00	7	Replicate	152
NR 9	7/7/2010	1045	32.0	22.2	8.3	400	380	380	0.00	7	Duplicate	436
NR 6	7/7/2010	1035	32.0	24.3	7.6	416	420	400	0.00	7		
NR 4	7/7/2010	1025	35.0	24.9	12.8	446	256	228	0.00	7	Field Blank	0
SM 3	7/7/2010	1010	31.0	24.4	7.1	299	80	80	0.00	7		
NR 1	7/7/2010	955	32.0	25.0	8.4	469	240	240	0.00	7		

Table B1 (continued)

Site	Date	Time	Air Temp. ° C	Water Temp. ° C	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFU/100 mL	E. coli CFU/100 mL	Amount of rain (in)	Days prior to sampling	QA/QC	Fecal Coliform. CFU/100 mL
NR 23	7/15/2010	1028	23.0	21.1	8.3	520	300	300	1.62	1*		
NR 22	7/15/2010	1040	24.0	22.4	8.8	740	0	n/a	1.62	1*	Field Blank	0
NR 21	7/15/2010	1050	26.0	22.0	3.5	675	370	370	1.62	1*		
NR 20	7/15/2010	1058	24.0	22.6	4.6	516	290	290	1.62	1*		
NR 15	7/15/2010	1107	25.5	23.0	8.0	410	308	308	1.62	1*		
NR 13	7/15/2010	1120	25.0	23.2	7.8	405	820	820	1.62	1*	Replicate	1020
NR 9.5	7/15/2010	1110	23.6	23.7	7.4	408	330	330	1.62	1*		
NR 9	7/15/2010	100	23.1	23.2	7.8	407	400	400	1.62	1*		
NR 6	7/15/2010	1045	22.4	23.3	8.0	411	670	670	1.62	1*		
NR 4	7/15/2010	1030	22.5	23.6	5.8	400	14000	14000	1.62	1*	Field Blank	0
SM 3	7/15/2010	1000	25.0	23.8	7.4	241	580	580	1.62	1*	Replicate	550
NR 1	7/15/2010	1015	24.5	23.5	7.9	379	770	770	1.62	1*		
NR 23	7/22/2010	1045	25.0	21.2	8.7	505	900	700	1.16	1		
NR 22	7/22/2010	1055	28.0	22.4	9.1	774	3	3	1.16	1	Field Blank	0
NR 21	7/22/2010	1105	26.0	21.6	3.6	650	450	450	1.16	1		
NR 20	7/22/2010	1115	26.0	22.6	5.8	451	300	300	1.16	1	Duplicate	250
NR 15	7/22/2010	1132	26.0	23.4	8.7	528	210	210	1.16	1	Replicate	180
NR 13	7/22/2010	1145	28.0	23.7	7.6	428	460	390	1.16	1		
NR 9.5	7/22/2010	1100	25.5	23.7	7.2	363	80	70	1.16	1		
NR 9	7/22/2010	1045	25.0	22.5	7.9	322	530	470	1.16	1		
NR 6	7/22/2010	1035	24.0	22.5	7.8	289	1500	800	1.16	1	Field Blank	0
NR 4	7/22/2010	1025	31.0	23.1	9.2	283	3600	2400	1.16	1	Replicate	3800
SM 3	7/22/2010	1010	25.0	22.4	8.3	214	1800	1400	1.16	1	Duplicate	1200
NR 1	7/22/2010	955	25.0	23.1	7.9	250	1700	800	1.16	1		
NR 23	7/28/2010	1038	28.0	20.8	8.4	1022	80	56	0.11	3		
NR 22	7/28/2010	1047	28.0	21.6	8.9	841	0	0	0.11	3	Field Blank	0
NR 21	7/28/2010	1109	32.0	21.6	4.4	862	240	240	0.11	3	Duplicate	360
NR 20	7/28/2010	1056	30.0	22.5	8.2	796	84	80	0.11	3		
NR 15	7/28/2010	1024	26.0	21.0	7.4	632	165	120	0.11	3	Replicate	160
NR 13	7/28/2010	1127	30.0	22.6	7.7	476	380	380	0.11	3		
NR 9.5	7/28/2010	1105	28.0	23.3	7.0	444	56	52	0.11	3	Field Blank	0
NR 9	7/28/2010	1055	27.0	20.5	8.3	376	480	420	0.11	3	Replicate	440
NR 6	7/28/2010	1040	27.0	20.8	8.6	388	164	156	0.11	3	Duplicate	144
NR 4	7/28/2010	1025	30.0	22.7	10.9	425	248	212	0.11	3		
SM 3	7/28/2010	1015	27.0	22.1	7.9	238	108	96	0.11	3		
NR 1	7/28/2010	1005	26.0	23.0	8.5	364	144	120	0.11	3		
NR 23	8/5/2010	1020	28.0	22.6	8.5	1100	264	204	0.02	7	Field Blank	0
NR 22	8/5/2010	1052	31.0	23.0	9.3	928	0	0	0.02	7		
NR 21	8/5/2010	1105	28.0	24.0	5.8	947	360	360	0.02	7	Duplicate	336
NR 20	8/5/2010	1121	30.0	24.7	9.0	906	168	168	0.02	7		
NR 15	8/5/2010	1132	29.0	23.4	11.7	723	64	64	0.02	7		
NR 13	8/5/2010	1145	29.5	23.4	7.7	505	620	620	0.02	7	Replicate	600
NR 9.5	8/5/2010	1100	28.0	23.9	6.6	467	420	420	0.02	7		
NR 9	8/5/2010	1050	27.0	21.2	8.4	355	600	600	0.02	7		
NR 6	8/5/2010	1043	28.0	22.6	7.3	390	260	260	0.02	7	Field Blank	0
NR 4	8/5/2010	1030	28.5	23.6	12.0	430	440	440	0.02	7	Duplicate	660
SM 3	8/5/2010	950	26.0	23.2	8.0	279	116	116	0.02	7	Replicate	88
NR 1	8/5/2010	1010	27.0	23.7	8.2	441	240	240	0.02	7		
NR 23	8/11/2010	1034	27.0	22.2	8.2	1245	420	420	0.00	7		
NR 22	8/11/2010	1043	26.0	23.1	8.8	527	0	1	0.00	7	Field Blank	0
NR 21	8/11/2010	1102	30.0	23.5	6.0	900	248	176	0.00	7		
NR 20	8/11/2010	1051	28.0	23.3	8.2	872	104	104	0.00	7		
NR 15	8/11/2010	1015	27.0	22.5	7.5	680	248	244	0.00	7	Duplicate	216
NR 13	8/11/2010	1117	28.0	23.2	6.7	505	440	400	0.00	7	Duplicate	460
NR 9.5	8/11/2010	1111	24.5	23.1	meter bad	450	232	204	0.00	7	Duplicate	260
NR 9	8/11/2010	1059	24.0	20.0	meter bad	344	1060	880	0.00	7		
NR 6	8/11/2010	1049	25.0	22.4	meter bad	399	232	168	0.00	7		
NR 4	8/11/2010	1032	29.0	23.4	meter bad	233	188	172	0.00	7	Field Blank	0
SM 3	8/11/2010	1022	26.0	23.5	meter bad	292	44	44	0.00	7		
NR 1	8/11/2010	1005	27.0	22.8	meter bad	478	212	200	0.00	7		

Table B1 (continued)

Site	Date	Time	Air Temp. ° C	Water Temp. ° C	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFU/100 mL	E. coli CFU/100 mL	Amount of rain (in)	Days prior to sampling	QA/QC	Fecal Coliform. CFU/100 mL
NR 23	8/19/2010	1025	28.0	19.5	7.8	1083	188	188	0.47	3	Duplicate	120
NR 22	8/19/2010	1038	28.0	21.8	9.0	838	0	1	0.47	3		
NR 21	8/19/2010	1046	28.0	21.0	6.1	866	320	220	0.47	3	Field Blank	0
NR 20	8/19/2010	1051	28.0	20.7	8.7	814	112	112	0.47	3		
NR 15	8/19/2010	1107	26.5	19.8	7.8	711	96	88	0.47	3		
NR 13	8/19/2010	1120	28.0	20.9	7.8	581	740	600	0.47	3	Replicate	560
NR 9.5	8/19/2010	1220	29.0	21.8	7.5	416	108	104	0.47	3	Replicate	112
NR 9	8/19/2010	1210	29.0	19.7	8.9	357	820	720	0.47	3		
NR 6	8/19/2010	1240	30.0	21.4	8.1	368	300	300	0.47	3		
NR 4	8/19/2010	1145	30.0	22.0	5.4	395	120	88	0.47	3	Duplicate	160
SM 3	8/19/2010	1133	27.0	21.7	7.3	279	440	440	0.47	3	Field Blank	0
NR 1	8/19/2010	1115	27.0	21.2	7.7	551	280	220	0.47	3		
NR 23	8/25/2010	1038	22.0	17.7	8.7	520	660	460	1.91	2*		
NR 22	8/25/2010	1048	22.0	20.5	9.2	778	0	1	1.91	2*		
NR 21	8/25/2010	1057	22.0	18.5	4.4	590	272	272	1.91	2*	Field Blank	0
NR 20	8/25/2010	1111	22.0	18.3	4.0	477	128	104	1.91	2*	Replicate	112
NR 15	8/25/2010	1124	22.0	18.7	8.7	443	228	164	1.91	2*	Duplicate	216
NR 13	8/25/2010	1140	23.0	18.8	8.6	371	380	240	1.91	2*		
NR 9.5	8/25/2010	1106	23.0	17.2	8.7	334	460	260	1.91	2*		
NR 9	8/25/2010	1054	22.0	19.0	8.9	332	600	400	1.91	2*		
NR 6	8/25/2010	1043	22.0	18.9	9.2	323	840	720	1.91	2*	Replicate	980
NR 4	8/25/2010	1029	23.0	19.2	9.6	329	780	560	1.91	2*	Field Blank	0
SM 3	8/25/2010	1013	18.5	19.1	8.7	224	256	236	1.91	2*	Duplicarte	280
NR 1	8/25/2010	956	18.0	19.3	5.1	310	540	340	1.91	2*		
NR 23	9/2/2010	1043	30.0	22.1	8.3	1207	216	208	0.02	7		
NR 22	9/2/2010	1056	32.0	22.8	9.2	881	0	1	0.02	7	Field Blank	0
NR 21	9/2/2010	1105	34.0	23.3	6.7	933	380	380	0.02	7	Replicate	360
NR 20	9/2/2010	1115	30.0	23.6	8.5	885	112	80	0.02	7	Duplicate	80
NR 15	9/2/2010	1125	28.0	22.5	7.3	648	252	116	0.02	7		
NR 13	9/2/2010	1139	30.0	22.6	7.8	367	148	136	0.02	7		
NR 9.5	9/2/2010	1139	29.0	23.6	7.1	453	88	60	0.02	7		
NR 9	9/2/2010	1123	27.0	21.0	8.3	389	540	340	0.02	7	Replicate	472
NR 6	9/2/2010	1106	27.0	21.5	8.1	400	172	152	0.02	7	Duplicate	204
NR 4	9/2/2010	1047	30.0	22.5	9.6	425	400	320	0.02	7	Field Blank	0
SM 3	9/2/2010	1036	27.0	22.0	8.1	269	108	72	0.02	7		
NR 1	9/2/2010	1021	29.0	23.1	9.0	420	112	72	0.02	7		
NR 23	9/8/2010	1159	30.0	20.8	8.8	1330	480	340	0.01	5		
NR 22	9/8/2010	1207	28.0	21.4	9.1	880	0	1	0.01	5	Replicate	0
NR 21	9/8/2010	1215	30.0	23.1	6.8	937	252	196	0.01	5	Field Blank	0
NR 20	9/8/2010	1226	29.0	22.9	8.9	898	104	84	0.01	5	Duplicate	116
NR 15	9/8/2010	1238	27.0	20.7	8.1	742	120	96	0.01	5		
NR 13	9/8/2010	1254	27.0	21.9	8.8	476	1400	1240	0.01	5		
NR 9.5	9/8/2010	1200	27.0	20.9	8.3	463	180	156	0.01	5	Replicate	172
NR 9	9/8/2010	1130	26.0	19.0	9.2	380	340	300	0.01	5	Dupliacte	360
NR 6	9/8/2010	1114	27.0	20.4	8.0	403	156	144	0.01	5		
NR 4	9/8/2010	1048	28.0	21.5	9.8	436	340	300	0.01	5	Field Blank	0
SM 3	9/8/2010	1035	27.0	20.3	8.1	286	60	48	0.01	5		
NR 1	9/8/2010	1015	28.0	21.4	9.5	480	172	132	0.01	5		
NR 23	9/22/2010	1145	26.0	16.6	9.6	1284	168	144	0.79	6	Replicate	120
NR 22	9/22/2010	1154	25.0	19.1	9.6	883	0	1	0.79	6	Field Blank	0
NR 21	9/22/2010	1204	27.0	19.9	8.0	924	240	152	0.79	6	Duplicate	200
NR 20	9/22/2010	1216	25.0	18.5	10.1	890	48	36	0.79	6		
NR 15	9/22/2010	1227	25.0	15.9	9.2	756	88	44	0.79	6		
NR 13	9/22/2010	1242	27.0	17.2	10.6	581	112	108	0.79	6		
NR 9.5	9/22/2010	1206	25.0	17.0	8.5	470	84	68	0.79	6	Duplicate	76
NR 9	9/22/2010	1149	24.0	16.0	9.8	390	204	160	0.79	6		
NR 6	9/22/2010	1132	26.0	16.0	8.3	412	124	100	0.79	6		
NR 4	9/22/2010	1100	25.0	17.4	7.4	402	328	260	0.79	6	Field Blank	0
SM 3	9/22/2010	1039	23.0	16.8	8.3	295	140	124	0.79	6		
NR 1	9/22/2010	1017	23.0	17.2	9.4	431	248	140	0.79	6	Replicate	192
NR 23	10/7/2010	1040	17.0	13.5	11.0	977	56	56	0.04	2		
NR 22	10/7/2010	1046	17.0	17.7	8.7	800	0	1	0.04	2		
NR 21	10/7/2010	1057	17.0	14.5	7.0	775	120	104	0.04	2		
NR 20	10/7/2010	1105	18.0	13.7	8.0	628	60	52	0.04	2		
NR 15	10/7/2010	1113	17.0	13.9	9.8	449	156	140	0.04	2	Duplicate	
NR 13	10/7/2010	1129	17.0	14.2	10.1	360	112	88	0.04	2	Replicate	188
NR 9.5	10/7/2010	1142	19.0	14.3	9.2	330	224	204	0.04	2		
NR 9	10/7/2010	1127	20.0	13.9	9.2	328	208	188	0.04	2		
NR 6	10/7/2010	1113	18.0	14.2	9.3	331	108	108	0.04	2		
NR 4	10/7/2010	1053	19.0	14.4	10.2	343	204	204	0.04	2		
SM 3	10/7/2010	1044	18.0	14.2	9.0	264	124	88	0.04	2	Replicate	84
NR 1	10/7/2010	1023	19.0	14.6	9.8	335	140	104	0.04	2	Duplicate	

Table B2 Results of fecal coliform bacteria counts (colonies/100 mLs) inter-laboratory services with the Norwalk Public Health Laboratory (NPHL)

Date	Site	Fecal coliform bacteria counts (NPHL)	Fecal coliform bacteria counts HW/RW Lab
6/10/10	NR23	691	550/420
7/7/10	NR15	192	210
7/28/10	NR6	148	164/144

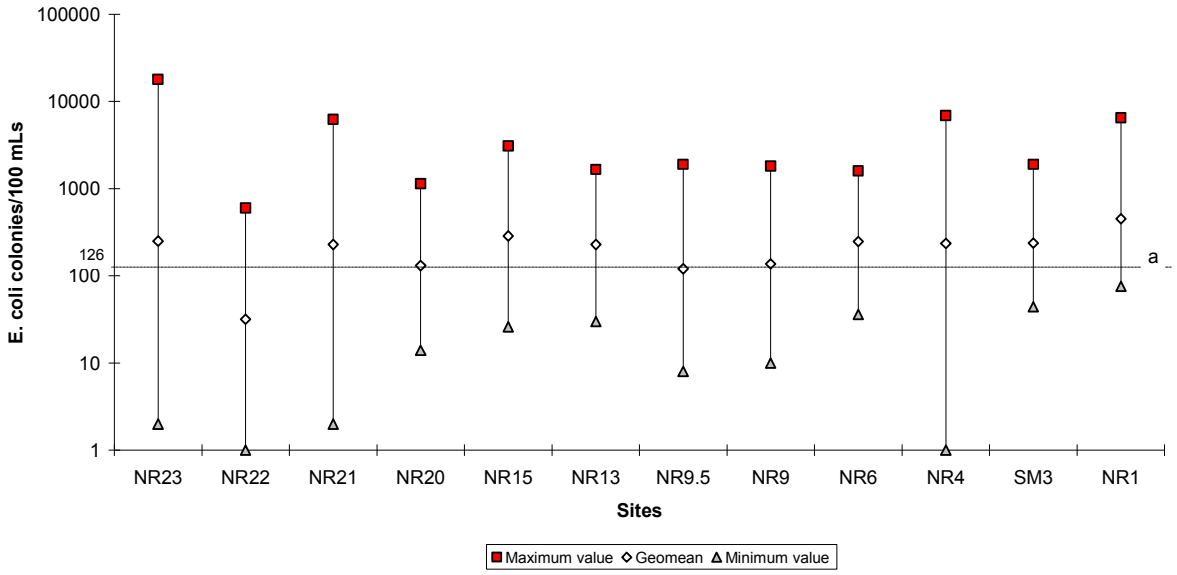
Appendix C

How to read the graphs in this report:

Monitoring data are presented in this report with graphs and tables. Selected Figures and Tables are used to highlight critical parameters of the Norwalk River's water quality on either a monthly or total project basis. The following are some examples of the types of graphs and how to read them.

Graphs of Physical and Bacteria Data
Physical and bacteria data are graphed in the following way:
During a sampling period (usually a three month period) the *E. coli* colony concentration, the dissolved oxygen level and the conductivity are graphed by displaying the maximum value, the minimum value, and the mean or geomean value for each sampling site. The graph below is an example of a graph displaying *E. coli* counts

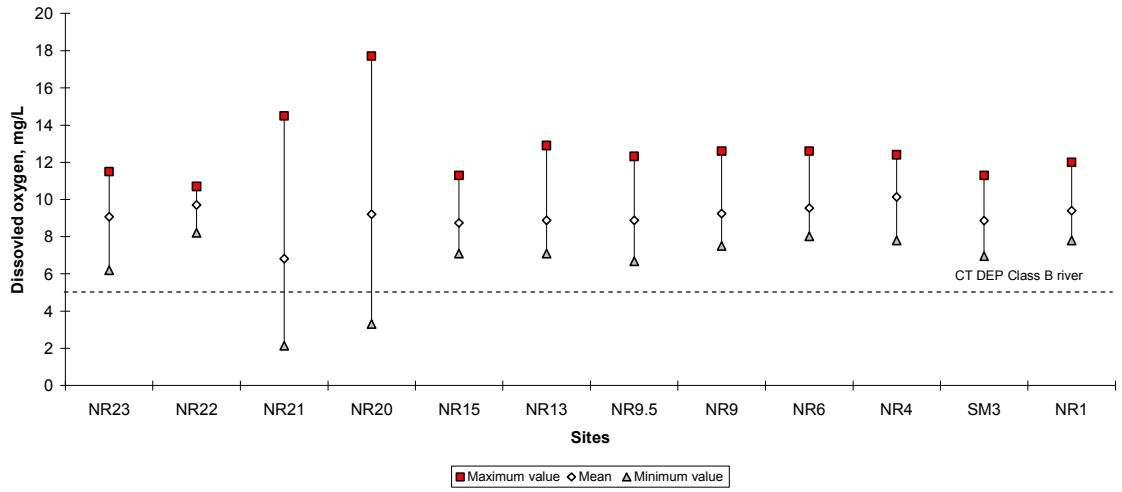
An example of a graph for maximum, geometric means, and minimum values of *E. coli* bacteria concentrations at 12 monitoring sites in the Norwalk River Watershed when the two Ridgefield and one Georgetown wastewater treatment facilities are required by NPDES permits to disinfect sewage effluent



[a]CT DEP water quality geometric mean limit for *E. coli* bacteria level for Class B rivers

The previous graph shows the results for *E. coli* bacteria for the Norwalk River watershed. The sample sites are arranged along the bottom (X-axis), upstream to downstream, left to right. The concentration of *E. coli* bacteria forming units (CFUs) per 100 mL is arranged on the logarithmic scale along the left (Y-axis). The dashed horizontal line at 126 colonies/100 mL (left Yaxis) indicates the geomean *E. coli* criterion in the Connecticut Department of Environmental Protection (CT DEP) Water Quality Standards (WQS) that are set for Class B surface waters. The geometric mean presents results of all sample runs in a way that minimizes the impact on the entire data set by very high or very low individual results An *E. coli* geometric mean marker extending above this line exceeds the criterion. For example, every site except NR22 exceeded the geomean criterion

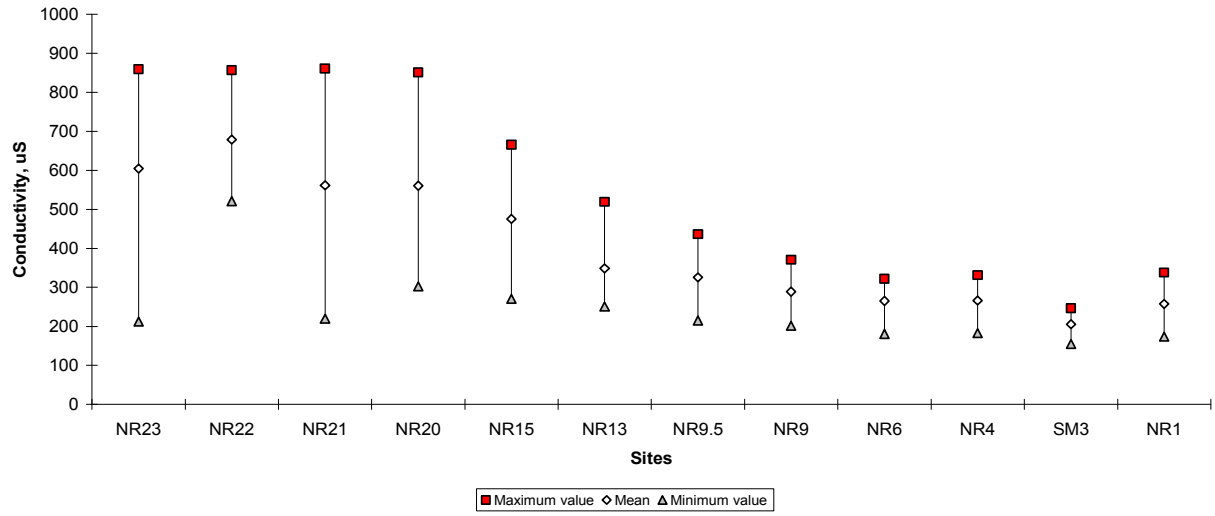
The graph below is an example of a graph showing maximum, mean and minimum values for dissolved oxygen at 12 sampling sites on the Norwalk River Watershed



5 mg/L dissolved oxygen = The CT DEP water quality standard for a Class B rivers

The graph above is read in the same way as the previous one. However, it displays the maximum, minimum values and the mean for dissolved oxygen levels for each sampling site during the sampling period. The dashed horizontal line shows the CT DEP water quality standard for dissolved oxygen for a Class B river. In the example above all mean values for dissolved oxygen meet the CT DEP Class B criterion for dissolved oxygen. However, Sites NR21 and NR20 had minimum readings below the CT DEP criterion.

An example of a Conductivity graph is below.



The line graph above again displays the conductivity range (maximum value to minimum value) with the mean for that range. The conductivity is recorded in micro-Siemens (µS)

Appendix D

Glossary

Dissolved oxygen: The oxygen dissolved in water and readily available to aquatic organisms expressed in milligrams per liter (mg/L) or parts per million (ppm). Connecticut's Water Quality Standards requires that the dissolved oxygen of a Class B stream shall not be less than 5 mg/L at any time.

Conductivity: Conductivity is a measure of the ability of water to pass an electrical current. Conductivity of water is positively affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate (ions that carry a negative charge) as well as sodium, magnesium, calcium, iron and aluminum (ions that carry a positive charge). Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity measurements. Significant changes in conductivity can be used as an indicator of pollution entering a stream. For example, the presence of metal trash in water and/or the use of iron pipes can increase conductivity. An elevated conductivity level can also occur from natural sources such as the presence of limestone in streambeds. Conductivity is measured in micromhos per cm, (μmhos/cm) a measure of conductance equal to one millionth of a mho/cm. While there is no CT DEP criterion for conductivity, the rivers in the United States generally range from 50 to 1500 μmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 μmhos. Conductivity values outside this range could indicate that the water is not suitable for certain species of fish or macro invertebrates.

Fecal coliform bacteria: Fecal coliform bacteria are that portion of the coliform group that originates in the intestinal tract of man and other warm-blooded animals. Fecal bacteria are used as indicator organisms, which are not usually harmful to man. Their presence indicates that pathogens (such as cholera, salmonella, etc.) may be present in surface waters. The higher the count in colonies per 100 milliliters indicates a higher probability that pathogens are being discharged to surface waters. Fecal bacteria are used because they are more universal and survive for longer periods than pathogens in water. The Connecticut Water Quality Standards for a Class B stream are as follows: As an indicator of general sanitary quality Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms/100 mL in any group of samples nor shall 10% of the samples exceed 400 organisms/100 mL.

***E. coli* bacteria:** *Escherichia coli* (*E. coli*) bacteria are one of two organisms that comprise fecal coliform bacteria. Studies have indicated that *E. coli* alone may be a more specific indicator organism of gut level contaminants to fresh surface waters from either man or animal. The other organism comprising coliform bacteria is *Klebsiella*, which sometimes occurs in soil or leaves. The EPA recommends *E. coli* as the best indicator of health risk from water contact in recreational waters.

Quality Assurance/Quality Control (QA/QC): Analytical measures taken to assure that field and laboratory work meets the highest standards of precision and accuracy. QA is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. QA activities involve planning quality control, quality assessment, data management and quality improvement. QC is the overall system of technical activities designed to measure quality and limit error in a product or service. A QC program
manages quality so that data meets the needs of the user as expressed in a quality assurance project plan. All scientific analysis of the Norwalk River is accomplished in accord with an EPA approved QA/QC which was re-approved on April 25, 2001 and covers the monitoring period from April 2001 through September 2001.

Water temperature: Water temperature is measured in degrees centigrade (^{o}C). Connecticut's Water Quality Standards state that no temperature increase is allowable except when the increase will not exceed the recommended limit on the most sensitive receiving water use. In no case shall the temperature exceed 85^{o}F (29.4^{o}C), or in any case raise the normal temperature of the receiving water more than 4^{o}F (2.2^{o}C).

Rainfall: Rainfall measurements used in this report follows criteria used by the CT State Health Services. The day of sampling is referred to as day zero. Days are numbered backwards from the testing date to the first rainfall in inches prior to the testing date. For example, if a test was conducted on Monday 5/25 and the previous rain of 0.2 inches occurred on 5/18, the records would indicate 0.2 inches for the amount of rain occurring seven days before the sampling date. If the rain were continuous over the time period, for example, if 0.3 inches fell on 5/17 and 0.2 more inches fell on 5/18, rainfall would be shown as 0.5 inches occurring seven days before the sampling. Rainfall is recorded at rainfall monitoring station located at the Town Hall in Norwalk.

Storm events: Storm events are classified as rainfall exceeding one inch in 24 hours. This much rain will increase surface runoff (input) and flow through the storm drain networks. Storm water runoff carries many pollutants to the river, especially during the first hour.

Observations: Observations are noteworthy occurrences in the river ecology such as the appearance of stranding blue-green algae, a flock of geese or fish kills. These observations can be incorporated into the data record sheets. These help provide a seasonal definition for water related problems which are not recorded elsewhere.

Seasonal Disinfection: Seasonal disinfection is action taken by a wastewater treatment plant to eliminate bacteria from the effluent discharge. Connecticut's Water Quality Standards require disinfection for the period of May 1st through September 30th at all Wastewater Treatment Plants discharging effluent into streams north of Route I-95. The process is carried out by chlorination or exposing the effluent to ultra violet light just prior to discharge. The period of this disinfection presently takes place when the public is deemed more likely to be fishing or bathing in the water.

LAKE TROPHIC CATEGORIES

Criteria for Total Phosphorus, Total Nitrogen, Chlorophyll-a, and Secci Disk Transparency appearing in the table below represent acceptable ranges for these parameters within which recreational uses will be fully supported and maintained for lakes in each trophic category. For the purpose of determining consistency with the water quality standards for lakes classified AA, A or B, an assessment of the natural trophic category of the lake, absent significant cultural impacts, must be performed to determine which criteria apply.

OLIGOTROPHIC

May be Class AA, Class A, or Class B water. Low in plant nutrients. Low biological productivity characterized by the absence of macrophyte beds. High potential for water contact recreation.

Parameters		Criteria
1.	Total Phosphorus	0-10 ug/l spring and summer
2.	Total Nitrogen	0-200 ug/l spring and summer
3.	Chlorophyll-a	0-2 ug/l mid-summer
4.	Secchi Disk Transparency	6 + meters mid-summer

MESOTROPHIC

May be Class AA, Class A, or Class B water. Moderately enriched with plant nutrients. Moderate biological productivity characterized by intermittent blooms of algae and/or small areas of macrophyte beds. Good potential for water contact recreation.

Parameters		Criteria
1.	Total Phosphorus	10-30 ug/l spring and summer
2.	Total Nitrogen	200-600 ug/l spring and summer
3.	Chlorophyll-a	2-15 ug/l mid-summer
4.	Secchi Disk Transparency	2-6 meters mid-summer

EUTROPHIC

May be Class AA, Class A, or Class B water. Highly enriched with plant nutrients. High biological productivity characterized by frequent blooms of algae and/or extensive areas of dense macrophyte beds. Water contact recreation opportunities may be limited.

Parameters		Criteria
1.	Total Phosphorus	30-50 ug/l spring and summer
2.	Total Nitrogen	600-1000 ug/l spring and summer
3.	Chlorophyll-a	15-30- ug/l mid-summer
4.	Secchi Disk Transparency	1-2 meters mid-summer

HIGHLY EUTROPHIC

May be Class AA, Class A, or Class B water. Excessive enrichment with plant nutrients. High biological productivity, characterized by severe blooms of algae and/or extensive areas of dense macrophyte beds. Water contact recreation may be extremely limited.

	Parameters	Criteria
1.	Total Phosphorus	50 + ug/l spring and summer
2.	Total Nitrogen	1000 – ug/l spring and summer
3.	Chlorophyll-a	30 – ug/L mid-summer
4.	Secchi Disk Transparency	0-1 meters mid-summer

Appendix F

Pictures

Algae growth on Factory Pond

Face of Factory Pond Dam in the Wire Mill Complex

Algae growth in the Norwalk River as it flows through the Wire Mill Complex