Water Quality Data Report
For
The Norwalk River Watershed
October 2010 through April 2011

HW volunteers (Joe Racz & Dave Perman) take measurements and samples at Site NR22 in the Norwalk River Watershed in Ridgefield.

Submitted by:

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Funded by The Norwalk River Watershed Stakeholders:
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 Inc.-Manresa, Town of Ridgefield, Norm Bloom, Leslie Bloom-Miklovich, and Trout Unlimited-Mianus River Chapter

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

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

Date: July 11, 2011

Subject: The Norwalk River Watershed Project Water Quality Report for the period of October 21, 2010 through April 19, 2011

I. Introduction:

Purpose of Study: The Earthplace Harbor Watch (HW) 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 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 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 determined that the water quality in the Norwalk River Watershed was moderately impaired.

The CT DEP and HW executed a contract for a second year funding in September 1999 (from September 1, 1999 through November 30, 2000). HW 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, were again used under the original QAPP. This QAPP was extended on April 25, 2001 to September 30, 2001 by the EPA's Office of Environmental Measurement and Evaluation (Table 1).

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.

Presently the Norwalk River is monitored on a year round basis with weekly testing at 12 test sites from May 1 through September 30th and monthly testing from October through April.

Additional 319 funding was allocated to continue the HW 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 again renewed testing of the Norwalk River and its tributaries on May 1, 2005 thanks to the interest and generosity of the Town of Wilton, 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 have collectively continued to provide additional funds to support the 2010/2011 monitoring season.

Although these monthly reports are submitted to the CT DEP for review and comment, Harbor 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 Quality Assurance Project Plan (QAPP RFA#10160 approved by the EPA for five years 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.

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 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 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 1 CT 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 for swimming 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.

III. Results:

Five of the observed twelve testing sites on the Norwalk River exceeded the CT DEP *E. coli* geometric mean criteria of <126 CFUs/100mLs and the single sample maximum (SSM) of 576 CFUs/100mls (Figure 1, Table 1, Table 2). The SSM is applied to the geometric mean in that <10% of an individual sites total number of samples may not exceed 576 CFUs/100mLs. Based on the geometric mean and the SSM, Sites NR23, NR22 (effluent discharge for the Ridgefield Waste Water Treatment Plant), NR21, NR20 and NR13 all exceed the CT DEP's *E. coli* criteria for a Class B River (Table 1, Table 2, Figure 1, Figure A2). The remaining seven test sites all meet he CT DEP's *E. coli* criteria (Table 1, Table 2, Figure 2, and Figure A2).

Table 2 October 21, 2010 through April 19, 2011 *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 not required by NPDES permits to disinfect effluent discharges

Sites	10/21/2011	11/11/2011	12/9/2011	1/6/2011	2/17/2011	3/17/2011	4/19/2011	**Geomean**	%frequency over 576 colonies/100mLs
NR23	204	32	280	880	78	52	120	**134**	14.29%
NR22	1	1100	3600	8900	5000	TNTC	2	**266**	**66.67%**
NR21	240	112	80	500	640	17	52	**129**	**14.29%**
NR20	32	56	220	540	640	370	156	**187**	**14.29%**
NR15	132	40	24	60	42	124	128	**65**	**0.00%**
NR13	320	1840	28	600	200	12	100	**157**	**28.57%**
NR9.5	60	108	34	340	24	18	124	**63**	**0.00%**
NR9	52	44	40	136	16	30	100	**48**	**0.00%**
NR6	44	60	20	40	10	29	84	**34**	**0.00%**
NR4	116	40	32	56	20	26	100	**46**	**0.00%**
SM3	48	12	20	48	58	26	68	**34**	**0.00%**
NR1	38	980	32	28	40	30	120	**65**	**0.00%**
Rainfall (in.)	1.15	0.27	0.00	0.00	0.00	0.46	1.38		
Days prior	7	3	7	7	7	1	3		

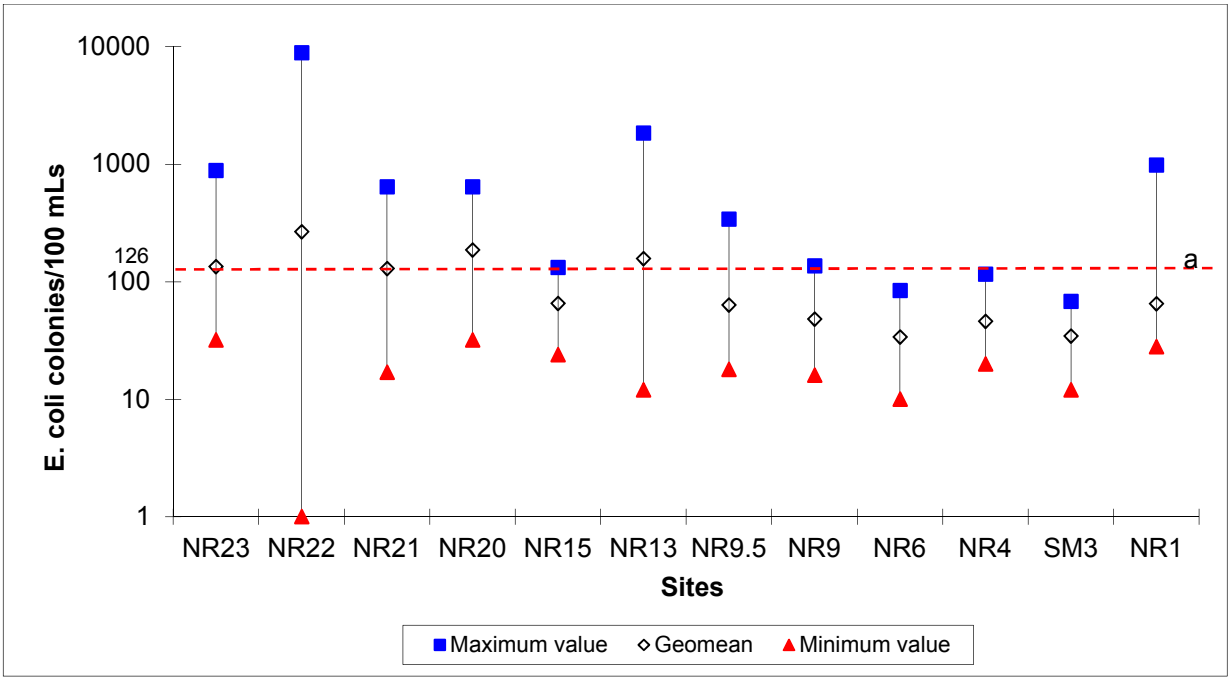
All observed dissolved oxygen means and all observed individual values meet the CT DEP dissolved oxygen criteria of 5mgL for a Class B river (Figure 2, Table B1).

Observed conductivity means range from a maximum of 920µS at Site NR23 in the upper watershed to a minimum of 255µS at Site SM3 on the Silvermine River (Figure 3, Table 3). Observed individual site ranges are at a maximum of 648µS at Site NR23 at Steep Brook and are at a minimum of 120µS at Site SM3 on the Silvermine River.

Table 3 Maximum, minimum, mean and site range for conductivity values (µS) at 12 monitoring sites on the Norwalk River from October 21, 2010 to April 19, 2011

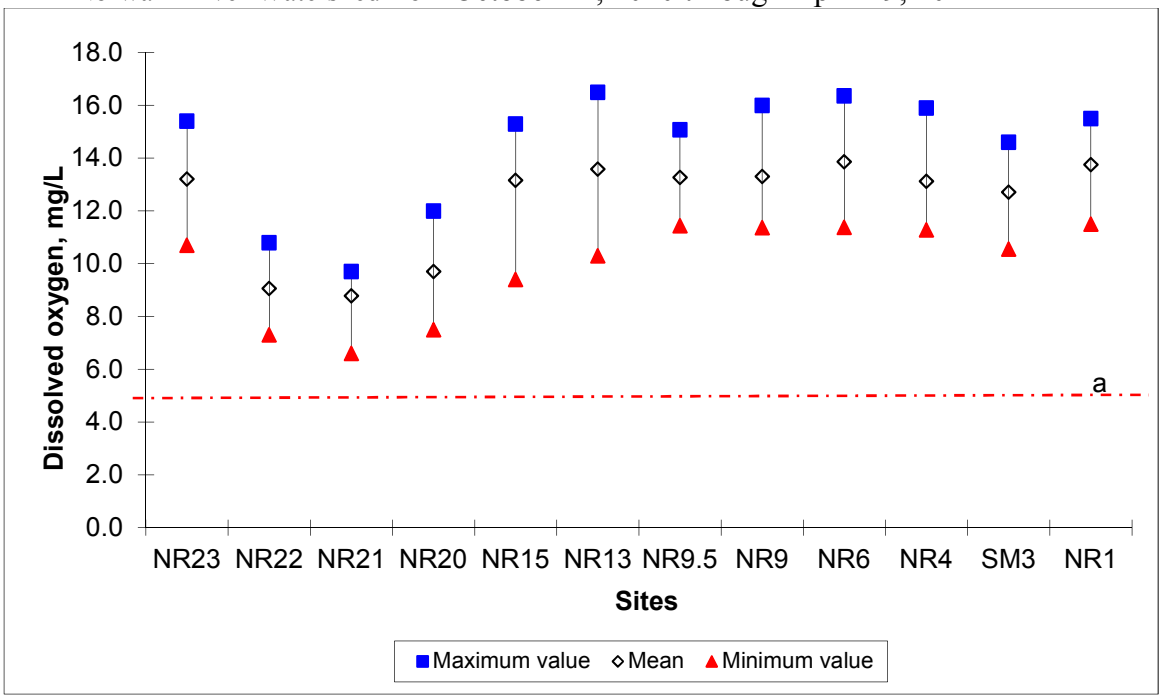
	NR23	NR22	NR21	NR20	NR15	NR13	NR9.5	NR9	NR6	NR4	SM3	NR1
Max value	1298	862	831	686	677	458	496	456	447	463	322	392
Min value	650	505	319	388	413	266	322	303	261	271	203	245
Range	648	357	512	298	264	192	174	153	186	192	120	147
Mean	920	692	562	550	544	361	397	373	363	372	255	337

Figure 1 Maximum, geometric means, and minimum values of *E. coli* bacteria concentrations at 12 monitoring sites in the Norwalk River Watershed from October 21, 2010 through April 19, 2011 when the two Ridgefield and one Georgetown wastewater treatment facilities are not 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 October 21, 2010 through April 19, 2011



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

Figure 3 Maximum, mean and minimum values for conductivity at 12 sampling sites in the Norwalk River Watershed from October 21, 2010 through April 19, 2011

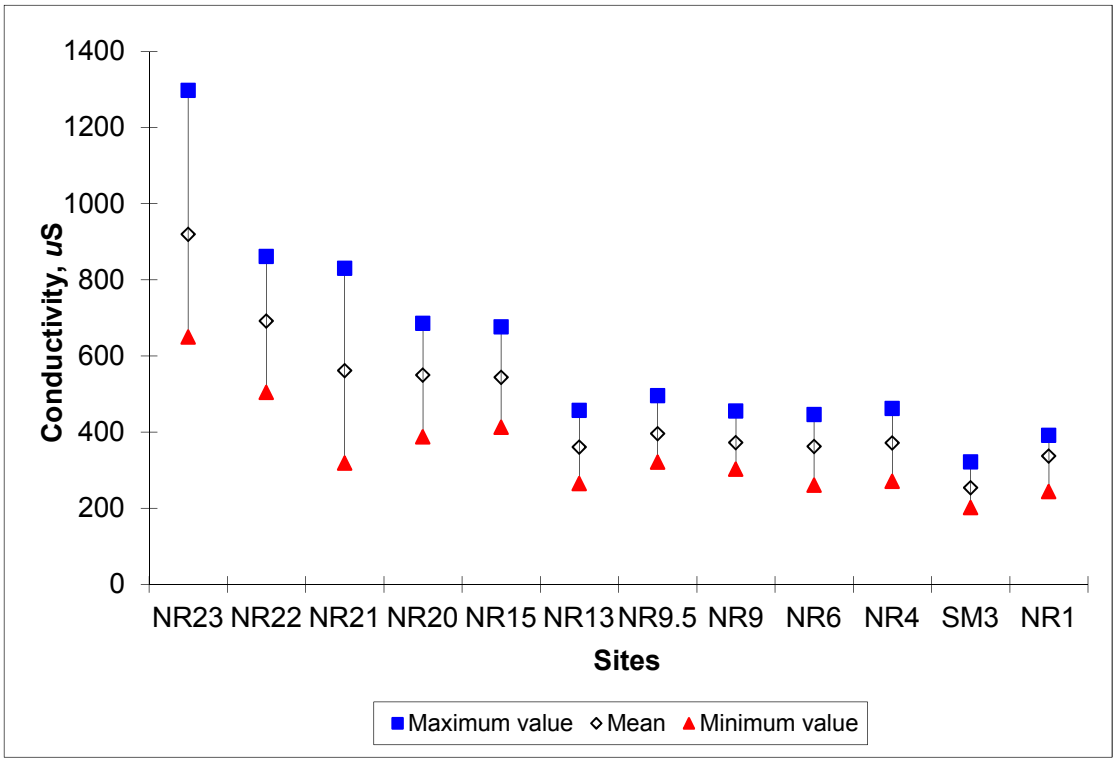
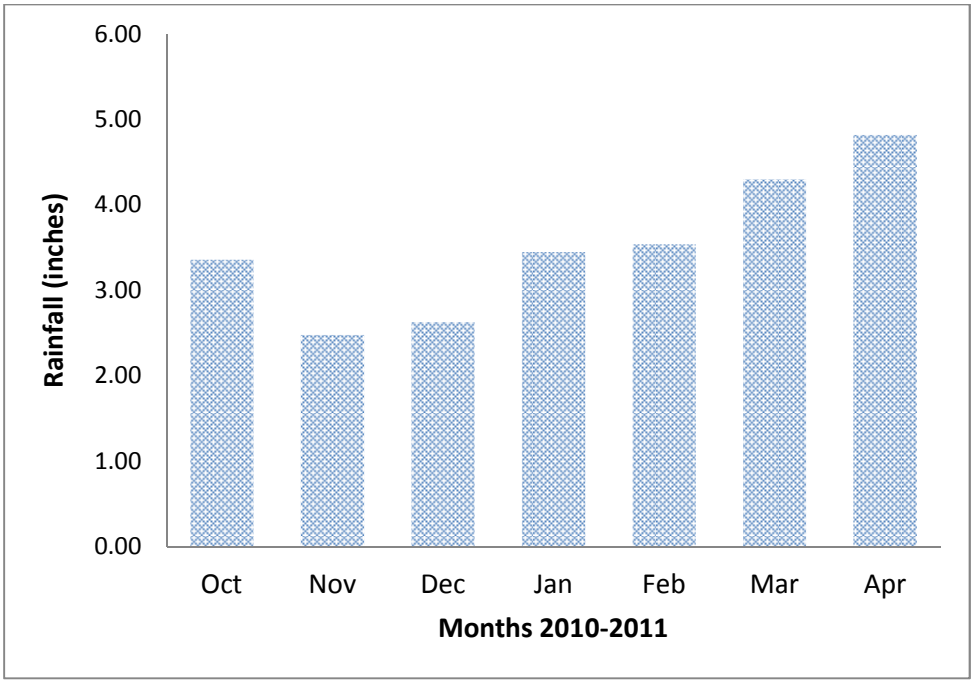


Figure 4 Monthly rainfalls (inches) from Oct 2010 to April 2011



IV Discussion:

Rainfall for the seven month period was a total of 24.6 inches[1] or an average of 3.5 inches per month (Figure 4). Reaching a low of 2.48 inches in November, rainfall increased month by month until reaching a high of 4.82 in April. Rainfall beginning in February relates to snowfall which has been converted to rain for values shown on Figure 4.

The Norwalk River beginning at Site NR15 (Stonehenge Inn, Figure 2A) shows all testing sites, with the exception of Site NR13 at the Branchville railroad station, the monitoring sites meet the CT DEP criteria for *E. coli* bacteria (Table 2, Figure 1). A possible reason for this is that cold weather and up to four feet of snow on the river banks froze the ground and helped create a temporary barrier to storm water runoff (Table 2, Figure 2). The snowcap lasted for many weeks and helped clean-up the lower watershed of the Norwalk River (Table 2).

The upper watershed is a different story because two sewage treatment plants discharge directly to the river and based on NPDES permit requirements, their ultraviolet lights for sanitizing the effluent stream can be turned off from October through April[2]. As a result, the waste stream is not disinfected and bacteria used in secondary and tertiary treatment are discharged to the waterway (Table 2). This is not the only reason for elevated bacteria counts. Steep Brook which runs between the two ridges comprising the Town of Ridgefield (Figure A3) has numerous storm drain connections (lateral) which discharge to the brook under the street level. *E. coli* bacteria counts have been elevated over the many years HW has been testing this small tributary (Site NR23, Table 2).

Site NR13 at Branchville is another site where *E. coli* bacteria input is evident (Table 2, Figure 1). HW has performed many tests in the immediate area to find the source of this pollution. Cooper Brook which forms a confluence with the Norwalk River just 200 feet upstream is not the source as proven by these tests. The source is upstream in the Norwalk River. HW will continue the search in the coming months.

Observed dissolved oxygen means and individual readings all meet the CT DEP DO criterion of 5mg/L or greater as would be expected in cold weather (Figure 2). The lower DO values observed at Site NR22 through NR20 are possibly due to lower DO levels in the Ridgefield WTP effluent discharge and the slower moving water in and around the great swamp (Figure 2).

Observed conductivity means and individual site ranges are most elevated at Site NR23 on Steep Brook (Figure 3, Table 4). This is due to the drainage of several lateral storm drains into Steep Brook prior to its arrival at Site NR23. Site NR22 (discharge of the Ridgefield WTF) also increases the ionic strength of the Norwalk River. Limestone beds in the Ridgefield area add calcium (Ca) and magnesium (Mg) ions to the Norwalk River.

As the Norwalk River flows to the south, Cooper Brook, Bennett's Brook, Comstock Brook and the Silvermine River all serve to dilute the ionic strength of the Norwalk River as can be seen in Figure 3. The Norwalk River test sites become more stable with less influence by storm water runoff as the water moves to Long Island Sound. The Silvermine River, Site SM3, shows the lowest conductivity means and shortest range of all test sites analyzed by HW (Table 4, Figure 3).

[1] Rainfall data courtesy of Norwalk Health Department

[2] The Ridgefield WTP turns lights on in mid April and turns them off in late October (Table 2) to assure that the UV lights are working ahead of schedule in April and to add extra days to the fishing season during October

V. Index

Figures and Tables:

Appendix A:

Appendix B:

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VI. References:

Belluci, C., M.B. Beauchene and M. Becker. 2009. Physical, Chemical and Biological attributes of least disturbed watersheds in Connecticut, CT Department of Environmental Protection, Bureau of Water Protection and Land Reuse, Planning Standards Division, Hartford, CT, 2009

CT DEP, Water Quality Standard 12/17/02

Harris, R. B. and P. J. Fraboni: Quality Assurance/Quality Control Plan for the Norwalk River Watershed Monitoring Project (RFA# 10160) (re-approved September 16, 2010 and extending to April 30, 2014).

Harris, R. B. and P. J. Fraboni. 2006. Water Quality Data Final Report for the Norwalk River Watershed (June 2006 –May 2006).

Harris, R. B. and P. J. Fraboni. 2007. Water Quality Data Final Report for the Norwalk River Watershed (July 2007–September 2007).

Harris, R. B. and P. J. Fraboni. 2008. Water Quality Data Final Report for the Norwalk River Watershed (July 2008 –September 2008).

Harris, R. B. and P. J. Fraboni. 2009. Water Quality Data Final Report for the Norwalk River Watershed (June 2009 –September 2009).

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

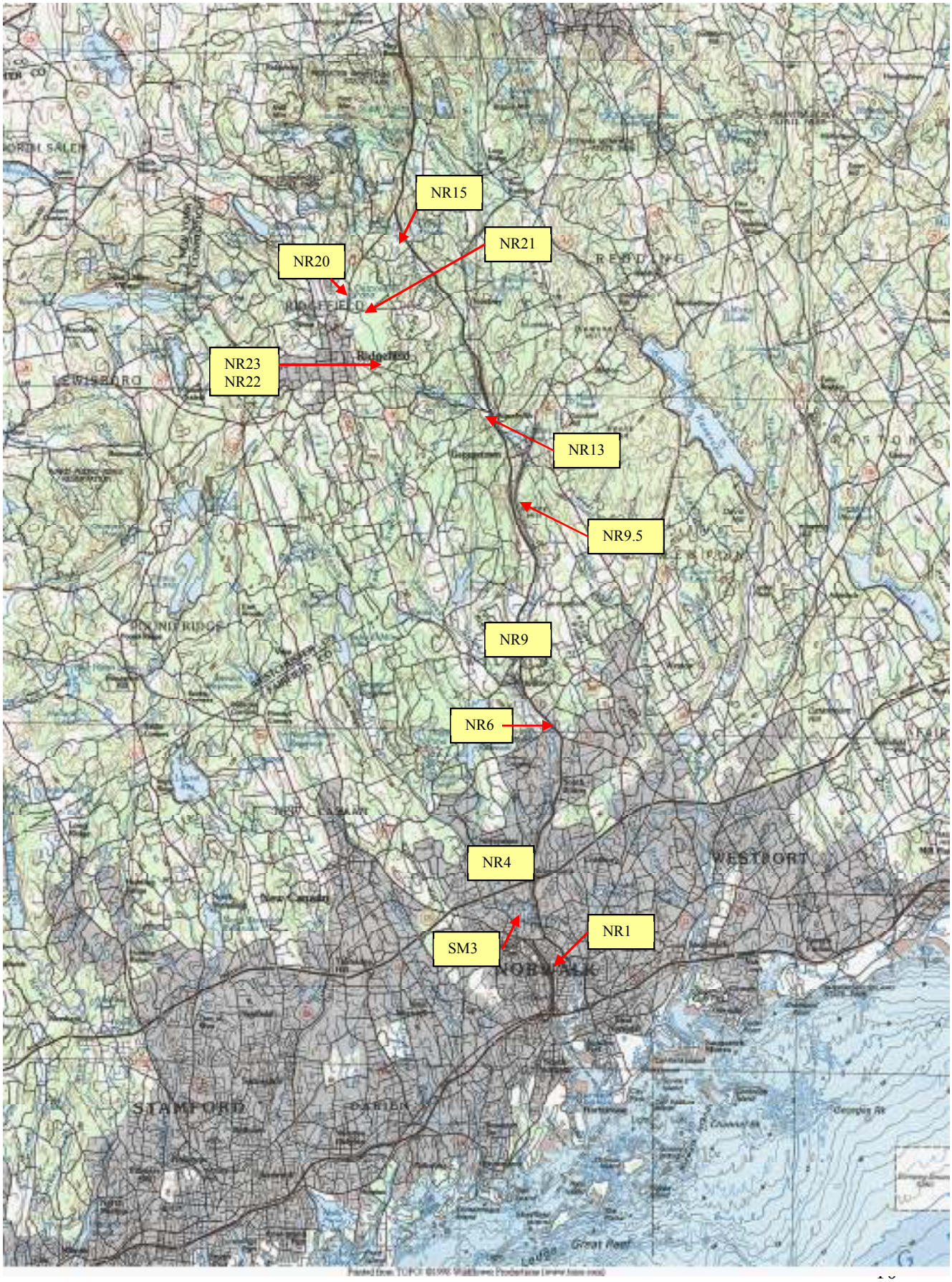
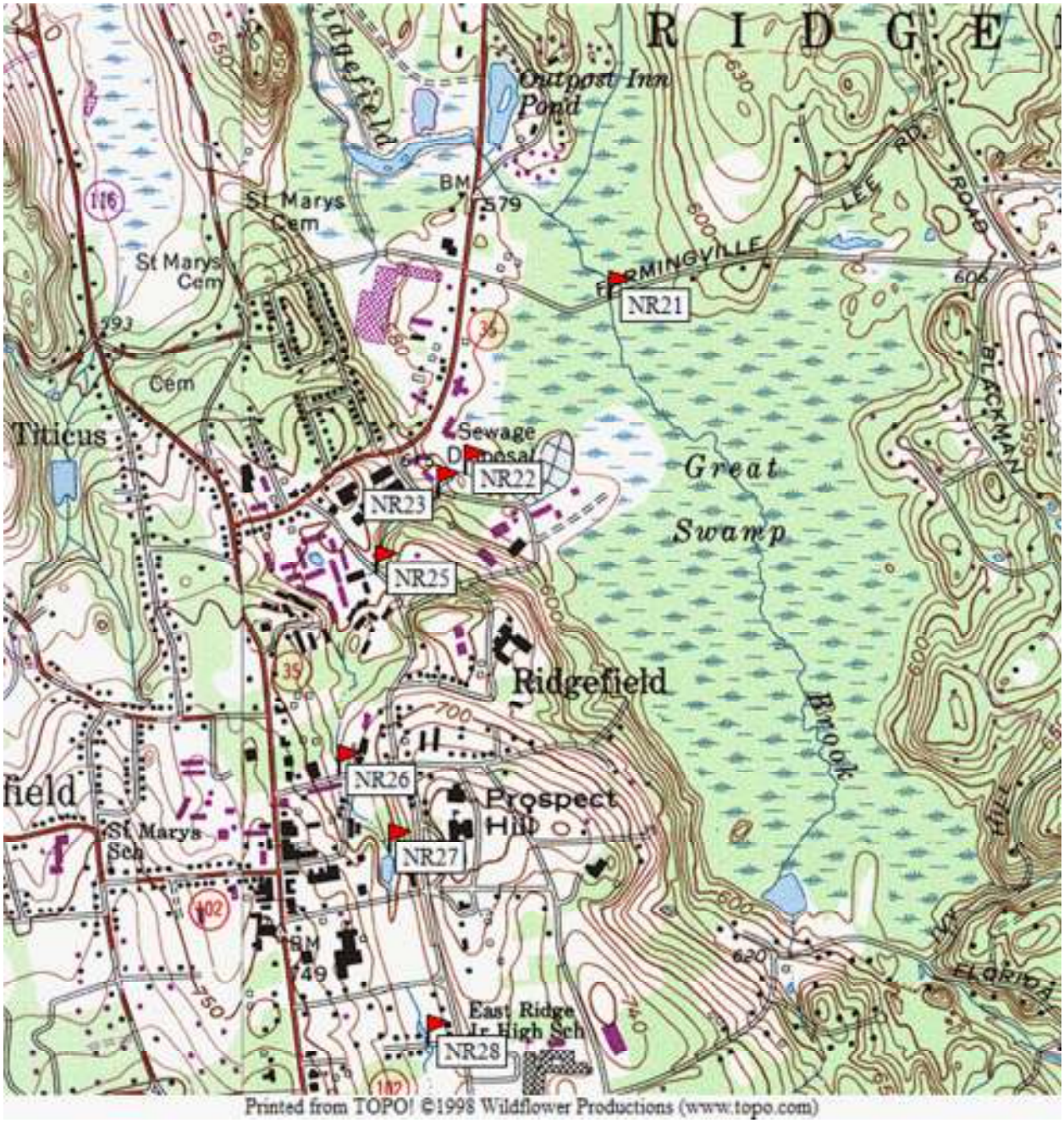


Figure A3 Map of Steep Brook course through Ridgefield, CT showing monitoring sites



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 October 21, 2010 to April 19, 2011

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 o rain (in)	Days prior o sampling	QA/QC	Fecal Coliform CFU/100 mL
NR 23	10/21/2010	1036	12.0	10.6	10.7	1298	208	204	1.15	7		
NR 22	10/21/2010	1045	13.0	15.8	7.3	862	2	1	1.15	7		
NR 21	10/21/2010	1054	13.0	10.4	6.6	831	400	240	1.15	7		
NR 20	10/21/2010	1105	12.0	9.5	7.5	538	40	32	1.15	7	Dupilcate	24
NR 15	10/21/2010	1120	13.0	10.0	9.4	5	144	132	1.15	7	Replicate	144
NR 13	10/21/2010	1140	13.0	10.2	10.3	332	480	320	1.15	7		
NR 9.5	10/21/2010	1148	12.0	10.4	11.8	449	64	60	1.15	7		
NR 9	10/21/2010	1135	12.0	10.1	11.5	418	52	52	1.15	7		
NR 6	10/21/2010	1121	12.0	10.0	11.6	413	44	44	1.15	7		
NR 4	10/21/2010	1102	12.0	10.5	11.9	419	116	116	1.15	7	Replicate	120
SM 3	10/21/2010	1047	11.0	10.5	10.6	279	56	48	1.15	7	Duplicate	50
NR 1	10/21/2010	1025	12.0	11.2	14.0	390	40	38	1.15	7		
NR 23	11/11/2010	1040	9.0	6.4	13.0	934	44	32	0.27	3		
NR 22	11/11/2010	1053	11.0	13.4	8.7	811	1200	1100	0.27	3		
NR 21	11/11/2010	1105	10.0	7.1	9.5	677	136	112	0.27	3	Duplicate	
NR 20	11/11/2010	1115	11.0	6.0	11.2	673	72	56	0.27	3	Replicate	40
NR 15	11/11/2010	1127	12.0	6.0	13.4	605	60	40	0.27	3		
NR 13	11/11/2010	1147	12.0	7.3	13.3	454	2060	1840	0.27	3		
NR 9.5	11/11/2010	1205	17.0	7.0	12.5	416.0	124	108	0.27	3		
NR 9	11/11/2010	1150	15.0	7.0	12.3	401	52	44	0.27	3		
NR 6	11/11/2010	1133	17.0	7.4	13.2	403	72	60	0.27	3	Replicate	52
NR 4	11/11/2010	1115	16.0	8.1	12.8	412	40	40	0.27	3		
SM 3	11/11/2010	1057	12.0	7.1	11.3	282	12	12	0.27	3		
NR 1	11/11/2010	1035	13.0	8.4	12.4	385	1320	980	0.27	3		
NR 23	12/9/2010	1040	0.0	0.3	15.4	949	360	280	0.00	7	Replicate	560
NR 22	12/9/2010	1047	-3.0	9.7	9.0	753	4300	3600	0.00	7		
NR 21	12/9/2010	1055	-2.0	0.6	9.2	613	128	80	0.00	7		
NR 20	12/9/2010	1105	-2.0	0.5	12.0	686	240	220	0.00	7		
NR 15	12/9/2010	1115	-1.0	0.5	15.3	540	24	24	0.00	7		
NR 13	12/9/2010	1128	-4.0	1.0	15.3	266	40	28	0.00	7	Duplicate	52
NR 9.5	12/9/2010	1140		1.2	15.0	322	34	34	0.00	7		
NR 9	12/9/2010	1128		1.0	14.9	308	48	40	0.00	7		
NR 6	12/9/2010	1116		0.7	15.5	316	20	20	0.00	7	Duplicate	40
NR 4	12/9/2010	1055		0.8	13.4	330	48	32	0.00	7	Replicate	32
SM 3	12/9/2010	1046		0.5	14.6	269	16	20	0.00	7		
NR 1	12/9/2010	1030		1.0	15.3	321	36	32	0.00	7		
NR 23	1/6/2011	1040	-3.0	0.6	14.9	1019	960	880	0.00	7		
NR 22	1/6/2011	1050	-3.0	8.5	9.2	505	10800	8900	0.00	7		
NR 21	1/6/2011	1058	-3.0	0.4	9.4	605	640	500	0.00	7		
NR 20	1/6/2011	1107	-2.0	0.4	9.7	650	780	540	0.00	7		
NR 15	1/6/2011	1120	-1.0	0.2	15.2	620	68	60	0.00	7	Duplicate	92
NR 13	1/6/2011	1134	-1.0	0.6	15.2	458	640	600	0.00	7		
NR 9.5	1/6/2011	1207	0.0	1.0	14.8	416	340	340	0.00	7		
NR 9	1/6/2011	1150	-1.0	0.9	15.0	393	144	136	0.00	7	Duplicate	
NR 6	1/6/2011	1128	0.2	0.4	16.4	389	48	40	0.00	7	Replicate	84
NR 4	1/6/2011	1111	0.0	1.0	15.9	389	60	56	0.00	7		
SM 3	1/6/2011	1045	1.0	0.6	14.1	217	72	48	0.00	7		
NR 1	1/6/2011	1021	-1.0	1.0	15.5	343	52	28	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 o rain (in)	Days prior o sampling	QA/QC	Fecal Coliform CFU/100 mL
NR 23	2/17/2011	1052	11.0	4.3	14.5	650	90	78	0.00	7		
NR 22	2/17/2011	1103	12.0	8.2	10.8	550	10000	5000	0.00	7	Replicate	14000
NR 21	2/17/2011	1115	12.0	2.3	9.7	445	900	640	0.00	7		
NR 20	2/17/2011	1123	12.0	2.2	9.4	401	820	640	0.00	7		
NR 15	2/17/2011	1223	13.0	2.0	14.5	677	42	42	0.00	7		
NR 13	2/17/2011	1143	14.0	1.6	16.5	278	210	200	0.00	7	Duplicate	
NR 9.5	2/17/2011	1222	11.0	2.4	15.1	496	20	24	0.00	7	Duplicate	
NR 9	2/17/2011	1205	8.0	3.2	16.0	456	18	16	0.00	7	Replicate	16
NR 6	2/17/2011	1151	12.0	3.3	16.2	447	10	10	0.00	7		
NR 4	2/17/2011	1130	6.0	3.6	14.8	463	16	20	0.00	7		
SM 3	2/17/2011	1112	8.0	2.3	14.1	322	60	58	0.00	7		
NR 1	2/17/2011	1053	7.0	3.1	15.0	392	54	40	0.00	7		
NR 23	3/17/2011	1044	12.0	6.8	12.3	882	64	52	0.46	1	Duplicate	48
NR 22	3/17/2011	1107	14.0	8.9	9.7	700	TNTC	TNTC	0.46	1		
NR 21	3/17/2011	1117	16.0	5.7	9.6	443	96	17	0.46	1	Replicate	100
NR 20	3/17/2011	1126	15.0	6.3	10.3	515	450	370	0.46	1		
NR 15	3/17/2011	1212	19.0	7.0	12.5	500	130	124	0.46	1		
NR 13	3/17/2011	1227	19.0	6.6	12.7	380	14	12	0.46	1		
NR 9.5	3/17/2011	1203	16.0	6.4	12.3	353	20	18	0.46	1	Replicate	18
NR 9	3/17/2011	1152	18.0	6.6	12.1	332	44	30	0.46	1		
NR 6	3/17/2011	1136	17.0	6.4	12.8	312	36	29	0.46	1		
NR 4	3/17/2011	1115	17.0	6.4	11.8	321	26	26	0.46	1		
SM 3	3/17/2011	1102	12.0	5.4	12.9	210	30	26	0.46	1		
NR 1	3/17/2011	1044	11.0	5.9	12.6	288	34	30	0.46	1	Duplicate	10
NR 23	4/19/2011	1052	15.0	10.0	11.6	710	120	120	1.38	3		
NR 22	4/19/2011	1103	16.0	10.6	8.8	664	2	2	1.38	3		
NR 21	4/19/2011	1113	17.0	10.3	7.5	319	52	52	1.38	3		
NR 20	4/19/2011	1120	16.0	10.3	7.8	388	156	156	1.38	3	Replicate	92
NR 15	4/19/2011	1133	17.0	10.8	11.9	413	132	128	1.38	3	Duplicate	144
NR 13	4/19/2011	1147	17.0	10.7	11.8	361	140	100	1.38	3		
NR 9.5	4/19/2011	1156	18.0	10.2	11.4	325	124	124	1.38	3		
NR 9	4/19/2011	1145	17.0	10.4	11.4	303	176	100	1.38	3		
NR 6	4/19/2011	1125	16.0	10.2	11.4	261	156	84	1.38	3		
NR 4	4/19/2011	1107	16.0	10.1	11.3	271	204	100	1.38	3		
SM 3	4/19/2011	1057	14.0	9.8	11.5	203	68	68	1.38	3	Duplicate	88
NR 1	4/19/2011	1036	16.0	9.9	11.5	245	248	120	1.38	3	Replicate	200

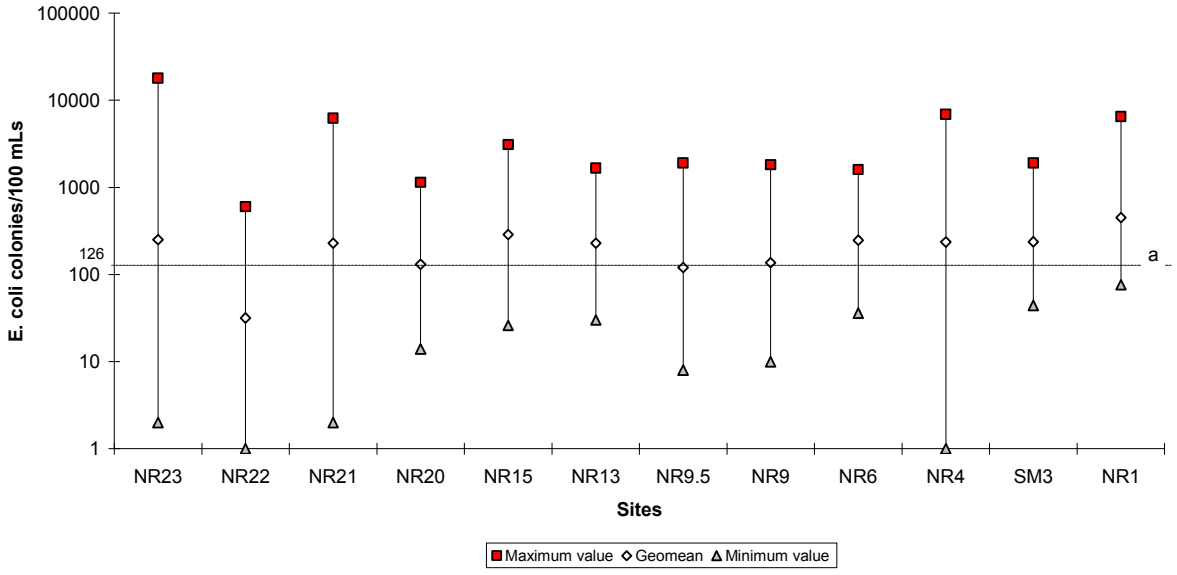
Appendix C

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

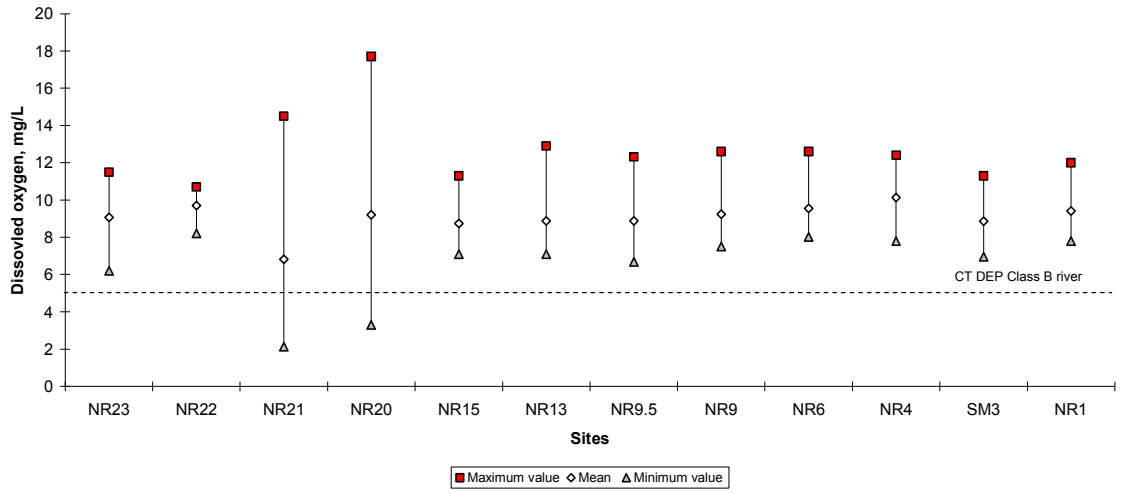
An example of a graph for maximum, geometric means, and minimum values of *E. coli* bacteria concentrations at 12 monitoring sites in the Norwalk River Watershed when the two Ridgefield and one Georgetown wastewater treatment facilities are required by NPDES permits to disinfect sewage effluent



[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 Y-axis) 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

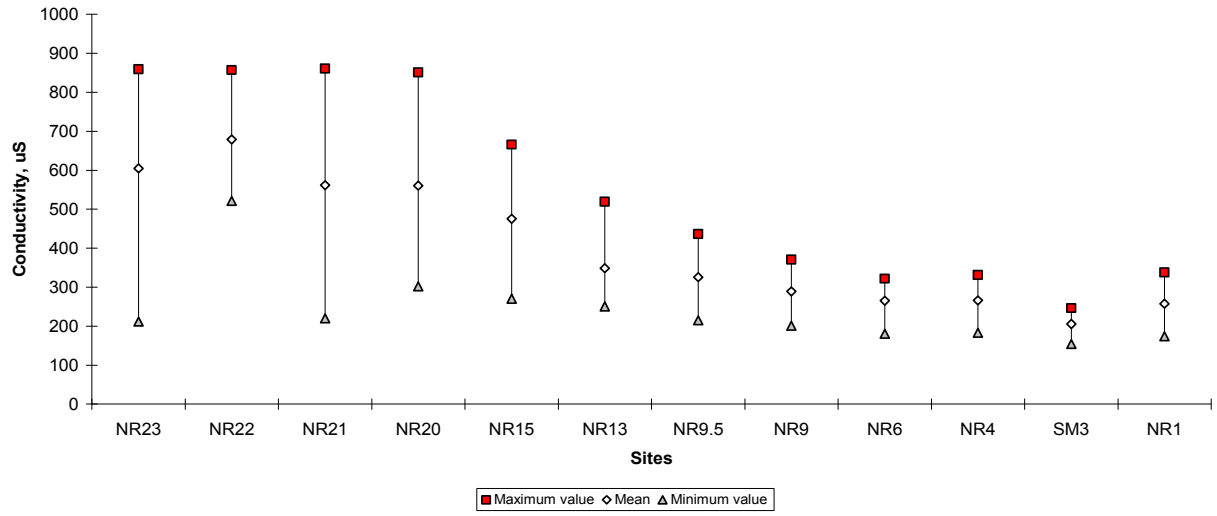
The graph below is an example of a graph showing maximum, mean and minimum values for dissolved oxygen at 12 sampling sites on the Norwalk River Watershed



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