A Total Maximum Daily Load Analysis for Recreational Uses of the Naugatuck River Regional Basin

FINAL – April 17, 2008

This document has been established pursuant to the requirements of Section 303(d) of the Federal Clean Water Act

s/ Betsey Wingfield 4/17/08

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INTRODUCTION

A Total Maximum Daily Load (TMDL) analysis was completed for indicator bacteria in the Naugatuck River Regional Basin. The specific waterbodies included in the TMDL analysis are the Naugatuck River, Great Brook, Steele Brook, Mad River, Hop Brook, and Long Meadow Pond Brook (Figure 1). These waterbodies are included on the *2006 List of Connecticut Waterbodies Not Meeting Water Quality Standards*[1] (2006 *List* - Appendix C of the 2006 Water Quality Report to Congress) due to exceedences of the indicator bacteria criteria contained within the State *Water Quality Standards* (WQS)[2]. Attainment of the target TMDLs presented herein is expected to result in achievement and maintenance of the bacteria criteria established in the WQS. (For more information regarding assessed and impaired waterbodies throughout the state, please refer to the 2006 *Water Quality Report to Congress*[1].)

Under section 303(d) of the Federal Clean Water Act (CWA), States are required to develop TMDLs for waters impacted by pollutants, are included on their Impaired Waters Lists, and for which technology-based controls are insufficient to achieve water quality standards. In general, the TMDL represents the maximum loading that a waterbody can receive without exceeding the water quality criteria, which have been adopted into the WQS for that parameter. Federal regulations (40CFR, section 130.2(i)) specify that TMDL loadings may be expressed as a mass per time, toxicity, or other appropriate measure[3]. For the Naugatuck River Regional Basin TMDLs, loadings are expressed as the percent reductions necessary at specific locations in order to achieve the water quality standards and support recreational uses. EPA's most recent guidance recommends that all TMDLs and associated load allocations and wasteload allocations be expressed in terms of daily time increments[4]. The percent reduction TMDLs for the Naugatuck River Regional Basin are applicable each and every day until recreational use goals are attained. Federal regulations require that the TMDL analysis identify the portion of the total loading which is allocated to point source discharges (termed the Wasteload Allocation or WLA) and the portion attributed to nonpoint sources (termed the Load Allocation or LA), which contribute the TMDL pollutant to the waterbody. In addition, TMDLs must include a Margin of Safety (MOS) to account for uncertainty in establishing the relationship between pollutant loadings and water quality. Seasonal variability in the relationship between pollutant loadings and WQS attainment was also considered in the TMDL analyses.

The Naugatuck River Regional Basin extends through the municipalities of Norfolk, Winchester, Goshen, Torrington, Litchfield, Harwinton, Morris, Thomaston, Plymouth, Watertown, Wolcott, Waterbury, Prospect, Middlebury, Naugatuck, Oxford, Beacon Falls, Bethany, Seymour, Ansonia, and Derby. The watershed municipalities of Thomaston, Plymouth, Watertown, Wolcott, Waterbury, Prospect, Middlebury, Naugatuck, Oxford, Beacon Falls, Bethany, Seymour, Ansonia, and Derby contain designated urban areas, as defined by the US Census Bureau[5] (Figure 2). Such municipalities are required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit). The general permit is applicable to municipalities that contain designated urban areas (or MS4

communities) and discharge stormwater via a separate storm sewer system to surface waters of the State. The permit requires municipalities to develop a program aimed at reducing the discharge of pollutants, as well as to protect water quality. The permit includes a provision requiring towns to focus their stormwater plans on waterbodies for which TMDLs have been developed. Such a program must include the following six control measures: public education and outreach; public participation; illicit discharge detection and elimination; construction stormwater management (greater than 1 acre); post-construction stormwater management; and pollution prevention and good housekeeping. Specific requirements have been developed within each of these control measures. Additional information regarding the general permit can be obtained on the Department of Environmental Protection (DEP) website at http://www.dep.state.ct.us/wtr/stormwater/ms4index.htm.

TMDLs that have been established by states are submitted to the Regional Office of the Federal Environmental Protection Agency (EPA) for review. The EPA can either approve the TMDL or disapprove the TMDL and act in lieu of the State. TMDLs provide a scientific basis for local stakeholders to develop and implement Watershed Based Management Plans (plan), which describe the control measures necessary to achieve acceptable water quality conditions. Therefore, plans derived from TMDLs typically include an implementation schedule and a description of ongoing monitoring activities to confirm that the TMDL will be effectively implemented and that WQS are achieved and maintained where technically and economically feasible. Public participation during development of the TMDL analysis and subsequent preparation of the plans is vital to the success of resolving water quality impairments.

TMDL analyses for indicator bacteria in the Naugatuck River Regional Basin are provided herein. As required in a TMDL analysis, load allocations have been determined, a margin of safety has been included, and seasonal variation has been considered. This document also includes recommendations for TMDL implementation as well as a water quality monitoring plan.

PRIORITY RANKING

Table 1. The status of impairment for each of the subject waterbodies as well as the TMDL development priority based on the 2006 *List*.

Waterbody Name	Waterbody Segment ID	Waterbody Segment Description	303(d) Listed (Yes/No)	Impairment Use/ Cause	Priority
Naugatuck River	CT6900-00_06 CT6900-00_05 CT6900-00_04 CT6900-00_03 CT6900-00_02 CT6900-00_01	From the confluence with Spruce Brook (Litchfield/Harwinton town border) downstream to the confluence with the Housatonic River (Derby).	Yes	Recreation Indicator Bacteria	H
Steele Brook	CT6912-00_02 CT6912-00_01	From the inlet to Heminway Pond downstream to the confluence with the Naugatuck River (Watertown).	Yes	Recreation Indicator Bacteria	H
Great Brook	CT6900-22_01	From Belleview Lake outlet dam (Great Brook Res) downstream to the confluence with the Naugatuck River (Waterbury).	Yes	Recreation Indicator Bacteria	H
Mad River	CT6914-00_03a CT6914-00_02 CT6914-00_01	From the confluence with Lily Brook (Wolcott) downstream to the confluence with the Naugatuck River (Waterbury).	Yes	Recreation Indicator Bacteria	H
Hop Brook	CT6916-00_01	From Hop Brook Lake dam outlet downstream to the confluence with the Naugatuck River (Naugatuck).	Yes	Recreation Indicator Bacteria	H
Long Meadow Pond Brook	CT6917-00_01	From the Naugatuck Ice Company Pond dam outlet downstream to the confluence with the Naugatuck River (Naugatuck).	Yes	Recreation Indicator Bacteria	H

An “H" indicates that the waterbody was included on the *List* as a high priority because assessment information suggested a TMDL may be needed to restore the water quality impairment and a TMDL was planned for development within 3-5 years.

DESCRIPTION OF THE WATERBODY

See "Site Specific Information" in Appendix A.

POLLUTANT OF CONCERN AND POLLUTANT SOURCES

Potential sources of indicator bacteria include point and nonpoint sources, such as stormwater runoff, sanitary sewer overflows (collection system failures), and illicit discharges. Potential sources that have been tentatively identified, based on land-use (Figure 3) and site survey work for each of the waterbodies are presented in Table 2.

Table 2. Potential sources of bacteria for each of the subject waterbodies.

Waterbody Name	Nonpoint Sources	Point Sources
Naugatuck River	Stormwater Runoff, Unknown Sources	Regulated Stormwater Runoff, Sanitary Sewer Overflows (collection system failures), Unknown Sources, Illicit Discharges
Steele Brook	Stormwater Runoff, Unknown Sources	Regulated Stormwater Runoff, Sanitary Sewer Overflows, Unknown Sources, Illicit Discharges
Great Brook	Stormwater Runoff, Unknown Sources	Regulated Stormwater Runoff, Sanitary Sewer Overflows (collection system failures), Unknown Sources, Illicit Discharges
Mad River	Stormwater Runoff, Unknown Sources	Regulated Stormwater Runoff, Sanitary Sewer Overflows, Unknown Sources, Illicit Discharges
Hop Brook	Stormwater Runoff, Unknown Sources	Regulated Stormwater Runoff, Unknown Sources, Illicit Discharges
Long Meadow Pond Brook	Stormwater Runoff, Unknown Sources	Regulated Stormwater Runoff, Unknown Sources, Illicit Discharges

Table 3 lists the eight municipal wastewater treatment plants that discharge to the Naugatuck River Regional Basin. Disinfection required under the National Pollutant Discharge Elimination System (NPDES) Permit is sufficient to reduce indicator bacteria densities to below levels of concern in the treatment plant effluent when in use and functioning properly (See Numeric Water Quality Target for further explanation).

Table 3. Wastewater Treatment Facilities in the Naugatuck River Regional Basin.

Facility	NPDES ID	Discharges to
Torrington WPCF	CT0100579	Naugatuck River
Thomaston WPCF	CT0100781	Naugatuck River
Waterbury WPCF	CT0100625	Naugatuck River
Naugatuck WPCF	CT0100641	Naugatuck River
Beacon Falls WPCF	CT0101061	Naugatuck River
Seymour WPCF	CT0100501	Naugatuck River
Ansonia WPCF	CT0100013	Naugatuck River
Derby WPCF	CT0100161	Naugatuck River

Data reported by the WWTPs in compliance with their NPDES Permit requirements was reviewed for the 2005, 2006, and 2007 disinfection seasons. The WWTPs monitor and report for fecal coliform bacteria, which *E. coli* bacteria is a component of. Their permit limits are less than 200 col/100ml based on a 30 day average and 400 col/100ml based on a 7 day geometric mean. None of the plants were found to exceed their permit limits over the review period. Because *E. coli* is one of the bacteria types that comprise the fecal coliform group and the plants did not exceed their fecal coliform limit, it is assumed that the WWTPs are not significant contributors to in-stream *E. coli* concentrations.

There are three industrial dischargers in the Naugatuck River Basin: Quality Rolling and Deburring (CT0025305), Whyco Technologies Inc (CT0001457), Summit Corporation (CT0001180). These facilities are metal finishing plants that discharge to the upper Naugatuck River (segment ID CT6900-00_05). A limit for indicator bacteria was not included when the initial NPDES Permits were issued because the discharges were not determined to contain significant levels of bacteria. These discharges are not considered potential point sources of indicator bacteria to the Naugatuck River Basin. They are, however, included in a whole effluent toxicity TMDL for the Naugatuck River, adopted by EPA on August 17, 2005.

There are approximately 139 industrial and commercial stormwater dischargers operating under general permits in the Naugatuck River Basin. These permits do not have a bacteria monitoring requirement and therefore actual indicator bacteria data is unknown from these dischargers. However, the MS4 Permit for stormwater does require indicator bacteria (*E. coli*) sampling at industrial, commercial, and residential sites. A review of 87 *E. coli* samples collected by ten towns in the basin at industrial and commercial sites indicated that bacteria levels ranged from 0 to 640,000 col/100mls during 2004, 2005, and 2006. The median concentration was 1,100 col/100mls. It is assumed that these values are comparable to stormwater discharging to the Naugatuck River Basin under the industrial and commercial general permits.

Typical of most rivers, a number of discharge pipes are located along the river for the purpose of conveying stormwater. However, the DEP's Monitoring and Assessment group has identified levels of indicator bacteria in water discharging from five pipes above the water quality criteria. Sources of bacteria contributing to high levels in water discharging from some of the pipes have been identified by DEP through site survey

work. Table 4 lists the station identification number, description, sample dates, sample ranges, and sources.

Table 4. List of stormwater pipes with elevated levels of bacteria.

Station ID	Description	Segment	Sample Dates	Number of *E. coli* Samples	*E. coli* Range col/100ml	Median	Sources
542	Chase River Rd, No, Waterbury - above 1029	CT6900-00_04	2000-2006	33	50-24,000	11,000	Sanitary sewer line failure and Illicit connections
634	Waterbury Hospital Area, Waterbury - above 204	CT6900-00_03	2001-2006	15	960-24,000	17,000	Sanitary sewer line failure and Illicit connections
651	Maple St West, Naugatuck - above 192	CT6900-00_02	2001-2006	11	All samples greater than 24,000		Sanitary line failure that leaches into the storm sewer
994	Hop Brook Pipe, Naugatuck - below 1479	CT6916-00_01	2006	1	24,000		Illicit connection
1520	Long Meadow Pond Bk Pipe, Naugatuck - below 1478	CT6917-00_01	2006	2	280-24,000		Source unknown

APPLICABLE SURFACE WATER QUALITY STANDARDS

Connecticut's WQS establish criteria for bacterial indicators of sanitary water quality that are based on protecting recreational uses such as swimming (both designated and non-designated swimming areas), kayaking, wading, water skiing, fishing, boating, aesthetic enjoyment and others. Indicator bacteria criteria are used as general indicators of sanitary quality based on the results of EPA research[6] conducted in areas with known human fecal material contamination. The EPA established a statistical correlation between levels of indicator bacteria and human illness rates, and set forth guidance for States to establish numerical criteria for indicator bacteria organisms so that recreational use of the water can occur with minimal health risks. However, it should be noted that the correlation between indicator bacteria densities and human illness rates varies greatly between sites and the presence of indicator bacteria does not necessarily indicate that human fecal material is present since indicator bacteria occur in all warm-blooded animals.

The applicable water quality criteria for indicator bacteria to the Naugatuck River Regional Basin are presented in Table 5. These criteria are applicable to all recreational uses established for these waters other than designated and non-designated swimming.

Table 5. Applicable indicator bacteria criteria for the subject waterbodies.

Waterbody	Waterbody Segment ID	Class	Bacterial Indicator	Criteria
Naugatuck River	CT6900-00_06 CT6900-00_05 CT6900-00_04 CT6900-00_03 CT6900-00_02 CT6900-00_01	B C/B	Escherichia coli (*E. Coli*)	Geometric mean less than 126 col/100ml Single sample maximum 596 col/100ml
Steele Brook	CT6912-00_02 CT6912-00_01	B		
Great Brook	CT6900-22_01	A		
Mad River	CT6914-00_03a CT6914-00_02 CT6914-00_01	B		
Hop Brook	CT6916-00_01	B/A		
Long Meadow Pond Brook	CT6917-00_01	B		

NUMERIC WATER QUALITY TARGET

TMDL calculations were performed consistent with the analytical procedures presented in the guidelines for *Development of TMDLs for Indicator Bacteria in Contact Recreation Areas Using the Cumulative Frequency Distribution Function Method* (Guidelines)[7] included as Appendix B. All data used in the analysis and the results of all calculations are presented in Appendix A. In addition, Appendix A also contains a summary of the TMDL analyses for each waterbody. The results are summarized in Table 6 below.

Table 6. Summary of TMDL analysis.

Waterbody	Waterbody Segment Description	Segment ID	Monitor-ing Site	Average Percent Reduction to Meet Water Quality Standards			
				TMDL	WLA	LA	MOS
Naugatuck River	From the confluence with Spruce Brook (Litchfield/Harwinton town border) downstream to the confluence with the Housatonic River (Derby).	CT6900-00_06	196	39	47	33	Implicit
		CT6900-00_05	198	12	15	10	Implicit
		CT6900-00_04	1029	45	52	41	Implicit
		CT6900-00_03	204	74	79	70	Implicit
		CT6900-00_02	192	61	67	56	Implicit
		CT6900-00_01-top	213	62	69	57	Implicit
		CT6900-00_01-mid	214	67	71	65	Implicit
Steele Brook	From the inlet to Heminway Pond downstream to the confluence with the Naugatuck River (Watertown).	CT6912-00_02	331	87	88	86	Implicit
		CT6912-00_01	514	88	89	87	Implicit
Great Brook	From Belleview Lake outlet dam (Great Brook Res) downstream to the confluence with the Naugatuck River (Waterbury).	CT6900-22_01	91	89	94	86	Implicit
Mad River	From the confluence with Lily Brook (Wolcott) downstream to the confluence with the Naugatuck River (Waterbury).	CT6914-00_03a	874	69	71	68	Implicit
		CT6914-00_02	*NS - Use159	84	85	83	Implicit
		CT6914-00_01	159	84	85	83	Implicit
Hop Brook	From Hop Brook Lake dam outlet downstream to the confluence with the Naugatuck River (Naugatuck).	CT6916-00_01	1479	21	29	14	Implicit
Long Meadow Pond Brook	From the Naugatuck Ice Company Pond dam outlet downstream to the confluence with the Naugatuck River (Naugatuck).	CT6917-00_01	1478	83	86	80	Implicit

*No sample for segment CT6914-00_02. Sample 159 from CT6914-00_01 was determined to be representative of segment CT6914-00_02 and used in the TMDL analysis.

MARGIN OF SAFETY

TMDL analyses are required to include a margin of safety (MOS) to account for uncertainties regarding the relationship between load and wasteload allocations, and water quality. The MOS may be either explicit or implicit in the analysis.

The analytical approach used to calculate the TMDLs incorporates an implicit MOS. Sampling results that indicate quality better than necessary to achieve consistency with the criteria are assigned a percent reduction of "zero" instead of a negative percent reduction. This creates an excess capacity that is averaged as a zero value thereby contributing to the implicit MOS. In addition, the indicator bacteria criteria used in this TMDL analysis were developed exclusively from data derived from studies conducted by EPA at high use designated public bathing areas with known human fecal contamination[6]. Therefore, the criteria provide an additional level of protection when applied to waters not used as designated swimming areas or contaminated by human fecal material. As a result, achieving the criteria results in an "implicit MOS". Additional explanation concerning the implicit MOS incorporated into the analysis is provided in the Guidelines[7] (Appendix B).

SEASONAL ANALYSIS

Previous investigations by the DEP into seasonal trends of indicator bacteria densities in surface waters indicates that the summer months typically exhibit the highest densities of any season (*Water Quality* Summary)[8]. This phenomenon is likely due to the enhanced ability of indicator bacteria to survive in surface waters and sediment when ambient temperatures more closely approximate those of warm-blooded animals, from which the bacteria originate. In addition, resident wildlife populations are likely to be more active during the warmer months and more migratory species are present during the summer. These factors combine to make the summer, recreational period representative of "worst-case" conditions.

TMDL IMPLEMENTATION GUIDANCE

The percent reductions established in this TMDL can be achieved by implementing control actions, where technically and economically feasible, that are designed to reduce *E. coli* bacteria loading from nonpoint sources (Load Allocation) and point sources (Waste Load Allocation). These actions may be taken by State and Local government, academia, volunteer citizens groups, and individuals to promote effective watershed management.

It is important to note that the TMDLs are effective for the entire watershed because they are a measurement of compounded impacts at a single point. As such, corrective actions must be undertaken at the source(s) whether it is a tributary or illicit discharge pipe, in order to achieve the required percent reductions. Also, the approach to TMDL implementation is anticipated to be on a watershed wide scale, which will require that all sources within the regional basin that are contributing to the in-stream impairment be

addressed. One approach to TMDL implementation would be to develop a watershed based plan for the Nauguatuck River Regional Basin. The plan should follow guidelines provided by the EPA and include participation for all watershed towns. The following guidance offers suggestions regarding BMP implementation, however the goal is to allow responsible parties flexibility in developing a TMDL implementation plan (watershed based plan). The DEP supports an adaptive and iterative management approach where reasonable controls are implemented and water quality is monitored in order to evaluate for achievement of the TMDL goals and modification of controls as necessary.

Point sources to Naugatuck River and its tributaries include regulated stormwater discharged by the watershed municipalities, as well as stormwater discharged by industrial and commercial facilities under the general permit. Control actions for regulated stormwater include the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit). Under the MS4 permit, municipalities are required to implement minimum control measures in their Stormwater Management Plans to reduce the discharge of pollutants, protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act. The six minimum control measures are:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-construction Runoff Control
- Pollution Prevention/Good Housekeeping

The minimum control measures include a number of Best Management Practices (BMP) for which an implementation schedule must be developed and submitted to the DEP as Part B Registration. Under the MS4 permit, all minimum control measures must be implemented by January 8, 2009. Information regarding Connecticut's MS4 permit can be found on the DEP's website at http://www.dep.state.ct.us/pao/download.htm#MS4GP. In addition, the EPA has developed fact sheets, which provide an overview of the Phase II final rule and MS4 permit, and provide detail regarding the minimum control measures, as well as optional BMPs not required in Connecticut's MS4 permit. The fact sheets can be found on the EPA's website at: http://cfpub.epa.gov/npdes/stormwater/swphases.cfm. Some of the information includes guidance for the development and implementation of Stormwater Management Plans, as well as guidance for establishing measurable goals for BMP implementation.

Section 6(K) of the MS4 Permit requires the municipality to modify their Stormwater Management Plan to implement the TMDL (achieve reductions) within four months of TMDL approval by EPA. It is recommended that municipalities focus their revised Stormwater Management Plans on the TMDL waterbodies for Section 6(a)(1)(A)(i) - implement public education program, Sections 6(a)(3)(A)(i, ii, iii) and 6(a)(3)(A)(i, ii, iii, iv) - illicit discharge detection, Section 6(a)(6)(A)(iv) - stormwater structures cleaning,

and Section 6(a)(6)(A)(v) - prioritize stormwater structures for repair or upgrade of the MS4 permit.

The TMDLs establish a benchmark to measure the effectiveness of BMP implementation. Achievement of the TMDLs is directly linked to incorporation of the provisions of the MS4 permit by municipalities, as well as the implementation of other BMPs to address nonpoint sources. Nonpoint sources can include wildlife and improper handling of pet waste. BMPs for the management of nonpoint sources nuisance wildlife control plans, and pet waste ordinances. Nuisance wildlife information can be found on the DEP's website at http://www.ct.gov/ dep/cwp/view.asp?a=2723&q=325944&depNav_GID =1655. It is expected that as progress is made implementing BMPs, *E. coli* bacteria levels will decrease and the water quality criteria for recreational use will be achieved and maintained.

The DEP encourages all local stakeholders to continue their efforts by working together to implement the TMDLs. One process is through the development of a watershed based plan. A watershed based plan for TMDL implementation formulated at the local level will most efficiently make use of local resources by assigning tasks to responsible parties and serving as an agreed roadmap to reducing bacteria loading to the Naugatuck River.

In addition, the DEP's watershed coordinator will continue to provide technical and educational assistance to the local municipalities and other stakeholders, as well as identify potential funding sources, when available, for implementation of the TMDL and monitoring plan.

WATER QUALITY MONITORING PLAN

A comprehensive water quality monitoring program is necessary to guide TMDL implementation efforts. The monitoring program should be designed to accomplish two objectives; source detection to identify specific sources of bacterial loading and direct BMP implementation efforts with fixed station monitoring to quantify progress in achieving TMDL established goals. The MS4 Permit that is the basis of TMDL implementation efforts in MS4 communities includes the following monitoring requirement:

> *"Stormwater monitoring shall be conducted by the Regulated Small MS4 annually starting in 2004. At least two outfalls apiece shall be monitored from areas of primarily industrial development, commercial development and residential development, respectively, for a total of six (6) outfalls monitored. Each monitored outfall shall be selected based on an evaluation by the MS4 that the drainage area of such outfall is representative of the overall nature of its respective land use type."*

This type of monitoring may be referred to as event monitoring because it is scheduled to coincide with a stormwater runoff event. Event monitoring can present numerous logistical difficulties for municipalities and may not be the most efficient way to measure

progress in achieving water quality standards. This is particularly true for streams draining urbanized watersheds where many sources contribute to excursions above water quality criteria. However, the municipality may request written approval from the DEP for an alternative monitoring program:

> *"The municipality may submit a request to the Commissioner in writing for implementation of an alternate sampling plan of equivalent or greater scope. The Commissioner will approve or deny such a request in writing.*

The DEP encourages municipalities faced with implementing a TMDL to request approval for an alternative monitoring program. Monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. The program must include sampling to address both objectives (source detection and progress quantification). Source detection monitoring may include such activities as visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient (in-stream) conditions at closely spaced intervals to identify "hot spots" for more detailed investigations leading to specific sources of high bacteria loads.

Progress in achieving TMDL established goals through BMP implementation may be most effectively gauged through implementing a fixed station ambient monitoring program. DEP strongly recommends that routine monitoring be performed at the same sites used to generate the data used to perform the TMDL calculations. Sampling should be scheduled at regularly spaced intervals during the recreational season. In this way the data set at the end of each season will include ambient values for both "wet" and "dry" conditions in relative proportion to the number of "wet" and "dry" days that occurred during that period. As additional data is generated over time it will be possible to repeat the TMDL calculations and compare the percent reductions needed under "dry" and "wet" conditions to the percent reductions needed at the time of TMDL adoption.

All pollutant parameters must be analyzed using methods prescribed in Title 40, CFR, Part 136 (1990). Electronic submission of data to DEP is highly encouraged. Results of monitoring that indicate unusually high levels of contamination or potentially illegal activities should be forwarded to the appropriate municipal or State agency for follow-up investigation and enforcement. Consistent with the requirements of the MS4 permit, the following parameters should be included in any monitoring program:

pH (SU)
Hardness (mg/l)
Conductivity (umos)
Oil and grease (mg/l)
Chemical Oxygen Demand (mg/l)
Turbidity (NTU)
Total Suspended Solids (mg/l)
Total Phosphorous (mg/l)
Ammonia (mg/l)

Total Kjeldahl Nitrogen (mg/l)
Nitrate plus Nitrite Nitrogen (mg/l)
E. coli (col/100ml)
precipitation (in)

DEP will continue to explore ways to provide funding support for monitoring efforts linked to TMDL implementation or other activities that exceed the minimum requirements of the MS4 permit. DEP is also committed to providing technical assistance in monitoring program design and establishing procedures for electronic data submission.

REASONABLE ASSURANCE

The MS4 Permit is a legally enforceable document that provides reasonable assurance that the municipalities will take steps towards achieving the target TMDLs and reducing point sources of stormwater containing bacteria. In addition, the DEP will work with watershed partners and conservation organizations to implement better stormwater management in the watershed. Although the segments of the watershed area were below the threshold for inclusion in the initial list of the Connecticut's MS4 Permit Program, the Commissioner has the authority under definitions contained in Sections 22a-423 of the Connecticut General Statutes and Section 22a-430-3(a) of the Regulations of Connecticut State Agencies to include "those additional municipally-owned or municipally-operated Small MS4s located outside an Urbanized Area as may be designated by the Commissioner. " This option could be pursued if future monitoring indicates non - attainment of recreational goals in the Naugatuck River Regional Watershed.

The DEP will continue to monitor, identify bacteria sources, and report conditions to the appropriate local and/or state authorities.

PROVISIONS FOR REVISING THE TMDL

The DEP reserves the authority to modify the TMDLs as needed to account for new information made available during the implementation of the TMDLs. Modification of the TMDLs will only be made following an opportunity for public participation and be subject to the review and approval of the EPA. New information, which may be generated during TMDL implementation, includes monitoring data, new or revised State or Federal regulations adopted pursuant to Section 303(d) of the Clean Water Act, and the publication by EPA of national or regional guidance relevant to the implementation of the TMDL program. The DEP will propose modifications to the TMDL analyses only in the event that a review of the new information indicates that such a modification is warranted and is consistent with the anti-degradation provisions in Connecticut Water Quality Standards. The subject waterbody of this TMDL analysis will continue to be included on the *List of Connecticut Waterbodies Not Meeting Water Quality Standards* until monitoring data confirms that recreation use is fully supported.

PUBLIC PARTICIPATION

The Naugatuck River Regional Basin TMDL document was noticed for public comment in the Waterbury Republican on January 24, 2008. In addition, the municipalities, as well as several interested parties were notified by mail of the comment period. At the close of the public comment period, the DEP received two comment letters. The final TMDL document was modified to reflect any reasonable requests submitted in the comment letters.

REFERENCES

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3 - Code of Federal Regulations, 40CFR section 130.2(i).

4 - USEPA. November 15, 2006 memorandum. *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No.05-5015, (April 25, 2006) and Implications for NPDES Permits*.

5 - U.S. Census Bureau, March 2002. www.census.gov/geo/www/ua/ua_2k.html.

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7 - Connecticut Department of Environmental Protection, 2005. *Development of Total Maximum Daily Loads (TMDLs) for Indicator Bacteria in Contact Recreation Areas Using the Cumulative Distribution Function Method*. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

8 - Connecticut Department of Environmental Protection, 2002. *Water Quality Summary Report for Sasco Brook, Mill River, Rooster River, Fairfield County Connecticut*. November 2002.

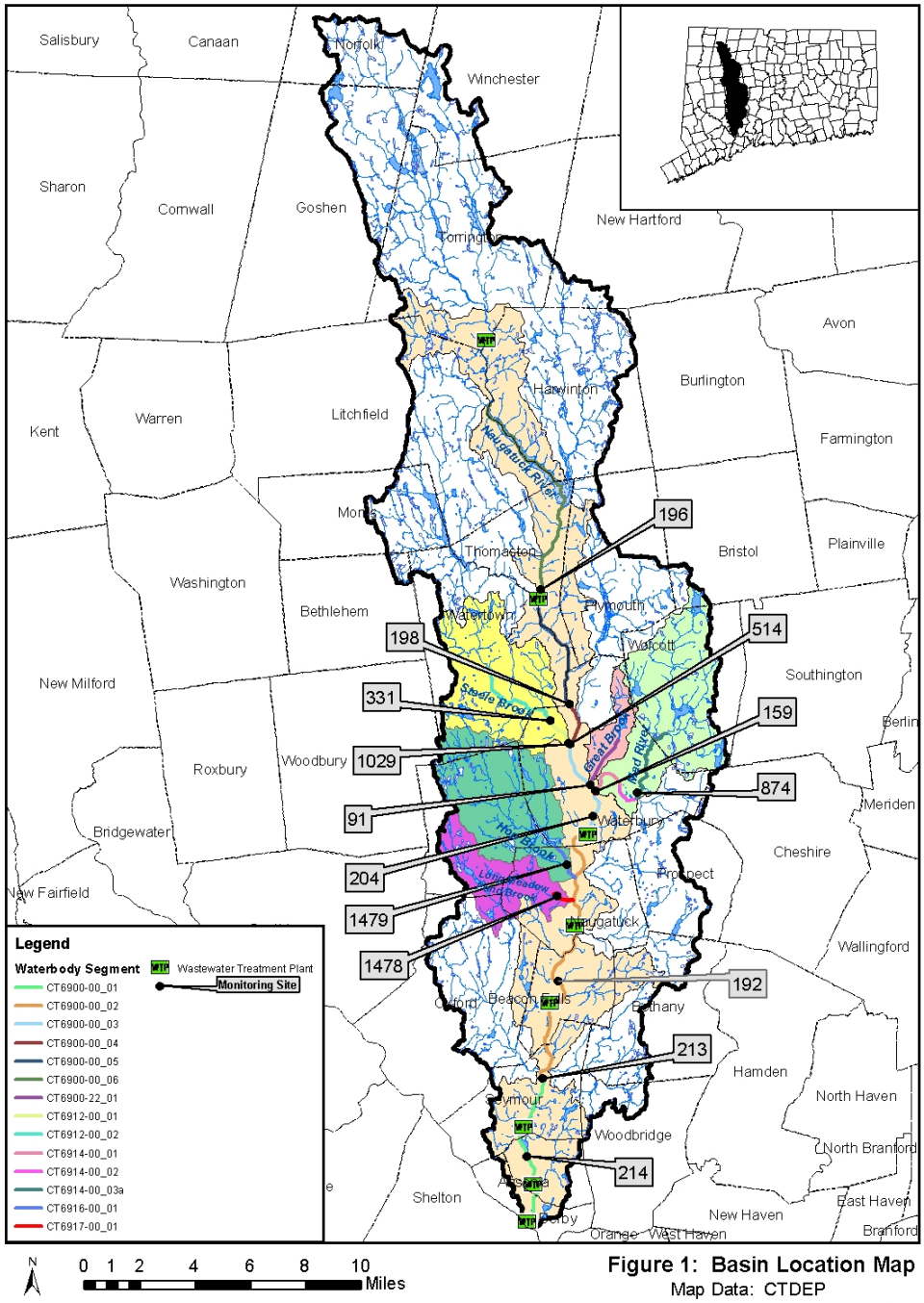


Figure 1: Basin Location Map
Map Data: CTDEP
Map Created: December 2007

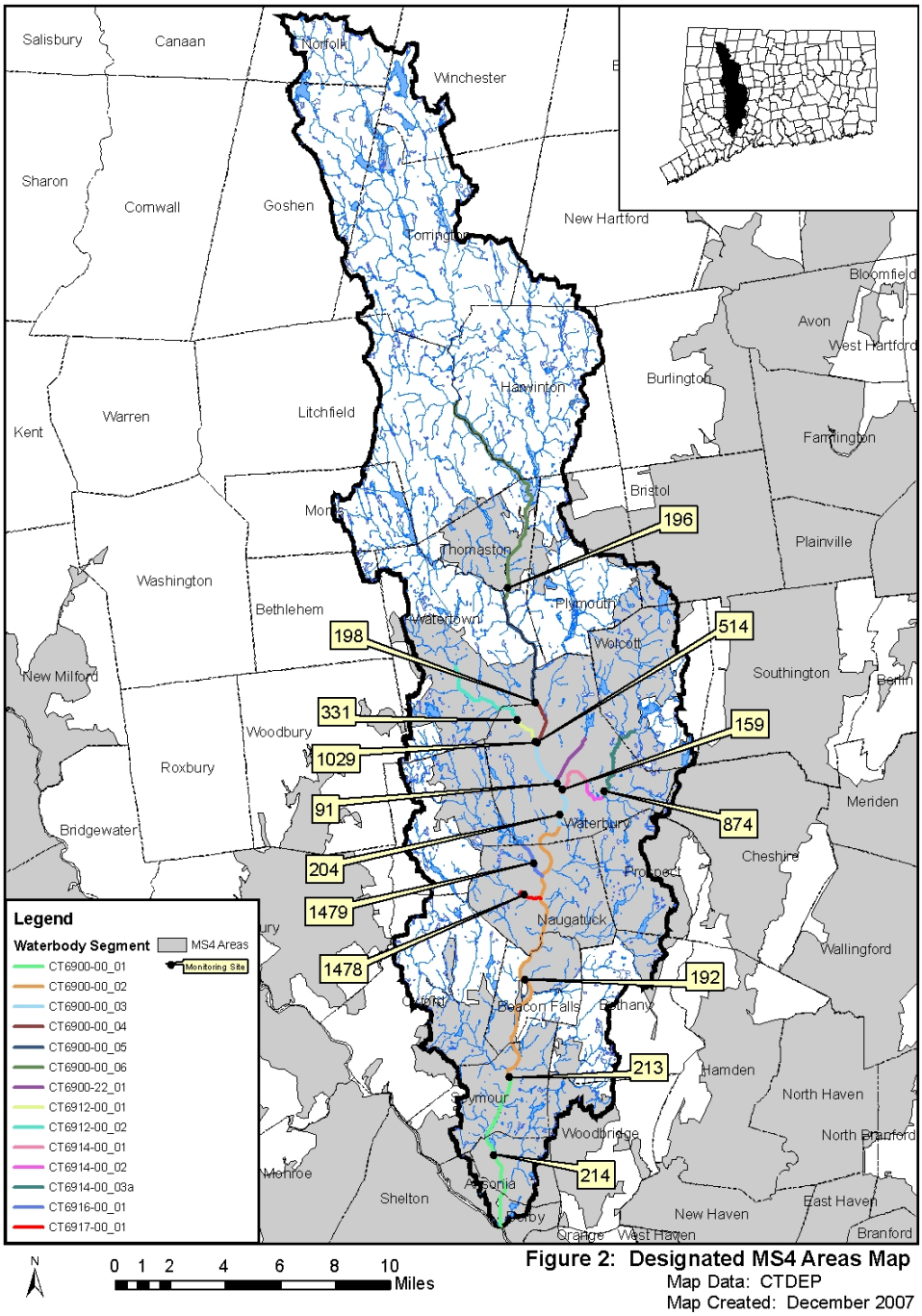


Figure 2: Designated MS4 Areas Map
Map Data: CTDEP
Map Created: December 2007

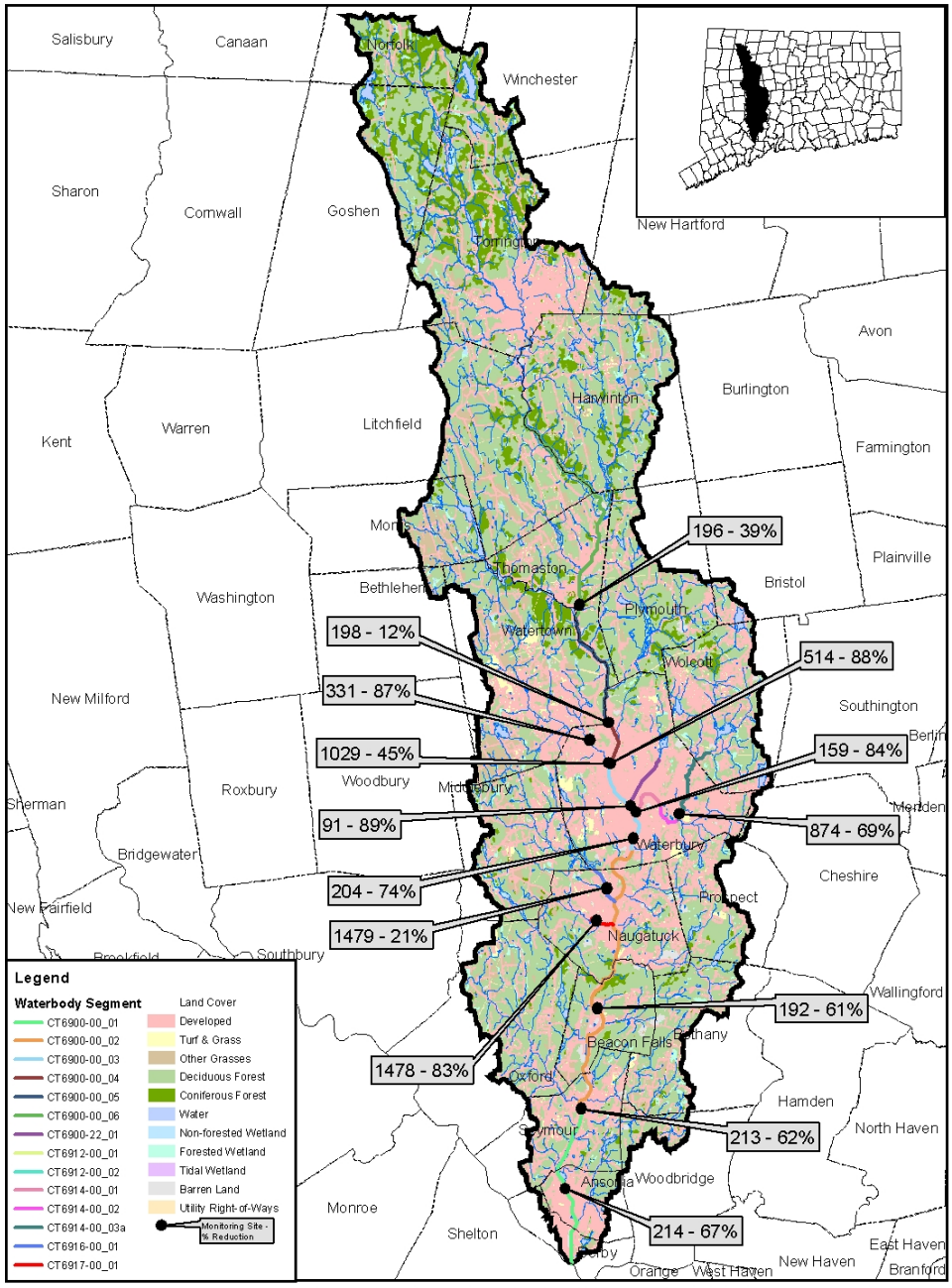


Figure 3: Basin Land Use Map and TMDL Percent Reductions

Map Data: CTDEP
Map Created: December 2007

Appendix A-1
Naugatuck River
Waterbody Specific Information

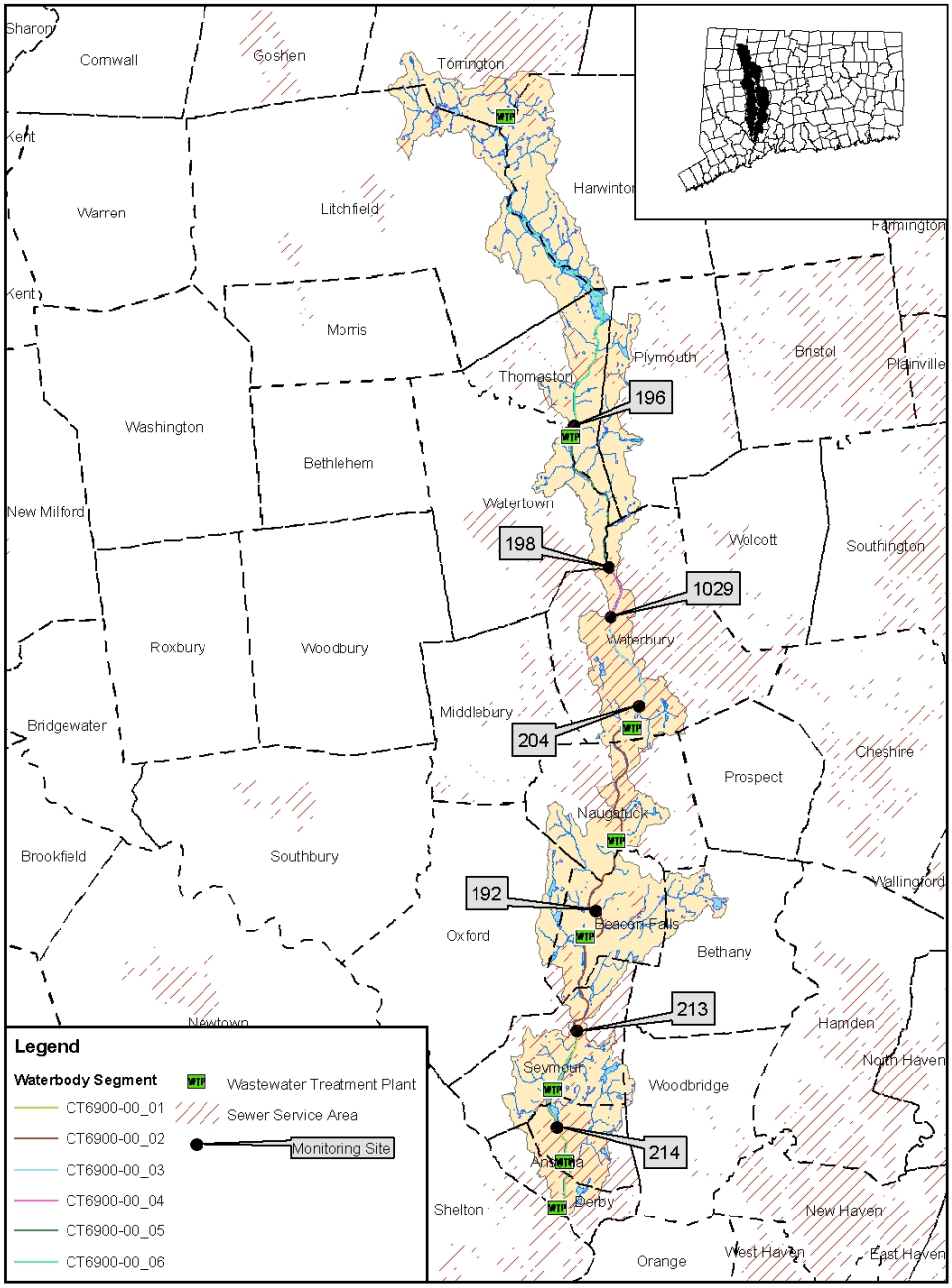
Impaired Waterbody
Waterbody Name: Naugatuck River
Waterbody Segment IDs: CT6900-00_01, CT6900-00_02, CT6900-00_03, CT6900-00_04, CT6900-00_05, CT6900-00_06
Waterbody Description: From the confluence with Spruce Brook (Litchfield/Harwinton town border) downstream to the confluence with the Housatonic River (Derby).
Waterbody Segment Size: 36.04 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class B and Class C/B

Watershed Description:
Total Drainage Basin Area: 199,203 acres
Subregional Basin Name & Code: Naugatuck River, 6900
Regional Basin: Naugatuck
Major Basin: Housatonic River Basin
Watershed Towns: Norfolk, Winchester, Goshen, Torrington, Litchfield, Harwinton, Morris, Thomaston, Plymouth, Watertown, Wolcott, Waterbury, Prospect, Middlebury, Naugatuck, Oxford, Beacon Falls, Bethany, Seymour, Ansonia, Derby
MS4 applicable? Yes, with the exception of Norfolk, Winchester, Goshen, Torrington, Litchfield, Harwinton, and Morris.
Applicable Season: Recreation Season (May 1 to September 30)
Regional Basin Landuse:

Land Use Category	Percent Composition
Barren	1.2
Coniferous Forest	9.1
Deciduous Forest	50
Developed	21.2
Forested Wetland	2.1
Non-forested Wetland	0.3
Other Grasses and Agriculture	10
Turf and Grass	3.4
Utility Right of Way	0.4
Water	2.3

Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.



Naugatuck River
Map Data: CTDEP
Map Created: December 2007

Naugatuck River

CT6900-00_06

Data Used in the Analysis

Monitoring Site: 196, Naugatuck River - downstream of Reynold Bridge at pull off

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	2900	25.0	0.9615	576	80
6/3/04	0.03	0.56	0.98	**WET**	540	20.0	0.7692	248	54
6/10/04	0.00	0.02	0.02	DRY	370	18.0	0.6923	200	46
6/17/04	0.16	0.16	0.16	**WET**	150	12.0	0.4615	115	23
6/24/04	0.00	0.00	0.01	DRY	110	7.5	0.2885	75	31
7/1/04	0.00	0.00	0.00	DRY	85	5.0	0.1923	57	33
7/8/04	0.02	0.02	0.02	DRY	310	17.0	0.6538	181	41
7/15/04	0.00	0.03	0.16	DRY	420	19.0	0.7308	222	47
7/22/04	0.00	0.00	0.00	DRY	120	9.5	0.3654	92	24
7/29/04	0.00	0.03	1.20	DRY	720	22.0	0.8462	322	55
8/5/04	0.00	0.65	0.65	**WET**	1500	24.0	0.9231	469	69
8/11/04	0.43	0.45	0.45	**WET**	140	11.0	0.4231	105	25
8/19/04	0.00	0.00	0.00	DRY	86	6.0	0.2308	64	26
9/2/04	0.00	0.00	0.00	DRY	20	1.5	0.0577	30	0
9/9/04	0.48	1.66	1.73	**WET**	3300	26.0	1.0000	576	83
9/13/04	0.00	0.00	0.00	DRY	120	9.5	0.3654	92	24
9/15/04	0.03	0.03	0.03	DRY	110	7.5	0.2885	75	31
9/21/04	0.00	0.00	0.00	DRY	990	23.0	0.8846	380	62
9/23/04	0.00	0.00	0.00	DRY	180	13.5	0.5192	132	27
9/30/04	0.08	0.08	2.74	**WET**	650	21.0	0.8077	281	57
7/5/05	0.15	0.15	0.15	**WET**	250	15.0	0.5769	151	40
7/18/05	0.18	0.18	0.21	**WET**	180	13.5	0.5192	132	27
8/1/05	0.10	0.10	0.10	**WET**	63	3.5	0.1346	46	28
8/9/05	0.00	0.80	0.80	**WET**	63	3.5	0.1346	46	28
8/16/05	0.01	0.01	0.83	DRY	300	16.0	0.6154	165	45
9/8/05	0.00	0.00	0.00	DRY	20	1.5	0.0577	30	0

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**227**
Log std deviation	**0.5679**

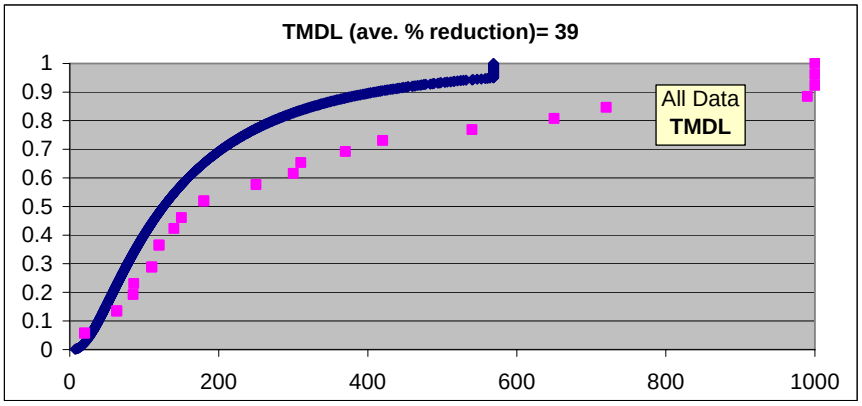
Avg % Reduction

Wet (WLA)	**47**
Dry (LA)	**33**
Total (TMDL)	**39**

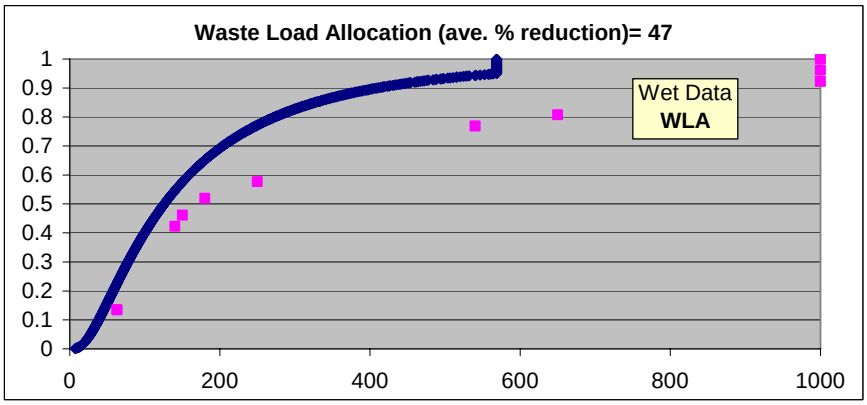
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 196

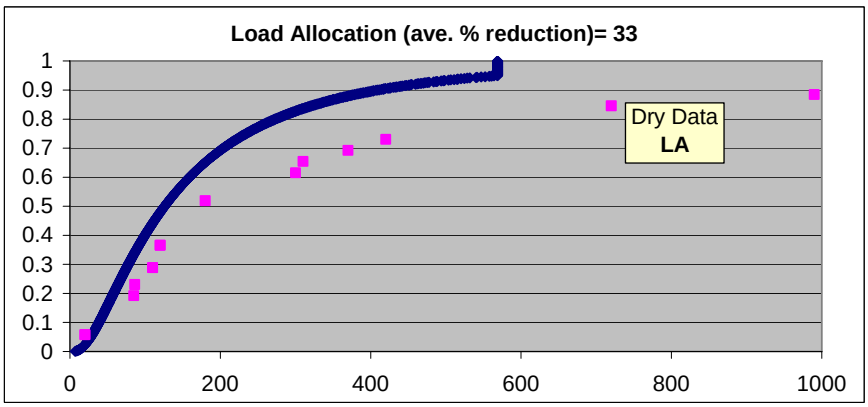
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Naugatuck River

CT6900-00_05

Data Used in the Analysis

Monitoring Site: 198, Naugatuck River - next to 300 Chase River Road

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	1200	24.5	0.9423	537	55
6/3/04	0.03	0.56	0.98	**WET**	250	20.0	0.7692	248	1
6/10/04	0.00	0.02	0.02	DRY	41	9.5	0.3654	92	0
6/17/04	0.16	0.16	0.16	**WET**	41	9.5	0.3654	92	0
6/24/04	0.00	0.00	0.01	DRY	10	1.5	0.0577	30	0
7/1/04	0.00	0.00	0.00	DRY	10	1.5	0.0577	30	0
7/8/04	0.02	0.02	0.02	DRY	63	14.5	0.5577	144	0
7/15/04	0.00	0.03	0.16	DRY	20	4.5	0.1731	53	0
7/22/04	0.00	0.00	0.00	DRY	20	4.5	0.1731	53	0
7/29/04	0.00	0.03	1.20	DRY	520	21.0	0.8077	281	46
8/5/04	0.00	0.65	0.65	**WET**	41	9.5	0.3654	92	0
8/11/04	0.43	0.45	0.45	**WET**	98	18.0	0.6923	200	0
8/19/04	0.00	0.00	0.00	DRY	20	4.5	0.1731	53	0
9/2/04	0.00	0.00	0.00	DRY	41	9.5	0.3654	92	0
9/9/04	0.48	1.66	1.73	**WET**	1400	26.0	1.0000	576	59
9/13/04	0.00	0.00	0.00	DRY	63	14.5	0.5577	144	0
9/15/04	0.03	0.03	0.03	DRY	31	8.0	0.3077	79	0
9/21/04	0.00	0.00	0.00	DRY	740	23.0	0.8846	380	49
9/23/04	0.00	0.00	0.00	DRY	86	17.0	0.6538	181	0
9/30/04	0.08	0.08	2.74	**WET**	1200	24.5	0.9423	537	55
7/5/05	0.15	0.15	0.15	**WET**	10	1.5	0.0577	30	0
7/18/05	0.18	0.18	0.21	**WET**	120	19.0	0.7308	222	0
8/1/05	0.10	0.10	0.10	**WET**	41	9.5	0.3654	92	0
8/9/05	0.00	0.80	0.80	**WET**	20	4.5	0.1731	53	0
8/16/05	0.01	0.01	0.83	DRY	74	16.0	0.6154	165	0
9/8/05	0.00	0.00	0.00	DRY	720	22.0	0.8462	322	55

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**79**
Log std deviation	**0.6815**

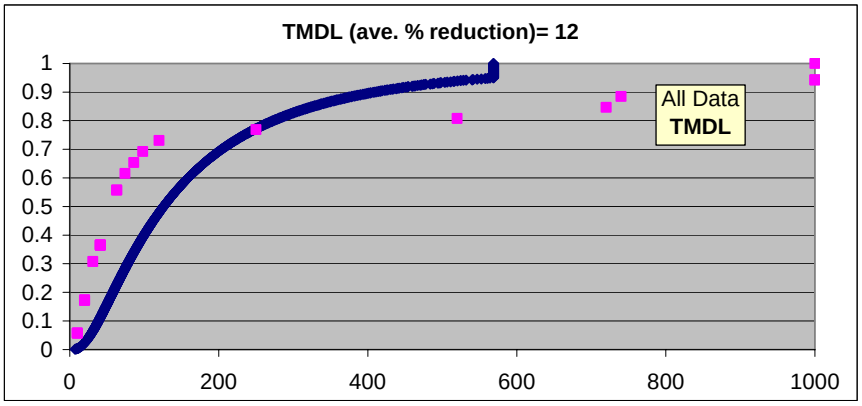
Avg % Reduction

Wet (WLA)	**15**
Dry (LA)	**10**
Total (TMDL)	**12**

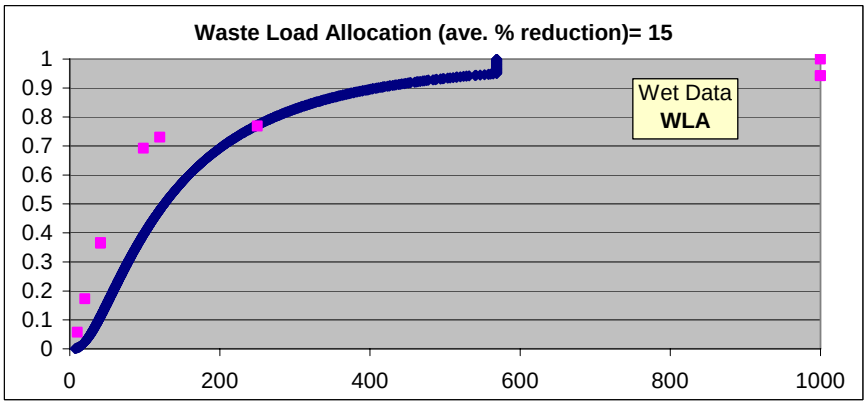
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 198

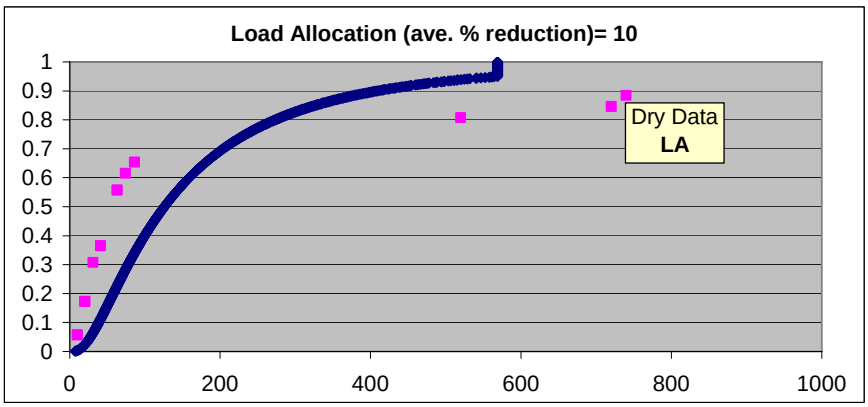
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Naugatuck River

CT6900-00_04

Data Used in the Analysis

Monitoring Site: 1029, Naugatuck River upstream of Steele Brook confluence

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	710	22.0	0.8462	322	55
6/3/04	0.03	0.56	0.98	**WET**	220	15.5	0.5962	158	28
6/10/04	0.00	0.02	0.02	DRY	330	19.0	0.7308	222	33
6/17/04	0.16	0.16	0.16	**WET**	86	1.5	0.0577	30	66
6/24/04	0.00	0.00	0.01	DRY	260	17.0	0.6538	181	30
7/1/04	0.00	0.00	0.00	DRY	350	20.0	0.7692	248	29
7/8/04	0.02	0.02	0.02	DRY	2400	26.0	1.0000	576	76
7/15/04	0.00	0.03	0.16	DRY	120	8.0	0.3077	79	34
7/22/04	0.00	0.00	0.00	DRY	110	4.5	0.1731	53	52
7/29/04	0.00	0.03	1.20	DRY	295	18.0	0.6923	200	32
8/5/04	0.00	0.65	0.65	**WET**	1700	25.0	0.9615	576	66
8/11/04	0.43	0.45	0.45	**WET**	96	3.0	0.1154	42	56
8/19/04	0.00	0.00	0.00	DRY	210	14.0	0.5385	138	34
9/2/04	0.00	0.00	0.00	DRY	110	4.5	0.1731	53	52
9/9/04	0.48	1.66	1.73	**WET**	1100	23.0	0.8846	380	65
9/13/04	0.00	0.00	0.00	DRY	110	4.5	0.1731	53	52
9/15/04	0.03	0.03	0.03	DRY	150	10.5	0.4038	101	33
9/21/04	0.00	0.00	0.00	DRY	650	21.0	0.8077	281	57
9/23/04	0.00	0.00	0.00	DRY	150	10.5	0.4038	101	33
9/30/04	0.08	0.08	2.74	**WET**	1200	24.0	0.9231	469	61
7/5/05	0.15	0.15	0.15	**WET**	170	13.0	0.5000	126	26
7/18/05	0.18	0.18	0.21	**WET**	220	15.5	0.5962	158	28
8/1/05	0.10	0.10	0.10	**WET**	86	1.5	0.0577	30	66
8/9/05	0.00	0.80	0.80	**WET**	110	4.5	0.1731	53	52
8/16/05	0.01	0.01	0.83	DRY	160	12.0	0.4615	115	28
9/8/05	0.00	0.00	0.00	DRY	140	9.0	0.3462	88	37

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**251**
Log std deviation	**0.4199**

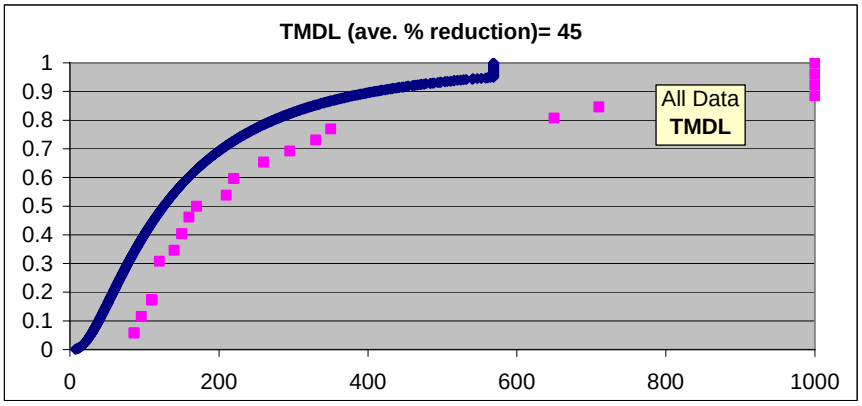
Avg % Reduction

Wet (WLA)	**52**
Dry (LA)	**41**
Total (TMDL)	**45**

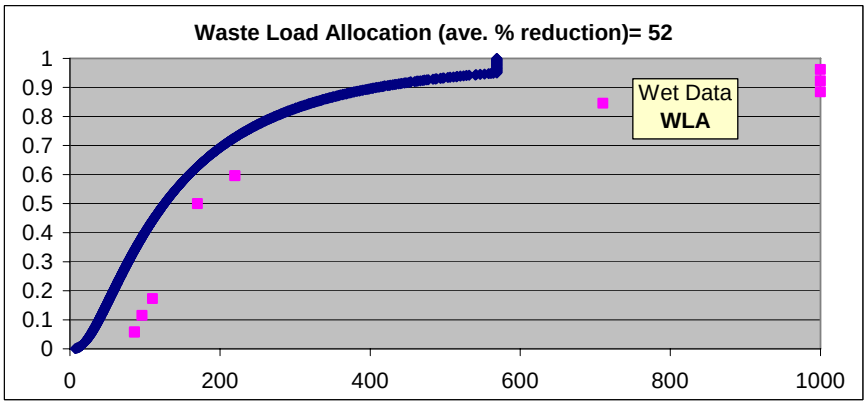
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 1029

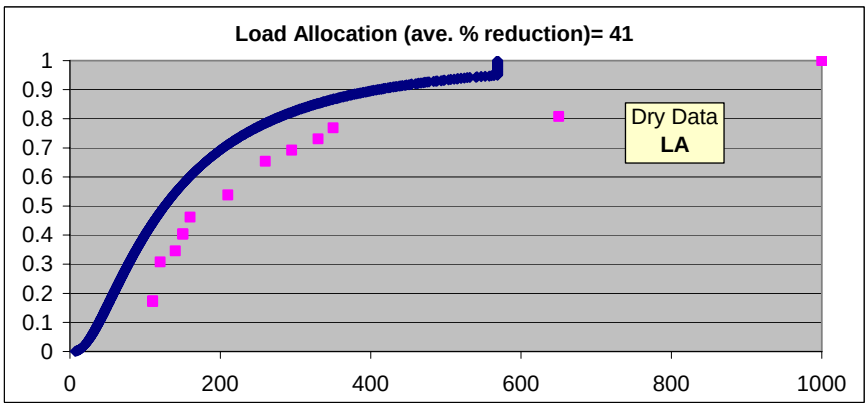
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Naugatuck River

CT6900-00_03

Data Used in the Analysis

Monitoring Site: 204, Naugatuck River - upstream South Leonard Street

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	1200	21.0	0.8077	281	77
6/3/04	0.03	0.56	0.98	**WET**	310	5.5	0.2115	60	81
6/10/04	0.00	0.02	0.02	DRY	570	18.5	0.7115	211	63
6/17/04	0.16	0.16	0.16	**WET**	330	9.0	0.3462	88	73
6/24/04	0.00	0.00	0.01	DRY	570	18.5	0.7115	211	63
7/1/04	0.00	0.00	0.00	DRY	430	16.0	0.6154	165	62
7/8/04	0.02	0.02	0.02	DRY	400	15.0	0.5769	151	62
7/15/04	0.00	0.03	0.16	DRY	1600	22.0	0.8462	322	80
7/22/04	0.00	0.00	0.00	DRY	360	13.0	0.5000	126	65
7/29/04	0.00	0.03	1.20	DRY	480	17.0	0.6538	181	62
8/5/04	0.00	0.65	0.65	**WET**	6900	25.0	0.9615	576	92
8/11/04	0.43	0.45	0.45	**WET**	350	11.5	0.4423	110	69
8/19/04	0.00	0.00	0.00	DRY	310	5.5	0.2115	60	81
9/2/04	0.00	0.00	0.00	DRY	110	1.0	0.0385	25	78
9/9/04	0.48	1.66	1.73	**WET**	7700	26.0	1.0000	576	93
9/13/04	0.00	0.00	0.00	DRY	320	8.0	0.3077	79	75
9/15/04	0.03	0.03	0.03	DRY	170	2.0	0.0769	34	80
9/21/04	0.00	0.00	0.00	DRY	800	20.0	0.7692	248	69
9/23/04	0.00	0.00	0.00	DRY	200	3.0	0.1154	42	79
9/30/04	0.08	0.08	2.74	**WET**	2100	24.0	0.9231	469	78
7/5/05	0.15	0.15	0.15	**WET**	340	10.0	0.3846	96	72
7/18/05	0.18	0.18	0.21	**WET**	1700	23.0	0.8846	380	78
8/1/05	0.10	0.10	0.10	**WET**	220	4.0	0.1538	49	78
8/9/05	0.00	0.80	0.80	**WET**	310	5.5	0.2115	60	81
8/16/05	0.01	0.01	0.83	DRY	350	11.5	0.4423	110	69
9/8/05	0.00	0.00	0.00	DRY	390	14.0	0.5385	138	65

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**541**
Log std deviation	**0.4497**

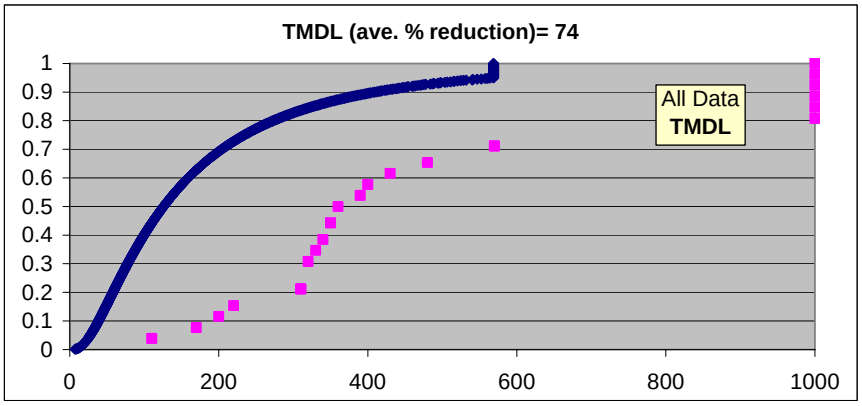
Avg % Reduction

Wet (WLA)	**79**
Dry (LA)	**70**
Total (TMDL)	**74**

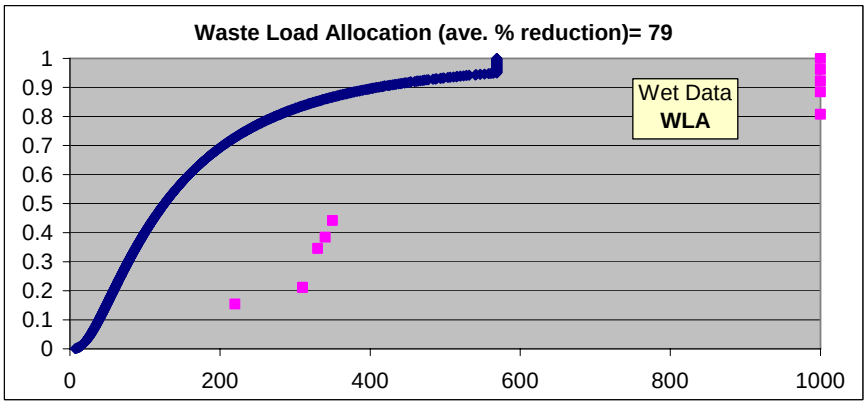
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 204

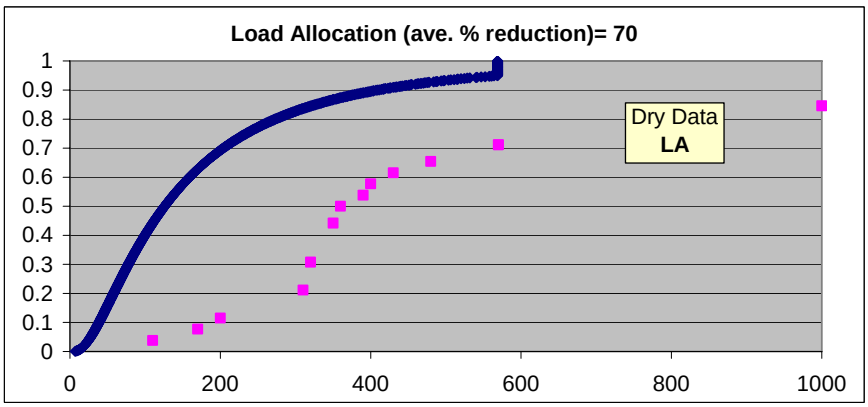
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Naugatuck River

CT6900-00_02

Data Used in the Analysis

Monitoring Site: 192, Naugatuck River - behind Beacon Falls Fire Station

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	2200	24.0	0.9231	469	79
6/3/04	0.03	0.56	0.98	**WET**	210	12.0	0.4615	115	45
6/10/04	0.00	0.02	0.02	DRY	2250	25.0	0.9615	576	74
6/17/04	0.16	0.16	0.16	**WET**	130	2.5	0.0962	38	71
6/24/04	0.00	0.00	0.01	DRY	130	2.5	0.0962	38	71
7/1/04	0.00	0.00	0.00	DRY	85	1.0	0.0385	25	71
7/8/04	0.02	0.02	0.02	DRY	390	18.5	0.7115	211	46
7/15/04	0.00	0.03	0.16	DRY	160	7.5	0.2885	75	53
7/22/04	0.00	0.00	0.00	DRY	160	7.5	0.2885	75	53
7/29/04	0.00	0.03	1.20	DRY	330	17.0	0.6538	181	45
8/5/04	0.00	0.65	0.65	**WET**	2000	23.0	0.8846	380	81
8/11/04	0.43	0.45	0.45	**WET**	310	16.0	0.6154	165	47
8/19/04	0.00	0.00	0.00	DRY	240	14.5	0.5577	144	40
9/2/04	0.00	0.00	0.00	DRY	230	13.0	0.5000	126	45
9/9/04	0.48	1.66	1.73	**WET**	6100	26.0	1.0000	576	91
9/13/04	0.00	0.00	0.00	DRY	240	14.5	0.5577	144	40
9/15/04	0.03	0.03	0.03	DRY	150	4.5	0.1731	53	65
9/21/04	0.00	0.00	0.00	DRY	1200	20.0	0.7692	248	79
9/23/04	0.00	0.00	0.00	DRY	190	10.0	0.3846	96	49
9/30/04	0.08	0.08	2.74	**WET**	1500	21.0	0.8077	281	81
7/5/05	0.15	0.15	0.15	**WET**	150	4.5	0.1731	53	65
7/18/05	0.18	0.18	0.21	**WET**	1900	22.0	0.8462	322	83
8/1/05	0.10	0.10	0.10	**WET**	170	9.0	0.3462	88	49
8/9/05	0.00	0.80	0.80	**WET**	390	18.5	0.7115	211	46
8/16/05	0.01	0.01	0.83	DRY	200	11.0	0.4231	105	47
9/8/05	0.00	0.00	0.00	DRY	150	4.5	0.1731	53	65

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**373**
Log std deviation	**0.5047**

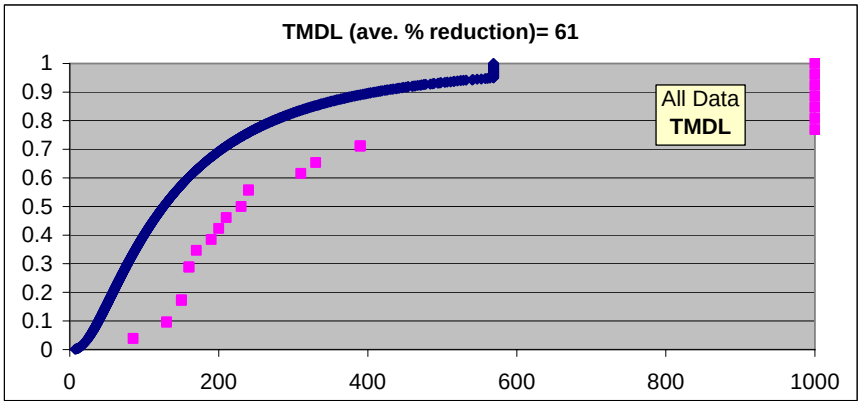
Avg % Reduction

Wet (WLA)	**67**
Dry (LA)	**56**
Total (TMDL)	**61**

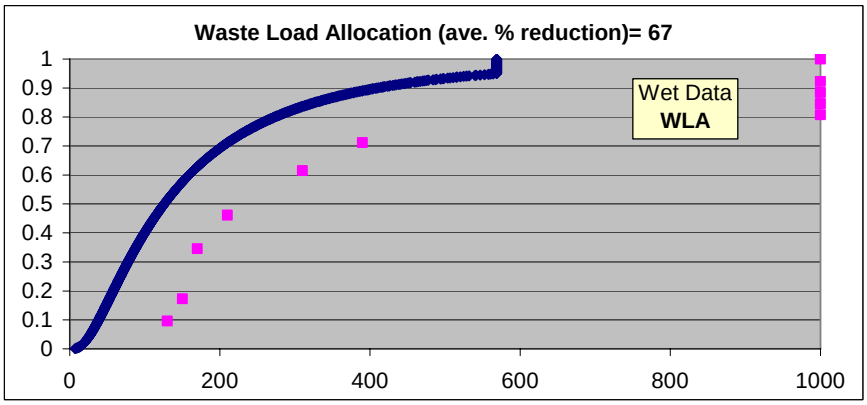
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 192

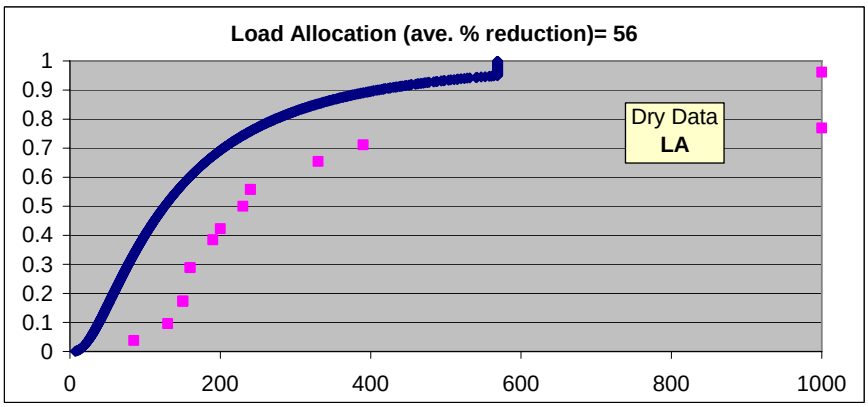
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Naugatuck River

CT6900-00_01, top of segment

Data Used in the Analysis

Monitoring Site: 213, Naugatuck River downstream of Broad Street

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	1800	24.0	0.9600	576	68
6/3/04	0.03	0.56	0.98	**WET**	180	6.0	0.2400	66	63
6/10/04	0.00	0.02	0.02	DRY	380	16.0	0.6400	175	54
6/17/04	0.16	0.16	0.16	**WET**	110	1.0	0.0400	25	77
6/24/04	0.00	0.00	0.01	DRY	390	17.5	0.7000	204	48
7/1/04	0.00	0.00	0.00	DRY	170	4.5	0.1800	54	68
7/8/04	0.02	0.02	0.02	DRY	240	12.0	0.4800	120	50
7/15/04	0.00	0.03	0.16	DRY	220	10.0	0.4000	100	55
7/22/04	0.00	0.00	0.00	DRY	200	9.0	0.3600	91	55
7/29/04	0.00	0.03	1.20	DRY	640	19.0	0.7600	241	62
8/5/04	0.00	0.65	0.65	**WET**	1400	21.0	0.8400	315	78
8/11/04	0.43	0.45	0.45	**WET**	170	4.5	0.1800	54	68
8/19/04	0.00	0.00	0.00	DRY	340	15.0	0.6000	159	53
9/9/04	0.48	1.66	1.73	**WET**	3300	25.0	1.0000	576	83
9/13/04	0.00	0.00	0.00	DRY	230	11.0	0.4400	110	52
9/15/04	0.03	0.03	0.03	DRY	150	2.0	0.0800	35	77
9/21/04	0.00	0.00	0.00	DRY	840	20.0	0.8000	274	67
9/23/04	0.00	0.00	0.00	DRY	190	7.5	0.3000	78	59
9/30/04	0.08	0.08	2.74	**WET**	1700	23.0	0.9200	460	73
7/5/05	0.15	0.15	0.15	**WET**	160	3.0	0.1200	43	73
7/18/05	0.18	0.18	0.21	**WET**	1500	22.0	0.8800	372	75
8/1/05	0.10	0.10	0.10	**WET**	260	14.0	0.5600	145	44
8/9/05	0.00	0.80	0.80	**WET**	190	7.5	0.3000	78	59
8/16/05	0.01	0.01	0.83	DRY	390	17.5	0.7000	204	48
9/8/05	0.00	0.00	0.00	DRY	250	13.0	0.5200	132	47

Statistics

# Samples DRY	**14**
# Samples WET	**11**
# Samples Total	**25**
Geomean	**371**
Log std deviation	**0.4089**

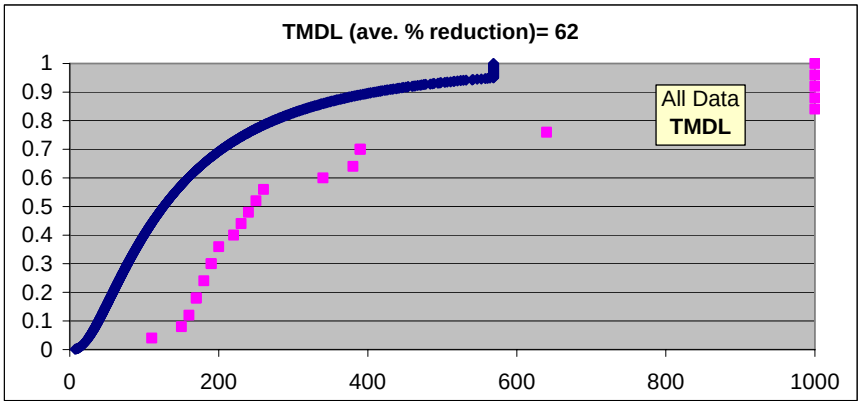
Avg % Reduction

Wet (WLA)	**69**
Dry (LA)	**57**
Total (TMDL)	**62**

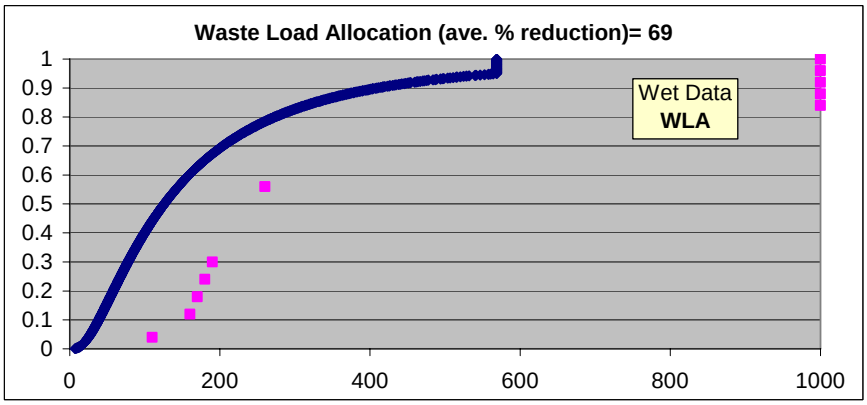
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 213

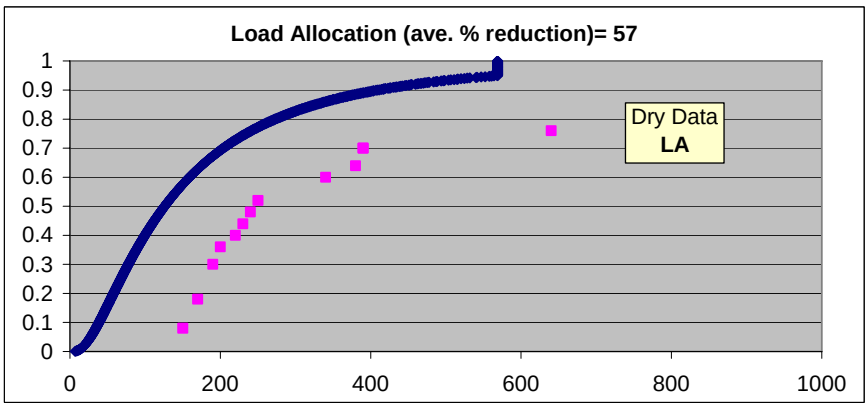
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Naugatuck River

CT6900-00_01, middle of segment

Data Used in the Analysis

Monitoring Site: 214, Naugatuck River at Route 34

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	405	16.0	0.6154	165	59
6/3/04	0.03	0.56	0.98	**WET**	500	17.0	0.6538	181	64
6/10/04	0.00	0.02	0.02	DRY	121	4.0	0.1538	49	59
6/17/04	0.16	0.16	0.16	**WET**	211	10.0	0.3846	96	54
6/24/04	0.00	0.00	0.01	DRY	200	9.0	0.3462	88	56
7/1/04	0.00	0.00	0.00	DRY	350	15.0	0.5769	151	57
7/8/04	0.02	0.02	0.02	DRY	2550	24.0	0.9231	469	82
7/15/04	0.00	0.03	0.16	DRY	340	14.0	0.5385	138	59
7/22/04	0.00	0.00	0.00	DRY	98	1.0	0.0385	25	75
7/29/04	0.00	0.03	1.20	DRY	845	19.0	0.7308	222	74
8/5/04	0.00	0.65	0.65	**WET**	4900	26.0	1.0000	576	88
8/11/04	0.43	0.45	0.45	**WET**	1960	22.0	0.8462	322	84
8/19/04	0.00	0.00	0.00	DRY	175	6.5	0.2500	68	61
9/2/04	0.00	0.00	0.00	DRY	101	2.0	0.0769	34	66
9/9/04	0.48	1.66	1.73	**WET**	2050	23.0	0.8846	380	81
9/13/04	0.00	0.00	0.00	DRY	120	3.0	0.1154	42	65
9/15/04	0.03	0.03	0.03	DRY	155	5.0	0.1923	57	64
9/21/04	0.00	0.00	0.00	DRY	1500	21.0	0.8077	281	81
9/23/04	0.00	0.00	0.00	DRY	180	8.0	0.3077	79	56
9/30/04	0.08	0.08	2.74	**WET**	3600	25.0	0.9615	576	84
7/5/05	0.15	0.15	0.15	**WET**	810	18.0	0.6923	200	75
7/18/05	0.18	0.18	0.21	**WET**	1075	20.0	0.7692	248	77
8/1/05	0.10	0.10	0.10	**WET**	220	11.0	0.4231	105	52
8/9/05	0.00	0.80	0.80	**WET**	175	6.5	0.2500	68	61
8/16/05	0.01	0.01	0.83	DRY	310	13.0	0.5000	126	59
9/8/05	0.00	0.00	0.00	DRY	275	12.0	0.4615	115	58

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**438**
Log std deviation	**0.5102**

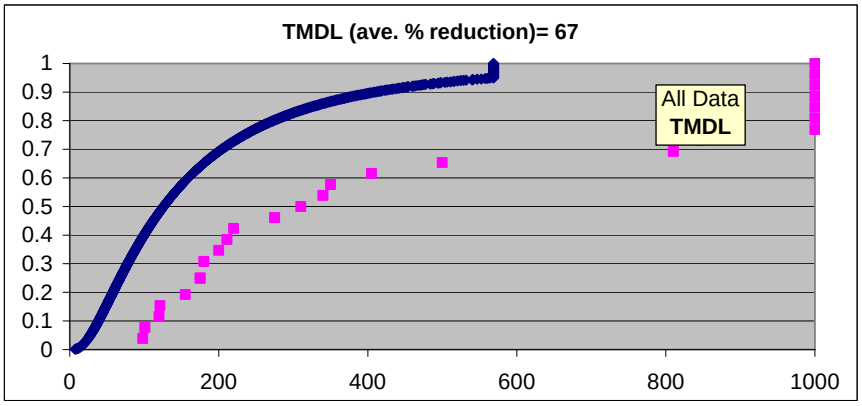
Avg % Reduction

Wet (WLA)	**71**
Dry (LA)	**65**
Total (TMDL)	**67**

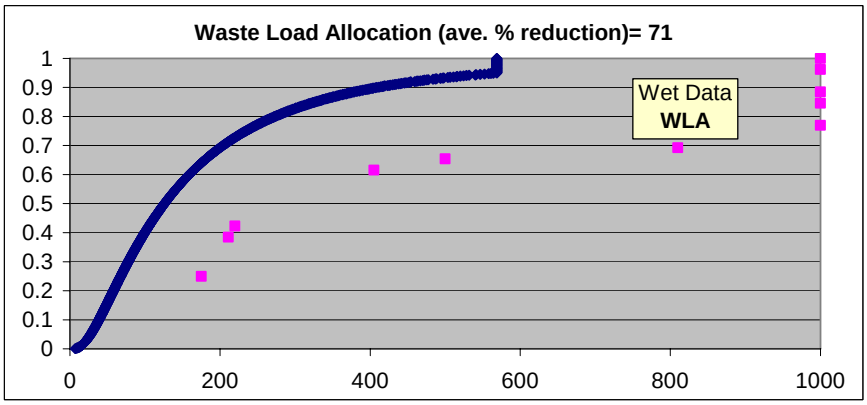
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Naugatuck River Criteria Curve for Monitoring Site 214

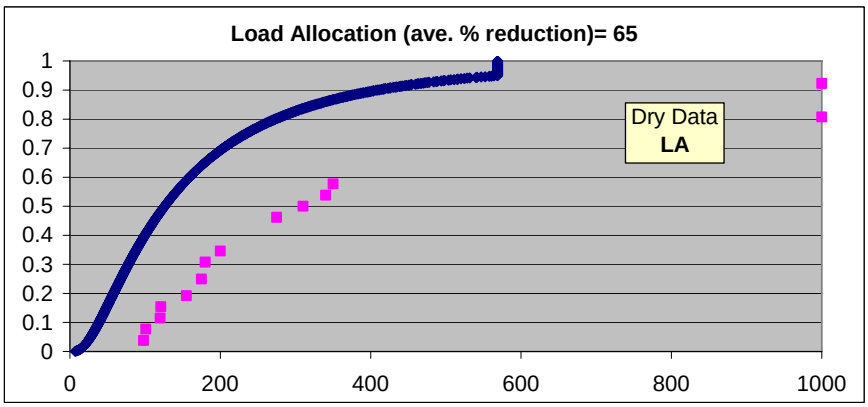
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-1
Naugatuck River
TMDL Summary

The TMDL analysis for the Naugatuck River was conducted at seven sites, which are representative of six river segments. The analysis indicates that the sites are influenced by sources of bacteria active under both wet weather and dry weather conditions. However, percent reductions for wet weather conditions were found to be slightly higher than dry weather conditions. The DEP is aware of three pipes that discharge to the river and potentially contain wastewater from illicit connections as well as failed sanitary collection systems. As such, reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers and the upgrade of failed sanitary infrastructure. The WLA also includes regulated stormwater and can be further reduced by the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality will also reduce inputs of bacteria to the river. This action can be beneficial to reducing the WLA but to a lesser degree than those formerly mentioned given the conditions. Since illicit discharges and failed sanitary collection systems may also be active under dry conditions, it is likely that corrective actions aimed at eliminating these sources will also reduce the Load Allocation (LA). Other contributors to the LA include as domestic animal waste, wildlife, and stormwater input as sheet flow.

It is important to note that the required percent reductions increase moving down river indicating that bacterial inputs are highest in the more developed locations. The lowest TMDL percent reductions occurred in segment CT6900-00_05 (from upstream side of sewage leak from pipe under river along Chase River Road, Watertown/Waterbury town border, upstream to confluence with Thomaston WWTP outfall, Thomaston).

Appendix A-2
Steele Brook
Waterbody Specific Information

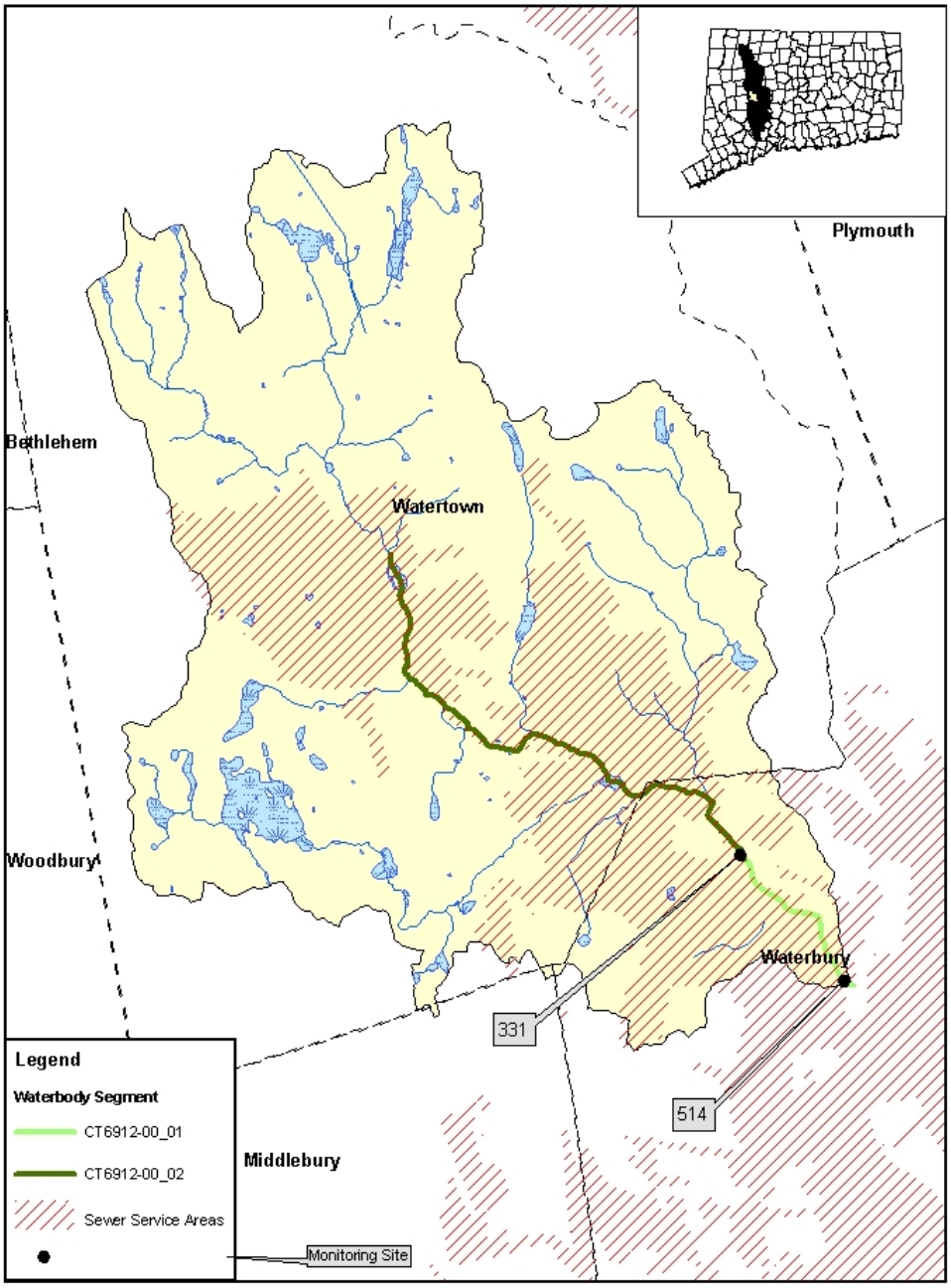
Impaired Waterbody
Waterbody Name: Steele Brook
Waterbody Segment IDs: CT6912-00_01, CT6912-00_02
Waterbody Description: From the inlet to Heminway Pond downstream to the confluence with the Naugatuck River (Watertown).
Waterbody Segment Size: 4.96 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class B

Watershed Description:
Total Drainage Basin Area: 10,906 Acres
Subregional Basin Name & Code: Steele Brook, 6912
Regional Basin: Naugatuck
Major Basin: Housatonic River Basin
Watershed Towns: Watertown, Waterbury
MS4 applicable? Yes
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Landuse:

Land Use Category	Percent Composition
Barren	1.1
Coniferous Forest	1.8
Deciduous Forest	33.2
Developed	33.7
Forested Wetland	0.9
Non-forested Wetland	0.1
Other Grasses and Agriculture	15.3
Turf and Grass	11.2
Utility Right of Way	0.6
Water	2.1

Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.



Steele Brook
Map Data: CTDEP
Map Created: December 2007

Steele Brook

CT6912-00_02

Data Used in the Analysis

Monitoring Site: 331, Steele Brook - parallel municipal stadium north parking lot

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	3300	23.0	0.8846	380	88
6/3/04	0.03	0.56	0.98	**WET**	530	7.0	0.2692	71	87
6/10/04	0.00	0.02	0.02	DRY	1600	20.0	0.7692	248	84
6/17/04	0.16	0.16	0.16	**WET**	540	8.0	0.3077	79	85
6/24/04	0.00	0.00	0.01	DRY	610	9.0	0.3462	88	86
7/1/04	0.00	0.00	0.00	DRY	1300	17.0	0.6538	181	86
7/8/04	0.02	0.02	0.02	DRY	1900	21.0	0.8077	281	85
7/15/04	0.00	0.03	0.16	DRY	3900	24.0	0.9231	469	88
7/22/04	0.00	0.00	0.00	DRY	750	11.0	0.4231	105	86
7/29/04	0.00	0.03	1.20	DRY	1000	13.0	0.5000	126	87
8/5/04	0.00	0.65	0.65	**WET**	10400	25.0	0.9615	576	94
8/11/04	0.43	0.45	0.45	**WET**	310	4.0	0.1538	49	84
8/19/04	0.00	0.00	0.00	DRY	1400	18.0	0.6923	200	86
9/2/04	0.00	0.00	0.00	DRY	510	6.0	0.2308	64	87
9/9/04	0.48	1.66	1.73	**WET**	11900	26.0	1.0000	576	95
9/13/04	0.00	0.00	0.00	DRY	1200	15.0	0.5769	151	87
9/15/04	0.03	0.03	0.03	DRY	1200	15.0	0.5769	151	87
9/21/04	0.00	0.00	0.00	DRY	980	12.0	0.4615	115	88
9/23/04	0.00	0.00	0.00	DRY	2000	22.0	0.8462	322	84
9/30/04	0.08	0.08	2.74	**WET**	1100	14.0	0.5385	138	87
7/5/05	0.15	0.15	0.15	**WET**	460	5.0	0.1923	57	88
7/18/05	0.18	0.18	0.21	**WET**	1500	19.0	0.7308	222	85
8/1/05	0.10	0.10	0.10	**WET**	180	1.0	0.0385	25	86
8/9/05	0.00	0.80	0.80	**WET**	630	10.0	0.3846	96	85
8/16/05	0.01	0.01	0.83	DRY	230	3.0	0.1154	42	82
9/8/05	0.00	0.00	0.00	DRY	210	2.0	0.0769	34	84

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**1030**
Log std deviation	**0.4571**

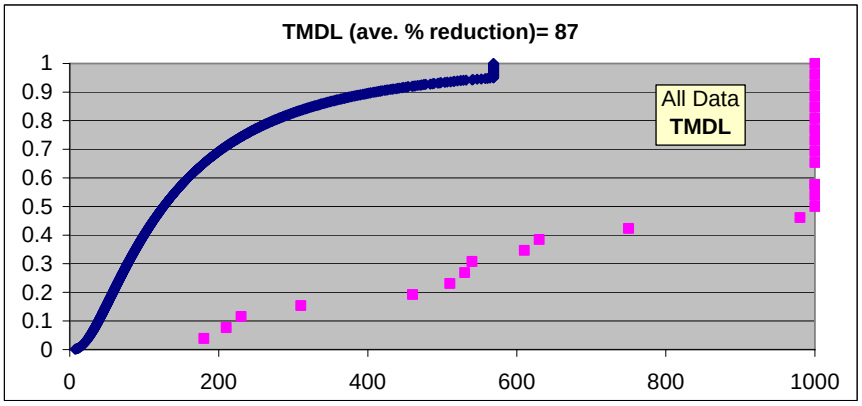
Avg % Reduction

Wet (WLA)	**88**
Dry (LA)	**86**
Total (TMDL)	**87**

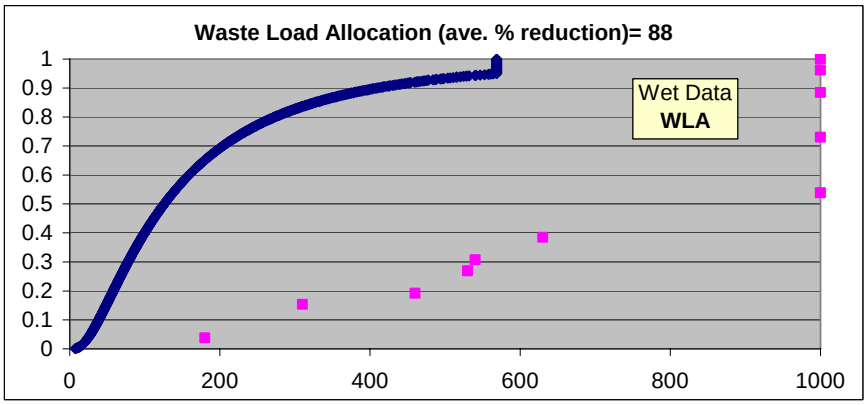
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Steele Brook Criteria Curve for Monitoring Site 331

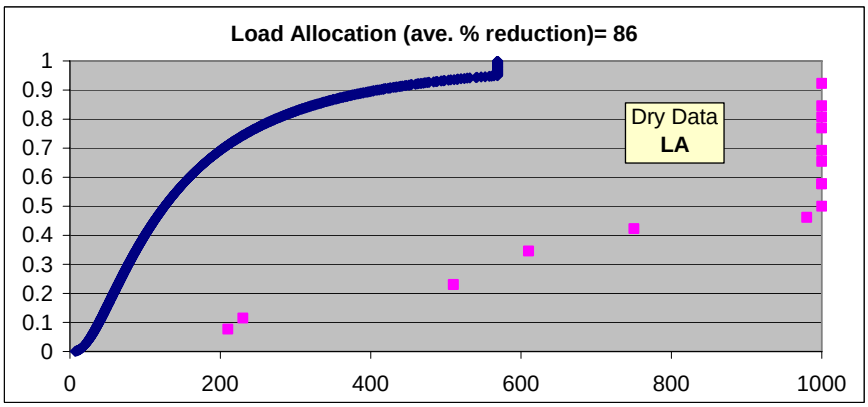
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Steele Brook

CT6912-00_01

Data Used in the Analysis

Monitoring Site: 514, Steele Brook - under Route 8 at Naugatuck Rvr confluence

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	6100	24.0	0.9231	469	92
6/3/04	0.03	0.56	0.98	**WET**	530	7.0	0.2692	71	87
6/10/04	0.00	0.02	0.02	DRY	1800	21.0	0.8077	281	84
6/17/04	0.16	0.16	0.16	**WET**	1100	12.0	0.4615	115	90
6/24/04	0.00	0.00	0.01	DRY	990	10.0	0.3846	96	90
7/1/04	0.00	0.00	0.00	DRY	1700	20.0	0.7692	248	85
7/8/04	0.02	0.02	0.02	DRY	4100	23.0	0.8846	380	91
7/15/04	0.00	0.03	0.16	DRY	660	8.0	0.3077	79	88
7/22/04	0.00	0.00	0.00	DRY	690	9.0	0.3462	88	87
7/29/04	0.00	0.03	1.20	DRY	1000	11.0	0.4231	105	89
8/5/04	0.00	0.65	0.65	**WET**	10000	26.0	1.0000	576	94
8/11/04	0.43	0.45	0.45	**WET**	360	4.0	0.1538	49	86
8/19/04	0.00	0.00	0.00	DRY	1200	13.5	0.5192	132	89
9/2/04	0.00	0.00	0.00	DRY	260	2.0	0.0769	34	87
9/9/04	0.48	1.66	1.73	**WET**	9800	25.0	0.9615	576	94
9/13/04	0.00	0.00	0.00	DRY	460	6.0	0.2308	64	86
9/15/04	0.03	0.03	0.03	DRY	270	3.0	0.1154	42	85
9/21/04	0.00	0.00	0.00	DRY	1300	16.0	0.6154	165	87
9/23/04	0.00	0.00	0.00	DRY	410	5.0	0.1923	57	86
9/30/04	0.08	0.08	2.74	**WET**	1500	18.0	0.6923	200	87
7/5/05	0.15	0.15	0.15	**WET**	1200	13.5	0.5192	132	89
7/18/05	0.18	0.18	0.21	**WET**	2900	22.0	0.8462	322	89
8/1/05	0.10	0.10	0.10	**WET**	1400	17.0	0.6538	181	87
8/9/05	0.00	0.80	0.80	**WET**	1200	13.5	0.5192	132	89
8/16/05	0.01	0.01	0.83	DRY	1600	19.0	0.7308	222	86
9/8/05	0.00	0.00	0.00	DRY	120	1.0	0.0385	25	79

Statistics

# Samples DRY	**15**
# Samples WET	**11**
# Samples Total	**26**
Geomean	**1131**
Log std deviation	**0.4677**

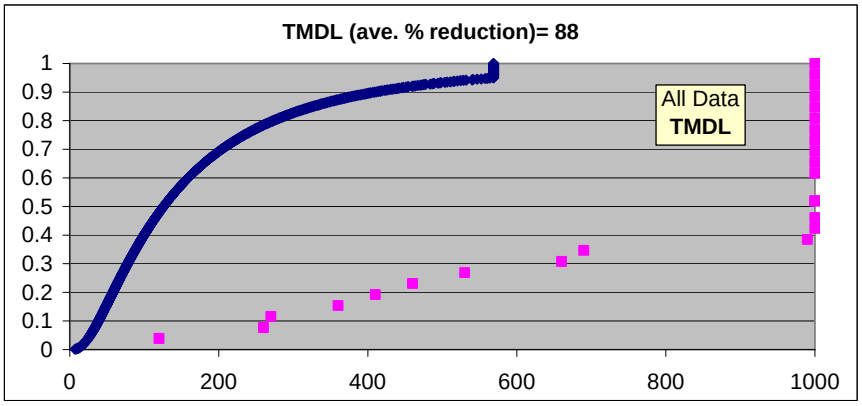
Avg % Reduction

Wet (WLA)	**89**
Dry (LA)	**87**
Total (TMDL)	**88**

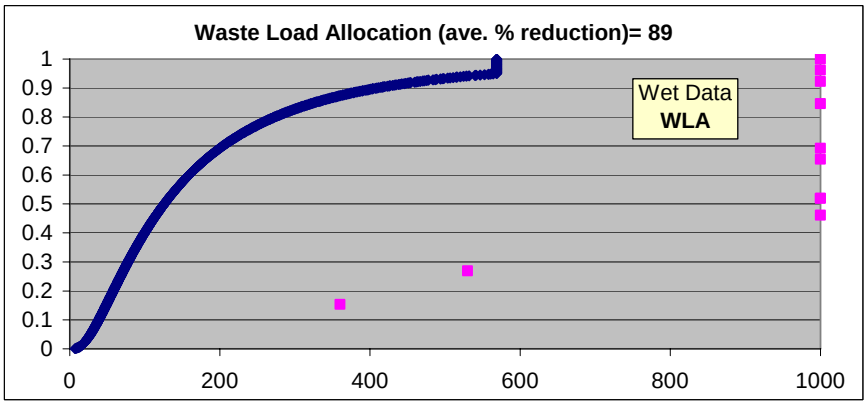
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Steele Brook Criteria Curve for Monitoring Site 514

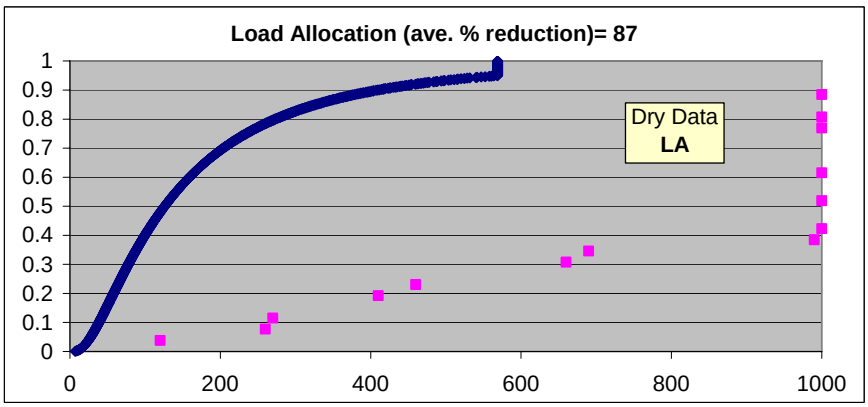
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-2
Steele Brook
TMDL Summary

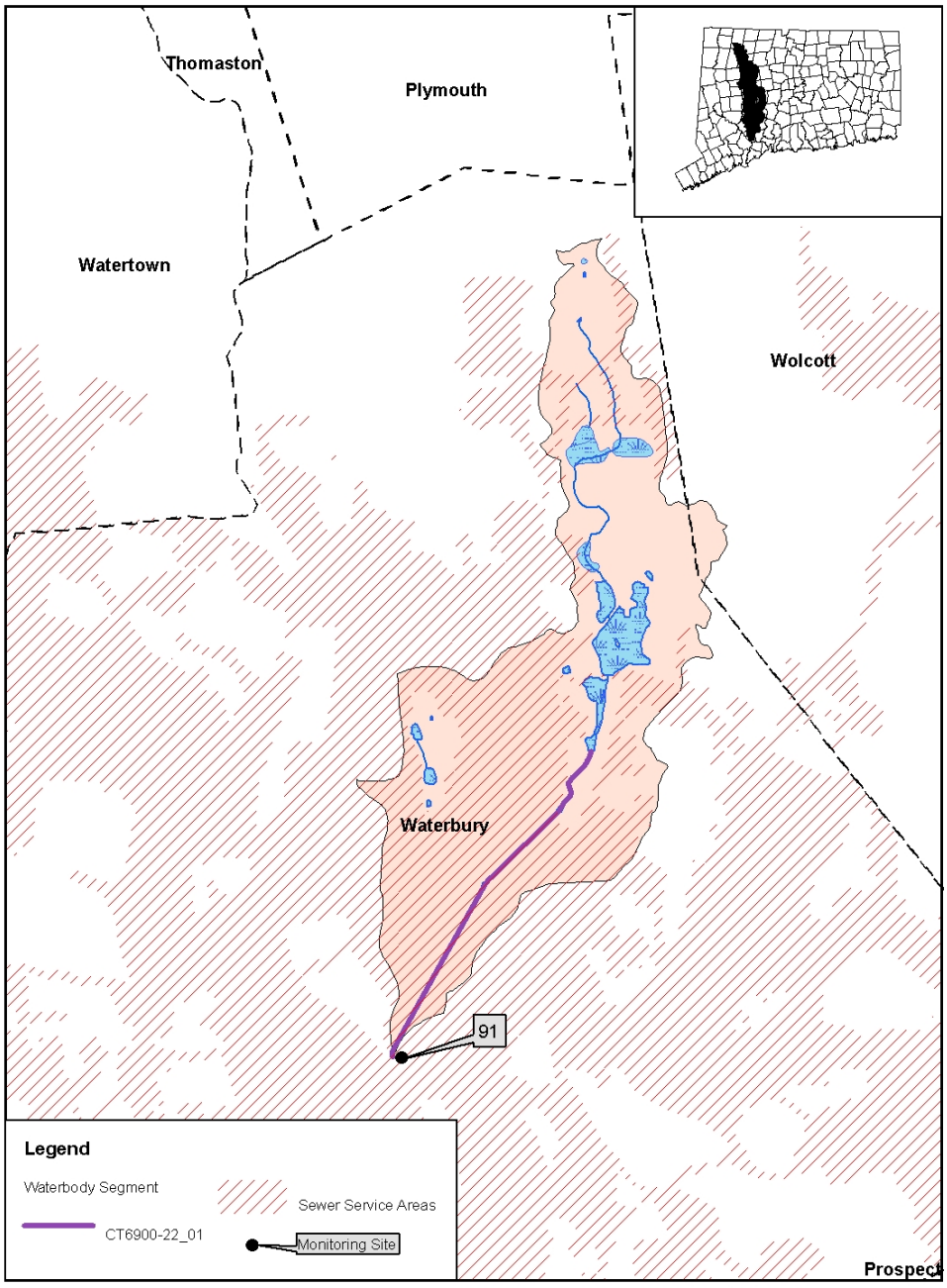
The TMDL analysis for Steele Brook was conducted at two sites, which are representative of two river segments. The analysis indicates that the sites are influenced equally by sources of bacteria active under both wet weather and dry weather conditions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers or directly to the river and the upgrade of failed sanitary infrastructure. The WLA also includes regulated stormwater and can be further reduced through the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality. This action can be beneficial to reducing the WLA but to a lesser degree than those formerly mentioned given the conditions. Since illicit discharges and failed sanitary collection systems may also be active under dry conditions, it is likely that corrective actions aimed at eliminating these sources will also reduce the Load Allocation (LA). Other contributors to the LA include as domestic animal waste, wildlife, and stormwater input as sheet flow.

Appendix A-3
Great Brook
Waterbody Specific Information

Impaired Waterbody
Waterbody Name: Great Brook
Waterbody Segment IDs: CT6900-22_01
Waterbody Description: From Belleview Lake outlet dam (Great Brook Res) downstream to the confluence with the Naugatuck River (Waterbury).
Waterbody Segment Size: 1.98 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class A

Watershed Description:
Total Drainage Basin Area: Included in the area for the Naugatuck Rvr Regional Basin
Subregional Basin Name & Code: Naugatuck River, 6900
Regional Basin: Naugatuck
Major Basin: Housatonic River Basin
Watershed Towns: Waterbury
MS4 applicable? Yes
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Landuse: Accounted for in the Naugatuck Rvr Landuse



Great Brook
Map Data: CTDEP
Map Created: December 2007

Great Brook

CT6900-22_01

Data Used in the Analysis

Monitoring Site: 91, Great Brook at mouth off West Liberty St.

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	1400	10.5	0.4200	105	93
6/3/04	0.03	0.56	0.98	**WET**	1200	7.5	0.3000	78	94
6/10/04	0.00	0.02	0.02	DRY	610	3.0	0.1200	43	93
6/17/04	0.16	0.16	0.16	**WET**	1800	15.0	0.6000	159	91
6/24/04	0.00	0.00	0.01	DRY	3400	19.0	0.7600	241	93
7/1/04	0.00	0.00	0.00	DRY	870	4.0	0.1600	50	94
7/8/04	0.02	0.02	0.02	DRY	1300	9.0	0.3600	91	93
7/15/04	0.00	0.03	0.16	DRY	1900	16.0	0.6400	175	91
7/22/04	0.00	0.00	0.00	DRY	10	1.0	0.0400	25	0
7/29/04	0.00	0.03	1.20	DRY	560	2.0	0.0800	35	94
8/5/04	0.00	0.65	0.65	**WET**	1700	13.5	0.5400	138	92
8/11/04	0.43	0.45	0.45	**WET**	1400	10.5	0.4200	105	93
8/19/04	0.00	0.00	0.00	DRY	1200	7.5	0.3000	78	94
9/2/04	0.00	0.00	0.00	DRY	4100	21.0	0.8400	315	92
9/9/04	0.48	1.66	1.73	**WET**	12000	23.0	0.9200	460	96
9/13/04	0.00	0.00	0.00	DRY	1600	12.0	0.4800	120	92
9/15/04	0.03	0.03	0.03	DRY	990	6.0	0.2400	66	93
9/21/04	0.00	0.00	0.00	DRY	2000	17.0	0.6800	194	90
9/23/04	0.00	0.00	0.00	DRY	1700	13.5	0.5400	138	92
9/30/04	0.08	0.08	2.74	**WET**	960	5.0	0.2000	58	94
7/5/05	0.15	0.15	0.15	**WET**	20000	25.0	1.0000	576	97
7/18/05	0.18	0.18	0.21	**WET**	5200	22.0	0.8800	372	93
8/1/05	0.10	0.10	0.10	**WET**	17000	24.0	0.9600	576	97
8/16/05	0.01	0.01	0.83	DRY	2400	18.0	0.7200	216	91
9/8/05	0.00	0.00	0.00	DRY	3900	20.0	0.8000	274	93

Statistics

# Samples DRY	**15**
# Samples WET	**10**
# Samples Total	**25**
Geomean	**1731**
Log std deviation	**0.6184**

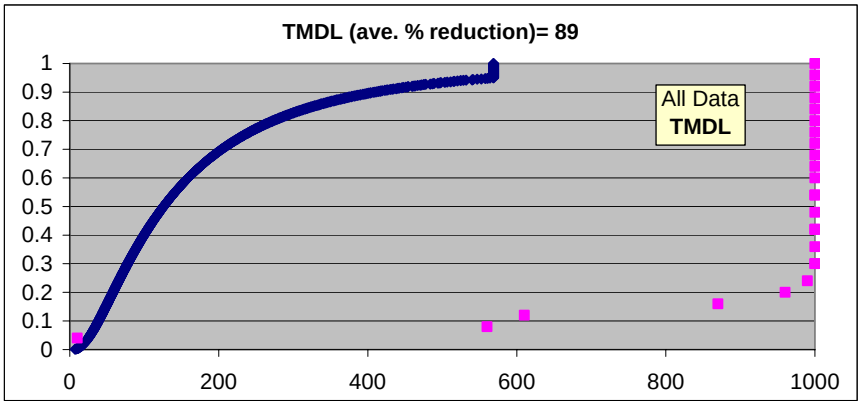
Avg % Reduction

Wet (WLA)	**94**
Dry (LA)	**86**
Total (TMDL)	**89**

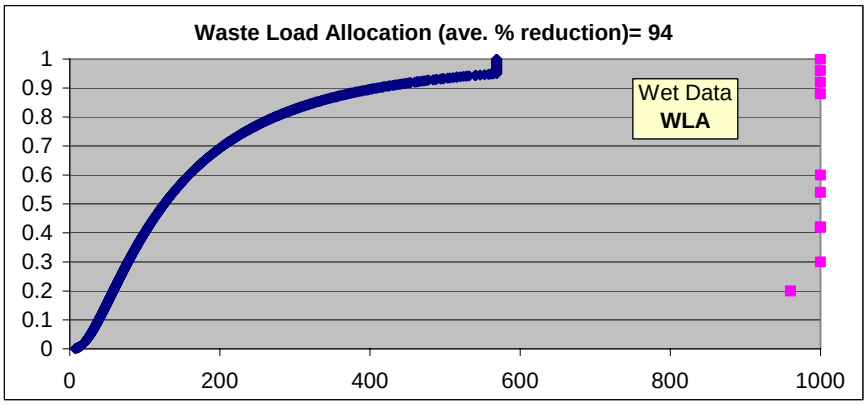
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Great Brook Criteria Curve for Monitoring Site 91

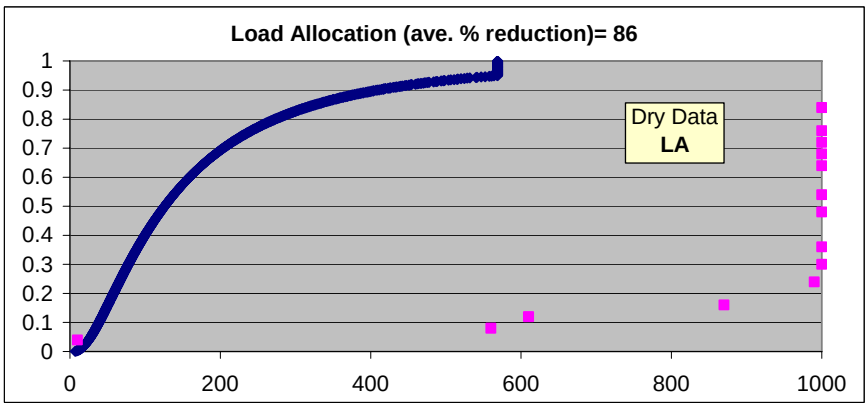
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-3
Great Brook
TMDL Summary

The TMDL analysis for Great Brook was conducted at one site, which is representative of one river segment. The analysis indicates that the site is influenced equally by sources of bacteria active under both wet weather and dry weather conditions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers or directly to the river and the upgrade of failed sanitary infrastructure. Most of Great Brook travels underneath the City of Waterbury and is likely subjected to direct sanitary inputs from old industrial buildings as well as sanitary collection system failure. The WLA also includes regulated stormwater and can be further reduced through the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality. This action can be beneficial to reducing the WLA but to a lesser degree than those formerly mentioned given the conditions. Since illicit discharges and failed sanitary collection systems may also be active under dry conditions, it is likely that corrective actions aimed at eliminating these sources will also reduce the Load Allocation (LA). Other contributors to the LA include as domestic animal waste, wildlife, and stormwater input as sheet flow.

Appendix A-4
Mad River
Waterbody Specific Information

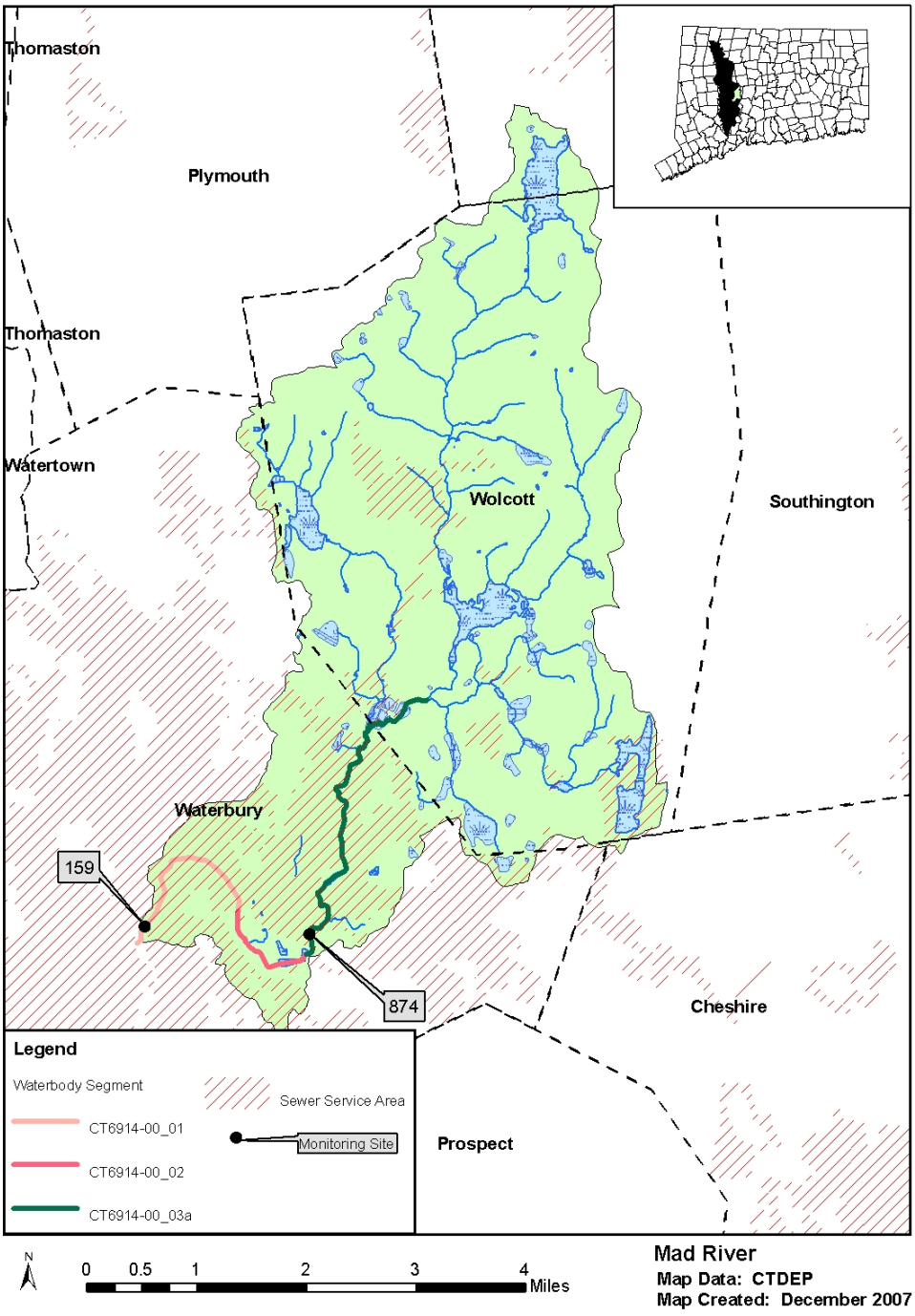
Impaired Waterbody
Waterbody Name: Mad River
Waterbody Segment IDs: CT6914-00_01, CT6914-00_02, CT6914-00_03a
Waterbody Description: From the confluence with Lily Brook (Wolcott) downstream to the confluence with the Naugatuck River (Waterbury).
Waterbody Segment Size: 6.24 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class B

Watershed Description:
Total Drainage Basin Area: 13,024 Acres
Subregional Basin Name & Code: Mad River, 6914
Regional Basin: Naugatuck
Major Basin: Housatonic River Basin
Watershed Towns: Wolcott
MS4 applicable? Yes
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Landuse:

Land Use Category	Percent Composition
Barren	1.7
Coniferous Forest	2.5
Deciduous Forest	43.5
Developed	35.7
Forested Wetland	2.6
Non-forested Wetland	0.2
Other Grasses and Agriculture	4.4
Turf and Grass	5
Utility Right of Way	0.5
Water	3.9

Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.


Thomaston
Plymouth
Thomaston
Watertown
Wolcott
Southington
Waterbury
159
874
Cheshire
Prospect
Legend
Waterbody Segment
Sewer Service Area
CT6914-00_01
Monitoring Site
CT6914-00_02
CT6914-00_03a
N
0 0.5 1 2 3 4
Miles
Mad River
Map Data: CTDEP
Map Created: December 2007

Mad River

CT6914-00_03a

Data Used in the Analysis

Monitoring Site: 874, Mad River - downstream of East Main Street

Date	Precip.(in)[1]			Condition[2]	E. coli	Rank	Proportion	Criteria	%
	24h	48h	96h	(WET/DRY)	(col./100 ml)			Value	Reduction
5/27/04	0.04	1.02	1.02	**WET**	1200	23.0	0.9200	460	62
6/3/04	0.03	0.56	0.98	**WET**	130	2.0	0.0800	35	73
6/10/04	0.00	0.02	0.02	DRY	390	13.5	0.5400	138	65
6/17/04	0.16	0.16	0.16	**WET**	240	6.0	0.2400	66	73
6/24/04	0.00	0.00	0.01	DRY	235	5.0	0.2000	58	75
7/1/04	0.00	0.00	0.00	DRY	390	13.5	0.5400	138	65
7/8/04	0.02	0.02	0.02	DRY	355	11.0	0.4400	110	69
7/15/04	0.00	0.03	0.16	DRY	290	7.0	0.2800	74	75
7/22/04	0.00	0.00	0.00	DRY	1400	24.0	0.9600	576	59
7/29/04	0.00	0.03	1.20	DRY	630	19.5	0.7800	257	59
8/5/04	0.00	0.65	0.65	**WET**	550	17.0	0.6800	194	65
8/19/04	0.00	0.00	0.00	DRY	220	4.0	0.1600	50	77
9/2/04	0.00	0.00	0.00	DRY	520	16.0	0.6400	175	66
9/9/04	0.48	1.66	1.73	**WET**	4400	25.0	1.0000	576	87
9/13/04	0.00	0.00	0.00	DRY	470	15.0	0.6000	159	66
9/15/04	0.03	0.03	0.03	DRY	180	3.0	0.1200	43	76
9/21/04	0.00	0.00	0.00	DRY	610	18.0	0.7200	216	65
9/23/04	0.00	0.00	0.00	DRY	330	9.0	0.3600	91	73
9/30/04	0.08	0.08	2.74	**WET**	370	12.0	0.4800	120	67
7/5/05	0.15	0.15	0.15	**WET**	350	10.0	0.4000	100	71
7/18/05	0.18	0.18	0.21	**WET**	960	21.0	0.8400	315	67
8/1/05	0.10	0.10	0.10	**WET**	74	1.0	0.0400	25	66
8/9/05	0.00	0.80	0.80	**WET**	310	8.0	0.3200	82	74
8/16/05	0.01	0.01	0.83	DRY	1100	22.0	0.8800	372	66
9/8/05	0.00	0.00	0.00	DRY	630	19.5	0.7800	257	59

Statistics

# Samples DRY	**15**
# Samples WET	**10**
# Samples Total	**25**
Geomean	**439**
Log std deviation	**0.3632**

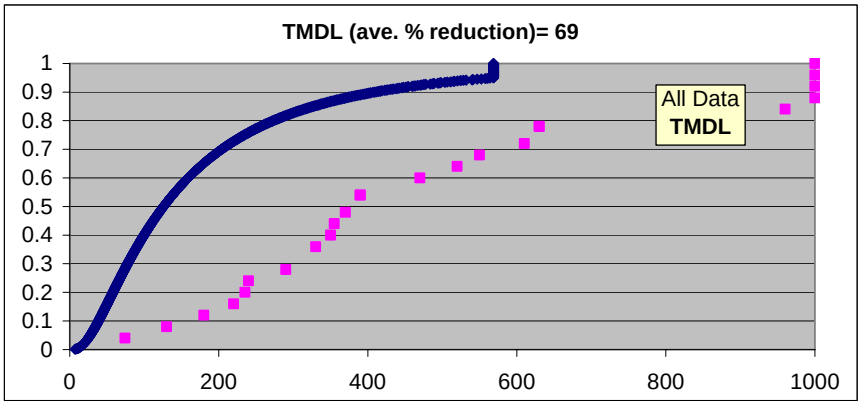
Avg % Reduction

Wet (WLA)	**71**
Dry (LA)	**68**
Total (TMDL)	**69**

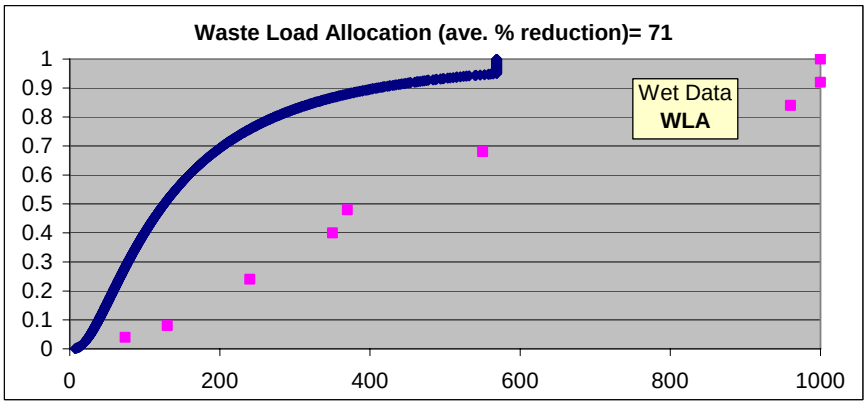
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Mad River Criteria Curve for Monitoring Site 874

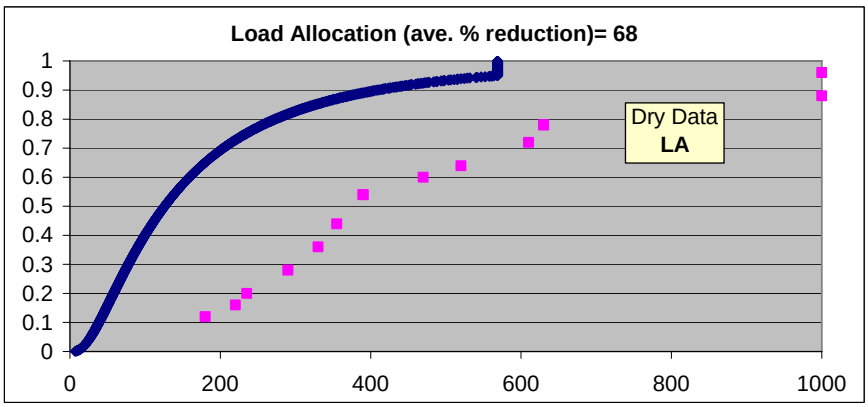
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Mad River

CT6914-00_01

Data Used in the Analysis

Monitoring Site: 159, Mad River - near mouth at Washington Street

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
5/27/04	0.04	1.02	1.02	**WET**	1400	21.0	0.8400	315	78
6/3/04	0.03	0.56	0.98	**WET**	450	5.0	0.2000	58	87
6/10/04	0.00	0.02	0.02	DRY	710	13.5	0.5400	138	81
6/17/04	0.16	0.16	0.16	**WET**	1300	20.0	0.8000	274	79
6/24/04	0.00	0.00	0.01	DRY	2500	22.0	0.8800	372	85
7/1/04	0.00	0.00	0.00	DRY	350	4.0	0.1600	50	86
7/8/04	0.02	0.02	0.02	DRY	560	9.0	0.3600	91	84
7/15/04	0.00	0.03	0.16	DRY	890	15.0	0.6000	159	82
7/22/04	0.00	0.00	0.00	DRY	930	17.0	0.6800	194	79
7/29/04	0.00	0.03	1.20	DRY	710	13.5	0.5400	138	81
8/5/04	0.00	0.65	0.65	**WET**	5500	23.0	0.9200	460	92
8/19/04	0.00	0.00	0.00	DRY	320	3.0	0.1200	43	87
9/2/04	0.00	0.00	0.00	DRY	1200	19.0	0.7600	241	80
9/9/04	0.48	1.66	1.73	**WET**	6100	24.0	0.9600	576	91
9/13/04	0.00	0.00	0.00	DRY	620	11.0	0.4400	110	82
9/15/04	0.03	0.03	0.03	DRY	920	16.0	0.6400	175	81
9/21/04	0.00	0.00	0.00	DRY	470	6.5	0.2600	70	85
9/23/04	0.00	0.00	0.00	DRY	270	2.0	0.0800	35	87
9/30/04	0.08	0.08	2.74	**WET**	24000	25.0	1.0000	576	98
7/5/05	0.15	0.15	0.15	**WET**	470	6.5	0.2600	70	85
7/18/05	0.18	0.18	0.21	**WET**	1100	18.0	0.7200	216	80
8/1/05	0.10	0.10	0.10	**WET**	630	12.0	0.4800	120	81
8/9/05	0.00	0.80	0.80	**WET**	510	8.0	0.3200	82	84
8/16/05	0.01	0.01	0.83	DRY	580	10.0	0.4000	100	83
9/8/05	0.00	0.00	0.00	DRY	230	1.0	0.0400	25	89

Statistics

# Samples DRY	**15**
# Samples WET	**10**
# Samples Total	**25**
Geomean	**905**
Log std deviation	**0.4601**

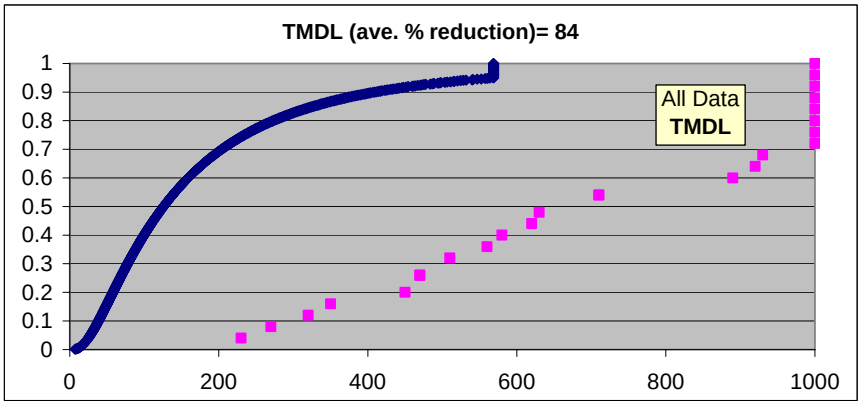
Avg % Reduction

Wet (WLA)	**85**
Dry (LA)	**83**
Total (TMDL)	**84**

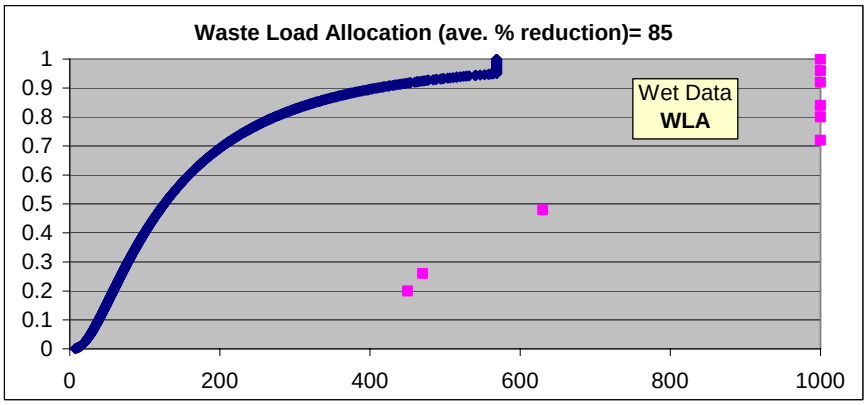
Precipitation and E. coli data provided Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Mad River Criteria Curve for Monitoring Site 159

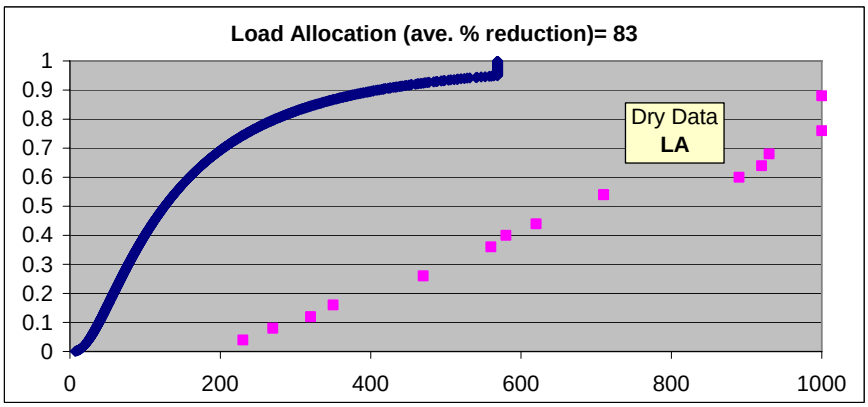
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-4
Mad River
TMDL Summary

The TMDL analysis for Mad River was conducted at two sites, which are representative of three river segments. The analysis indicates that the sites are influenced equally by sources of bacteria active under both wet weather and dry weather conditions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers or directly to the river and the upgrade of failed sanitary infrastructure. The WLA also includes regulated stormwater and can be further reduced through the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality. This action can be beneficial to reducing the WLA but to a lesser degree than those formerly mentioned. Since illicit discharges and failed sanitary collection systems may also be active under dry conditions, it is likely that corrective actions aimed at eliminating these sources will also reduce the Load Allocation (LA). Other contributors to the LA include as domestic animal waste, wildlife, and stormwater input as sheet flow.

Appendix A-5
Hop Brook
Waterbody Specific Information

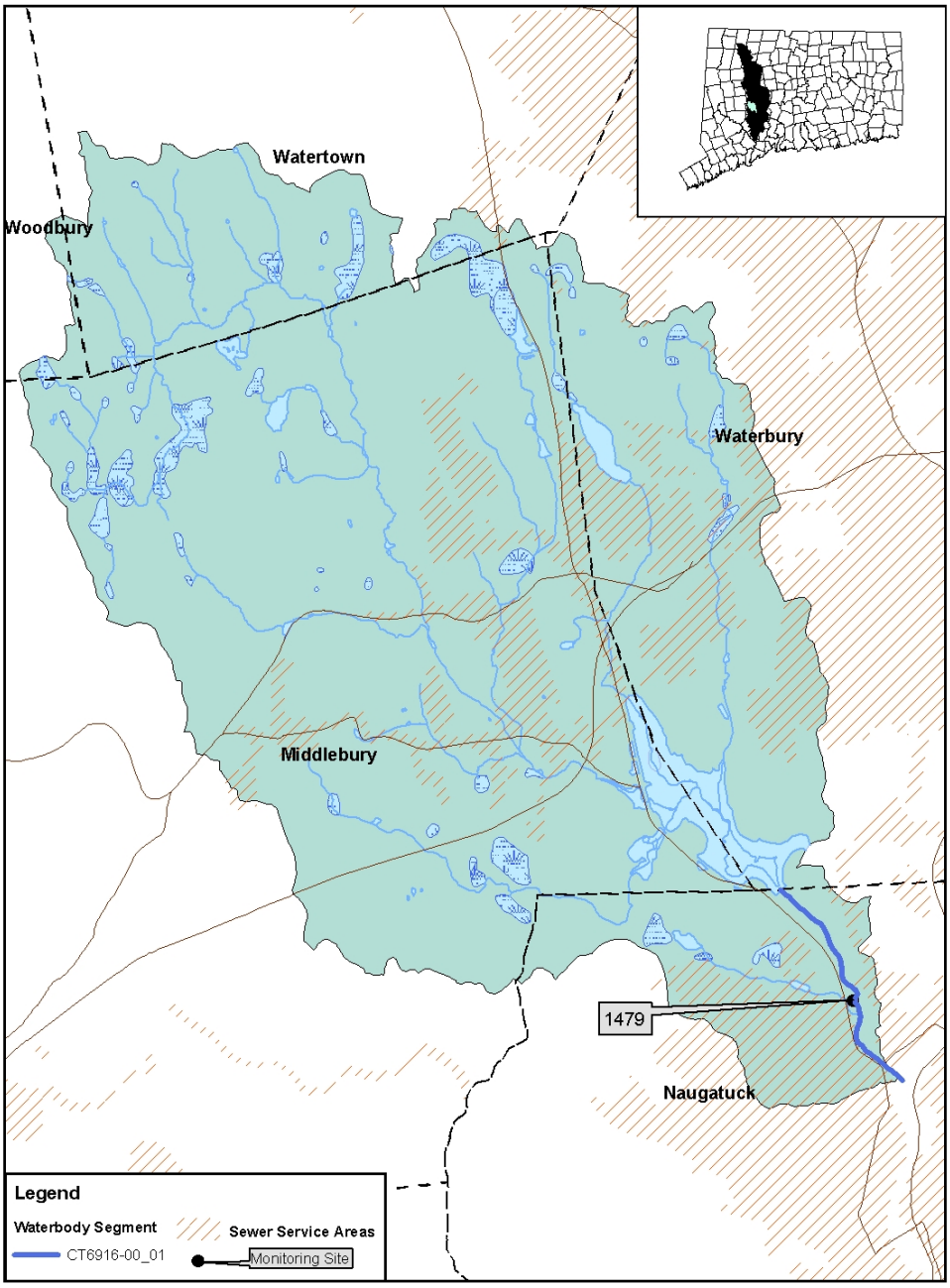
Impaired Waterbody
Waterbody Name: Hop Brook
Waterbody Segment IDs: CT6916-00_01
Waterbody Description: From Hop Brook Lake dam outlet downstream to the confluence with the Naugatuck River (Naugatuck).
Waterbody Segment Size: 1.44 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class B/A

Watershed Description:
Total Drainage Basin Area: 11,136 Acres
Subregional Basin Name & Code: Hop Brook, 6916
Regional Basin: Naugatuck
Major Basin: Housatonic River Basin
Watershed Towns: Middlebury, Waterbury, Naugatuck, Watertown
MS4 applicable? Yes
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Landuse:

Land Use Category	Percent Composition
Barren	0.8
Coniferous Forest	1.1
Deciduous Forest	50
Developed	22.3
Forested Wetland	3.2
Non-forested Wetland	0.3
Other Grasses and Agriculture	13.5
Turf and Grass	7.5
Utility Right of Way	0.4
Water	0.9

Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.



Hop Brook
Map Data: CTDEP
Map Created: December 2007

Hop Brook

CT6916-00_01

Data Used in the Analysis

Monitoring Site: 1479, Hop Brook - upstream of Porter Avenue

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
9/2/04	0.00	0.00	0.00	DRY	85	8.0	0.3810	95	0
9/9/04	0.48	1.66	1.73	**WET**	390	17.0	0.8095	282	28
9/13/04	0.00	0.00	0.00	DRY	73	6.0	0.2857	75	0
9/15/04	0.03	0.03	0.03	DRY	52	2.5	0.1190	43	18
9/21/04	0.00	0.00	0.00	DRY	3400	21.0	1.0000	576	83
9/23/04	0.00	0.00	0.00	DRY	150	13.0	0.6190	167	0
9/30/04	0.08	0.08	2.74	**WET**	2900	20.0	0.9524	576	80
7/5/05	0.15	0.15	0.15	**WET**	52	2.5	0.1190	43	18
7/18/05	0.18	0.18	0.21	**WET**	54	4.0	0.1905	56	0
8/1/05	0.10	0.10	0.10	**WET**	120	9.5	0.4524	113	6
8/9/05	0.00	0.80	0.80	**WET**	380	16.0	0.7619	243	36
8/16/05	0.01	0.01	0.83	DRY	200	14.0	0.6667	187	6
9/8/05	0.00	0.00	0.00	DRY	120	9.5	0.4524	113	6
6/6/07	0.00	0.12	1.55	DRY	880	19.0	0.9048	421	52
6/21/07	0.07	0.09	0.09	DRY	63	5.0	0.2381	65	0
6/26/07	0.00	0.00	0.00	DRY	120	9.5	0.4524	113	6
6/28/07	0.36	0.36	0.36	**WET**	120	9.5	0.4524	113	6
7/5/07	0.54	1.00	1.00	**WET**	310	15.0	0.7143	212	32
7/12/07	0.00	0.21	0.21	DRY	74	7.0	0.3333	85	0
8/8/07	0.33	0.33	0.33	**WET**	800	18.0	0.8571	337	58
8/15/07	0.00	0.00	0.12	DRY	20	1.0	0.0476	27	0

Statistics

# Samples DRY	**12**
# Samples WET	**9**
# Samples Total	**21**
Geomean	**177**
Log std deviation	**0.5817**

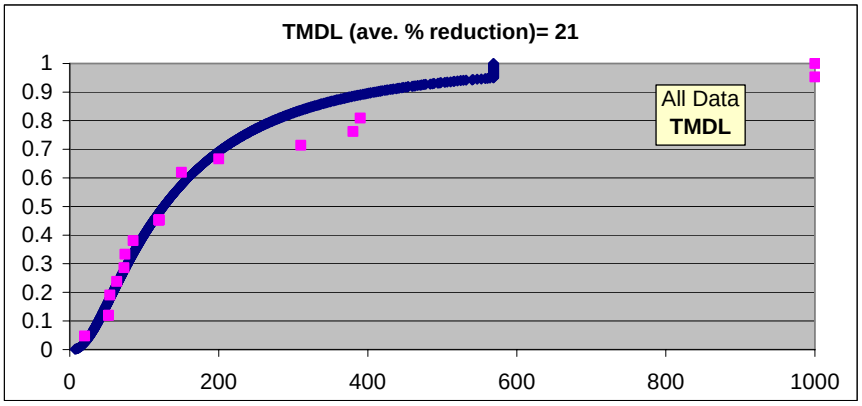
Avg % Reduction

Wet (WLA)	**29**
Dry (LA)	**14**
Total (TMDL)	**21**

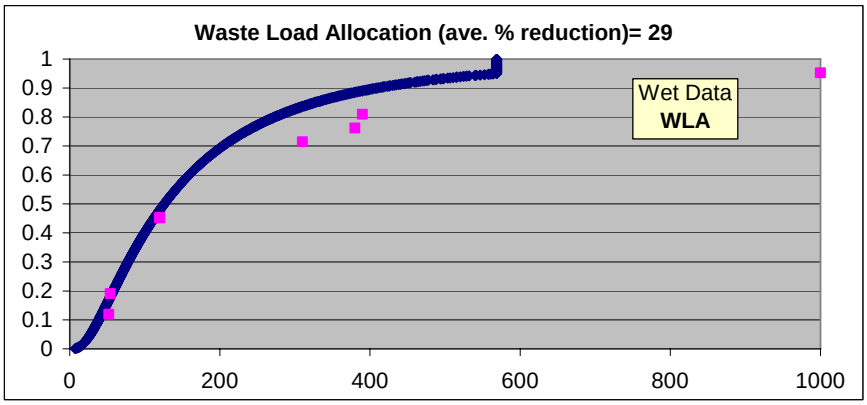
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Hop Brook Criteria Curve for Monitoring Site 1479

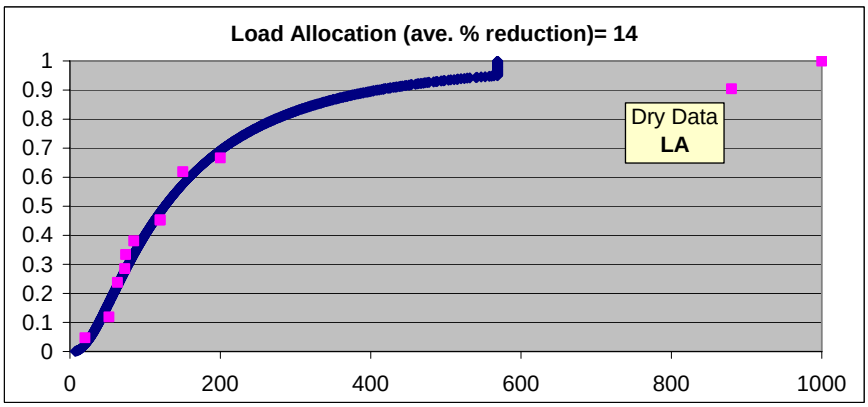
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-5
Hop Brook
TMDL Summary

The TMDL analysis for Hop Brook was conducted at one site, which is representative of one river segment. The analysis indicates that the site is influenced predominantly by sources of bacteria active under wet weather conditions. Although the required percent reductions are low, the DEP is aware of one pipe that discharges to the river and potentially contains an illicit connection(s). The pipe is located below the sample location (1479) where the TMDL was determined. It is important to note that the TMDLs are effective for the entire watershed because they are a measurement of compounded impacts at a single point. As such, corrective actions must be undertaken at the source(s) whether it is a tributary or illicit discharge pipe, in order to achieve the required percent reductions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers or directly to the river. The WLA also includes regulated stormwater and can be further reduced through the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality. Nonpoint sources that contribute to the Load Allocation (LA) include domestic animal waste, wildlife, and stormwater input as sheet flow.

Appendix A-6
Long Meadow Pond Brook
Waterbody Specific Information

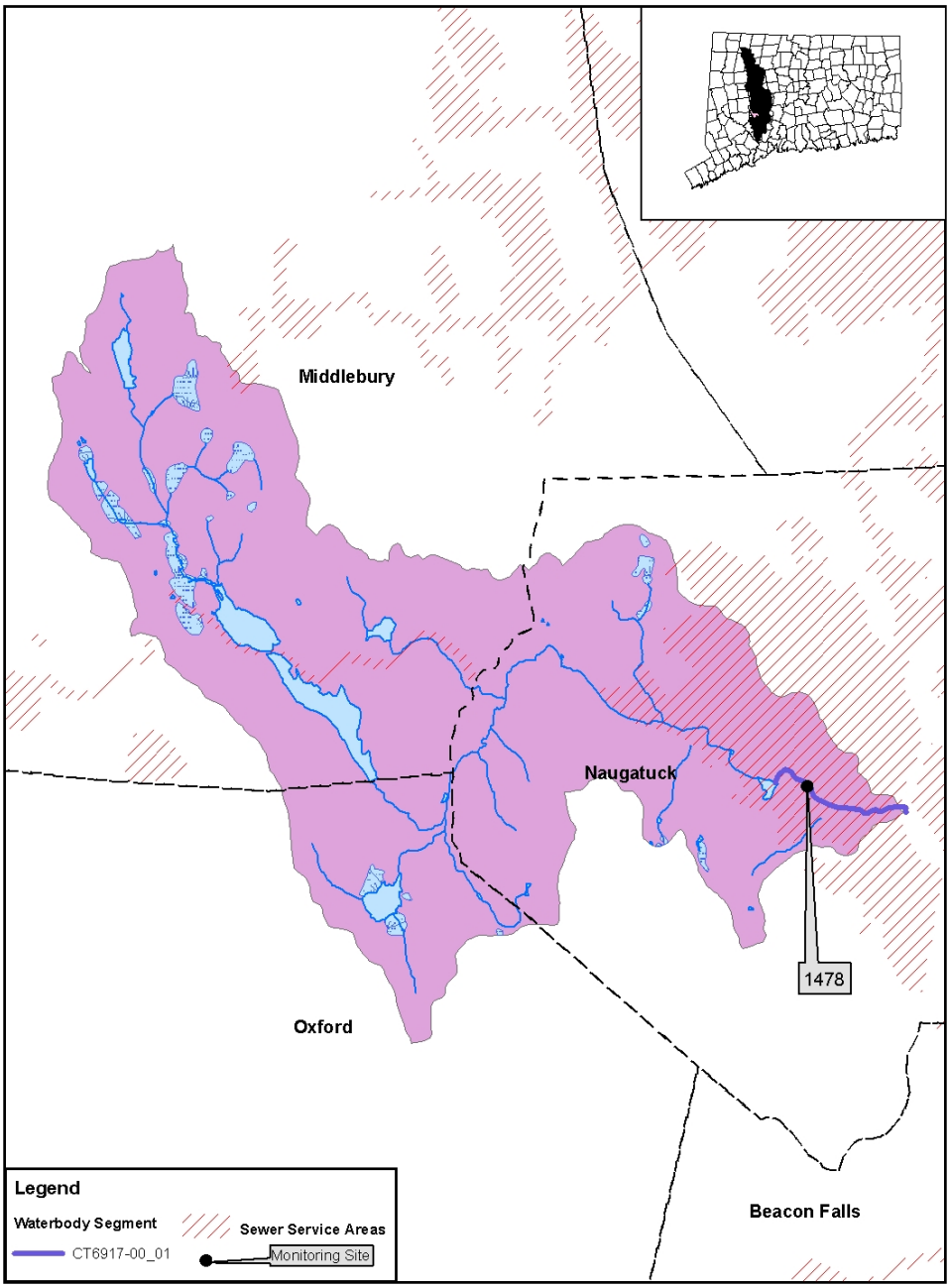
Impaired Waterbody
Waterbody Name: Long Meadow Pond Brook
Waterbody Segment IDs: CT6917-00_01
Waterbody Description: From the Naugatuck Ice Company Pond dam outlet downstream to the confluence with the Naugatuck River (Naugatuck).
Waterbody Segment Size: 0.94 linear miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class B

Watershed Description:
Total Drainage Basin Area: 5,421 Acres
Subregional Basin Name & Code: Long Meadow Pond Brook, 6917
Regional Basin: Naugatuck
Major Basin: Housatonic River Basin
Watershed Towns: Middlebury, Naugatuck, Oxford
MS4 applicable? Yes
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Landuse:

Land Use Category	Percent Composition
Barren	0.9
Coniferous Forest	3
Deciduous Forest	53.6
Developed	20.6
Forested Wetland	2.7
Non-forested Wetland	0.8
Other Grasses and Agriculture	12.6
Turf and Grass	2.8
Utility Right of Way	0.6
Water	2.4

Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.



Long Meadow Pond Brook

Map Data: CTDEP

Map Created: December 2007

Long Meadow Pond Bk

CT6916-00_01

Data Used in the Analysis

Monitoring Site: 1478, Upstream of Rubber Avenue bridge

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
9/2/04	0.00	0.00	0.00	DRY	720	13.0	0.6500	180	75
9/9/04	0.48	1.66	1.73	**WET**	7700	20.0	1.0000	576	93
9/13/04	0.00	0.00	0.00	DRY	1000	15.0	0.7500	235	77
9/15/04	0.03	0.03	0.03	DRY	500	8.5	0.4250	106	79
9/21/04	0.00	0.00	0.00	DRY	490	7.0	0.3500	88	82
9/23/04	0.00	0.00	0.00	DRY	470	6.0	0.3000	78	83
9/30/04	0.08	0.08	2.74	**WET**	560	11.0	0.5500	141	75
7/5/05	0.15	0.15	0.15	**WET**	520	10.0	0.5000	126	76
7/18/05	0.18	0.18	0.21	**WET**	6900	18.0	0.9000	410	94
8/1/05	0.10	0.10	0.10	**WET**	290	2.0	0.1000	39	87
8/9/05	0.00	0.80	0.80	**WET**	340	3.5	0.1750	53	84
8/16/05	0.01	0.01	0.83	DRY	500	8.5	0.4250	106	79
9/8/05	0.00	0.00	0.00	DRY	1700	16.0	0.8000	274	84
6/21/07	0.07	0.09	0.09	DRY	610	12.0	0.6000	159	74
6/26/07	0.00	0.00	0.00	DRY	250	1.0	0.0500	28	89
6/28/07	0.36	0.36	0.36	**WET**	370	5.0	0.2500	68	82
7/5/07	0.54	1.00	1.00	**WET**	6900	18.0	0.9000	410	94
7/12/07	0.00	0.21	0.21	DRY	960	14.0	0.7000	204	79
8/8/07	0.33	0.33	0.33	**WET**	5000	17.0	0.8500	327	93
8/15/07	0.00	0.00	0.12	DRY	340	3.5	0.1750	53	84

Statistics

# Samples DRY	**11**
# Samples WET	**9**
# Samples Total	**20**
Geomean	**874**
Log std deviation	**0.4888**

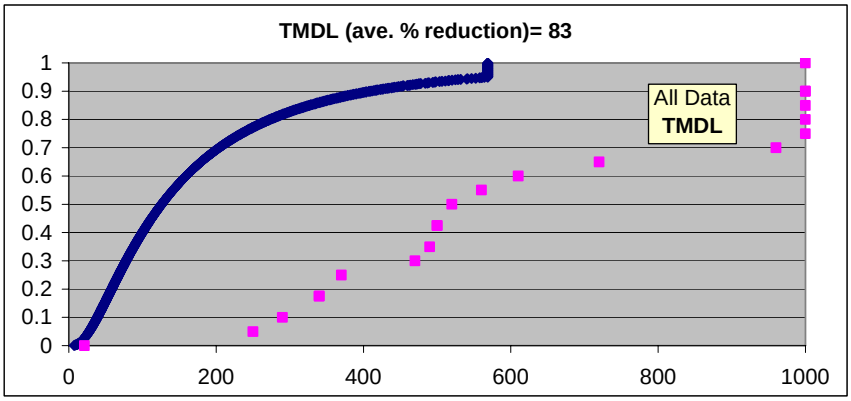
Avg % Reduction

Wet (WLA)	**86**
Dry (LA)	**80**
Total (TMDL)	**83**

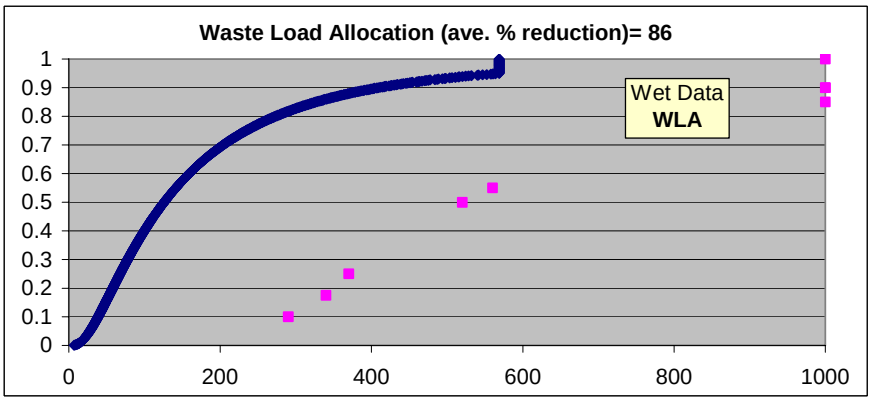
Precipitation and E. coli data provided by Torrington WWTP and CTDEP, respectively.
WET Condition defined as greater than 0.1" precipitation in 24 hours or
0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

Long Meadow Pond Bk Criteria Curve for Monitoring Site 1478

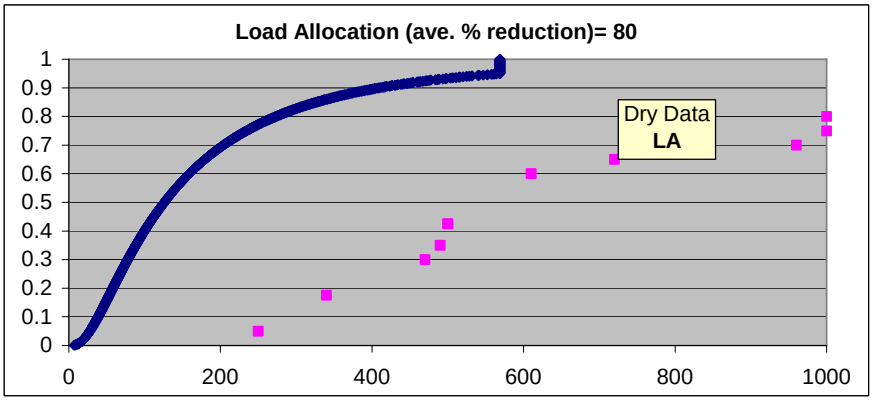
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Appendix A-6
Long Meadow Pond Brook
TMDL Summary

The TMDL analysis for Long Meadow Pond Brook was conducted at one site, which is representative of one river segment. The analysis indicates that the site is influenced by sources of bacteria active under both wet weather and dry weather conditions. However, percent reductions for wet weather conditions were found to be slightly higher than dry weather conditions. The DEP is aware of one pipe that discharges to the river and potentially contains an illicit connection(s). It is important to note that the TMDLs are effective for the entire watershed because they are a measurement of compounded impacts at a single point. As such, corrective actions must be undertaken at the source(s) whether it is a tributary or illicit discharge pipe, in order to achieve the required percent reductions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers or directly to the river. The WLA also includes regulated stormwater and can be further reduced through the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality. Nonpoint sources that contribute to the Load Allocation (LA) include domestic animal waste, wildlife, and stormwater input as sheet flow.

Appendix B
Technical Support Document for the Cumulative Frequency Distribution Function Method

DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR INDICATOR BACTERIA IN CONTACT RECREATION AREAS USING THE CUMULATIVE FREQUENCY DISTRIBUTION FUNCTION METHOD

Lee E. Dunbar, Assistant Director
Mary E. Becker, Environmental Analyst
CT Department of Environmental Protection
Total Maximum Daily Load Program

Last revised: November 8, 2005

OVERVIEW OF APPROACH

The analytical methodology presented in this document provides a defensible scientific and technical basis for establishing TMDLs to address recreational use impairments in surface waters. Representative ambient water quality monitoring data for a minimum of 21 sampling dates during the recreational season (May 1 – September 31) is required for the analysis. The reduction in bacteria density from current levels needed to achieve consistency with the criteria is quantified by calculating the difference between the cumulative relative frequency of the sample data set and the criteria adopted by Connecticut to support recreational use. Connecticut's adopted water quality criteria for indicator bacteria (*Escherichia coli*) are represented by a statistical distribution of the geometric mean 126 and log standard deviation 0.4 for purposes of the TMDL calculations.

TMDLs developed using this approach are expressed as the average percentage reduction from current conditions required to achieve consistency with criteria. The procedure partitions the TMDL into wet weather allocation and dry weather allocation components by quantifying the contribution of ambient monitoring data collected during periods of high stormwater influence and minimal stormwater influence to the current condition. The partition is used to determine the effect of high stormwater influence on the contribution of sources to the waterbody. TMDLs developed using this analytical approach provide an ambient monitoring benchmark ideally suited for quantifying progress in achieving water quality goals as a result of TMDL implementation.

APPLICABILITY

The methodology is intended solely for use in developing TMDLs for waters that are identified as impaired on the *List of Connecticut Water Bodies Not Meeting Water Quality Standards* [1]. It is expected that implementation of these TMDLs will be accomplished through implementing the provisions of the Small Municipal Separate Storm Sewer System general permit (MS4 permit) [2] in designated urban areas, as well as through measures that address non-point sources. The method as described here is not intended for use as an assessment tool for purposes of identifying use attainment status relative to listing or delisting of waterbody segments pursuant to Section 303(d) of the federal Clean Water Act. Assessment of use support is performed in accordance with the Department's guidance document, *Connecticut Consolidated Assessment and Listing Methodology (CT-CALM)* [3].

BACKGROUND

TMDLs are established by the State in accordance with the requirements established in the federal Clean Water Act. Section 303(d) of the Act requires the State to perform an assessment of waters within the State relative to their ability to support designated uses including recreational use. The procedure used by the Department to assess use attainment is described in the guidance document, *CT-CALM* [3]. The list of waterbody segments in Connecticut that do not currently support recreational use is updated to incorporate the most recent monitoring information by the Department every two years. As a result of this process, waterbodies may be added to or deleted from the list of impaired waters in accordance with the *CT-CALM* guidance. Once complete, the list is submitted to the Regional office of the federal EPA for approval. Section 303(d) of the Act requires the State to establish TMDLs for each pollutant contributing to the impairment of each waterbody segment identified on the list.

WATER QUALITY CRITERIA FOR INDICATOR BACTERIA

Connecticut's adopted water quality criteria for the indicator bacteria *Escherichia coli (E.coli)* in the CT Water Quality Standards [4] include a geometric mean and upper confidence limit (i.e. single sample maximum), which are based on three recreational use categories. The categories include designated swimming, non-designated swimming, and all other recreational uses. 'Designated swimming' includes areas that have been designated by State or Local authorities. 'Non-designated swimming' includes waters suitable for swimming but have not been designated by State or Local authorities, as well as water that support recreational activities where full body contact is likely, such as tubing or water skiing. 'All other recreational uses' include waters that support recreational activities where full body contact is infrequent, such as fishing, boating, kayaking, and wading. The recreational uses and applicable criteria are provided in the following table.

Recreational Use Category	Indicator Bacteria	Geometric Mean	Single Sample Maximum Upper Confidence Limit
Designated Swimming	*E.coli*	126col/100mls	256col/100mls 75th Percentile
Non-designated Swimming			410col/100mls 90th Percentile
All Other Recreational Uses			576col/100mls 95th Percentile

Table 1. Applicable indicator bacteria (*E.coli*) water quality criteria for recreational uses

The indicator bacteria, *E. coli*, is not pathogenic, rather its presence in water is an indicator of contamination with fecal material that may also contribute pathogenic organisms. Connecticut's criteria are based on federal guidance [5]. In this guidance, the basis for the criteria and the relationship between the geometric mean criterion and the single sample maximum criterion is explained in detail.

The geometric mean criterion was derived by EPA scientists from epidemiological studies at beaches where the incidence of swimming related health effects (gastrointestinal illness rate) could be correlated with indicator bacteria densities. EPA's recommended criteria reflect an average illness rate of 8 illnesses per 1000 swimmers exposed. This condition was predicted to exist based on studies cited in the federal guidance when the steady-state geometric mean density of *E. coli* was 126 col/100ml. The distribution of individual sample results around the geometric mean is such that approximately half of all individual samples are expected to exceed the geometric mean and half will be below the geometric mean.

EPA also derived a single sample maximum criterion from this same database to support decisions by public health officials regarding the closure of beaches when an elevated risk of illness exists. Because approximately half of all individual sample results for a beach where the risk of illness is considered "acceptable" are expected to exceed the geometric mean criteria of 126 col/100ml, an upper boundary to the range of individual sample results was statistically derived that will be exceeded at frequencies less than 50% based on the variability of sample data. The mean log standard deviation for *E. coli* densities at the freshwater beach sites studied by EPA was 0.4. The single sample maximum criterion of 235 col/100mls, 410 col/100mls, and 576 col/100mls adopted by Connecticut represents the 75^{th}, 90^{th}, and 95^{th} percentile upper confidence limit, respectively, for a statistical distribution of data with a geometric mean of 126 and a log standard deviation of 0.4 as recommended by EPA [5].

Consistent with the State's disinfection policy (Water Quality Standard #23), the critical period for application of the indicator bacteria criteria is the recreational season, defined as May 1 through September 30. For waters that do not receive point discharges of treated sewage subject to the disinfection policy, a review of ambient monitoring data contained in the State's Ambient Monitoring Database [6] confirms that bacteria densities are typically highest during the summer months. Consistency with criteria during the summer is indicative of consistency at all times of the year. Lower densities reported during other portions of the year are most likely a result of several environmental factors including more rapid die-off of enteric bacteria in colder temperatures and reduced loadings from wildlife and domestic animal populations. Further, human exposure to potentially contaminated water is greatly reduced during the colder months, particularly exposure that results from immersion in the water since cold temperatures discourage participation in recreational activities that typically involve immersion.

Connecticut's adopted criteria are based on federal guidance and reflect an idealized distribution of bacteria monitoring data for sites studied by EPA that can be represented by statistical distribution with a geometric mean of 126 col/100ml and a log standard deviation of 0.4. The criteria can therefore be expressed as a cumulative frequency distribution or "criteria curve" as shown in figures 1a through1c for each of the specified recreational uses in Connecticut's bacteria criteria.

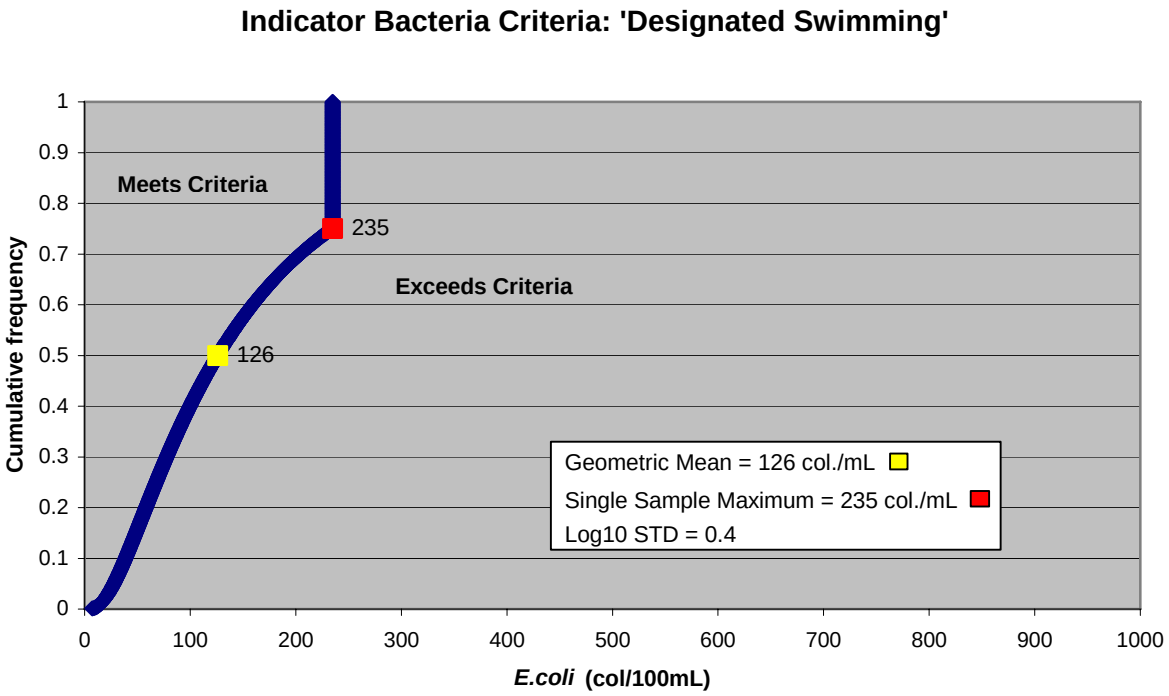


Figure 1a. Cumulative Relative Frequency Distribution representing water quality to support designated swimming use.

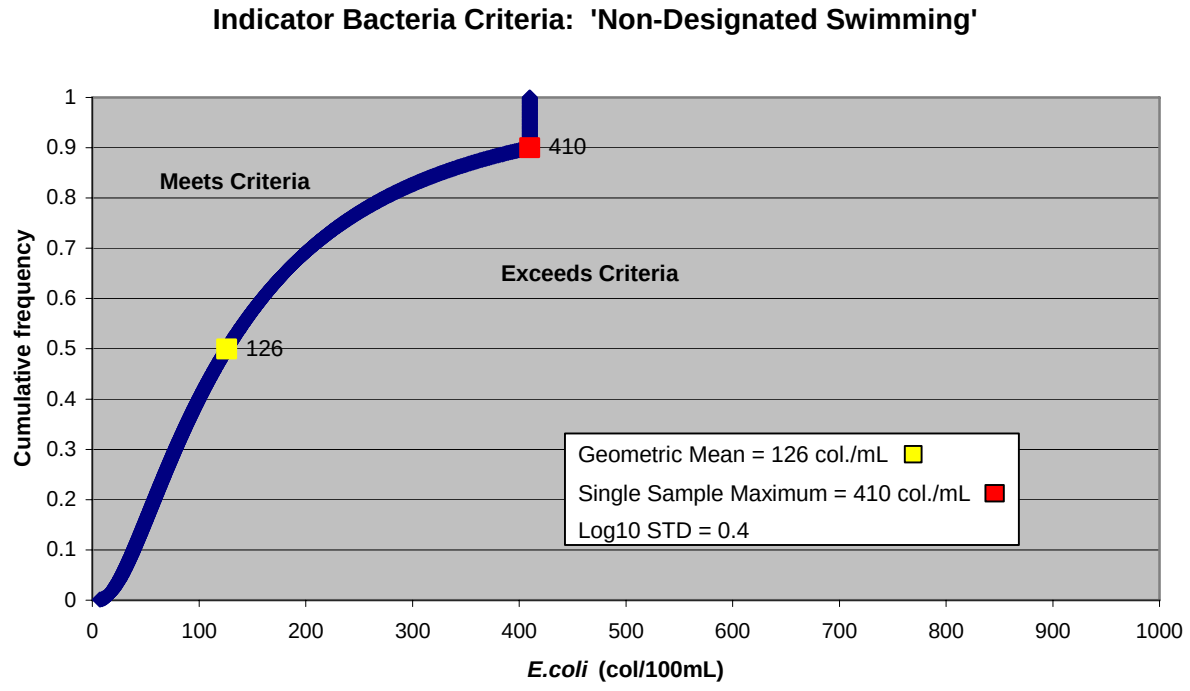


Figure 1b. Cumulative Relative Frequency Distribution representing water quality to support non-designated swimming use.

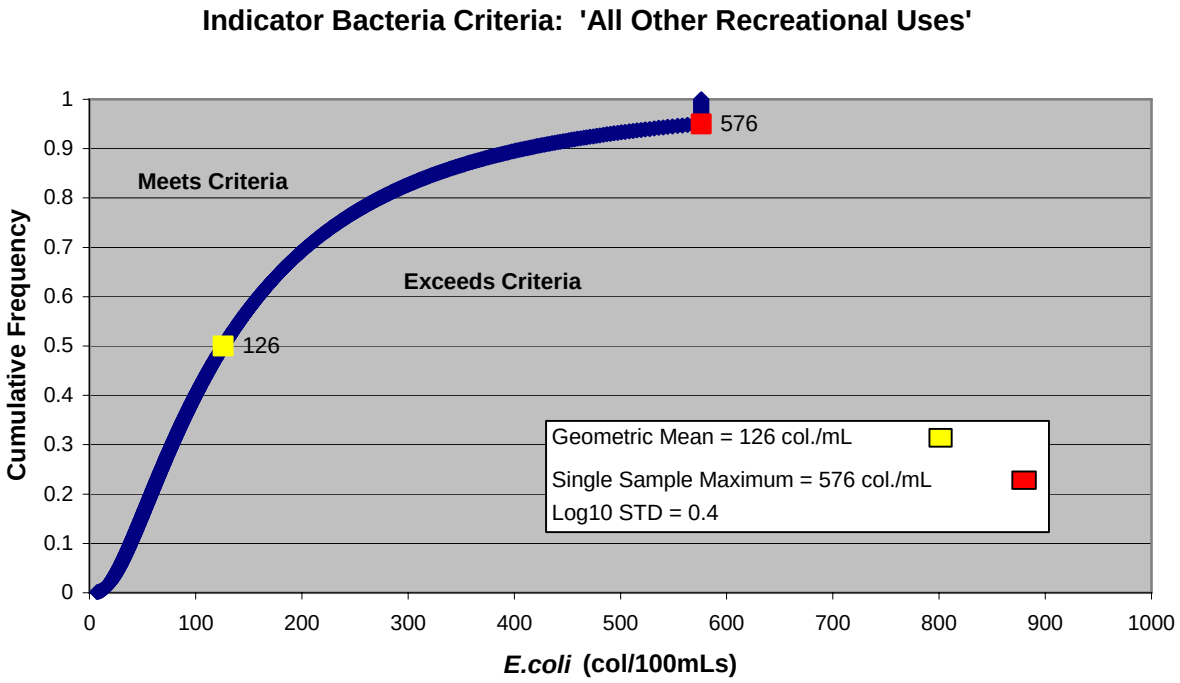


Figure 1c. Cumulative Relative Frequency Distribution representing water quality criteria to support all other recreational uses.

TMDL

As with the cumulative relative frequency curves representing the criteria shown in Figure 1a through 1c, a cumulative relative frequency curve can be prepared using site-specific sample data to represent current conditions at the TMDL monitoring site. The TMDL for the monitored segment is derived by quantifying the difference between these two distributions as shown conceptually in Figures 2a through 2c. This is accomplished by calculating the reduction required at representative points on the sample data cumulative frequency distribution curve and then averaging the reduction needed across the entire range of sampling data. This procedure allows the contribution of each individual sampling result to be considered when estimating the percent reduction needed to meet a criterion that is expressed as a geometric mean.

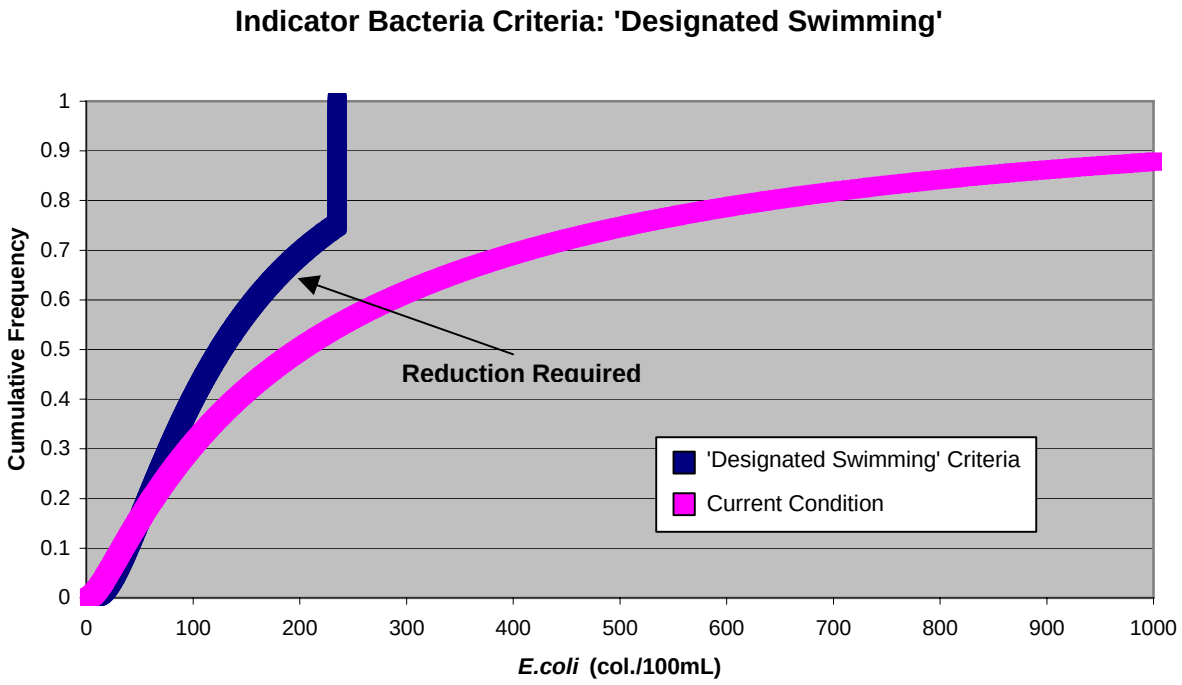


Figure 2a. Reduction indicator bacteria density needed from current condition to meet 'designated swimming' criteria based on cumulative relative frequency distribution.

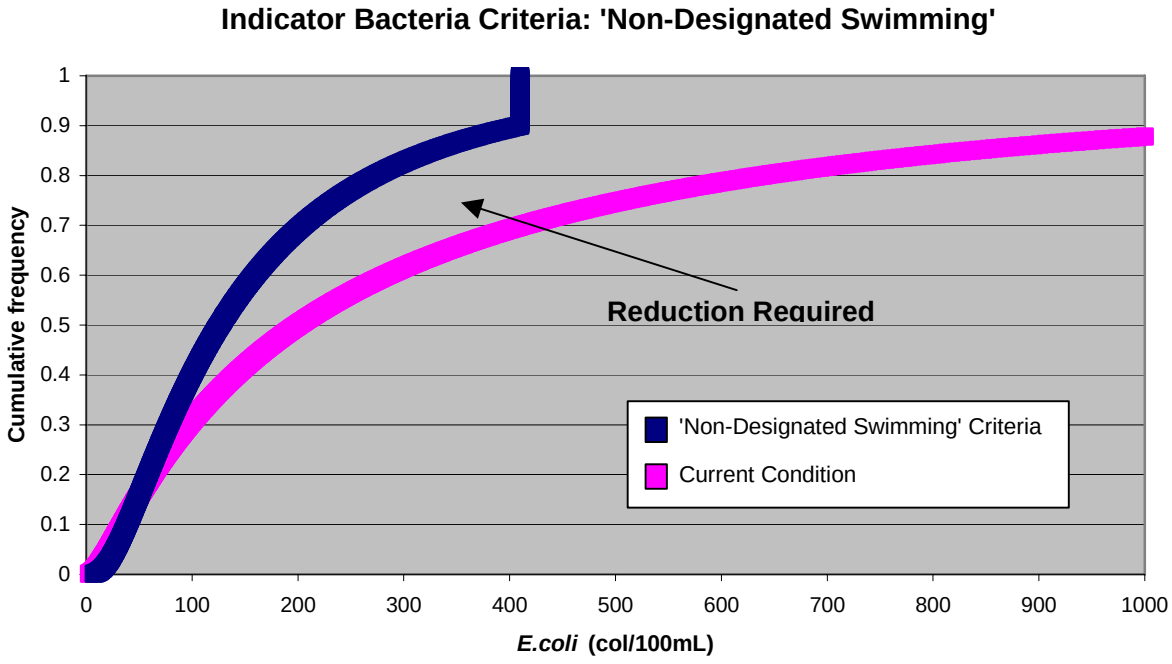


Figure 2b. Reduction indicator bacteria density needed from current condition to meet 'non-designated swimming' criteria based on cumulative relative frequency distribution.

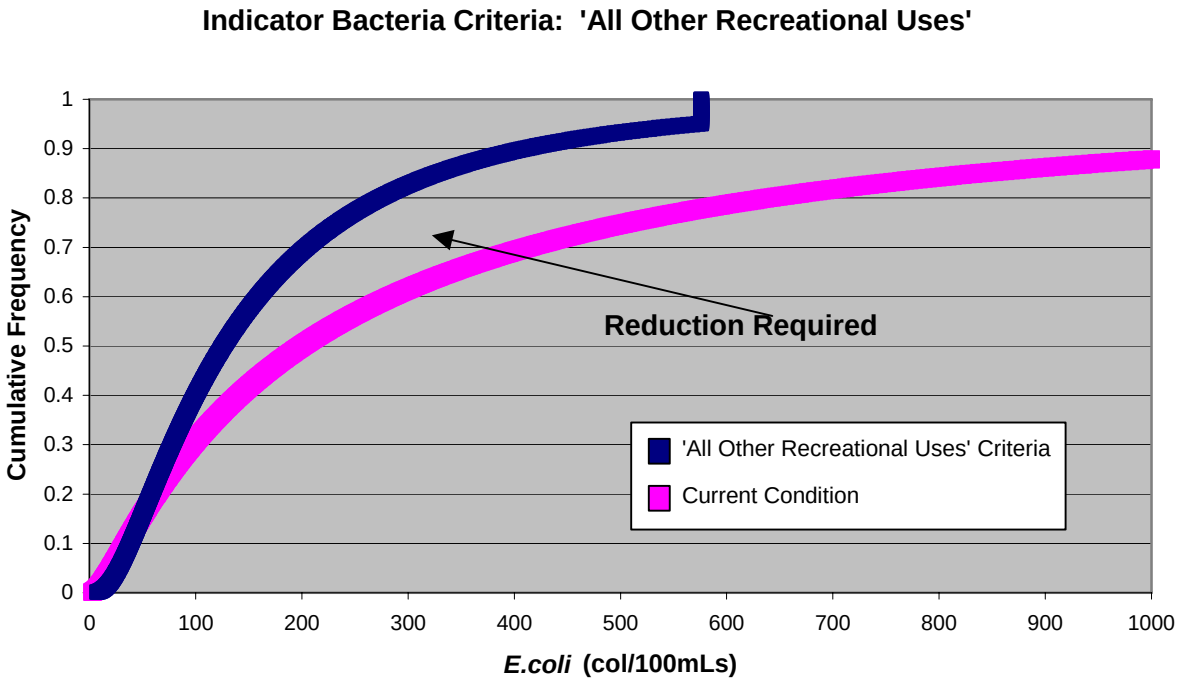


Figure 2c. Reduction indicator bacteria density needed from current condition to meet 'all other recreational uses' criteria based on cumulative relative frequency distribution.

TMDL ALLOCATIONS

Federal regulations require that the TMDL analysis identify the portion of the total loading which is allocated to point source discharges and the portion attributed to non-point sources, which contribute that pollutant to the waterbody. Stormwater runoff is considered a point source subject to regulation under the NPDES permitting program in designated urbanized areas. Designated urban areas, as defined by the US Census Bureau [7], are required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit). The general permit is applicable to municipalities that contain designated urban areas (or MS4 communities) and discharge stormwater via a separate storm sewer system to surface waters of the State. TMDLs for indicator bacteria in waters draining urbanized areas must therefore be partitioned into a WLA to accommodate point source stormwater loadings of indicator bacteria and a LA to accommodate non-point loadings from unregulated sources. One common characteristic of urbanized areas is the high percentage of impervious surface. Much of the impervious surface is directly connected to nearby surface waters through stormwater drainage systems. As a result, runoff is rapid following rain events and flow in urban streams is typically dominated by stormwater runoff during these periods. Monitoring results for samples collected under these conditions are strongly influenced by stormwater quality. During dry conditions, urban streams contain little stormwater since urban watersheds drain quickly and baseflows are reduced due to lower infiltration rates and reduced recharge of groundwater. At baseflow, urban stream water quality is dominated by non-point sources of indicator bacteria since stormwater outfalls are inactive.

A WLA for stormwater discharges is not warranted in non-designated urbanized areas and in waterbody segments where there are no stormwater outfalls. As such, sources of bacteria in these waterbodies segments are attributed solely to nonpoint sources. However, wet weather and dry weather percent reductions are partitioned in the LA analysis to demonstrate the effect of stormwater events on the contribution of nonpoint sources of bacteria to the waterbody.

The relative contribution of indicator bacteria loadings occurring during periods of high or low stormwater influence to the geometric mean indicator density is estimated by calculating separate averages of the reduction needed to achieve consistency with criteria under "wet" and "dry" conditions. In urbanized areas, the reduction needed under "wet" conditions is assigned to the WLA and the reduction needed under "dry" conditions is assigned to the LA. In non-designated urbanized areas, the LA is comprised of "wet" and "dry" conditions, which are partitioned into separate reduction goals. Separate reduction goals are established for baseflow and stormwater dominated periods that can assist local communities in selection of best management practices to improve water quality. The technique also facilitates the use of ambient stream monitoring data to track future progress in meeting water quality goals.

The sources contributing to the WLA and LA can be further subdivided depending on knowledge of sources present in the watershed (Table 2). Some existing sources such as dry weather flows from stormwater collections systems, illicit discharges to stormwater systems, and combined sewer overflows are allocated "100 percent reduction" since the management goal for these sources is elimination. Permitted discharges of treated and disinfected domestic wastewater (sewage treatment plants) are allocated "zero percent reduction" since disinfection required by the NPDES permit is sufficient to reduce indicator bacteria levels to below levels of concern. Natural sources such as wildlife are also allocated a "zero percent reduction" since the management goal is to foster a sustainable natural habitat and stream corridor to the extent practicable. Management measures to control nuisance populations of some wildlife species that can result in elevated indicator bacteria densities such as Canadian geese however should be considered in developing an overall watershed management plan. The management goal for point sources in designated swimming areas is elimination when the source is determined to be the main contributor of bacteria to the swimming area. This is consistent with the United States Environmental Protection Agency's (EPA) advisory for swimmers to avoid areas with discharge pipes [8] and a recent study indicating an increased potential for health risk to people swimming in areas near storm drains [9].

Source	Critical Conditions	Assigned To
On-Site Septic	Baseflow (DRY)	LA
Domestic Animal	Baseflow (DRY)	LA
Natural (Wildlife)	Baseflow (DRY)	LA
Wastewater Treatment Plants	Baseflow (DRY)	WLA
Regulated Urban Runoff/Storm Sewers	Wet Weather Flow (WET)	WLA
Dry Weather Overflow	Baseflow (DRY)	None
Illicit Discharges	Baseflow (DRY)	None
Combined Sewer Overflow	Wet Weather Flow (WET)	None

Table 2: Establishing WLA and LA Pollutant Sources

MARGIN OF SAFETY

Federal regulations require that all TMDL analyses include either an implicit or explicit margin of safety (MOS). The analytical approach described here incorporates an implicit MOS. Factors contributing to the MOS include assigning a percent reduction of "zero" to sampling results that indicate quality better than necessary to achieve consistency with the criteria. The increase in loadings on those dates that could be assimilated by the stream without exceeding criteria is not quantified (as a negative percent reduction) and averaged with the load reductions needed on other sampling dates. Rather, this excess capacity is averaged as a zero value thereby contributing to the implicit MOS.

The means of implementing the TMDL also contributes to the MOS. The loading reductions specified in the TMDL for regulated stormwater discharges and nonpoint sources must be sufficient to achieve water quality standards since confirmation that these reductions have been achieved will be based on ambient monitoring data documenting that water quality standards are met. Further, achieving compliance with the requirements of the MS4 permit includes elimination of high loading sources such as illicit discharges and dry weather overflows from storm sewer systems. Eliminating loads from these sources, as opposed to allocating a percent reduction equal to that given other sources, contributes to the implicit MOS. Further assurance that implementing the TMDL will meet water quality standards is provided by the iterative implementation required for compliance with the MS4 permit. This approach mandates that additional management efforts must be implemented until ambient monitoring data confirms that standards are met.

Many of the best management practices that are implemented to address either wet or dry weather sources will have some degree of effectiveness in reducing loads under all conditions. For example, the TMDL allocates all the percent reduction needed to meet standards under wet weather conditions to the WLA. However, reductions resulting from best management practices implemented to reduce dry weather loads (LA) will provide some benefit during wet weather conditions as well. These reductions also contribute to the implicit MOS.

DATA REQUIREMENTS

Ambient monitoring data for a minimum of 21 sampling dates during the recreational season (May 1 – September 30) is required. Data collected at other times during the year are excluded from the analysis. In addition to data on indicator bacteria density, precipitation data for each sampling date and the week prior to the sampling is necessary. Sampling dates should be selected to insure that representative data is available for both wet and dry conditions. This may be accomplished most easily by selecting sampling dates without prior knowledge of the meteorological conditions likely to be encountered on that date.

Data must reflect current conditions in the TMDL segment. The monitoring location where data is collected must therefore be sited in an area that can be considered representative of water quality throughout the TMDL segment. Data obtained under unusual circumstances may be excluded from the analysis provided the reason for excluding that data is provided in the TMDL. Potential reasons for excluding data may include such things as evidence that a spill, upset in

wastewater treatment, or sewer line breakage occurred that resulted in a short-term excursion from normal conditions. Data that represent conditions during an extreme storm event that resulted in widespread failure of wastewater treatment or stormwater best management practices may also be excluded. However, data for periods following typical rainfall events must be retained. Reasons for excluding any data must be provided in the TMDL Analysis.

All data must be less than five years old. If circumstances in any watershed suggest that conditions have changed during the most recent five-year period, the analysis may be restricted to more recent data in order to be representative of the current status provided the minimum data requirements are met.

Assurance of acceptable data quality must be provided. Typically, all data should be collected and results analyzed and reported pursuant to an EPA approved Quality Assurance Project Plan (QAPP). Data collected in the absence of a QAPP may be acceptable provided there is evidence that confirms acceptable data quality.

ANALYTICAL PROCEDURE – TMDL

1.

The *E. coli* monitoring data is ranked from lowest to highest. In the event of ties, monitoring results are assigned consecutive ranks in chronological order of sampling date. The sample proportion (*p*) is calculated for each monitoring result by dividing the assigned rank (*r*) for each sample by the total number of sample results (*n*):

$$p = r / n$$

2.

Next, a single sample criteria reference value is calculated for each monitoring result according to the specified recreational use (designated swimming, non-designated swimming, or all other) in a waterbody segment from the statistical distribution used to represent the criteria following the procedure described in steps **3 - 6** below:

3.

Designated Swimming	**Non-Designated Swimming**	**All Other Recreational Uses**
If the sample proportion is ≥ 0.75, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (235 col/100ml)	If the sample proportion is ≥ 0.90, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (410 col/100ml)	If the sample proportion is ≥ 0.95, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (576 col/100ml)

4.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is less than 0.75, and greater than 0.50, the single sample criteria reference value is calculated as:	If the sample proportion is less than 0.90, and greater than 0.50, the single sample criteria reference value is calculated as:	If the sample proportion is less than 0.95, and greater than 0.50, the single sample criteria reference value is calculated as:

$$\textit{criteria reference value} = \text{antilog}_{10}\,[\log_{10} 126 \text{ col/100ml} + (F * 0.4)]$$

N.B. 126 col/100ml is the geometric mean indicator bacteria criterion adopted into Connecticut's Water Quality Standards, *F* is a factor determined from areas under the normal probability curve for a probability level equivalent to the sample proportion, 0.4 is the $\log_{10}$ standard deviation used by EPA in deriving the national guidance criteria recommendations (Table 4).

5.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is equal to 0.50, the single sample reference criteria value is equal to the geometric mean criterion adopted into the Water Quality Standards (126 col/100 ml)		

6.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is less than 0.50, the single sample reference criteria value is calculated as:		

$$\textit{criteria reference value} = \text{antilog}_{10}\,[\log_{10} 126 \text{ col/100ml} - (F * 0.4)]$$

7. The percent reduction necessary to achieve consistency with the criteria is then calculated following the procedure described in steps **8 - 9** below:

8. If the monitoring result is less than the single sample reference criteria value, the percent reduction is zero.

9. If the monitoring result exceeds the single sample criteria reference value, the percent reduction necessary to meet criteria on that sampling date is calculated as:

$$\textit{percent reduction} = [(\textit{monitoring result} - \textit{criteria reference value})/\textit{monitoring result}]*100$$

10. The TMDL, expressed as the average percent reduction to meet criteria, is then calculated as the arithmetic average of the percent reduction calculated for each sampling date.

ANALYTICAL PROCEDURE – WET AND DRY WEATHER EVENTS

Precipitation data is reviewed and each sampling date is designated as a "dry" or "wet" sampling event. Although a site-specific protocol may be specified in an individual TMDL analysis, "wet" conditions are typically defined as greater than 0.1 inches precipitation in 24 hours or 0.25 inches precipitation in 48 hours, or 2.0 inches precipitation in 96 hours.

In designated urbanized areas the average percent reduction for all sampling events used to derive the TMDL that are designated as "wet" is computed and established as the WLA. The average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed and established as the LA.

In areas that do not have point sources, the average percent reduction for all sampling events used to derive the TMDL that are designated "wet" is computed as the wet weather LA, and the average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed as the dry weather LA.

ANALYTICAL PROCEDURE – SPREADSHEET MODEL

An Excel$^{(tm)}$ spreadsheet has been developed that performs all calculations necessary to derive a TMDL using this procedure. Copies of the spreadsheet in electronic form may be obtained from DEP by contacting Thomas Haze at (860) 424-3734 or by email at thomas.haze@po.state.ct.us.

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