A Total Maximum Daily Load Analysis for the Hockanum River Regional Basin

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

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INTRODUCTION

A Total Maximum Daily Load (TMDL) analysis was completed for indicator bacteria in the Hockanum River Regional Basin by the Connecticut Department of Energy and Environmental Protection (CT DEEP). The waterbodies included in this TMDL analysis are the Hockanum River and Charters Brook (Figure 1). These waterbodies are included on the *2008 List of Connecticut Waterbodies Not Meeting Water Quality Standards*[1] (*2008 List*) due to exceedences of the indicator bacteria criteria contained within the State *Water Quality Standards* (WQS) [2]. Under section 303(d) of the Federal Clean Water Act (CWA), States are required to develop TMDLs for waters impaired by pollutants that are included on the *2008 List* for which technology-based controls are insufficient to achieve water quality standards. Please refer to the *2008 List* for more information on impaired waterbodies throughout the State. The *2008 List* is included as Appendix C in the *2008 Integrated Water Quality Report to Congress*[3], which contains information regarding all assessed waterbodies in the State.

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. In this TMDL, loadings are expressed as the average percent reduction from current loadings that must be achieved to meet water quality standards. The United States Environmental Protection Agency's (EPA) November 15, 2006 memorandum entitled *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*[4], recommends that TMDL submittals express allocations in terms of daily time increments. The percent reduction TMDLs for the Hockanum 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 that 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 is also considered in this TMDL analysis.

The Hockanum River and Charters Brook Basins extend into the Connecticut municipalities of Somers, Stafford, Ellington, Tolland, Vernon, South Windsor, East Hartford, and Bolton. Within each of these municipalities are designated urban areas, as defined by the US Census Bureau [5] (Figure 2). These 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 are identified in Appendix A of the MS4 permit, that contain designated urban areas and discharge stormwater via a separate storm sewer system to surface waters of the State. The permit requires municipalities to develop a program to reduce the discharge of pollutants, as well as to protect water quality. The Stormwater Management Plan (plan) must include the following six control measures: public education and outreach; public participation; illicit discharge detection and elimination; management of stormwater from construction sites (greater than 1 acre); post-construction stormwater management; and pollution prevention and good housekeeping. Each regulated municipality must identify, implement, and measure the effectiveness of measures utilized to comply with plan requirements. Additional information regarding the general permit can be obtained on the Connecticut Department of Environmental Protection (DEEP) website at http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325702& depNav_GID=1654.

TMDLs that have been established by states are submitted to the Regional Office of the (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 (WBMP), which describe the control measures necessary to achieve acceptable water quality conditions. Therefore, WBMPs 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 WBMPs is vital to the success of resolving water quality impairments.

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

PRIORITY RANKING

Table 1. The impairment status and TMDL development priority for each subject waterbody based on the 2008 *List*.

Waterbody Name	Waterbody Segment ID	Waterbody Segment Description	303(d) Listed (Yes/No)	Impaired Use Cause	Priority
Hockanum River	CT4500-00_01 CT4500-00_02 CT4500-00_03 CT4500-00_04a CT4500-00_04b CT4500-00_05 CT4500-00_06a CT4500-00_06b CT4500-00_07 CT4500-00_08	From mouth at Connecticut River, East Hartford, upstream through headwaters at Shenipsit Lake outlet dam	Yes	Recreation *Escherichia coli*	H
Charters Brook	CT4501-00_01	From mouth at Shenipsit Lake Tolland US to headwaters near Webster Rd Ellington	Yes	Recreation *Escherichia coli*	H

"H" indicates that the waterbody is 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 years.

DESCRIPTION OF EACH WATERBODY

See "Site Specific Information" in Appendix A-1 and A-2.

POLLUTANT OF CONCERN AND POLLUTANT SOURCES

Potential sources of indicator bacteria include point and nonpoint sources, such as stormwater runoff, agriculture, and illicit discharges/hook ups to storm sewers. Potential sources that are tentatively identified based on land-use (Figure 3) for each of the waterbodies are presented in Table 2.

Table 2. Potential sources of bacteria for each subject waterbody.

Waterbody Name	Nonpoint sources	Point Sources
Hockanum River	Unspecified Urban Stormwater, Source Unknown, Agriculture	Regulated stormwater runoff, Illicit connections/Hook ups to storm sewers, Municipal Point Sources
Charters Brook	Unspecified Urban Stormwater, Source Unknown	Regulated stormwater runoff, Illicit connections/Hook ups to storm sewers

There are three municipal wastewater treatment plants (East Hartford WPCF, Manchester WPCF, and Vernon WPCF) that are located in the Hockanum River Regional Basin and receive indicator bacteria limits in their National Pollutant Discharge Elimination (NPDES) Permits. Disinfection required under the NPDES Permit is sufficient to reduce indicator bacteria densities to below levels of concern in the effluent when in use and functioning properly (See Numeric Water Quality Target for further explanation).

Table 3. Treatment plant discharges and the associated NPDES permit numbers.

Facility Name	NPDES Permit #	Discharges to
East Hartford WPCF	CT0100170	Connecticut River
Manchester WPCF	CT0100293	Hockanum River
Vernon WPCF	CT0100609	Hockanum River

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 Hockanum River Regional Basin are presented in Table 4. These criteria are applicable to all recreational uses established for these waters. However, it should be noted that the water quality classification and target criteria should not be considered as a certification of quality by the State or an approval to engage in certain activities such as swimming. Full body contact should be avoided immediately downstream of wastewater treatment plants, in areas known to have high levels *E.coli*, and during times when *E.coli* levels are expected to be particularly high, such as during and following storm events.

Table 4. Applicable indicator bacteria criteria for the subject waterbodies.

Waterbody	Waterbody Segment ID	Class	Bacterial Indicator	Criteria
Hockanum River	CT4500-00_01 CT4500-00_02 CT4500-00_03 CT4500-00_04a CT4500-00_04b CT4500-00_05 CT4500-00_06a CT4500-00_06b CT4500-00_07 CT4500-00_08	C/B	*Escherichia coli* (*E. coli*)	Geometric Mean less than 126/100ml Single Sample Maximum 576/100ml
Charters Brook	CT4501-00_01	AA		

NUMERIC WATER QUALITY TARGET

TMDL calculations are 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* [7] included as Appendix C. All data used in the analysis and the results of all calculations are presented in Appendix A. The results are summarized in Table 5 below.

Segment CT4500-00_01 did not originally contain a monitored sample location. An additional location was selected for a limited grab sampling and results from these grabs were consistent with sample data from the upstream segment (CT4500-00_02). Since landuse is similar between the two segments, reduction goals and calculations for CT4500-00_02 will be utilized for segment CT4500-00_01. A more detailed explanation of this additional monitoring and comparison, including a map and table of collected data values, is included in Appendix D.

Table 5. Summary of TMDL analysis.

Waterbody	Waterbody Segment Description	Segment ID	Monitoring Site	Average Percent Reduction to Meet Water Quality Standards			
				TMDL	WLA	LA	MOS
Charters Brook	From mouth at Shenipsit Lake Tolland US to headwaters near Webster Rd Ellington	CT4501-00_01	955	18	20	17	Implicit
Hockanum River	From mouth at Connecticut River, East Hartford, upstream through	CT4500-00_01	6160	48	54	43	Implicit
		CT4500-00_02	120	48	54	43	Implicit
		CT4500-00_03	112 1175	39	48	37.5	Implicit

Waterbody	Waterbody Segment Description	Segment ID	Monitoring Site	Average Percent Reduction to Meet Water Quality Standards			
				TMDL	WLA	LA	MOS
	headwaters at Shenipsit Lake outlet dam	CT4500-00_04a	916	52	54	52	Implicit
		CT4500-00_04b	117	53	50	56	Implicit
		CT4500-00_05	116	53	50	54	Implicit
		CT4500-00_06a	114	48	52	45	Implicit
		CT4500-00_06b	957	25	40	14	Implicit
		CT4500-00_07	1804	14	28	4	Implicit
		CT4500-00_08	956	0	0	0	Implicit

The numeric target allocated to NPDES permitted discharges is "0% reduction" because disinfection reduces bacteria densities to below levels of concern as stated in the Guidelines[7]. The current NPDES permits for the three municipal wastewater treatment plants (WWTPs) require disinfection from May 1 - September 30 (See Seasonal Analysis below). Under the NPDES Permits, indicator bacteria (fecal coliform) cannot exceed a geometric mean of 200 col/100mls over a 30-day period or a single sample maximum of 400 col/100mls. The indicator bacteria used in this TMDL is *E.coli*, which is one of several species that make up the fecal coliform group. Therefore, only a portion of fecal coliform densities account for *E.coli* in the sample and *E.coli* densities are always lower than total fecal coliform densities. Based on this information, NPDES Permit limits for the WWTPs are sufficient to reduce *E.coli* to below levels of concern and do not need to be reduced further as part of the waste load allocation. Also, WWTPs and industrial dischargers are required to sample effluent through the disinfection period and submit monitoring reports to DEEP. The Department reviews the monitoring reports and takes action to mitigate any problems when there are consistent violations of the Permit.

The East Hartford WPCF has several permit violations for coliform bacteria in the past 3 years. While the plant is physically located in the Hockanum basin, the effluent actually discharges into the Connecticut River and therefore does not increase the bacterial loading on the Hockanum River. The Vernon WPCF has no coliform bacteria permit violations during the past 5 years and therefore the disinfection process is functioning properly at this plant. The Manchester WPCF has one coliform bacteria limit violation in 2005 with a 214 cols/100 ml for the 30 day geomean. The permit limit for this facility is 200 cols/100ml. There are no more recent coliform violations for Manchester; therefore the plant disinfection appears to be functioning to sufficiently reduce bacteria loading to the Hockanum River. Continued monitoring and reporting from each facility will assure the protection of the river from additional bacteria loads.

The need for reduction in bacterial loadings was demonstrated at all monitoring sites except the site located furthest upstream on the Hockanum mainstem, located in segment CT4500-00_08. Bacterial concentrations measured from the monitoring site (956) located in this segment ranged from 10 colonies/100ml through 180 colonies/100 ml. None of the sample results exceeded criteria contained in the CT WQS [2]. Precipitation amounts for the sampling trips are variable and the resultant data should provide a sufficient survey of in-stream conditions year round. The assessment of the above bacteria data demonstrates that water quality within this segment of the Hockanum River is better than that required to meet minimum bacterial standards within the CT WQS[2]. The current water quality within this portion of the river should be protected and maintained through the application of CT DEEP anti-degradation policies, which are located in Appendix E of the CT WQS [2].These anti-degradation policies are valid for any applicable regulated activity within this portion of the watershed. Adhering to anti-degradation policies will keep existing bacteria loads stable and prevent overloading the assimilative capacity of the stream. Any increase in bacterial loading to the segment could result or contribute to a future finding of water quality impairment and subsequent listing of the segment in future CT Impaired Waters Lists. See table 6 for a comparison of CT WQS [2] values versus segment results.

Table 6. Comparison of no reduction sample values versus CT WQS

Data Type	Water Quality Standard	CT4500-00_08	% difference
Geomean	126 col/100ml	21 col/100ml	83%
Single sample maximum	576 col/100ml	180 col/100ml	69%

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. 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 Appendix C.

SEASONAL ANALYSIS

The TMDLs presented in this document are applicable during the typical disinfection (summer) season from May 1 to September 30. Previous investigations by the DEEP into seasonal trends of indicator bacteria densities in surface waters indicate that the summer months typically exhibit the highest densities of any season[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. Achieving consistency with the

TMDLs through the summer months will result in achieving full support of recreational uses throughout the remainder of the year.

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* 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. The DEEP advocates that a watershed based plan for the Hockanum River Regional Basin be developed to implement the TMDLs. This plan should follow guidelines provided by the EPA and include participation from 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 DEEP 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.

Potential point sources of *E. coli* to the Hockanum River Regional Basin include waste water treatment plants, agriculture, and regulated stormwater. During the disinfection season the treatment plants should not be significantly contributing *E.*coli to the waterways. Control actions for regulated stormwater include the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit). Under this 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 DEEP 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 DEEP's website at http://www.ct.gov/dep/cwp/view.asp?a=2709&q=324154&depNav_GID=1643#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.

Upon approval of a TMDL by EPA, Section 6(k) of the MS4 Permit requires the municipality to review its plan to determine if its stormwater discharges contribute the pollutant(s) for which the TMDL had been designated. If the municipality contributes a pollutant(s) in excess of the designated TMDL allocation, the municipality must modify its plan to implement the TMDL within four months of TMDL approval by EPA. For the discharges to the TMDL waterbody(ies), the municipality must assess the six minimum measures of its plan and modify the plan to implement additional, necessary controls for each appropriate measure. Particular focus should be placed on the following plan components: public education program, illicit discharge detection and elimination, stormwater structures cleaning, priority for the repair, upgrade, or retrofit of storm sewer structures.

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. Potential nonpoint sources include domestic animal waste, wildlife and surface water base flow. BMPs for the management of nonpoint sources include nuisance wildlife control plans and pet waste ordinances. Nuisance wildlife information can be found on the DEEP's website at http://www.ct.gov/dep/cwp/view.asp?a=2723&q=325944&depNav_GID=1655. Pet waste information can be found on the CT River Coastal Conservation District website at http://www.conservect.org/ctrivercoastal/give_a_bark_resources.shtml. As progress is made implementing BMPs, the "percent reduction" needed to meet criteria will decrease.

The DEEP encourages all local stakeholders to continue their efforts by working together to formulate a watershed based plan to implement the TMDL. A watershed based plan 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 levels in the Basin.

In addition, the members of the DEEP's watershed management program 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. Please use the following link for contact information for involved DEEP staff: http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325624&depNav_GID=1654.

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 to direct BMP implementation efforts with fixed station monitoring to quantify progress in achieving TMDL established goals.

Section 6(h)(1)(a) of the MS4 Permit specifies 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, a comprehensive water quality monitoring program is necessary to guide TMDL implementation efforts. Therefore, 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. In order to customize their monitoring plan to better identify TMDL pollutant sources and track the effectiveness of TMDL pollutant reduction measures, the municipality may request written approval from the DEEP for an alternative monitoring program as allowed by Section 6(h)(1)(B) of the permit:

> *"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 DEEP advises municipalities with discharges that contribute pollutant(s) for which a TMDL(s) has been designated to request approval for an alternative monitoring program to address both source detection and progress quantification objectives. Source detection monitoring may include 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. Such monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. Further guidance for an Alternative Municipal Monitoring is attached as Appendix B.

Progress in achieving TMDL established goals through BMP implementation may be most effectively gauged through implementing a fixed station ambient monitoring program. The DEEP strongly recommends that routine monitoring be performed at the same sites used to generate the data to perform the TMDL calculations. Sampling should be scheduled at regularly spaced intervals during the recreational season (May 1- Sept 30). 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. Additional schedule sampling guidance can be found in Appendix C of this document.

All pollutant parameters must be analyzed using methods prescribed in Title 40, CFR, Part 136 (1990). Electronic submission of data to DEEP is highly encouraged and the preferred method. 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)

DEEP 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. DEEP 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. If portions of a watershed are not subject to the Connecticut's MS4 Permit Program, the DEEP has the authority 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 Hockanum River Regional Basin.

The NPDES permits for all municipal wastewater treatment plants within the watershed provide an enforceable mechanism for regulating discharges of bacteria to surface waterbodies. Each permit contains limits for bacteria loading in the effluent discharging to the receiving waterbody. These limits and other components of the permit can be adjusted as needed if the wastewater discharge is shown to influence the water quality of the receiving waterbody.

In addition, the DEEP continues to work with watershed stakeholders to draft Watershed Based Plans (WBPs) under the CWA 319 program. (http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335504&depNav_GID=1654). As part of these WBPs, watershed stakeholders are required to investigate impairments and promote the implementation of nonpoint source pollution best management practices and stormwater management practices in the watershed. The DEEP approves CWA 319 Watershed Based Plans, including those that address management measures to reduce bacteria and source mitigation in order to support the TMDLs. WBPs include watershed-wide and place-based recommendations aimed at reducing nonpoint sources of pollution, including bacteria. These recommended WBP projects may be eligible for CWA 319 funding, as long as such projects are not used for permit compliance.

PROVISIONS FOR REVISING THE TMDLs

The DEEP 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 will be subject to the review and approval of the EPA. New information, which will 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 DEEP will propose modifications to the TMDL analysis 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 waterbodies of this TMDL analysis will continue to be included on the *List of Connecticut Water bodies Not Meeting Water Quality Standards* until monitoring data confirms that recreational uses are fully supported.

PUBLIC PARTICIPATION

A draft of this final TMDL document was public noticed for review and comment by the general public. A notice of Intent to Adopt and this actual document were published on the CT DEEP website on October 6, 2010. The Notice was also printed in the Hartford Courant on either October 6, 2010. All affected Municipalities were individually noticed as well as several potentially interested Non-Governmental Organizations. No formal comments were submitted internally or from outside parties. It is expected that open forums and discussion will continue as implementation of the TMDL occurs in the future.

REFERENCES

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(2) Connecticut Department of Environmental Protection, 2002. *Connecticut Water Quality Standards*. Bureau of Water Management, 79 Elm Street, Hartford, CT 06106-5127.

(3) Connecticut Department of Environmental Protection, 2008. *Integrated Water Quality Report to Congress*. Bureau of Water Protection and Land Reuse, 79 Elm Street, Hartford, CT 06106-5127.

(4) United States Environmental Protection Agency, 2006. *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.

(6) United States Environmental Protection Agency, 1986. *Ambient Water Quality Criteria for Bacteria -1986.* EPA 440/5-84-002.

(7) Connecticut Department of Environmental Protection, 2005. *Development of TMDLs for Indicator Bacteria in Contact Recreation Areas Using the Cumulative Frequency Distribution Function Method*. Bureau of Water Protection and Land Reuse, 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.

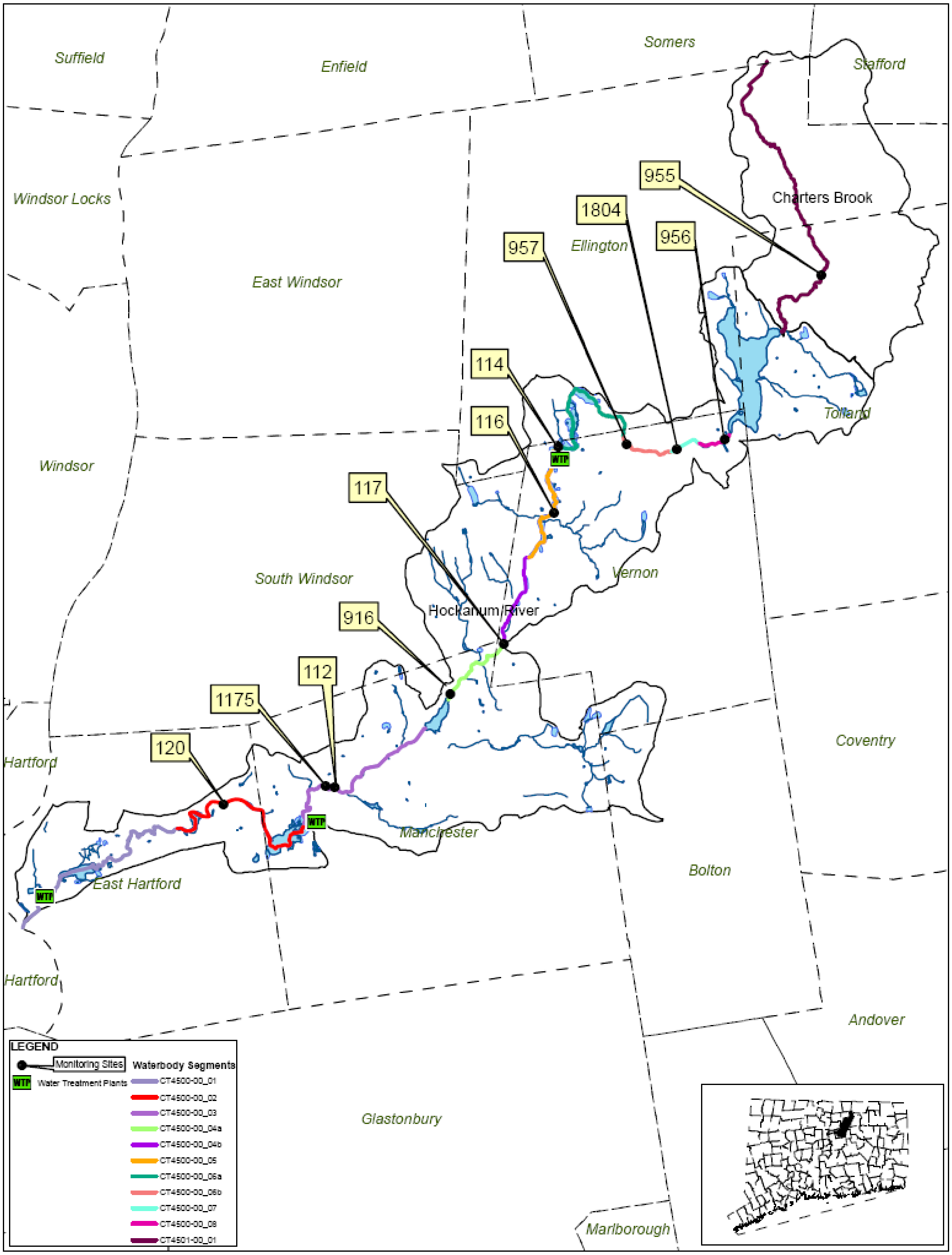


Figure 1: Hockanum and Charters Brook Location Map

N

0 0.5 1 2 3 4 5 Miles

Map Data: CTDEP
Map Created: May 2010

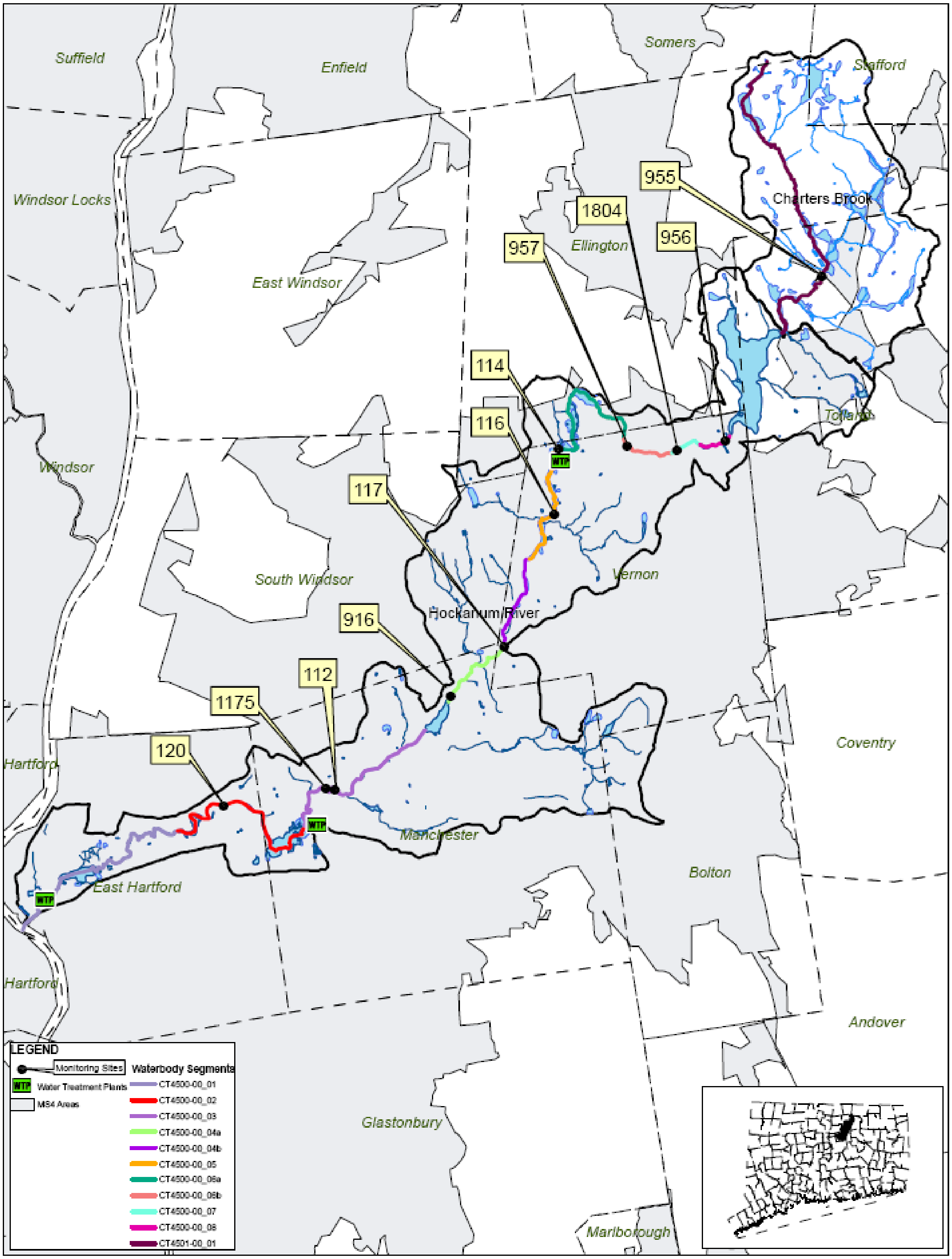


Figure 2: Hockanum and Charters Brook Designated MS4 Area Map

Map Data: CTDEP
Map Created: May 2010

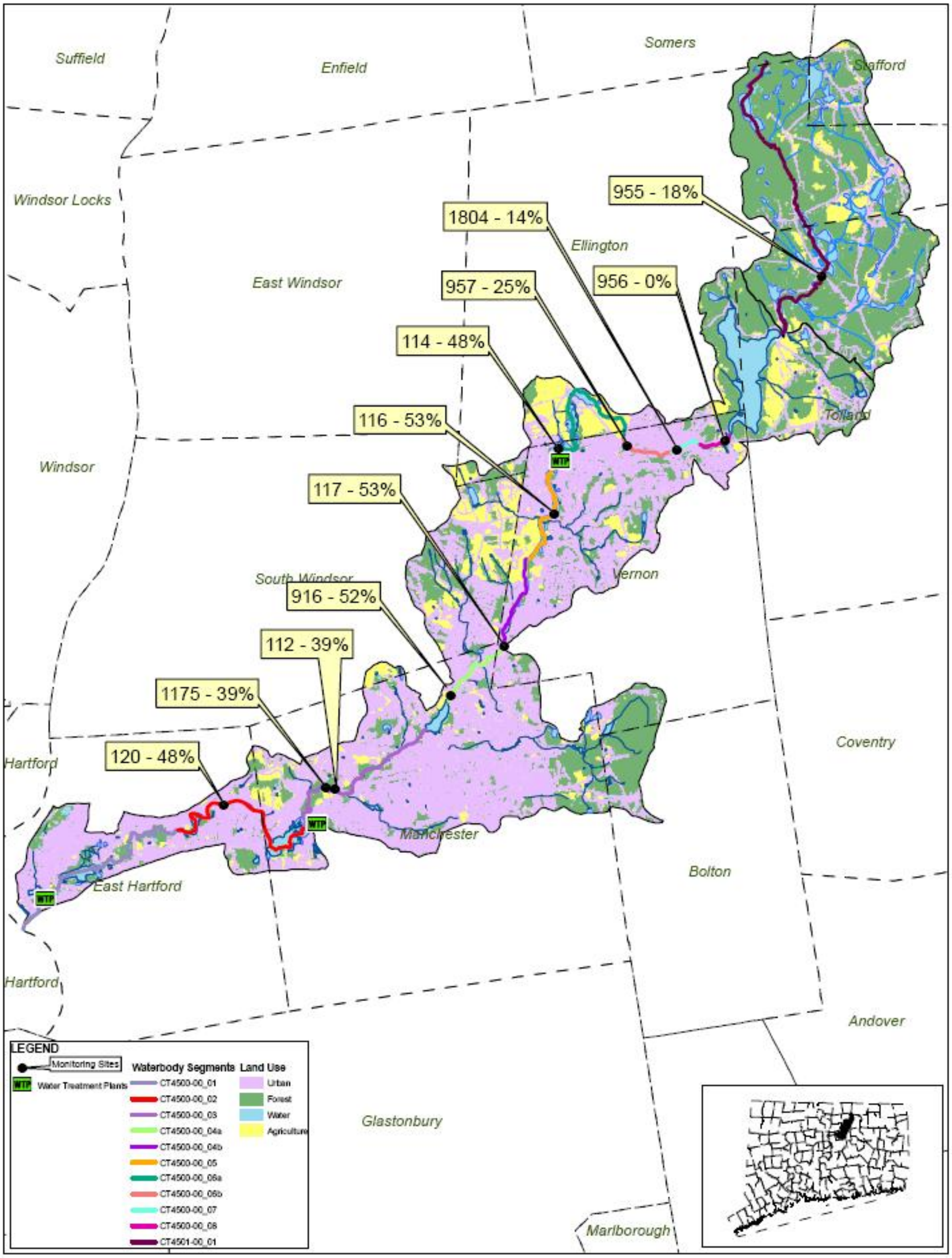


Figure 3: Hockanum and Charters Brook Land Use and TMDL % Reductions Map

Map Data: CTDEP
Map Created: May 2010

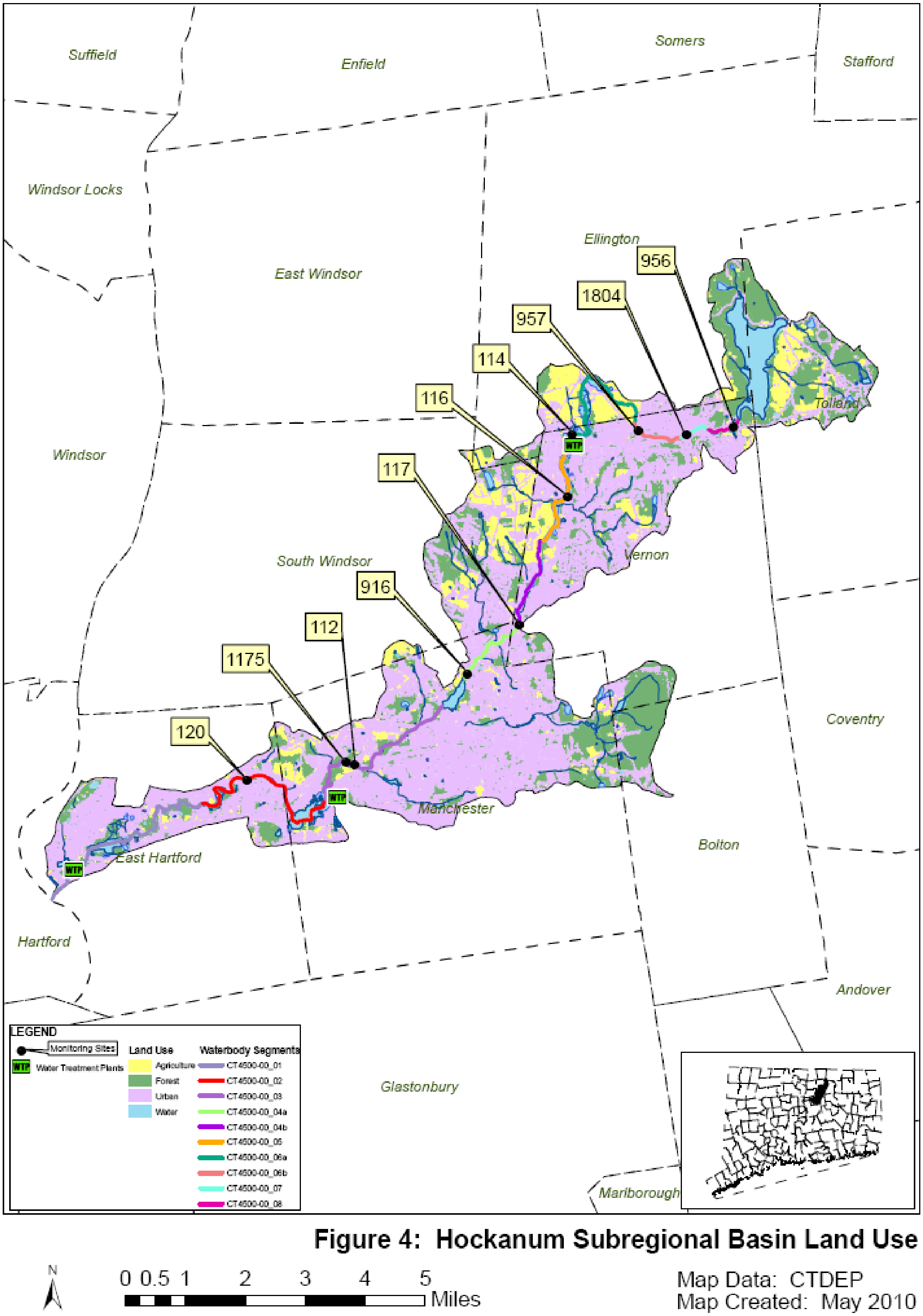


Figure 4: Hockanum Subregional Basin Land Use

Map Data: CTDEP
Map Created: May 2010

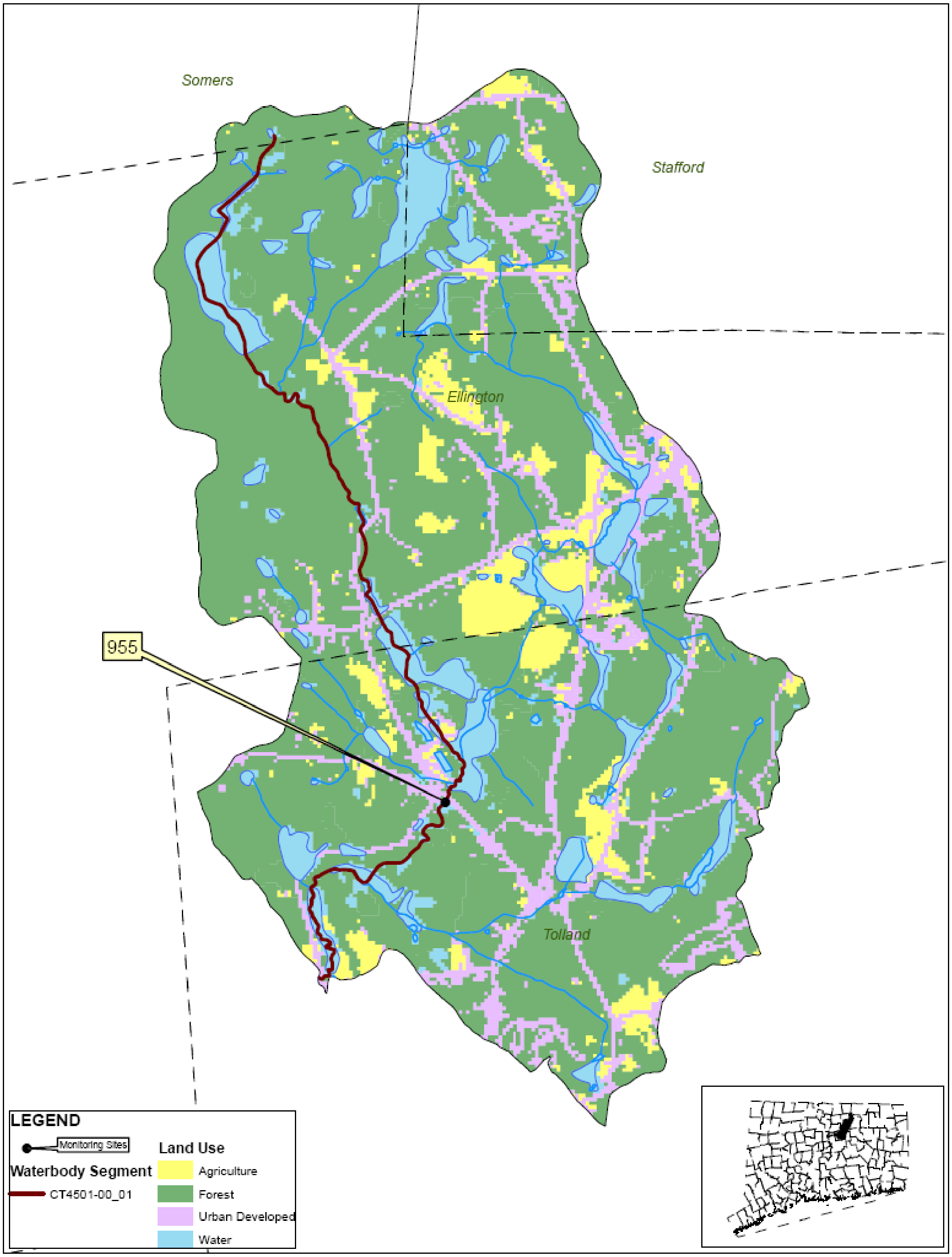


Figure 5: Charters Brook Subregional Basin Land Use

Map Data: CTDEP
Map Created: May 2010

Appendix A

A-1 Site Specific Information for Hockanum River
A-2 Site Specific Information for Charters Brook

Appendix A-1
Hockanum River
Waterbody Specific Information

Impaired Waterbody
Waterbody Name: Hockanum River
Waterbody Segment ID: CT4500-00_01, CT4500-00_02, CT4500-00_03, CT4500-00_04a, CT4500-00_04b, CT4500-00_05, CT4500-00_06a, CT4500-00_06b, CT4500-00_07, CT4500-00_08
Waterbody Segment Description: From mouth at Connecticut River, East Hartford, upstream through headwaters at Shenipsit Lake outlet dam

Impairment Description:
Designated Use Impairment: Recreation
Size of Impaired Segment:
Surface Water Classification: Class C/B, B

Watershed Description:
Total Regional Drainage Basin Area: 22578.5 acres
Tributary To: Connecticut River
Subregional Basin Name & Code: Hockanum River, 4500
Regional Basin: Hockanum River
Major Basin: Connecticut
Watershed Towns: Bolton, South Windsor, Ellington, Tolland, Vernon, Manchester, East Hartford
Phase II GP applicable? : Bolton- Y, South Windsor – Y, Ellington – Y, Tolland – Y, Manchester – Y, East Hartford – Y
Applicable Season: Recreation Season (May 1 to September 30)

Landuse:

Land Cover Category	Percent Composition
Forested	25.8% (5823.897 acres)
Urban/Developed	56.2% (12684.2 acres)
Water/Wetland	5.4% (1220.958 acres)
Agriculture	12.6% (2850.956 acres)

Data Source: Connecticut Land Use Land Cover Data Layer LANDSTAT (2002) Thematic Mapper Satellite Imagery.

Appendix A-1

Hockanum River
TMDL Summary

The TMDL analysis for the Hockanum River was conducted at ten sites, which are representative of eight of the nine waterbody segments. Current data is unavailable to conduct a complete TMDL analysis for segment CT4500-00_01 in the Hockanum River. This section is the furthest downstream segment of the river prior to emptying into the Connecticut River. The sites upstream of this location have reduction levels between 39% and 53%. The furthest downstream location will have a reduction of at least the same as the immediately adjacent upstream segment. Some investigative grab samples in segment CT4500-00_01 show that there are elevated coliform counts in the segment, similar in value to the immediately upstream segments. The similarity of the results further supports the use of similar reduction goals for CT4500-00_01 as CT4500-00_02.

The analysis indicates that most of the sites are influenced by sources of bacteria active under both wet weather and dry weather conditions. The Waste Load Allocation (WLA) is applicable to regulated stormwater. Reduction in the WLA can be achieved through the detection and elimination of illicit discharges to the storm sewers, as well as the installation of engineered controls to reduce the surge of stormwater to the river, promote groundwater recharge, and improve water quality. Nonpoint sources, such as domestic animal waste, and wildlife may contribute to the Load Allocation (LA).

The reduction goals for each segment generally increase as the Hockanum flows from its headwaters to its mouth. Since basin landuse becomes increasingly developed and urban as the river flows downstream, it can be expected that there will be a gradual increase in bacterial reduction goals. In fact this expectation is shown in the table of assessed data with a gradual increase and a plateau in the last few segments. The furthest upstream segment (CT4500-00_08) requires no reduction of bacteria load after analyzing collected data. The goal for this segment is to utilize anti-degradation policies to maintain the existing water quality. The approach for maintaining this segment is described earlier in this document and data is summarized in Table 6.

TMDL reduction goals range from 14% at the next downstream segment (CT4500-00_07) to a 48% reduction in the last fully assessed segment (CT4500-00_02). Some segments have slightly larger reduction goals (53 % and 52%) but there is no significant decline in reduction goals as the river flows downstream.

One assessed segment (CT4500-00_03) does contain two monitoring sites (112 and 1175) that were used in this TMDL analysis. The load reduction goals for each site were averaged to create the value of 39% total reduction goal that is displayed in the table 5. Site 1175 analysis resulted in the larger of the two reduction values with a 51% goal and site 112 registered a 27% reduction goal.

Table of Hockanum Site Photos. Upstream through downstream (left to right, top to bottom)

<table>
<tr><td>Site 956 (furthest upstream location)
</td><td>Site 1804 (adjacent to Brooklyn Street)
</td></tr>
<tr><td>Site 957 (West Street)
</td><td>Site 114 (Vernon WWTP)
</td></tr>
</table>

Site 116 (Dart Hill Road in Vernon) 	Site 117 (Confluence with Tankerhoosen) 
Site 916 (#440 Route 83 Odyssey School) 	Site 1175 (Behind High School) 

Site 112 (New State Street)	Site 120 (USGS gauge upstream of Walnut Street)
	

Hockanum River

CT4500-00_02

Data Used in the Analysis

Monitoring Site: 120, USGS gage upstream of Walnut Street

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	450	17.0	0.7391	227	49
7/1/08	0.60	0.03	0.33	WET	260	16.0	0.6957	202	22
7/10/08	0.00	0.00	0.00	DRY	230	14.0	0.6087	162	29
7/17/08	0.00	0.00	0.13	DRY	190	11.5	0.5000	126	34
7/23/08	0.50	0.02	0.77	WET	470	19.0	0.8261	299	36
8/7/08	0.71	0.95	0.00	WET	1700	22.0	0.9565	576	66
8/12/08	0.03	0.50	0.01	WET	1400	21.0	0.9130	441	69
8/21/08	0.00	0.00	0.02	DRY	140	6.0	0.2609	70	50
8/28/08	0.00	0.00	0.00	DRY	170	8.5	0.3696	93	45
9/2/08	0.00	0.00	0.06	DRY	180	10.0	0.4348	108	40
9/12/08	0.46	0.00	0.75	WET	150	7.0	0.3043	79	48
9/15/08	0.01	0.46	0.47	WET	780	20.0	0.8696	355	55
6/29/09	0.00	0.01	0.03	DRY	170	8.5	0.3696	93	45
7/10/09	0.00	0.00	1.24	DRY	230	14.0	0.6087	162	29
7/15/09	0.00	0.00	0.10	DRY	130	5.0	0.2174	61	53
7/24/09	1.12	0.42	2.10	WET	9800	23.0	1.0000	576	94
8/5/09	0.00	0.00	0.04	DRY	230	14.0	0.6087	162	29
8/14/09	0.00	0.41	0.01	WET	460	18.0	0.7826	259	44
8/28/09	0.38	0.00	0.00	WET	110	3.5	0.1522	49	56
9/4/09	0.00	0.00	0.00	DRY	63	1.0	0.0435	26	59
9/8/09	0.00	0.00	0.00	DRY	110	3.5	0.1522	49	56
9/15/09	0.00	0.00	0.13	DRY	86	2.0	0.0870	36	58
9/25/09	0.00	0.00	0.05	DRY	190	11.5	0.5000	126	34

Precipitation and E. coli data provided by the <wunderground.com> 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.

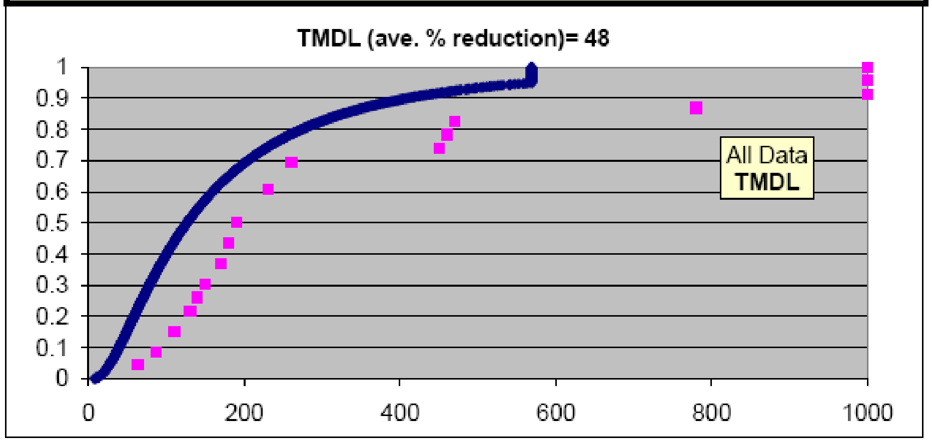
Statistics

# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	280
Log std deviation	0.4918

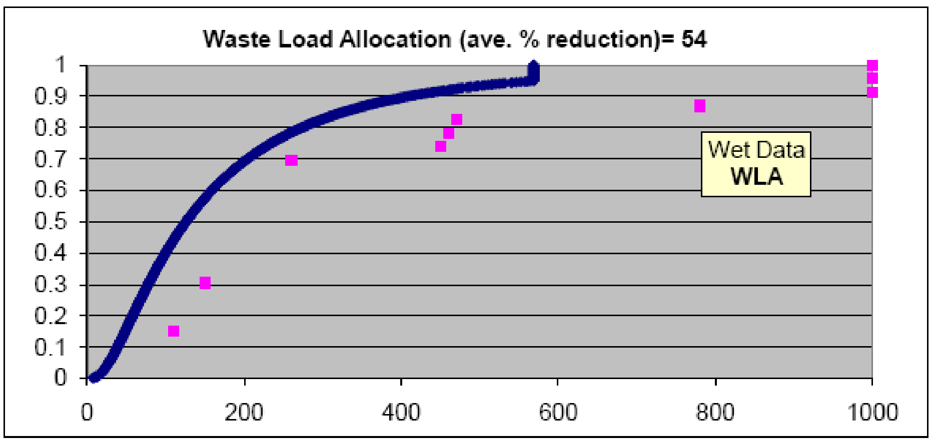
Avg % Reduction

Wet (WLA)	54
Dry (LA)	43
Total (TMDL)	48

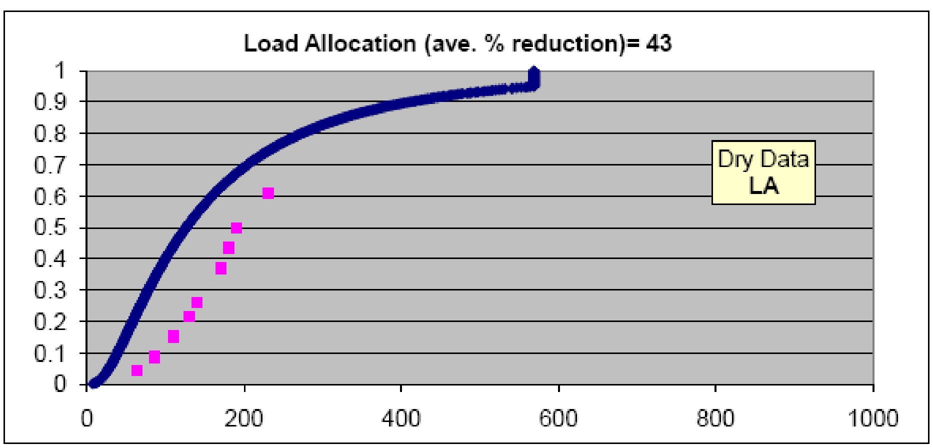
Hockanum River Criteria Curve for Monitoring Site 120
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River
CT4500-00_03

Data Used in the Analysis

Monitoring Site: 112, Site description: New State Street

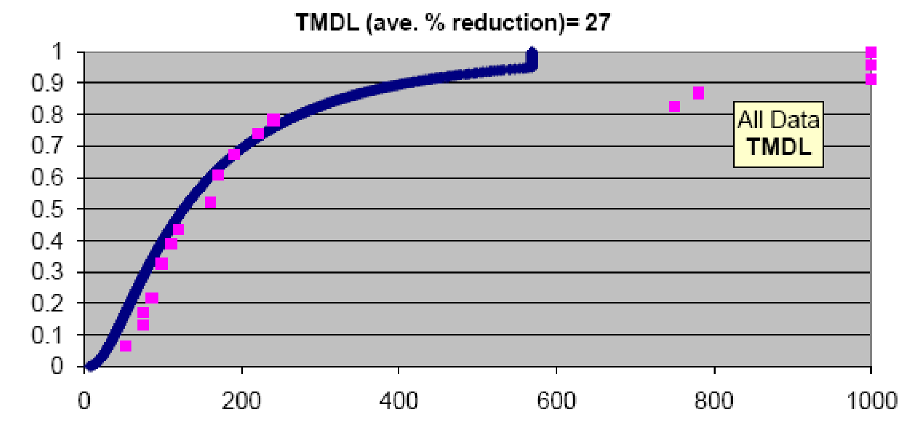
Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	240	18.0	0.7826	259	0
7/1/08	0.60	0.03	0.33	WET	160	12.0	0.5217	132	17
7/10/08	0.00	0.00	0.00	DRY	98	7.5	0.3261	83	15
7/17/08	0.00	0.00	0.13	DRY	74	3.0	0.1304	45	40
7/23/08	0.50	0.02	0.77	WET	1300	22.0	0.9565	576	56
8/7/08	0.71	0.95	0.00	WET	750	19.0	0.8261	299	60
8/12/08	0.03	0.50	0.01	WET	1100	21.0	0.9130	441	60
8/21/08	0.00	0.00	0.02	DRY	75	4.0	0.1739	53	29
8/28/08	0.00	0.00	0.00	DRY	86	5.0	0.2174	61	29
9/2/08	0.00	0.00	0.06	DRY	86	5.0	0.2174	61	29
9/12/08	0.46	0.00	0.75	WET	120	10.0	0.4348	108	10
9/15/08	0.01	0.46	0.47	WET	780	20.0	0.8696	355	55
6/29/09	0.00	0.01	0.03	DRY	160	12.0	0.5217	132	17
7/10/09	0.00	0.00	1.24	DRY	220	17.0	0.7391	227	0
7/15/09	0.00	0.00	0.10	DRY	160	12.0	0.5217	132	17
7/24/09	1.12	0.42	2.10	WET	5200	23.0	1.0000	576	89
8/5/09	0.00	0.00	0.04	DRY	110	9.0	0.3913	98	11
8/14/09	0.00	0.41	0.01	WET	190	15.5	0.6739	191	0
8/28/09	0.38	0.00	0.00	WET	190	15.5	0.6739	191	0
9/4/09	0.00	0.00	0.00	DRY	52	1.5	0.0652	31	40
9/8/09	0.00	0.00	0.00	DRY	98	7.5	0.3261	83	15
9/15/09	0.00	0.00	0.13	DRY	52	1.5	0.0652	31	40
9/25/09	0.00	0.00	0.05	DRY	170	14.0	0.6087	162	4

Precipitation and E. coli data provided by <Wunderground.com> and CT DEP 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.

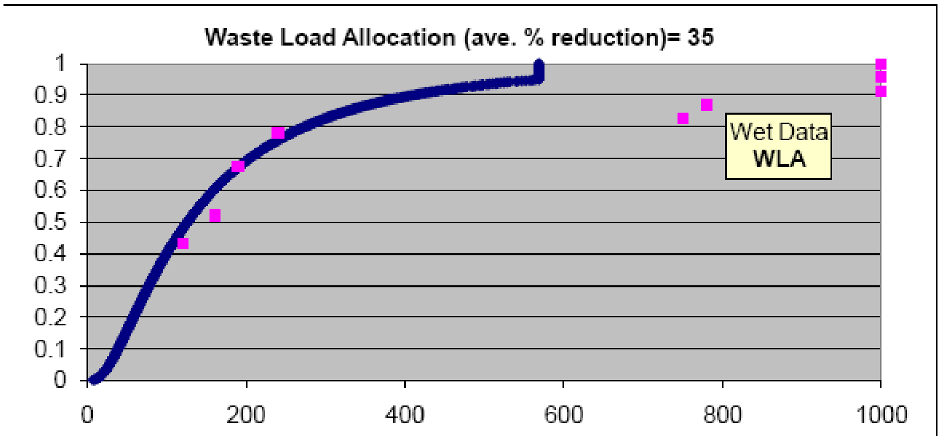
Statistics

# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	200
Log std deviation	0.5028
Avg % Reduction	
Wet (WLA)	35
Dry (LA)	22
Total (TMDL)	27

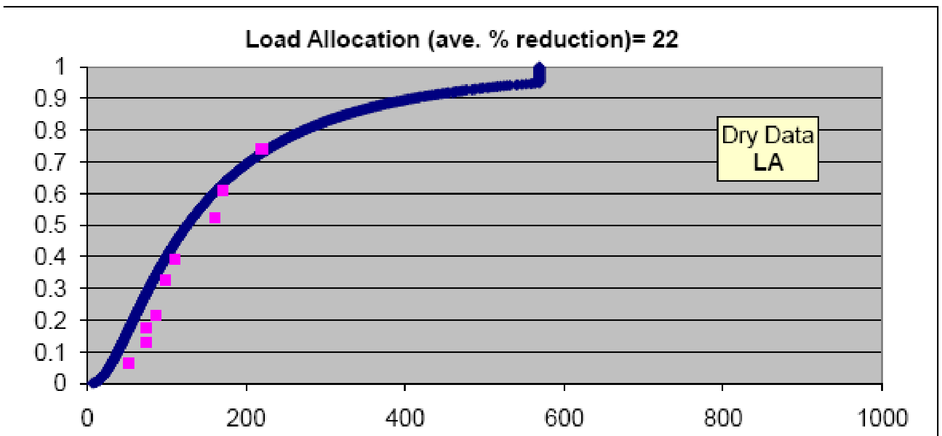
Hockanum River Criteria Curve for Monitoring Site 112
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River
CT4500-00_04a

Data Used in the Analysis

Monitoring Site: 916, #440 Route 83 Odessey School

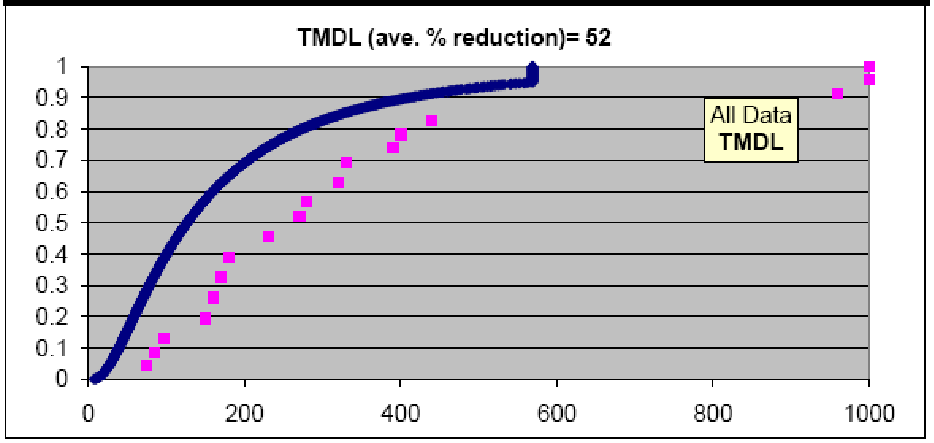
Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	320	14.5	0.6304	171	46
7/1/08	0.60	0.03	0.33	WET	400	18.0	0.7826	259	35
7/10/08	0.00	0.00	0.00	DRY	330	16.0	0.6957	202	39
7/17/08	0.00	0.00	0.13	DRY	390	17.0	0.7391	227	42
7/23/08	0.50	0.02	0.77	WET	860	20.0	0.8696	355	59
8/7/08	0.71	0.95	0.00	WET	1400	22.0	0.9565	576	59
8/12/08	0.03	0.50	0.01	WET	960	21.0	0.9130	441	54
8/21/08	0.00	0.00	0.02	DRY	170	7.5	0.3261	83	51
8/28/08	0.00	0.00	0.00	DRY	160	6.0	0.2609	70	56
9/2/08	0.00	0.00	0.06	DRY	97	3.0	0.1304	45	54
9/12/08	0.46	0.00	0.75	WET	150	4.5	0.1957	57	62
9/15/08	0.01	0.46	0.47	WET	230	10.5	0.4565	114	50
6/29/09	0.00	0.01	0.03	DRY	150	4.5	0.1957	57	62
7/10/09	0.00	0.00	1.24	DRY	280	13.0	0.5652	147	48
7/15/09	0.00	0.00	0.10	DRY	270	12.0	0.5217	132	51
7/24/09	1.12	0.42	2.10	WET	6500	23.0	1.0000	576	91
8/5/09	0.00	0.00	0.04	DRY	180	9.0	0.3913	98	46
8/14/09	0.00	0.41	0.01	WET	320	14.5	0.6304	171	46
8/28/09	0.38	0.00	0.00	WET	440	19.0	0.8261	299	32
9/4/09	0.00	0.00	0.00	DRY	85	2.0	0.0870	36	58
9/8/09	0.00	0.00	0.00	DRY	230	10.5	0.4565	114	50
9/15/09	0.00	0.00	0.13	DRY	170	7.5	0.3261	83	51
9/25/09	0.00	0.00	0.05	DRY	74	1.0	0.0435	26	65

Precipitation and E. coli data provided by <wunderground.com> 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.

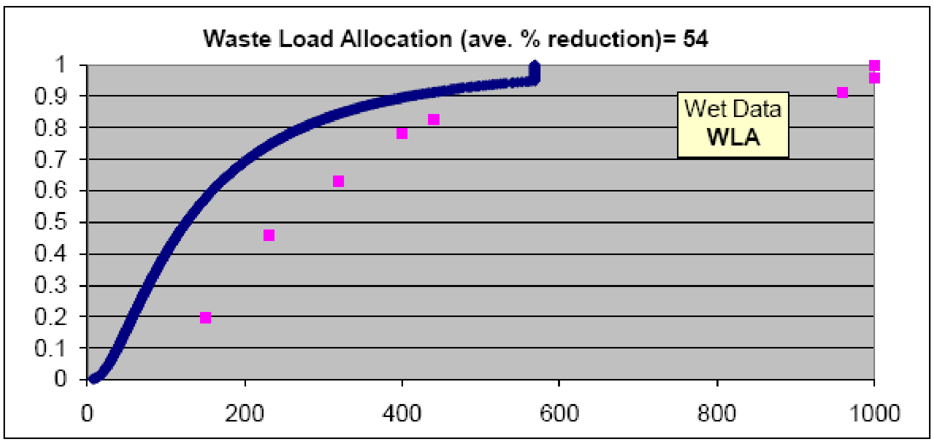
Statistics

# Samples DRY	**13**
# Samples WET	**10**
# Samples Total	**23**
Geomean	**298**
Log std deviation	**0.4328**
Avg % Reduction	
Wet (WLA)	**54**
Dry (LA)	**52**
Total (TMDL)	**52**

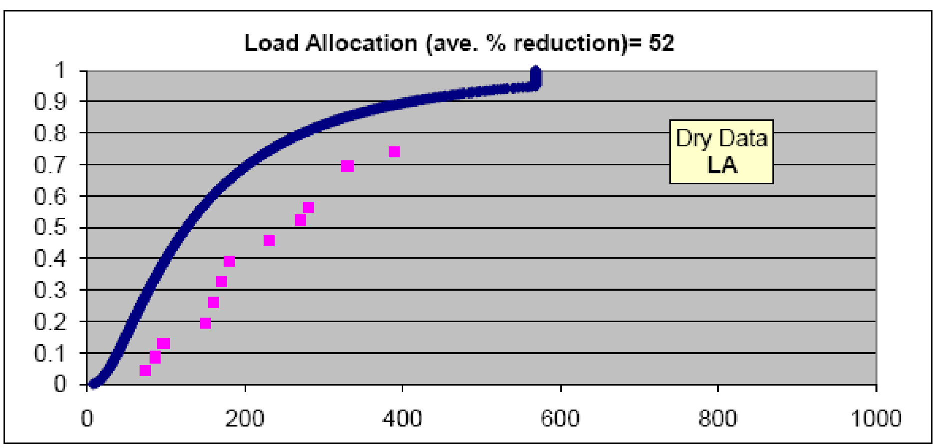
Hockanum River Criteria Curve for Monitoring Site 916
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River

CT4500-00_04b

Data Used in the Analysis

Monitoring Site: 117, Confluence with Tankerhoosen River

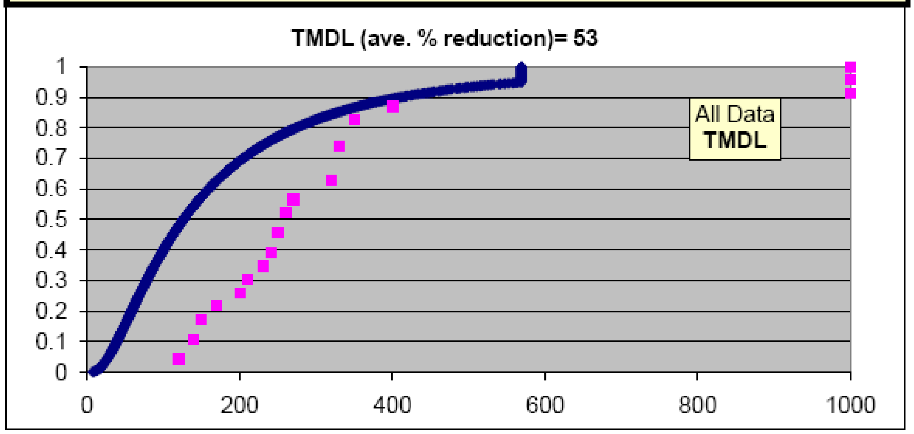
Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	320	14.5	0.6304	171	46
7/1/08	0.60	0.03	0.33	WET	330	17.0	0.7391	227	31
7/10/08	0.00	0.00	0.00	DRY	250	10.5	0.4565	114	54
7/17/08	0.00	0.00	0.13	DRY	350	19.0	0.8261	299	15
7/23/08	0.50	0.02	0.77	WET	1000	21.0	0.9130	441	56
8/7/08	0.71	0.95	0.00	WET	1700	22.0	0.9565	576	66
8/12/08	0.03	0.50	0.01	WET	320	14.5	0.6304	171	46
8/21/08	0.00	0.00	0.02	DRY	140	2.5	0.1087	40	71
8/28/08	0.00	0.00	0.00	DRY	170	5.0	0.2174	61	64
9/2/08	0.00	0.00	0.08	DRY	330	17.0	0.7391	227	31
9/12/08	0.46	0.00	0.75	WET	260	12.0	0.5217	132	49
9/15/08	0.01	0.46	0.47	WET	270	13.0	0.5652	147	46
6/29/09	0.00	0.01	0.03	DRY	230	8.0	0.3478	88	62
7/10/09	0.00	0.00	1.24	DRY	240	9.0	0.3913	98	59
7/15/09	0.00	0.00	0.10	DRY	330	17.0	0.7391	227	31
7/24/09	1.12	0.42	2.10	WET	6500	23.0	1.0000	576	91
8/5/09	0.00	0.00	0.04	DRY	150	4.0	0.1739	53	65
8/14/09	0.00	0.41	0.01	WET	250	10.5	0.4565	114	54
8/28/09	0.38	0.00	0.00	WET	400	20.0	0.8696	355	11
9/4/09	0.00	0.00	0.00	DRY	140	2.5	0.1087	40	71
9/8/09	0.00	0.00	0.00	DRY	120	1.0	0.0435	26	78
9/15/09	0.00	0.00	0.13	DRY	200	6.0	0.2609	70	65
9/25/09	0.00	0.00	0.05	DRY	210	7.0	0.3043	79	63

Statistics

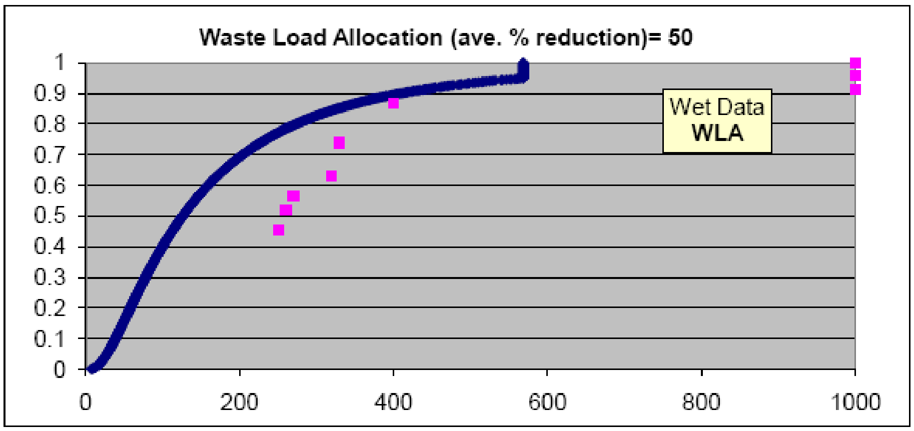
# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	318
Log std deviation	0.3851
Avg % Reduction	
Wet (WLA)	50
Dry (LA)	56
Total (TMDL)	53

Precipitation and E. coli data provided by <wunderground.com> and CT DEP 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.

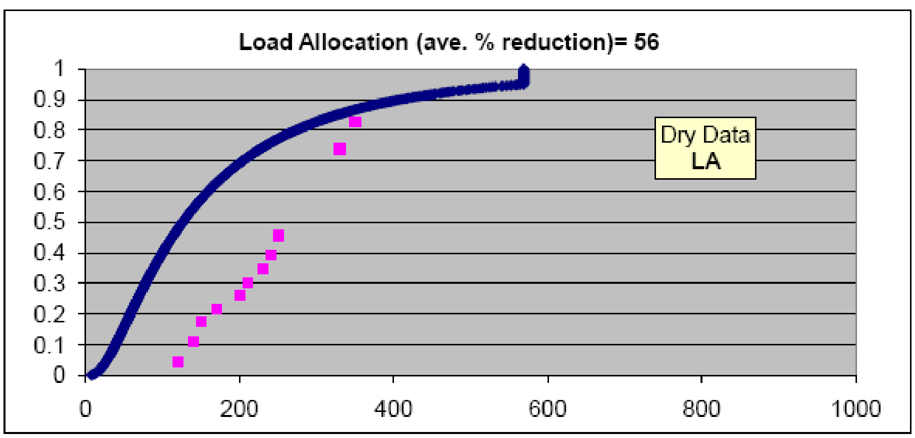
Hockanum River Criteria Curve for Monitoring Site 117
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River
CT4500-00_05

Data Used in the Analysis

Monitoring Site: 116, Dart Hill Road Vernon

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	340	17.0	0.7391	227	33
7/1/08	0.60	0.03	0.33	WET	430	18.0	0.7826	259	40
7/10/08	0.00	0.00	0.00	DRY	280	13.0	0.5652	147	48
7/17/08	0.00	0.00	0.13	DRY	525	20.0	0.8696	355	32
7/23/08	0.50	0.02	0.77	WET	620	21.0	0.9130	441	29
8/7/08	0.71	0.95	0.00	WET	1900	22.0	0.9565	576	70
8/12/08	0.03	0.50	0.01	WET	250	11.0	0.4783	120	52
8/21/08	0.00	0.00	0.02	DRY	185	5.0	0.2174	61	67
8/28/08	0.00	0.00	0.00	DRY	190	6.5	0.2826	74	61
9/2/08	0.00	0.00	0.08	DRY	330	16.0	0.6957	202	39
9/12/08	0.46	0.00	0.75	WET	190	6.5	0.2826	74	61
9/15/08	0.01	0.46	0.47	WET	240	10.0	0.4348	108	55
6/29/09	0.00	0.01	0.03	DRY	130	3.0	0.1304	45	66
7/10/09	0.00	0.00	1.24	DRY	260	12.0	0.5217	132	49
7/15/09	0.00	0.00	0.10	DRY	290	14.0	0.6087	162	44
7/24/09	1.12	0.42	2.10	WET	4100	23.0	1.0000	576	86
8/5/09	0.00	0.00	0.04	DRY	85	2.0	0.0870	36	58
8/14/09	0.00	0.41	0.01	WET	310	15.0	0.6522	181	42
8/28/09	0.38	0.00	0.00	WET	470	19.0	0.8261	299	36
9/4/09	0.00	0.00	0.00	DRY	160	4.0	0.1739	53	67
9/8/09	0.00	0.00	0.00	DRY	230	9.0	0.3913	98	58
9/15/09	0.00	0.00	0.13	DRY	210	8.0	0.3478	88	58
9/25/09	0.00	0.00	0.05	DRY	63	1.0	0.0435	26	59

Precipitation and E. coli data provided by the <wunderground.com> 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.

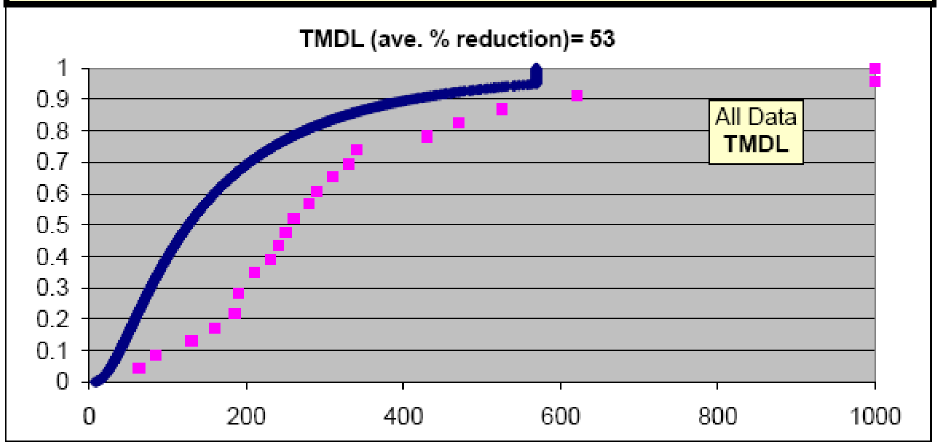
Statistics

# Samples DRY	**13**
# Samples WET	**10**
# Samples Total	**23**
Geomean	**298**
Log std deviation	**0.3876**

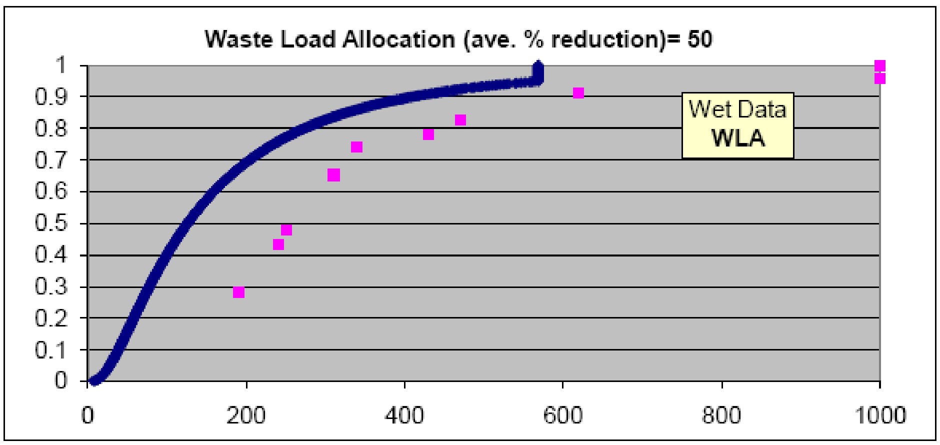
Avg % Reduction

Wet (WLA)	**50**
Dry (LA)	**54**
Total (TMDL)	**53**

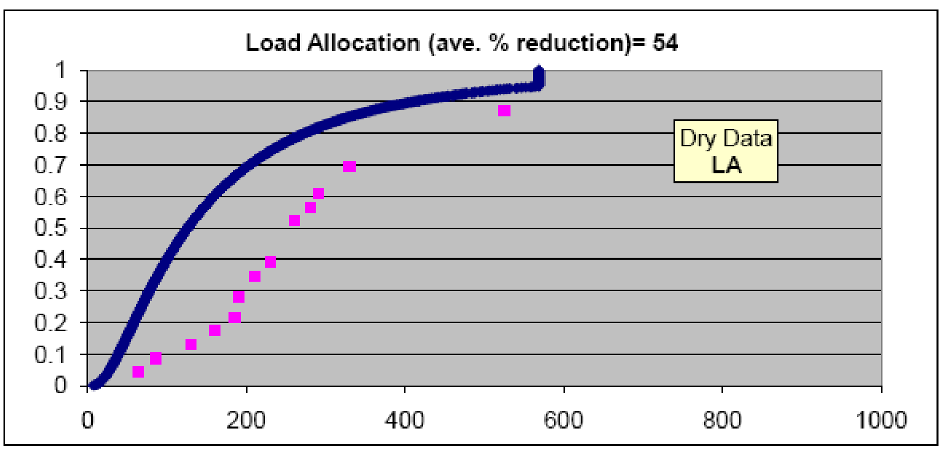
Hockanum River Criteria Curve for Monitoring Site 116
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River

CT4500-00_06a

Data Used in the Analysis

Monitoring Site: 114, Site description Vernon STP

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	320	15.0	0.6522	181	44
7/1/08	0.60	0.03	0.33	WET	240	11.0	0.4783	120	50
7/10/08	0.00	0.00	0.00	DRY	390	18.0	0.7826	259	34
7/17/08	0.00	0.00	0.13	DRY	300	14.0	0.6087	162	46
7/23/08	0.50	0.02	0.77	WET	400	19.5	0.8478	325	19
8/7/08	0.71	0.95	0.00	WET	1600	21.0	0.9130	441	72
8/12/08	0.03	0.50	0.01	WET	350	16.5	0.7174	214	39
8/21/08	0.00	0.00	0.02	DRY	120	6.0	0.2609	70	42
8/28/08	0.00	0.00	0.00	DRY	150	9.0	0.3913	98	35
9/2/08	0.00	0.00	0.06	DRY	350	16.5	0.7174	214	39
9/12/08	0.46	0.00	0.75	WET	230	10.0	0.4348	108	53
9/15/08	0.01	0.46	0.47	WET	250	12.0	0.5217	132	47
6/29/09	0.00	0.01	0.03	DRY	120	6.0	0.2609	70	42
7/10/09	0.00	0.00	1.24	DRY	120	6.0	0.2609	70	42
7/15/09	0.00	0.00	0.10	DRY	5200	23.0	1.0000	576	89
7/24/09	1.12	0.42	2.10	WET	4400	22.0	0.9565	576	87
8/5/09	0.00	0.00	0.04	DRY	120	6.0	0.2609	70	42
8/14/09	0.00	0.41	0.01	WET	74	1.0	0.0435	26	65
8/28/09	0.38	0.00	0.00	WET	280	13.0	0.5652	147	48
9/4/09	0.00	0.00	0.00	DRY	110	3.0	0.1304	45	59
9/8/09	0.00	0.00	0.00	DRY	86	2.0	0.0870	36	58
9/15/09	0.00	0.00	0.13	DRY	400	19.5	0.8478	325	19
9/25/09	0.00	0.00	0.05	DRY	120	6.0	0.2609	70	42

Statistics

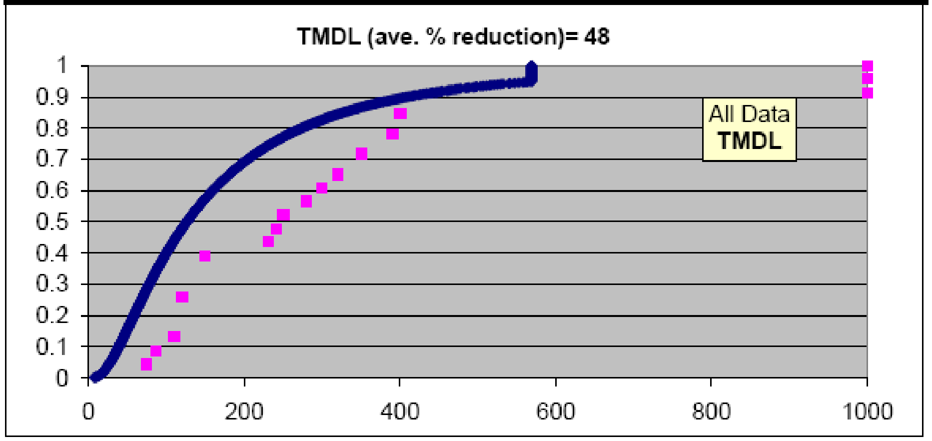
# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	284
Log std deviation	0.4876

Avg % Reduction

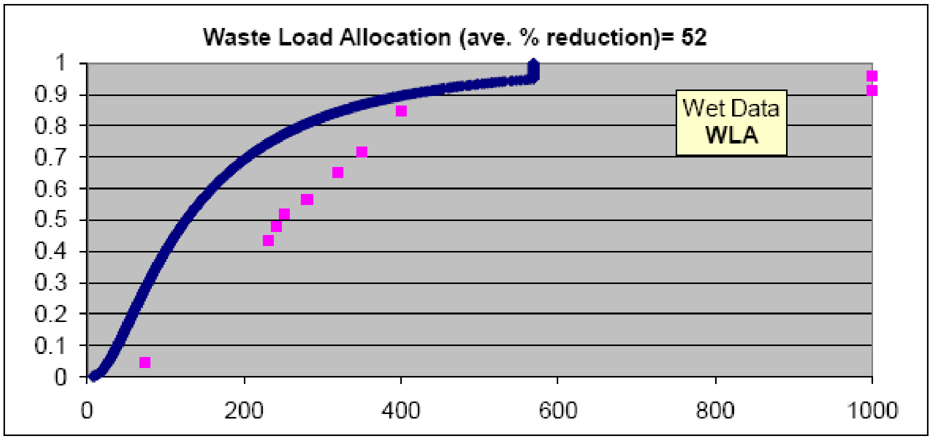
Wet (WLA)	52
Dry (LA)	45
Total (TMDL)	48

Precipitation and E. coli data provided by the <wunderground.com> 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.

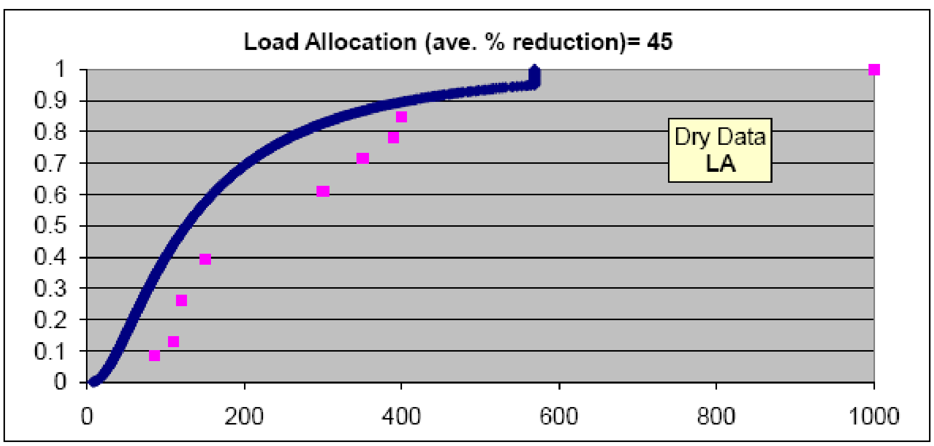
Hockanum River Criteria Curve for Monitoring Site 114
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River

CT4500-00_06b

Data Used in the Analysis

Monitoring Site: 957, West Street

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	300	20.0	0.8696	355	0
7/1/08	0.60	0.03	0.33	WET	175	14.0	0.6087	162	7
7/10/08	0.00	0.00	0.00	DRY	180	15.0	0.6522	181	0
7/17/08	0.00	0.00	0.13	DRY	190	16.0	0.6957	202	0
7/23/08	0.50	0.02	0.77	WET	3800	23.0	1.0000	576	85
8/7/08	0.71	0.95	0.00	WET	765	21.0	0.9130	441	42
8/12/08	0.03	0.50	0.01	WET	110	6.5	0.2826	74	33
8/21/08	0.00	0.00	0.02	DRY	75	3.0	0.1304	45	40
8/28/08	0.00	0.00	0.00	DRY	120	10.0	0.4348	108	10
9/2/08	0.00	0.00	0.06	DRY	260	19.0	0.8261	299	0
9/12/08	0.46	0.00	0.75	WET	96	4.0	0.1739	53	45
9/15/08	0.01	0.46	0.47	WET	63	1.0	0.0435	26	59
6/29/09	0.00	0.01	0.03	DRY	120	10.0	0.4348	108	10
7/10/09	0.00	0.00	1.24	DRY	120	10.0	0.4348	108	10
7/15/09	0.00	0.00	0.10	DRY	117	8.0	0.3478	88	25
7/24/09	1.12	0.42	2.10	WET	2900	22.0	0.9565	576	80
8/5/09	0.00	0.00	0.04	DRY	140	12.0	0.5217	132	5
8/14/09	0.00	0.41	0.01	WET	97	5.0	0.2174	61	37
8/28/09	0.38	0.00	0.00	WET	160	13.0	0.5652	147	8
9/4/09	0.00	0.00	0.00	DRY	250	18.0	0.7826	259	0
9/8/09	0.00	0.00	0.00	DRY	110	6.5	0.2826	74	33
9/15/09	0.00	0.00	0.13	DRY	200	17.0	0.7391	227	0
9/25/09	0.00	0.00	0.05	DRY	74	2.0	0.0870	36	51

Precipitation and E. coli data provided by <wunderground.com> 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.

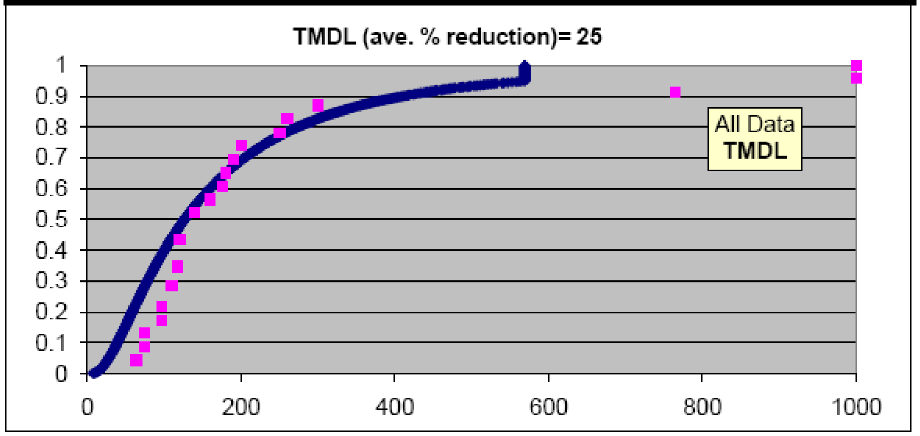
Statistics

# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	193
Log std deviation	0.4556

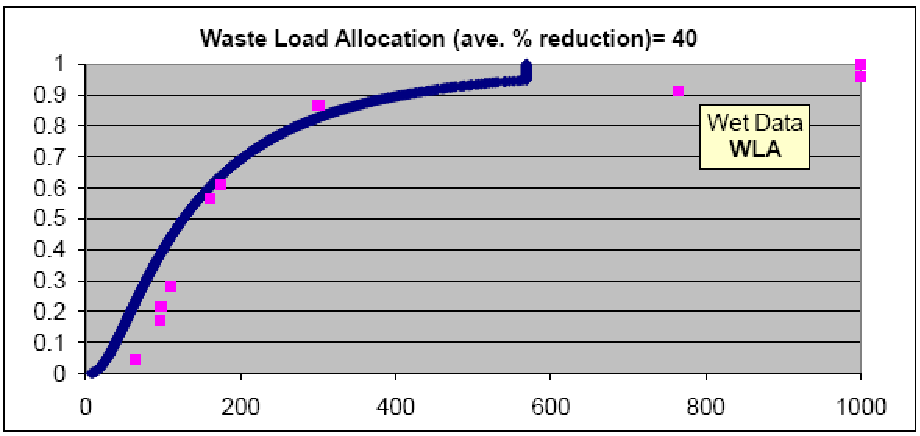
Avg % Reduction

Wet (WLA)	40
Dry (LA)	14
Total (TMDL)	25

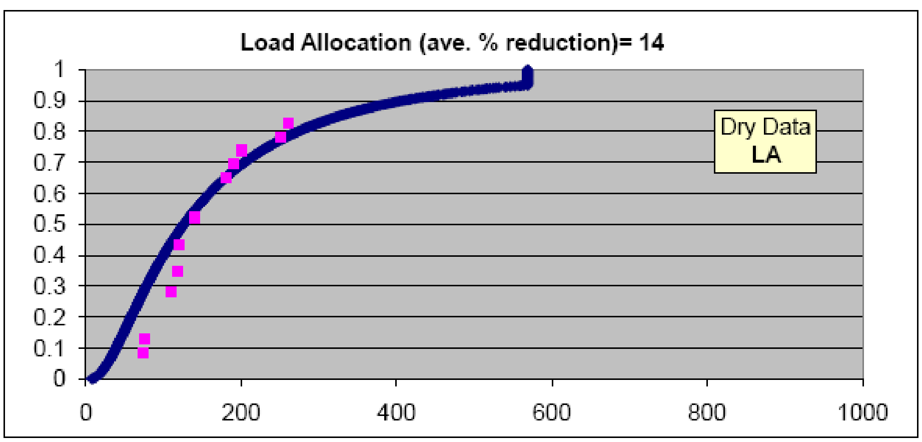
Hockanum River Criteria Curve for Monitoring Site 957
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River
CT4500-00_07

Data Used in the Analysis

Monitoring Site: 1804, adjacent to Brooklyn Street

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	160	17.5	0.7609	242	0
7/1/08	0.60	0.03	0.33	WET	97	11.0	0.4783	120	0
7/10/08	0.00	0.00	0.00	DRY	140	16.0	0.6957	202	0
7/17/08	0.00	0.00	0.13	DRY	120	14.0	0.6087	162	0
7/23/08	0.50	0.02	0.77	WET	16000	23.0	1.0000	576	96
8/7/08	0.71	0.95	0.00	WET	630	21.0	0.9130	441	30
8/12/08	0.03	0.50	0.01	WET	63	4.0	0.1739	53	16
8/21/08	0.00	0.00	0.02	DRY	73	6.0	0.2609	70	4
8/28/08	0.00	0.00	0.00	DRY	86	10.0	0.4348	108	0
9/2/08	0.00	0.00	0.06	DRY	84	8.0	0.3478	88	0
9/12/08	0.46	0.00	0.75	WET	98	12.0	0.5217	132	0
9/15/08	0.01	0.46	0.47	WET	41	1.0	0.0435	26	36
6/29/09	0.00	0.01	0.03	DRY	85	9.0	0.3913	98	0
7/10/09	0.00	0.00	1.24	DRY	63	4.0	0.1739	53	16
7/15/09	0.00	0.00	0.10	DRY	120	14.0	0.6087	162	0
7/24/09	1.12	0.42	2.10	WET	4400	22.0	0.9565	576	87
8/5/09	0.00	0.00	0.04	DRY	52	2.0	0.0870	36	31
8/14/09	0.00	0.41	0.01	WET	63	4.0	0.1739	53	16
8/28/09	0.38	0.00	0.00	WET	290	19.0	0.8261	299	0
9/4/09	0.00	0.00	0.00	DRY	120	14.0	0.6087	162	0
9/8/09	0.00	0.00	0.00	DRY	160	17.5	0.7609	242	0
9/15/09	0.00	0.00	0.13	DRY	350	20.0	0.8696	355	0
9/25/09	0.00	0.00	0.05	DRY	74	7.0	0.3043	79	0

Precipitation and E. coli data provided by <wunderground.com> 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.

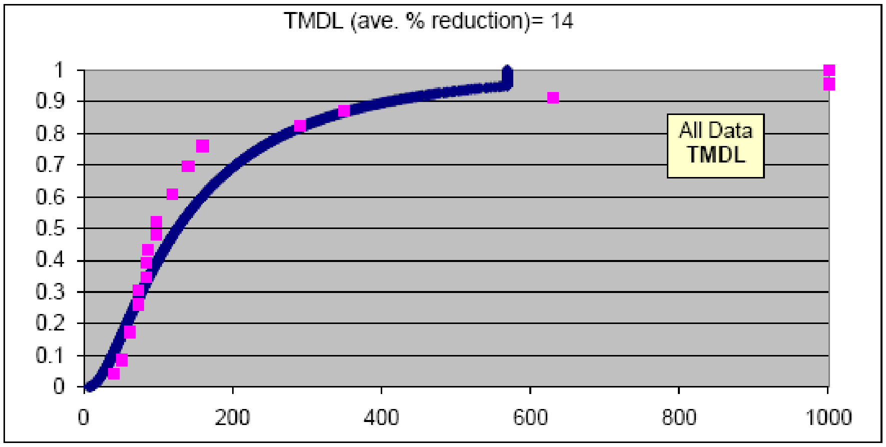
Statistics

# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	160
Log std deviation	0.6137

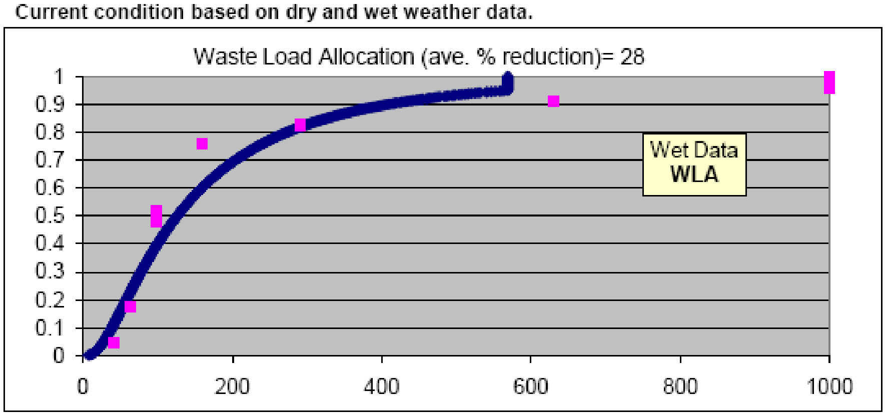
Avg % Reduction

Wet (WLA)	28
Dry (LA)	4
Total (TMDL)	14

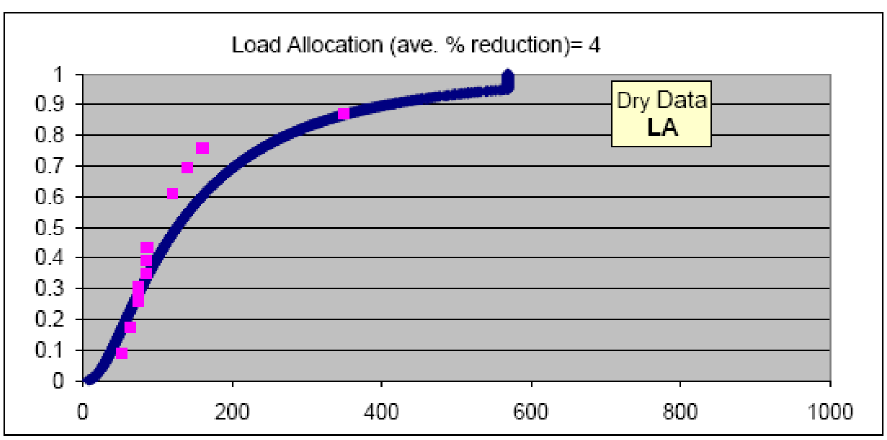
Hockanum River Criteria Curve for Monitoring Site 1804
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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.

Hockanum River

CT4500-00_08

Data Used in the Analysis

Monitoring Site: 956, Route 74 / Tolland Ave crossing

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	10	5.0	0.2174	61	0
7/1/08	0.60	0.03	0.33	WET	20	12.5	0.5435	139	0
7/10/08	0.00	0.00	0.00	DRY	10	5.0	0.2174	61	0
7/17/08	0.00	0.00	0.13	DRY	20	12.5	0.5435	139	0
7/23/08	0.50	0.02	0.77	WET	180	23.0	1.0000	576	0
8/7/08	0.71	0.95	0.00	WET	41	20.0	0.8696	355	0
8/12/08	0.03	0.50	0.01	WET	31	17.0	0.7391	227	0
8/21/08	0.00	0.00	0.02	DRY	20	12.5	0.5435	139	0
8/28/08	0.00	0.00	0.00	DRY	10	5.0	0.2174	61	0
9/2/08	0.00	0.00	0.06	DRY	20	12.5	0.5435	139	0
9/12/08	0.46	0.00	0.75	WET	10	5.0	0.2174	61	0
9/15/08	0.01	0.46	0.47	WET	40	18.0	0.7826	259	0
6/29/09	0.00	0.01	0.03	DRY	10	5.0	0.2174	61	0
7/10/09	0.00	0.00	1.24	DRY	20	12.5	0.5435	139	0
7/15/09	0.00	0.00	0.10	DRY	20	12.5	0.5435	139	0
7/24/09	1.12	0.42	2.10	WET	52	22.0	0.9565	576	0
8/5/09	0.00	0.00	0.04	DRY	10	5.0	0.2174	61	0
8/14/09	0.00	0.41	0.01	WET	41	20.0	0.8696	355	0
8/28/09	0.38	0.00	0.00	WET	10	5.0	0.2174	61	0
9/4/09	0.00	0.00	0.00	DRY	10	5.0	0.2174	61	0
9/8/09	0.00	0.00	0.00	DRY	10	5.0	0.2174	61	0
9/15/09	0.00	0.00	0.13	DRY	30	16.0	0.6957	202	0
9/25/09	0.00	0.00	0.05	DRY	41	20.0	0.8696	355	0

Statistics

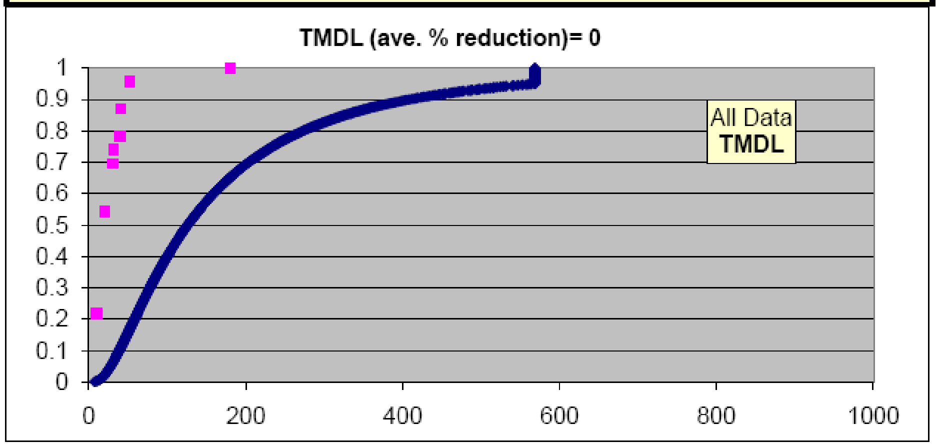
# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	21
Log std deviation	0.3265

Avg % Reduction

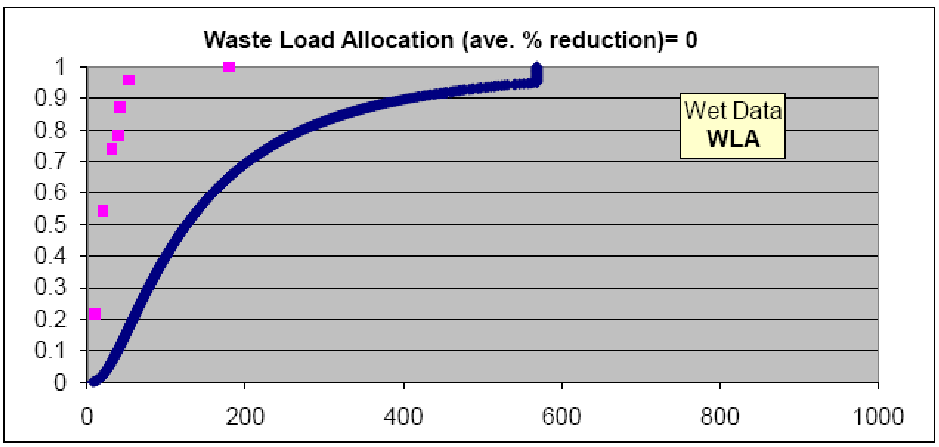
Wet (WLA)	0
Dry (LA)	0
Total (TMDL)	0

Precipitation and E. coli data provided by <wunderground.com> 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.

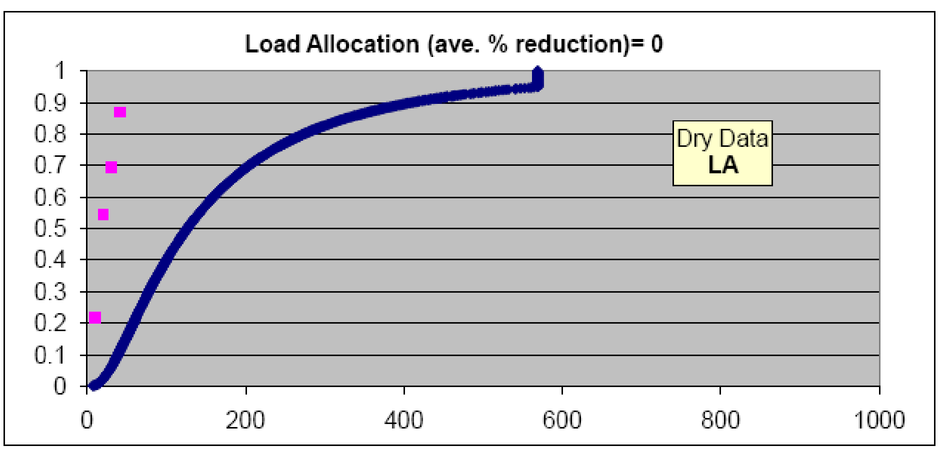
Hockanum River Criteria Curve for Monitoring Site 956
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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
Charters Brook
Waterbody specific information

<u>Impaired Waterbody</u>
Waterbody Name: Charters Brook
Waterbody Segment IDs: CT 4501-00_01
Waterbody Segment Description: From mouth at Shenipsit Lake, Tolland US to headwaters near Webster Rd Ellington

<u>Impairment Description:</u>
Designated Use Impairment: Recreation
Size of Impaired Segments: 6.216099 miles
Surface Water Classification: Class A

<u>Watershed Description:</u>
Drainage Basin Area: 7430.77002 acres
Tributary To: Hockanum River
Subregional Basin Name & Code: Charters Brook, 4501
Regional Basin: Hockanum
Major Basin: Connecticut
Watershed Towns: Tolland, Ellington, Stafford, Somers
Phase II GP applicable? : Tolland –Y, Ellington – Y, Stafford – Y, Somers – Y
Applicable Season: Recreation Season (May 1 to September 30)

Landuse:

Land Cover Category	Percent Composition
Forested	72.5% (5384.06 acres)
Urban/Developed	10.5% (783.4 acres)
Water/Wetland	9.1% (678.15 acres)
Agriculture	7.9% (585.393 acres)

Data Source: Connecticut Land Use Land Cover Data Layer LANDSTAT (2002) Thematic Mapper Satellite Imagery.

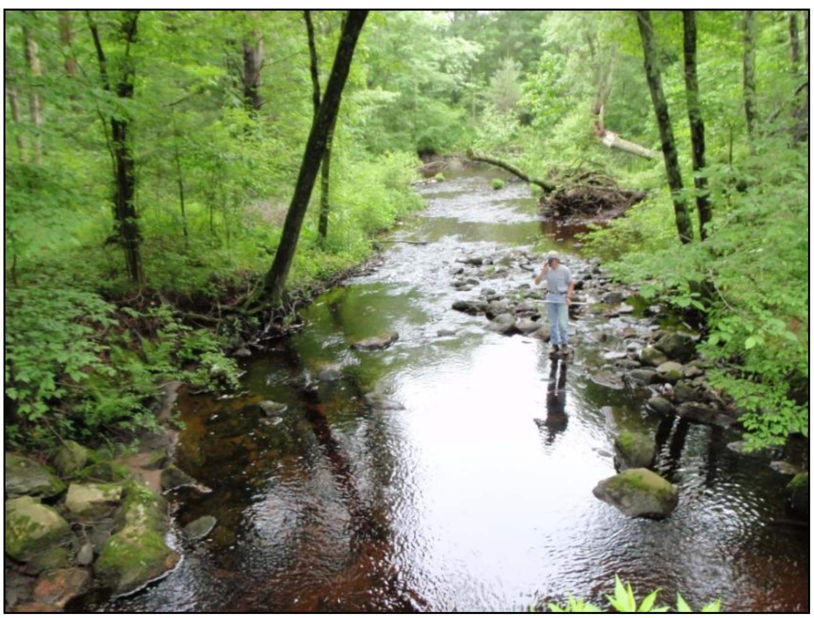
Appendix A-2

Charters Brook
TMDL Summary

The TMDL analysis for Charters Brook was conducted at one site (955), which is located approximately 1500 meters upstream from the mouth entering Shenipsit Lake, the headwaters of the Hockanum River. Charters Brook has only one 305b segment due to its short length and relatively uniform land use within the basin. The TMDL analysis indicates that the site is influenced by sources of bacteria active under both wet weather and dry weather conditions. The Waste Load Allocation (WLA) reduction (20%) is slightly higher than the Load Allocation (LA) reduction (17%) on this segment. The higher WLA value indicates that the stream is slightly more influenced by point sources of *e.coli* and stormwater. Reductions in the WLA can be achieved through the detection and elimination of illicit discharges to the storm sewers or directly to the brook and the upgrade of failed sanitary infrastructure, as well as, the installation of engineered controls to reduce the surge of stormwater to the brook, promote groundwater recharge, and improve water quality. 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.

Charters Brook Image

Site 955 [Browns Bridge Road (only sample location)]



Charters Brook

CT4501-00_01

Data Used in the Analysis

Monitoring Site: 955, Browns Bridge Road

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/16/08	1.12	0.60	0.43	WET	240	14.5	0.6304	171	29
7/1/08	0.60	0.03	0.33	WET	41	4.5	0.1957	57	0
7/10/08	0.00	0.00	0.00	DRY	31	3.0	0.1304	45	0
7/17/08	0.00	0.00	0.13	DRY	20	2.0	0.0870	36	0
7/23/08	0.50	0.02	0.77	WET	74	8.0	0.3478	88	0
8/7/08	0.71	0.95	0.00	WET	63	6.5	0.2826	74	0
8/12/08	0.03	0.50	0.01	WET	98	10.0	0.4348	108	0
8/21/08	0.00	0.00	0.02	DRY	960	22.0	0.9565	576	40
8/28/08	0.00	0.00	0.00	DRY	440	19.0	0.8261	299	32
9/2/08	0.00	0.00	0.06	DRY	890	21.0	0.9130	441	50
9/12/08	0.46	0.00	0.75	WET	850	20.0	0.8696	355	58
9/15/08	0.01	0.46	0.47	WET	4400	23.0	1.0000	576	87
6/29/09	0.00	0.01	0.03	DRY	41	4.5	0.1957	57	0
7/10/09	0.00	0.00	1.24	DRY	110	11.5	0.5000	126	0
7/15/09	0.00	0.00	0.10	DRY	200	13.0	0.5652	147	27
7/24/09	1.12	0.42	2.10	WET	63	6.5	0.2826	74	0
8/5/09	0.00	0.00	0.04	DRY	240	14.5	0.6304	171	29
8/14/09	0.00	0.41	0.01	WET	330	18.0	0.7826	259	22
8/28/09	0.38	0.00	0.00	WET	10	1.0	0.0435	26	0
9/4/09	0.00	0.00	0.00	DRY	290	17.0	0.7391	227	22
9/8/09	0.00	0.00	0.00	DRY	85	9.0	0.3913	98	0
9/15/09	0.00	0.00	0.13	DRY	260	16.0	0.6957	202	22
9/25/09	0.00	0.00	0.05	DRY	110	11.5	0.5000	126	0

Precipitation and E. coli data provided by <wunderground.com> 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.

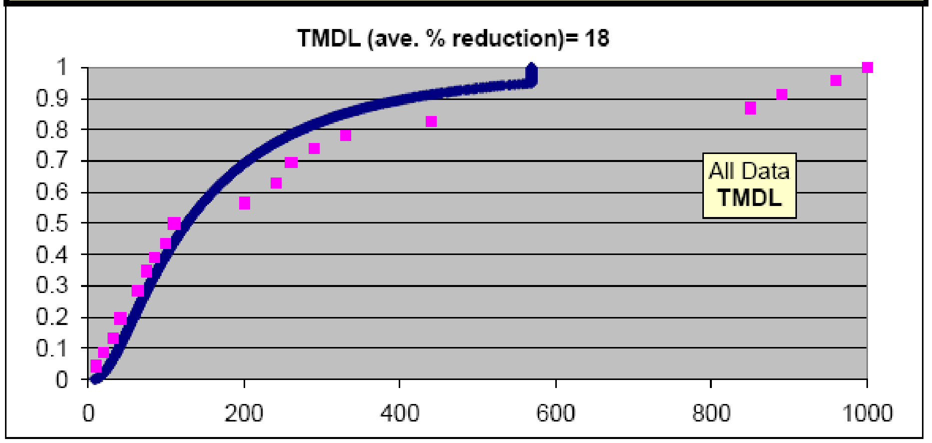
Statistics

# Samples DRY	13
# Samples WET	10
# Samples Total	23
Geomean	151
Log std deviation	0.6144

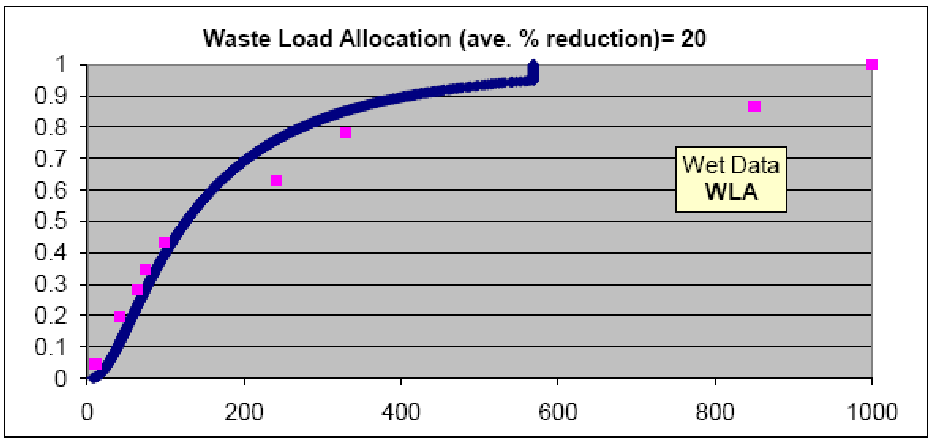
Avg % Reduction

Wet (WLA)	20
Dry (LA)	17
Total (TMDL)	18

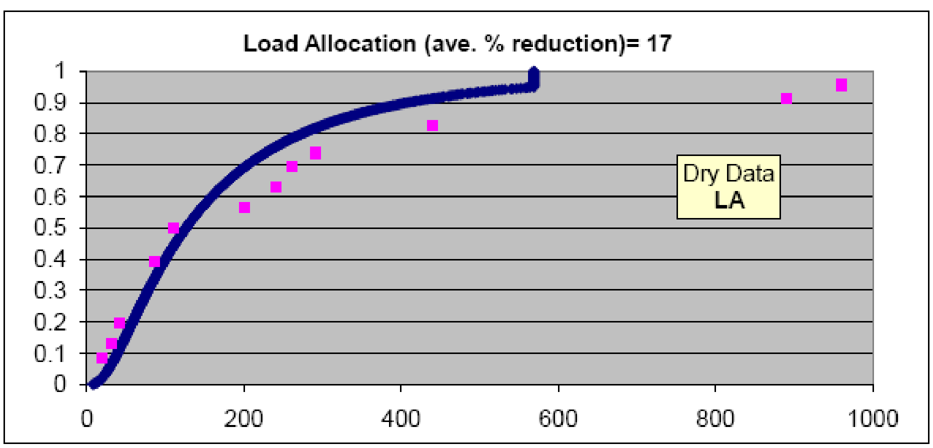
Charters Brook Criteria Curve for Monitoring Site 955
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



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 B. Municipal Stormwater Alternative Monitoring Guidance

Guidance for Implementing Bacteria-based TMDLs within the CTDEEP Stormwater Permitting Program

CTDEEP investigates impaired waterbodies to determine the major causes of impairment. This information is expressed as Total Maximum Daily Load (TMDL). TMDLs provide the framework for restoring impaired waters by establishing the maximum amount of a pollutant that a waterbody can take in without adverse impact to fish, wildlife, recreation, or other public uses. If a TMDL includes requirements for control of stormwater discharges it is the responsibility of the municipalities within the watershed to implement the recommendations of the TMDL (typically bacteria reduction). Management of stormwater quality within the municipality is governed by the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit).

The MS4 General Permit is required for any municipality with urbanized areas that initiates, creates, originates or maintains any discharge of stormwater from a storm sewer system to waters of the state. The MS4 permit requires towns to design a Stormwater Management Plan (SMP) to reduce the discharge of pollutants in stormwater to improve water quality. The plan must address the following 6 minimum measures.

1. Public Education and Outreach.
2. Public Involvement/Participation.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control.
5. Post-construction stormwater management in the new development and redevelopment.
6. Pollution prevention/good housekeeping for municipal operations.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within 4 months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established within the TMDL. For the discharges to the TMDL waterbody(ies), the municipality must assess the six minimum measures of its plan and modify the plan to implement additional, necessary controls for each appropriate measure. Particular focus should be placed on the following plan components: public education program, illicit discharge detection and elimination, stormwater structures cleaning, priority for the repair, upgrade, or retrofit of storm sewer structures. The goal of the modifications is to establish a program to improve water quality consistent with the requirements of the TMDL. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of CTDEEP for review and approval.

Also required under the MS4 General Permit is annual stormwater monitoring. The permit provides a general framework for monitoring stormwater quality within a municipality. At minimum, stormwater from six sample locations are to be collected annually: two outfalls from commercial areas, two from industrial areas, and two from residential areas. These six sample locations are point source discharges that drain areas with distinct characteristics. Each stormwater sample is tested for 12 parameters using methods prescribed in Title 40, CFR, Part 136.

pH (SU)	Total Suspended Solids (mg/l)

Hardness (mg/l)	Total Phosphorous (mg/l)
Conductivity (umos)	Ammonia (mg/l)
Oil and grease (mg/l)	Total Kjeldahl Nitrogen (mg/l)
Chemical Oxygen Demand (mg/l)	Nitrate plus Nitrite Nitrogen (mg/l)
Turbidity (NTU)	E. coli (col/100ml)

However, CTDEEP encourages municipalities affected by the establishment of a TMDL to develop an alternative stormwater monitoring plan to assess progress in meeting the goals of the TMDL. Alternate monitoring programs are established in accordance with Section 6(h)(1)(B) of the MS4 permit which allows towns to submit written requests to the Commissioner for the review and approval of alternate stormwater monitoring plans of equivalent or greater scope. This gives towns freedom to develop a plan that better assesses the stormwater quality in their watershed. 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. Monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. In order to secure DEEP approval, 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.

DEEP strongly recommends that stream monitoring be performed at the same locations DEEP sampled during TMDL development. Samples should also be collected at other key locations within the watershed, such as above and below potential contributing sources or areas slated for BMP implementation. Since watershed borders and TMDLs do not follow town borders there is a possibility DEEP did not sample locations in your town. If this is the case collecting a sample where the waterbody enters your town and another where the waterbody leaves your town maybe helpful to determine how stormwater from your town influences water quality. In all cases, 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.

Appendix C. 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

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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	235col/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.

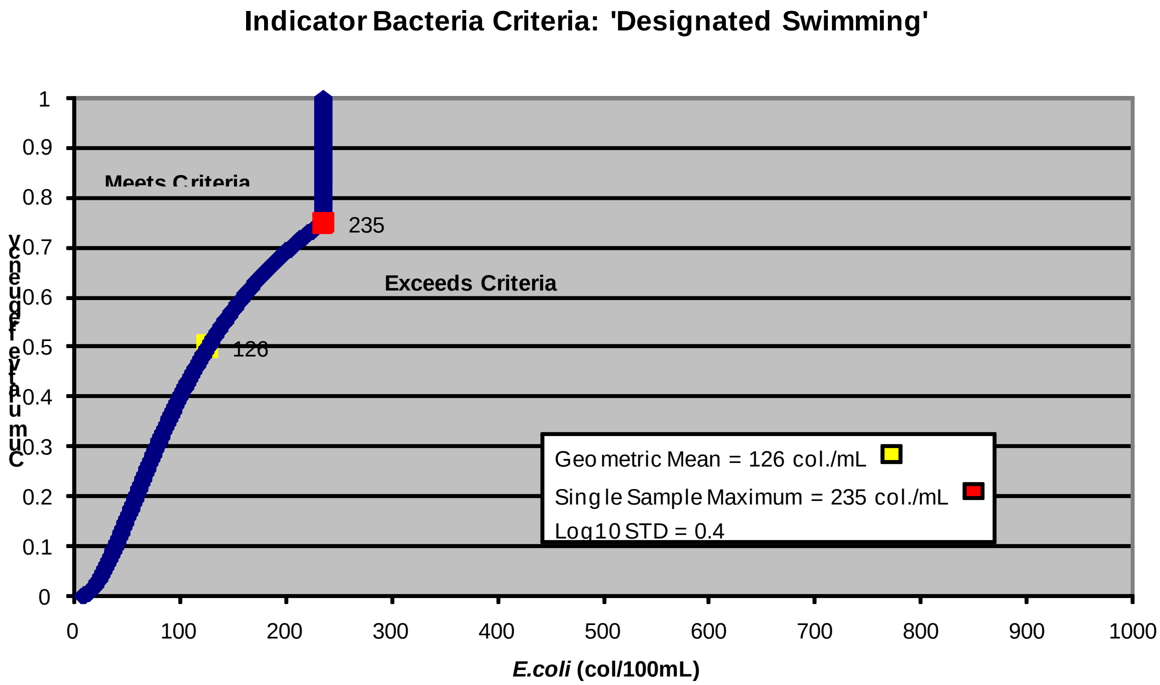

Figure 1a. Cumulative Relative Frequency Distribution representing water quality to support designated swimming use.

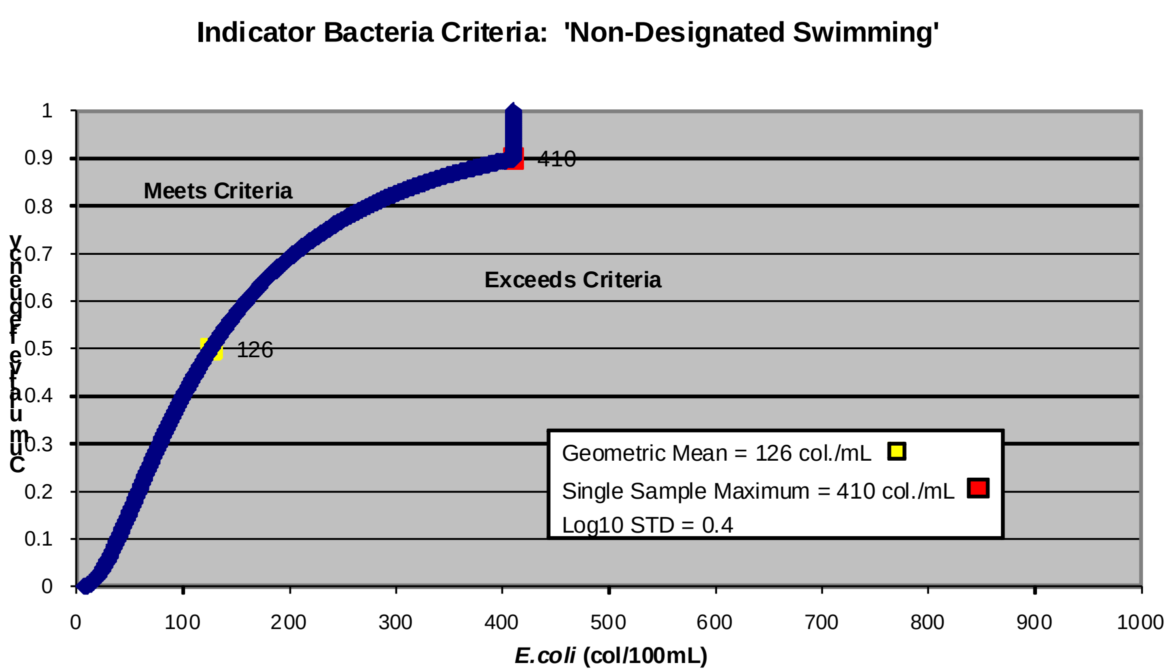

Figure 1b. Cumulative Relative Frequency Distribution representing water quality to support non-designated swimming use.

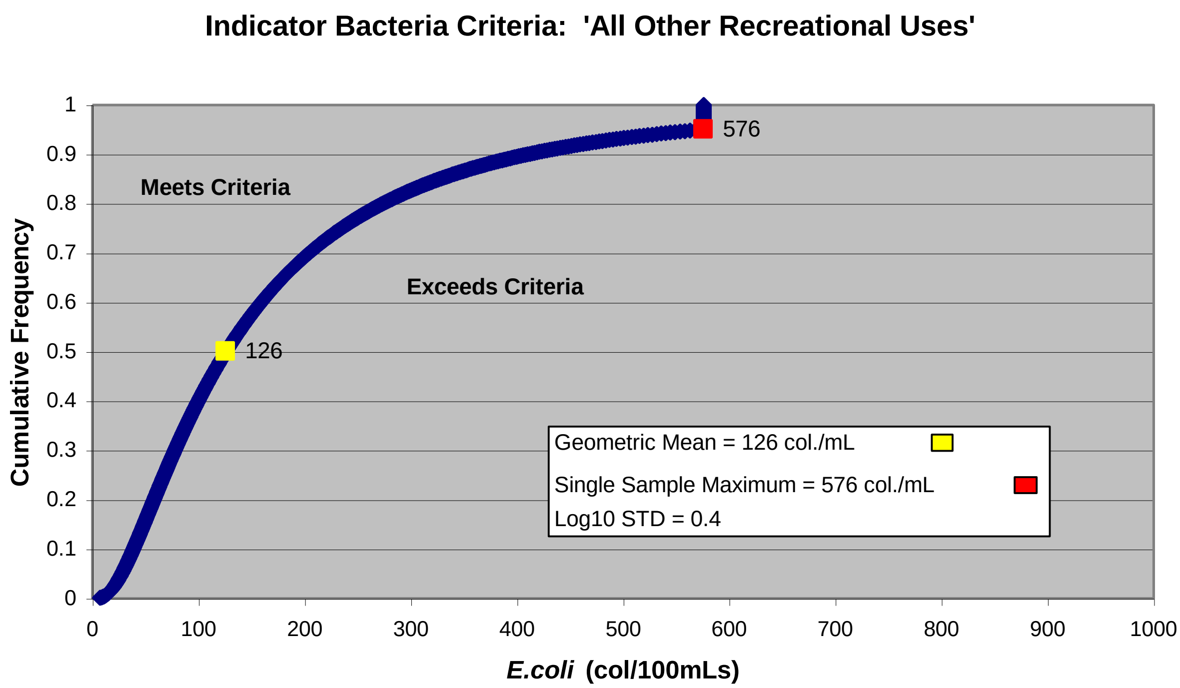

Figure 1c. Cumulative Relative Frequency Distribution representing water quality criteria to support all other recreational uses.

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.

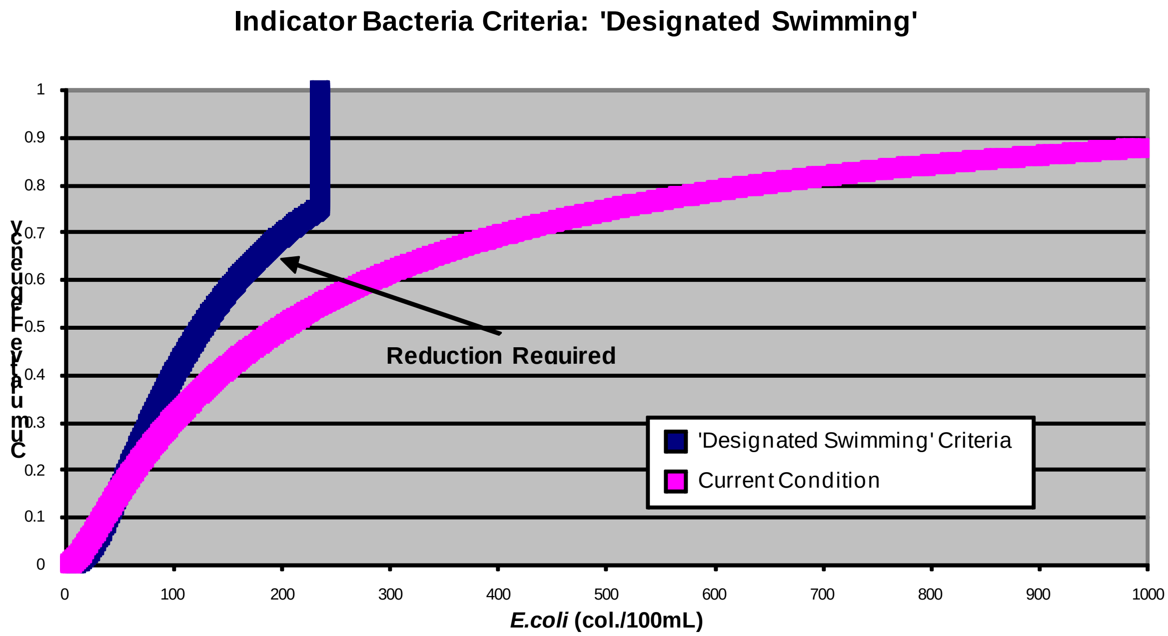

Figure 2a. Reduction indicator bacteria density needed from current condition to meet 'designated swimming' criteria based on cumulative relative frequency distribution.

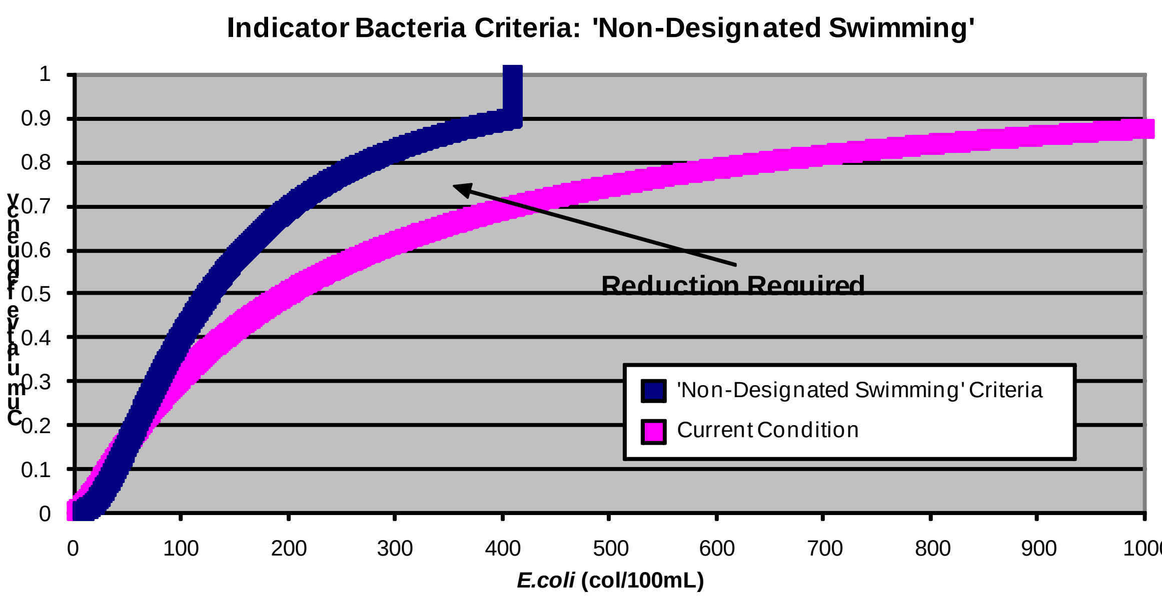

Figure 2b. Reduction indicator bacteria density needed from current condition to meet 'non-designated swimming' criteria based on cumulative relative frequency distribution.

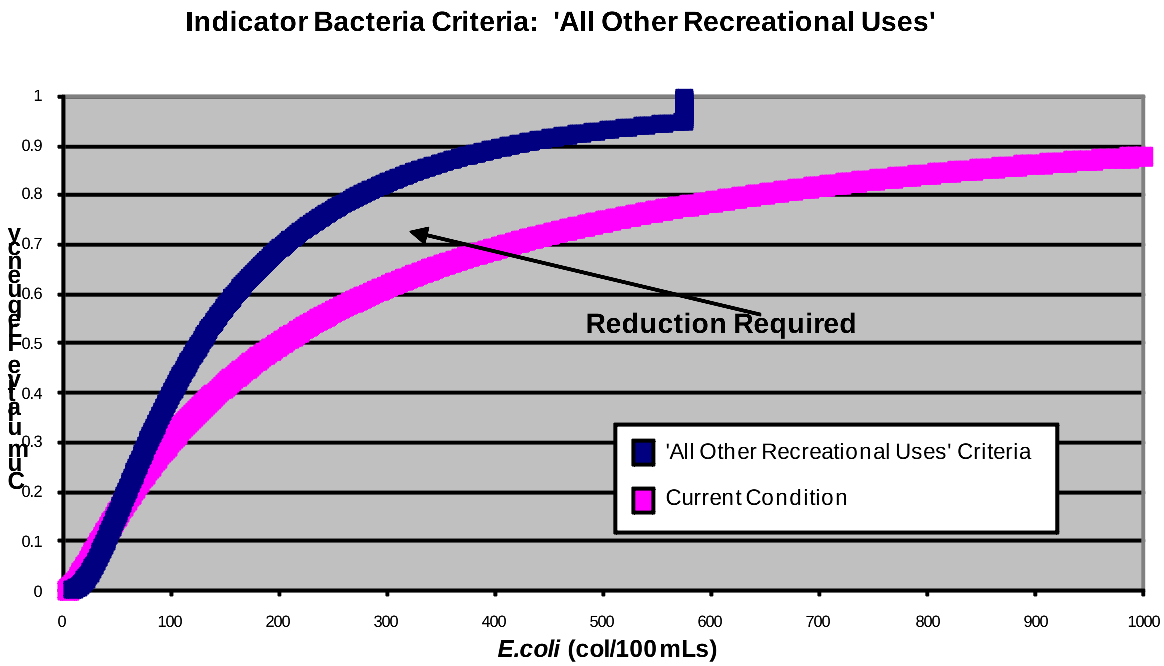

Figure 2c. Reduction indicator bacteria density needed from current condition to meet 'all other recreational uses' criteria based on cumulative relative frequency distribution.

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 DEEP by contacting Mary Becker at (860) 424-3262 or by email at mary.becker@ct.gov.

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1. 2004 List of Connecticut Water Bodies Not Meeting Water Quality Standards, Connecticut Department of Environmental Protection, Adopted April 28, 2004, approved June 24, 2004.

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5. Ambient Water Quality Criteria for Bacteria – 1986. U.S. Environmental Protection Agency, Office of Water, January 1986. (EPA440/5-84-002).

6. Water Quality Database. Connecticut Department of Environmental Protection, Monitoring and Assessment Program.

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Appendix D – 1 Additional *e.coli* Grab Sample Location Data

An additional sample site was selected to assess bacteria loads in the furthest downstream segment of the Hockanum River (CT4500-00_01). The site is located within 150 yards of the mouth of the Hockanum entering the Connecticut River. The monitoring site is located on a segment of the river that is 4.26 miles long and represents a fairly urban and developed portion of the river. Land use for this segment is similar to the immediately upstream adjacent segment (CT4500-00_02). Sample trips to this station were conducted during a variety of weather conditions and all samples were collected by CT DEEP staff.

The table below details the precipitation total, site coordinates, and colony counts for each sampling event at the additional monitoring station. The resultant data from the additional location is similar to the range of data collected within the upstream segment. The range of sample results for segment CT4500-00_02 was from 63 – 9800 cols/100mls with a geomean of 280 cols/100mls.

Sample Date	Stream	Station ID	e.coli (cols/100mls)	24-hr Precip (inches)	Lat	Long
3/5/10	Hockanum River	6160	160	0.10	41.7544	-72.6538
5/12/10	Hockanum River	6160	990	0.21	41.7544	-72.6538
6/18/10	Hockanum River	6160	110	0.00	41.7544	-72.6538
6/22/10	Hockanum River	6160	98	0.21*	41.7544	-72.6538

***** precipitation occurred in evening after the sample was collected

Appendix D- 2 Map of Additional Sample Location in Relation to Hockanum Basin