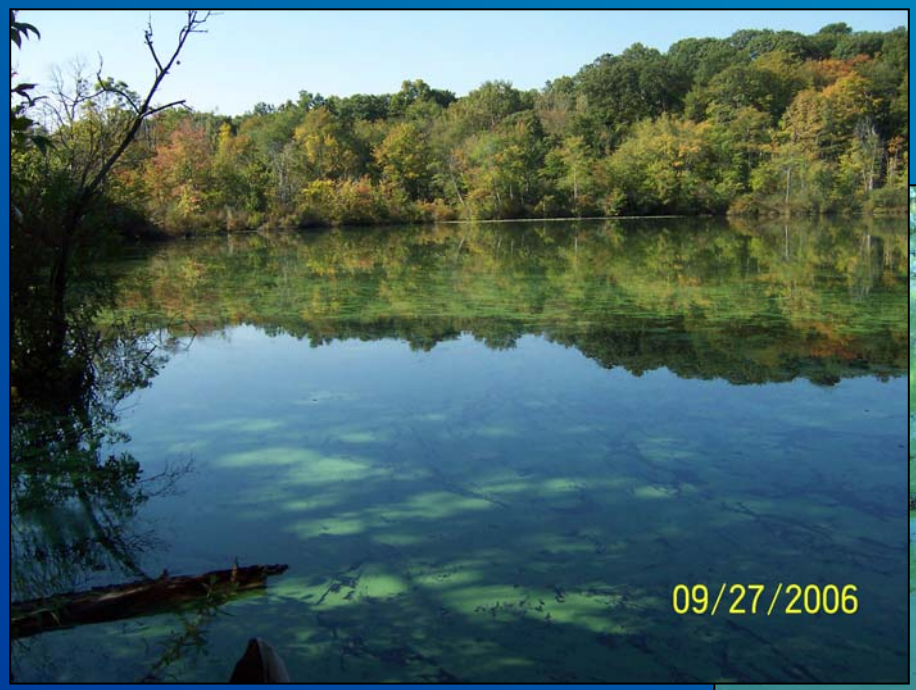
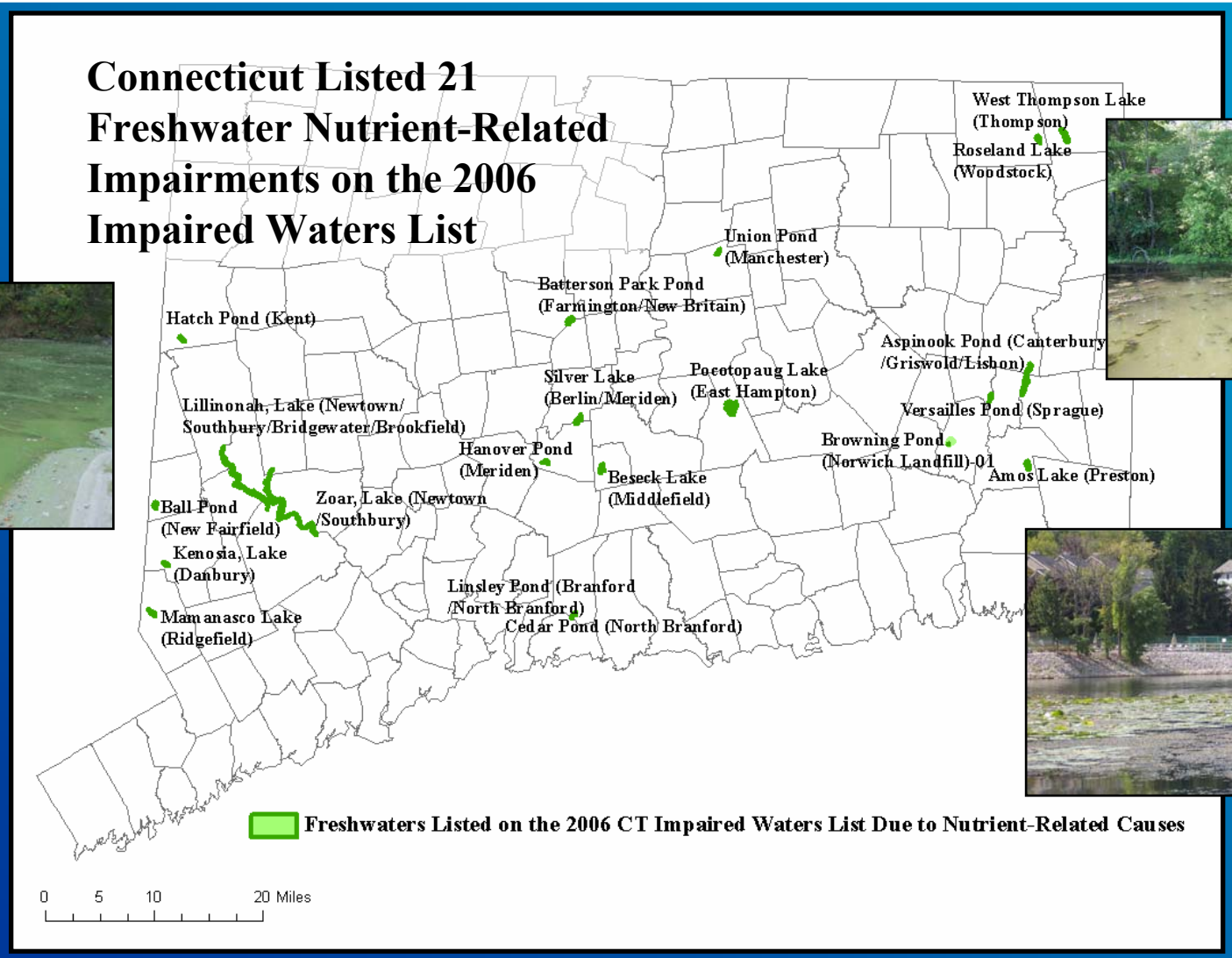
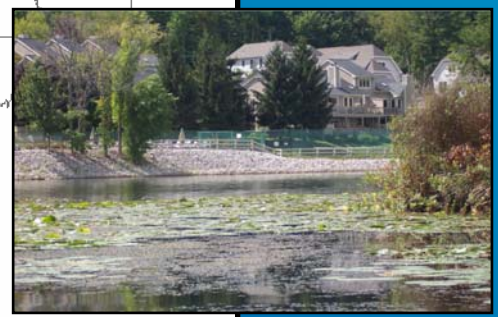
CT METHODOLOGY FOR FRESHWATER NUTRIENT CRITERIA DEVELOPMENT



NUTRIENT IMPAIRMENTS

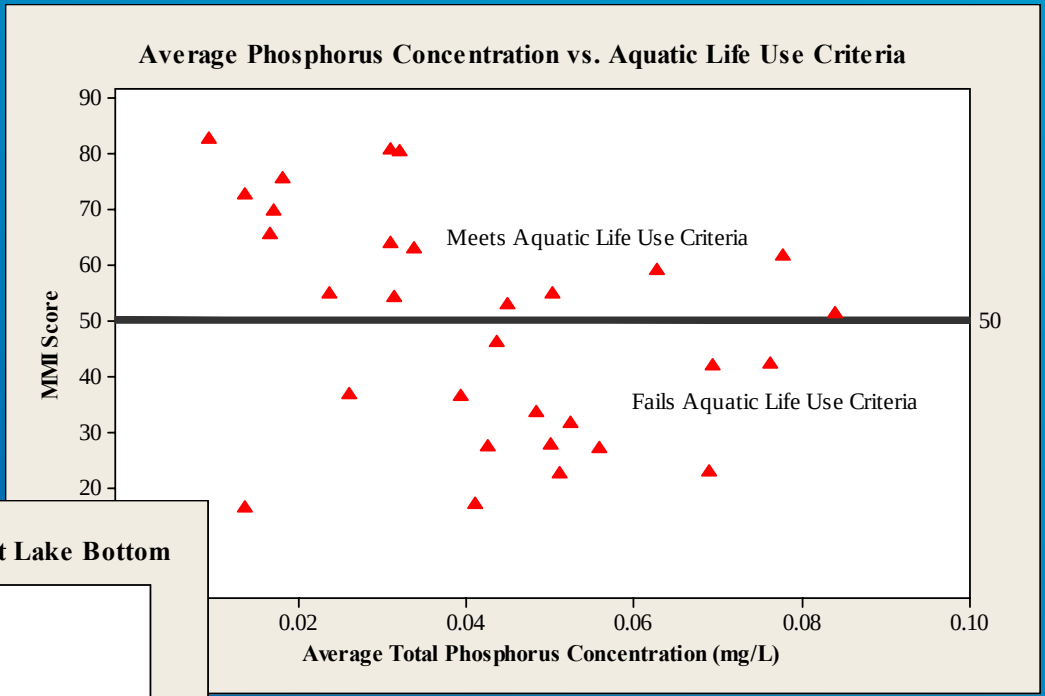
EPA cites nutrients (nitrogen and phosphorus) as one of the leading causes of water quality impairment in our Nation's rivers, lakes and estuaries and has required States to develop State-wide numeric criteria

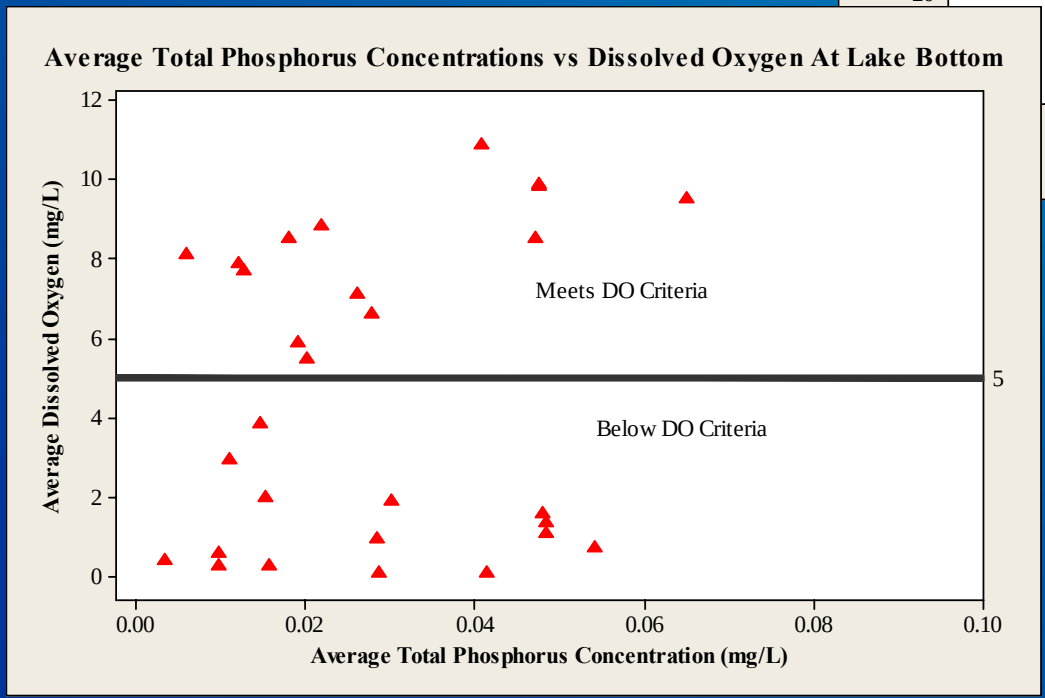




ISSUES

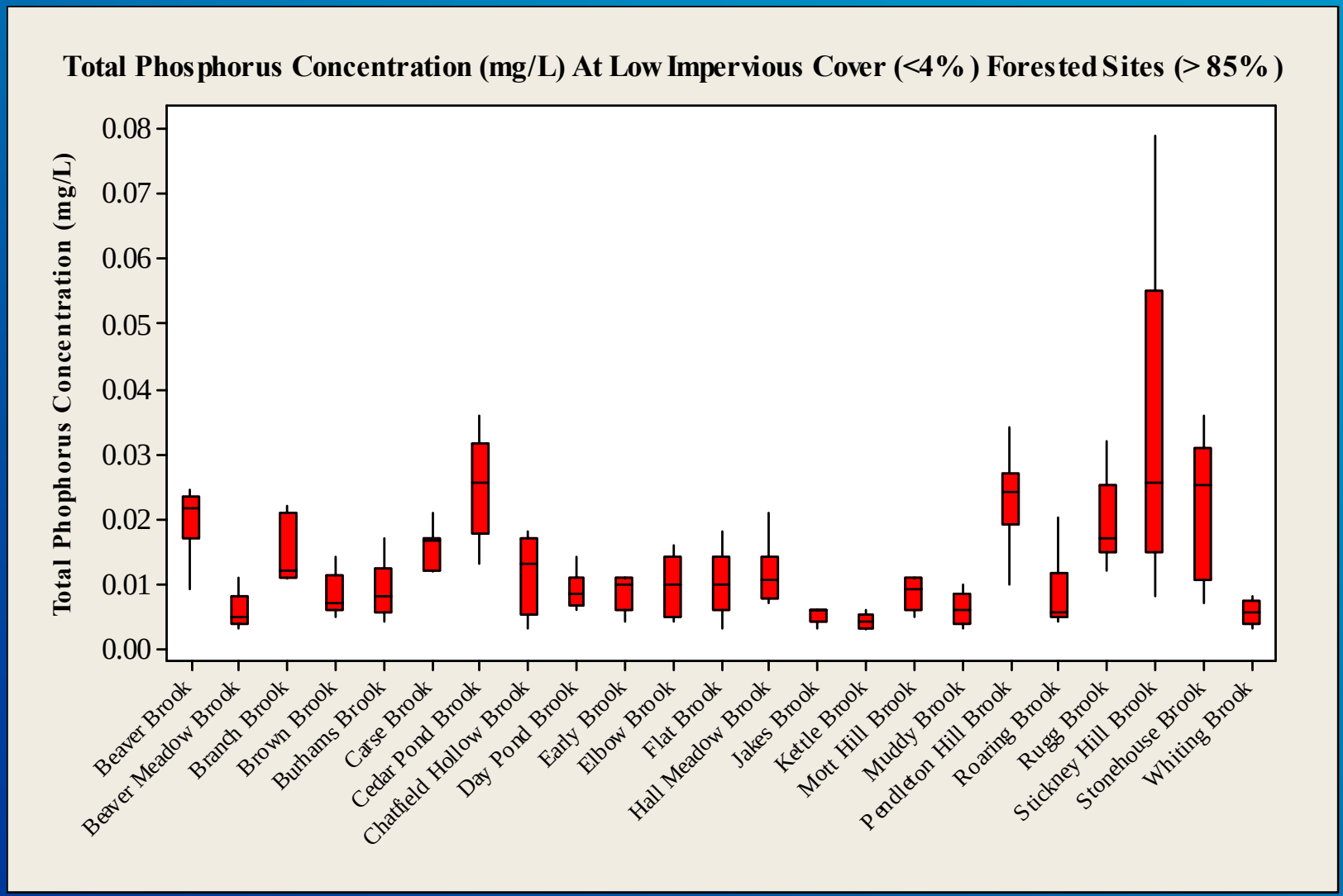
Phosphorus is NOT a Threshold Pollutant





ISSUES

Natural Variability



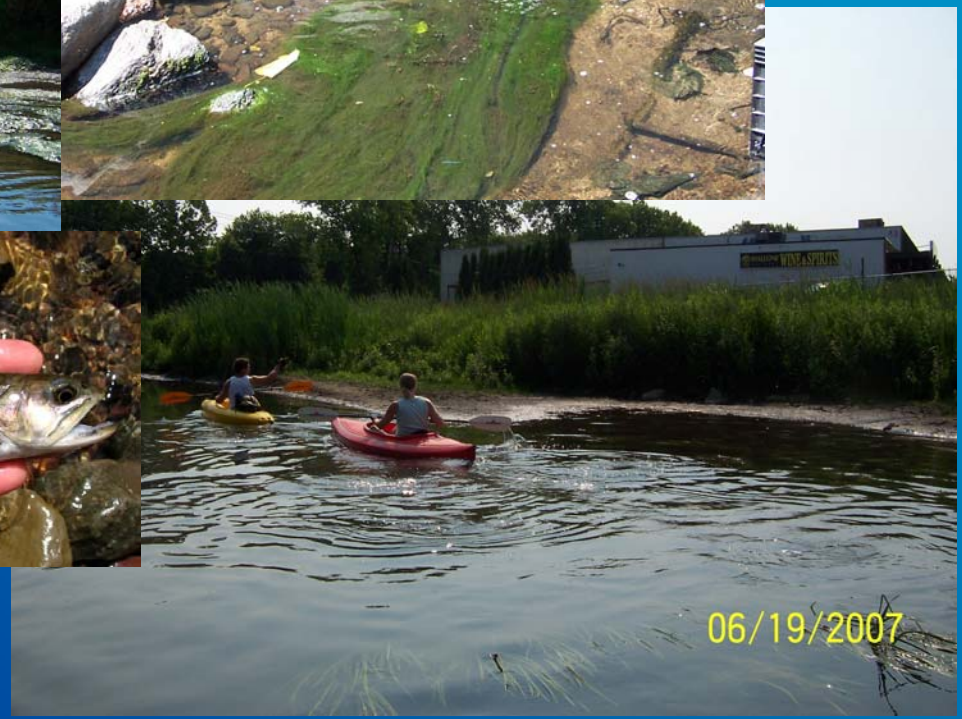
ISSUES

Implementation

Is this enough green?

Is this too green?

Does green impair recreational uses?



CURRENT WATER QUALITY STANDARDS

Numeric Interpretation of Current Narrative Water Quality Standard

8. ***Water Quality Criteria do not apply to certain conditions brought about by natural causes. Natural hydrologic and geologic conditions may cause excursions from established criteria. The meaning of the word 'natural' is not limited to only those conditions which would exist in water draining from pristine land. Conditions which exist in the surface water, in part due to normal uses of the land, may be considered natural, provided best management practices are used. It shall not be considered normal use of the land if excursions from established Criteria adversely impact an existing or designated use.***

19. ***Best Management Practices, discharge limitations or other reasonable controls on point and non-point sources of phosphorus and nitrogen, including sources of atmospheric deposition, which contribute to the impairment of any surface water shall be required by the Commissioner on a case-by-case basis as necessary to ensure maintenance and attainment of existing and designated uses.***

DEFINITIONS: Best Management Practices

means those practices which reduce pollution and which have been determined by the Commissioner to be acceptable based on, but not limited to, technical, economic, and institutional feasibility.

OBJECTIVES

Limit 'excess' nutrient export to waterbodies

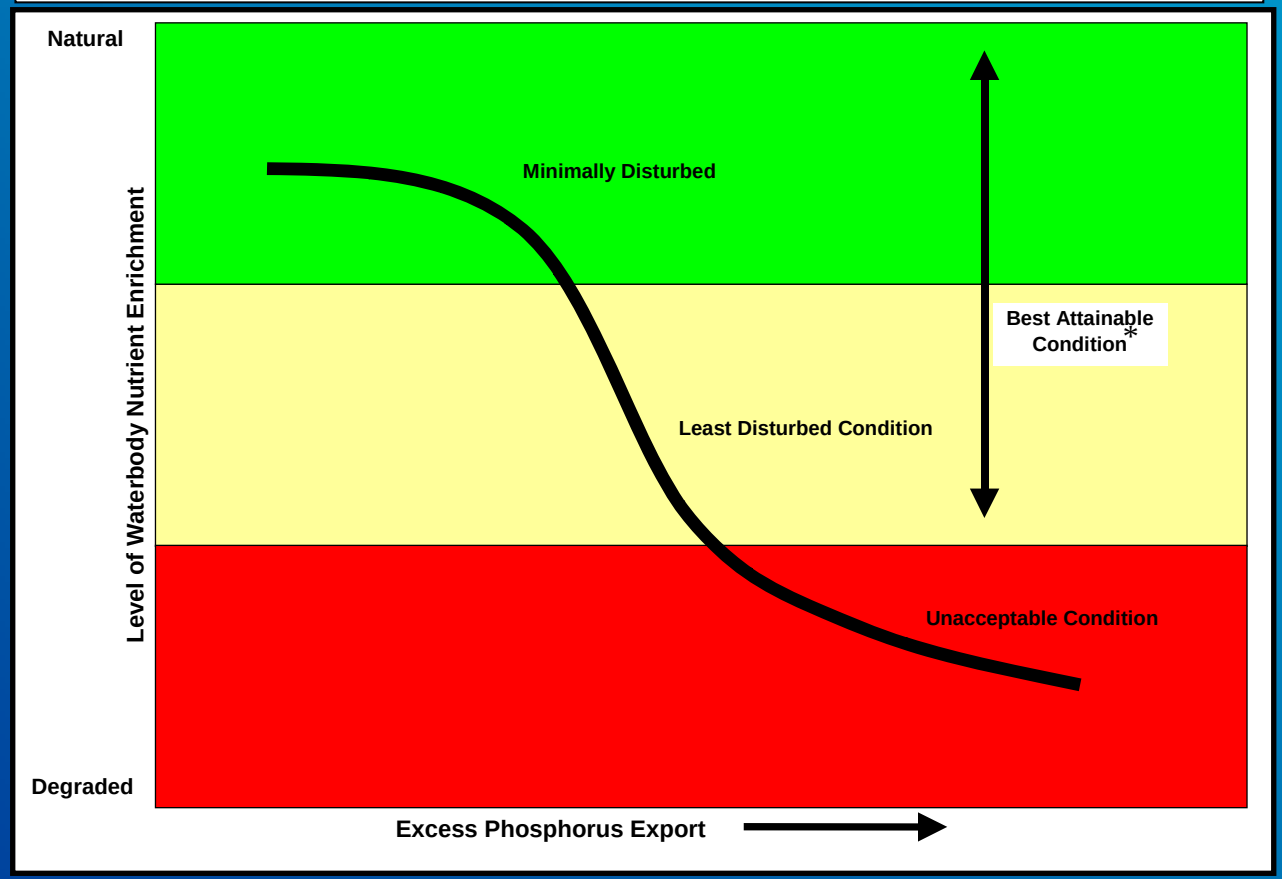
Work toward "reference conditions or the best attainable, most natural (trophic) conditions of the resource base at this time." (EPA, 2000)

Target waters at greatest risk of nutrient pollution

Provide direction for BMP implementation

reference conditions

Describe the characteristics of water body segments ***least impaired*** *by human activities. As such,* ***reference conditions can be used to describe attainable biological or habitat conditions*** *for water body segments with common watershed/catchment characteristics within defined geographical regions.* **(EPA, 2000)**



* (Stoddard, 2006)

METHODOLOGY

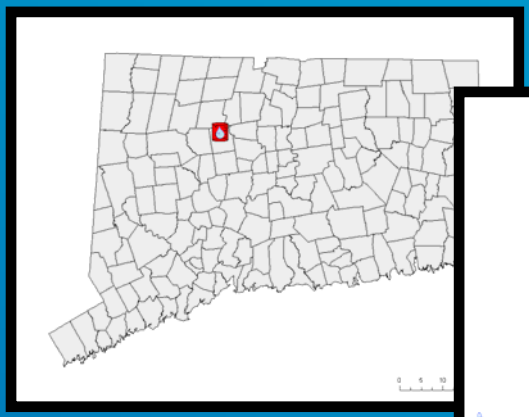
Pick a Location on Any Waterbody In the State and Delineate Watershed

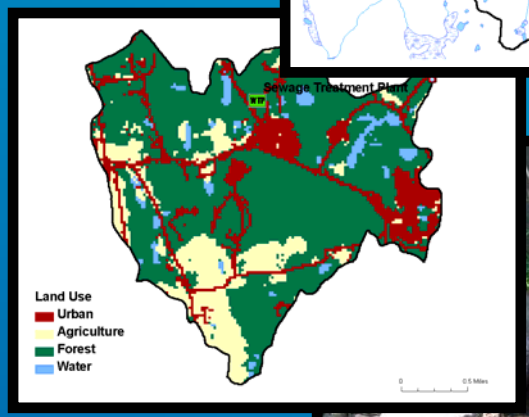
Classify Watershed by Land Use

Apply Best Management Practice (BMP) Land Use and Discharge Export Coefficients

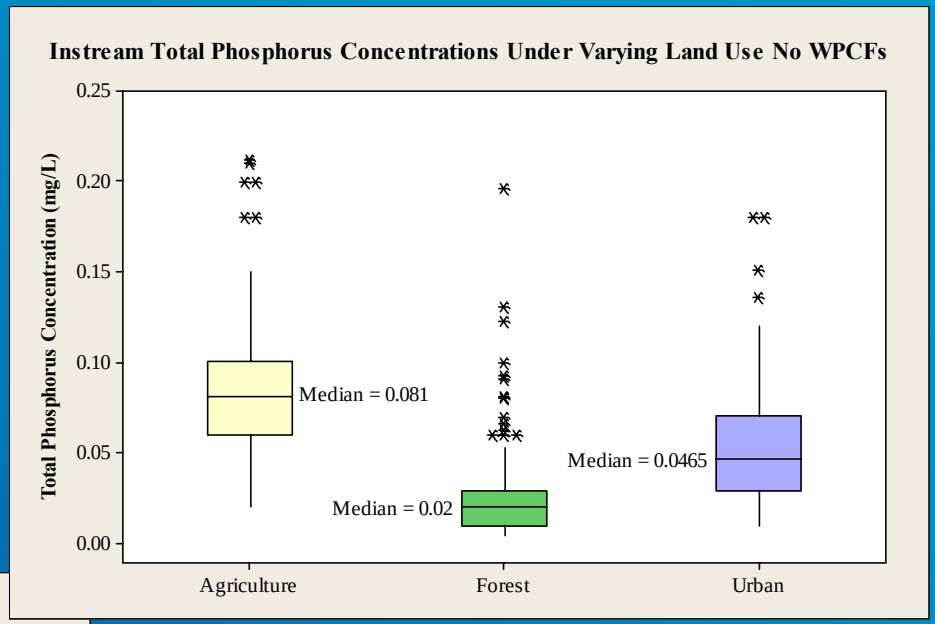
Calculate Best Attainable Condition (BAC) Nutrient Criteria for Watershed

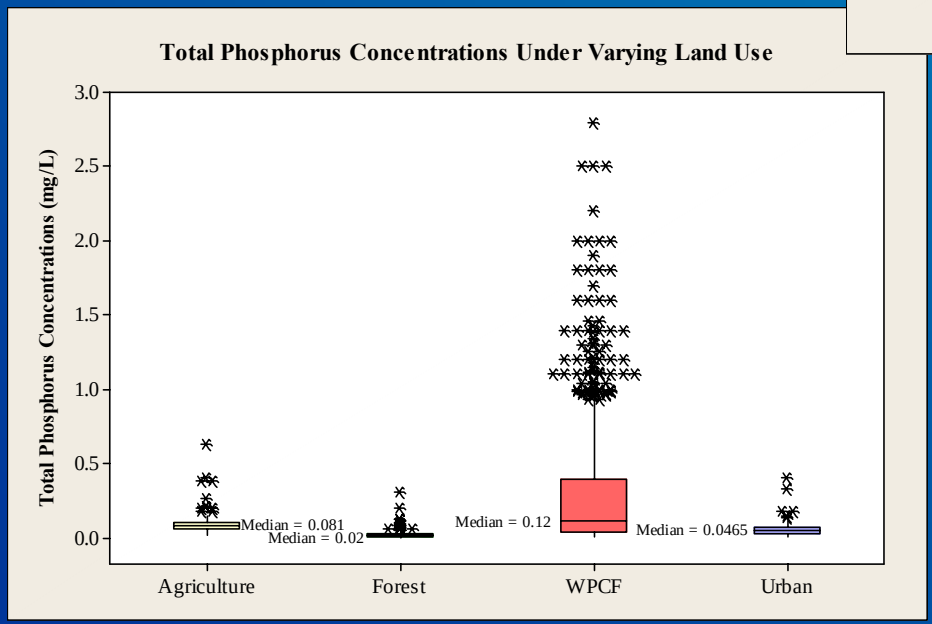
Develop Phosphorus TMDLs and Implement Nutrient Criteria





METHODOLOGY: Classify Watersheds By Land Use and Upstream Discharges





METHODOLOGY: Steps to Calculate Best Attainable Condition (BAC) Land Use Export Loads

1. **Obtained Seasonal (April through October) Long-Term USGS Water Quality and Discharge Data**
2. **Delineated Upstream Watershed from Gage Location and Calculate Land Use (Uconn Clear, 2002)**
3. **Applied Criteria to Determine which Gages to Use in Export Coefficients Models**
4. **Modeled Export Coefficients Across Varying Flow Conditions**
5. **Compared Export Coefficient Loads to 'Actual' Loads and Literature Values**
6. **Applied Applicable BMPs to Final Export Coefficients Across Varying Flow Conditions to Calculate BAC Land Use Load**

Criteria to Determine Relevant Gages for Export Coefficient Model*

Export Coefficient	% Land Cover Criteria	Other Land Cover Criteria	WPCF
Forest	> 75%	<= 10% Developed	NONE
Agriculture	> 25%	<= 10% Developed	NONE
Urban	> 25%	<= 10% Agriculture	NONE

* Based on (Gerritsen & Jessup, 2007) and (Wickham et al., 2005)

METHODOLOGY: Model Export Coefficients Across Varying Flow Conditions

Export Coefficient	Equation
Forest	= (0.0004553)(% Storm Chg) + 0.00005761
Urban	= (0.002002)(% Storm Chg) + 0.0001115
Agriculture	= (0.00589)(% Storm Chg) + 0.0008542

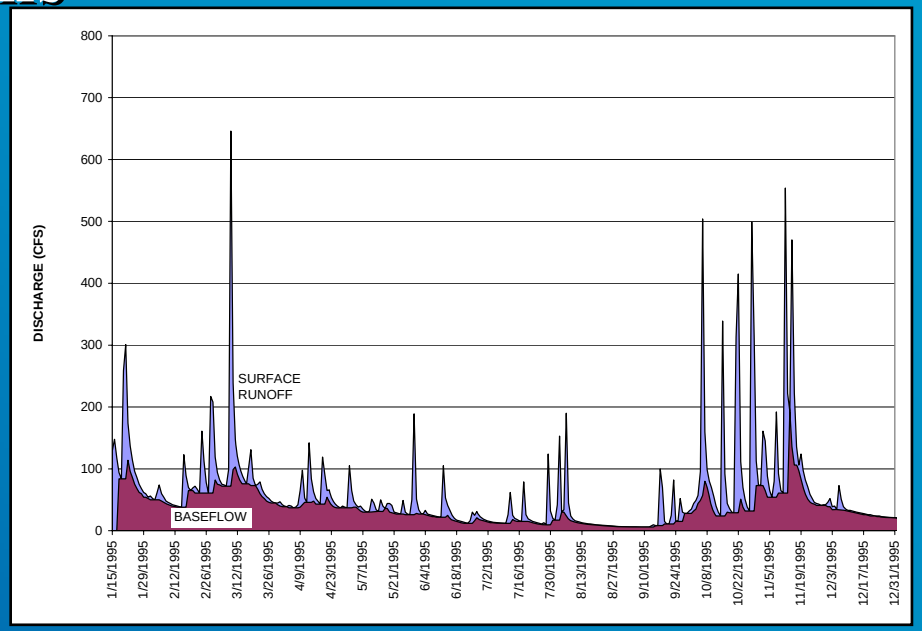


Figure 1. Forest Quantile Regression Scatterplot.

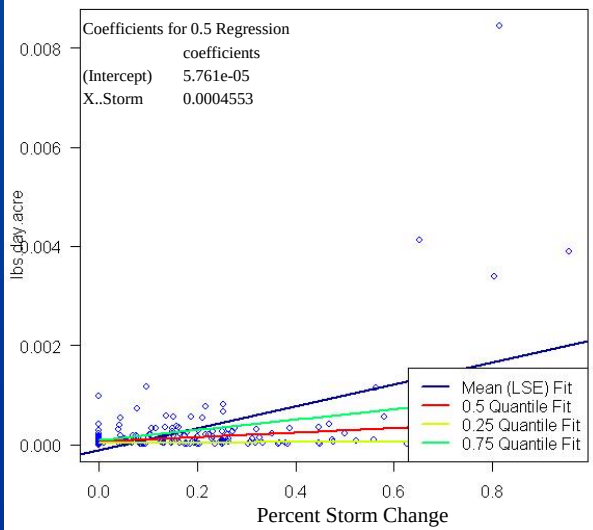


Figure 2. Agriculture Quantile Regression Scatterplot.

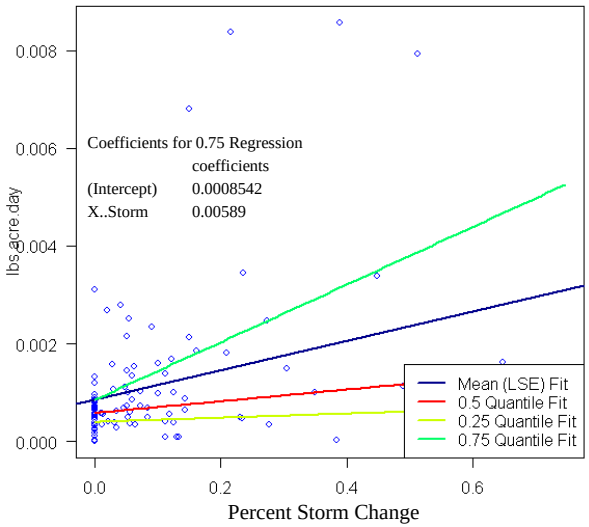
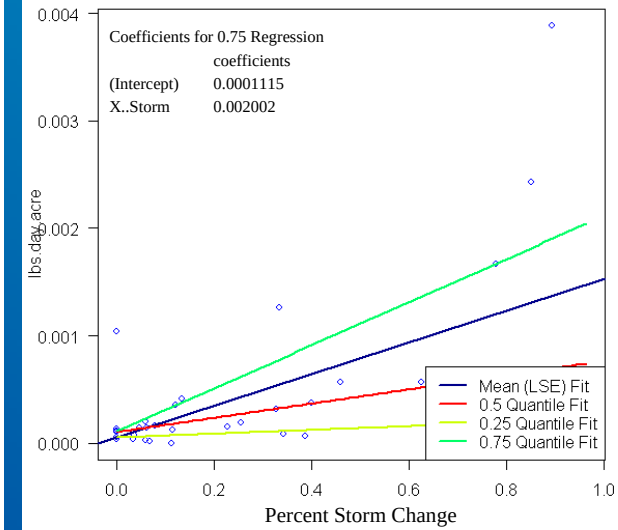


Figure 3. Urban Quantile Regression Scatterplot



METHODOLOGY: Compare Export Coefficient Non-Point Source Current Loads with 'Actual' Current Loads

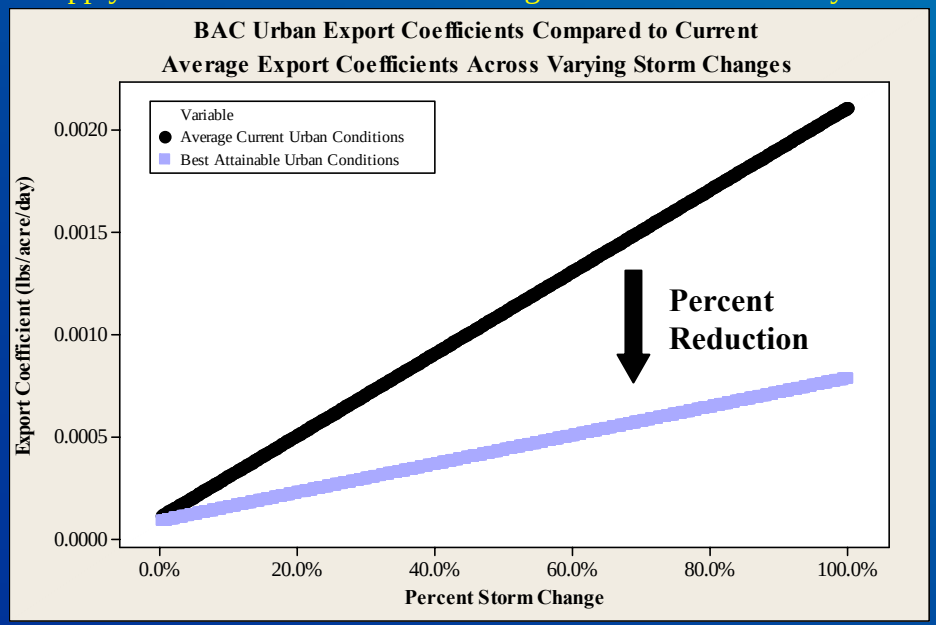
Station_ID	Station_Name	Watershed Area (Sq. Mi.)	%Urban	%Forest	%Agriculture	Total Export Coefficient Load (lbs/day)	Total Actual Load (lbs/day)
1608	MIRY BROOK AT YE OLDE RD	3.85	23.37%	68.29%	8.34%	**1.20**	**1.19**
1192704	MATTABESSET RIVER AT ROUTE 372 AT EAST BERLIN	46.9	44.11%	44.82%	11.07%	**16.95**	**23.07**
1184490	BROAD BROOK AT BROAD BROOK, CT.	15.6	12.09%	41.31%	46.60%	**6.96**	**12.72**
1188000	BUNNELL (BURLINGTON) BR NR BURLINGTON, CT	4.2	17.12%	67.45%	15.43%	**1.38**	**1.21**
1184100	STONY BROOK NEAR WEST SUFFIELD, CT.	10.5	10.37%	55.03%	34.60%	**6.64**	**4.81**

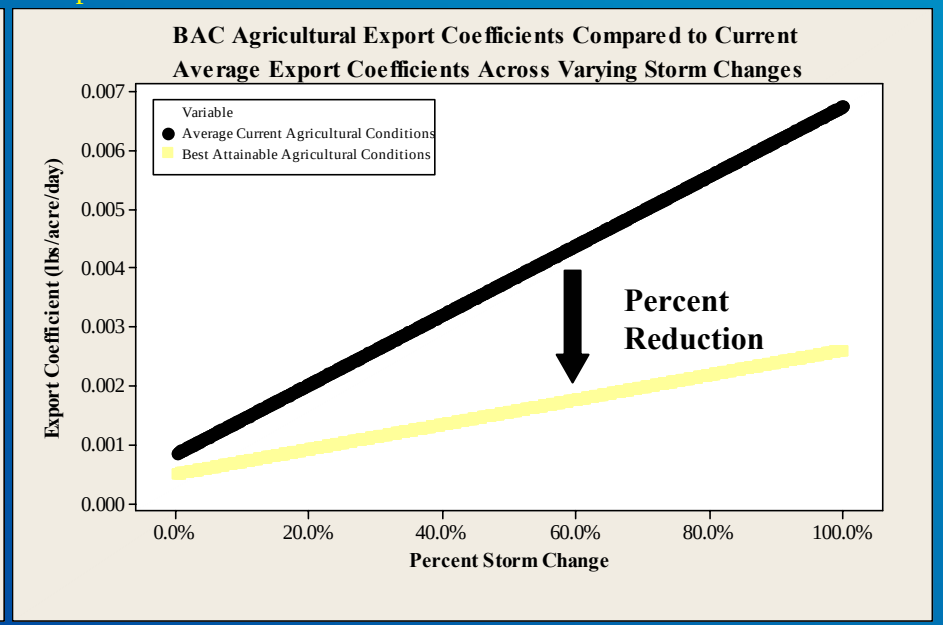
METHODOLOGY: Apply Applicable BMPs to Final Export Coefficients Across Varying Flow Conditions to Calculate BAC Land Use Export Load

Land Use Load = Σ[Average Land Use BMP Export * Upstream Land Use Area]

Export Coefficient	Average Export Coefficient (lbs/acre/day)	Literature Value BMP Percent Reductions (EPA, 1993)*	BMP Percent Reduction Used for Current Analysis*	Average BMP Export Coefficient (lbs/acre/day)
Urban	$4.34*10^{-4}$	5 – 65 %	60%	$2.61*10^{-4}$
Forest	$1.31*10^{-4}$	0 %	0%	$1.31*10^{-4}$
Agriculture	$18.04*10^{-4}$	30 –75 %	60%	$10.83*10^{-4}$

*Apply BAC BMPs Based on EPA Region 1 Stormwater Study When Complete





METHODOLOGY: Steps to Calculate BAC Discharge Export Loads

1. **Identify Flow in Surface Water Downstream from Relevant Discharge**
2. **Identify Indicators of Nutrient Enrichment in Surface Water Downstream from Discharge**
3. **Calculate the Percent Discharge Contribution to Waterbodies Indicating Nutrient Enrichment and Determine the Severity of Impact**
4. **Apply Appropriate Seasonal Limits Based on % Load Contribution and Severity of Impact**
5. **Calculate BAC Discharge Load Based on Current Flow**

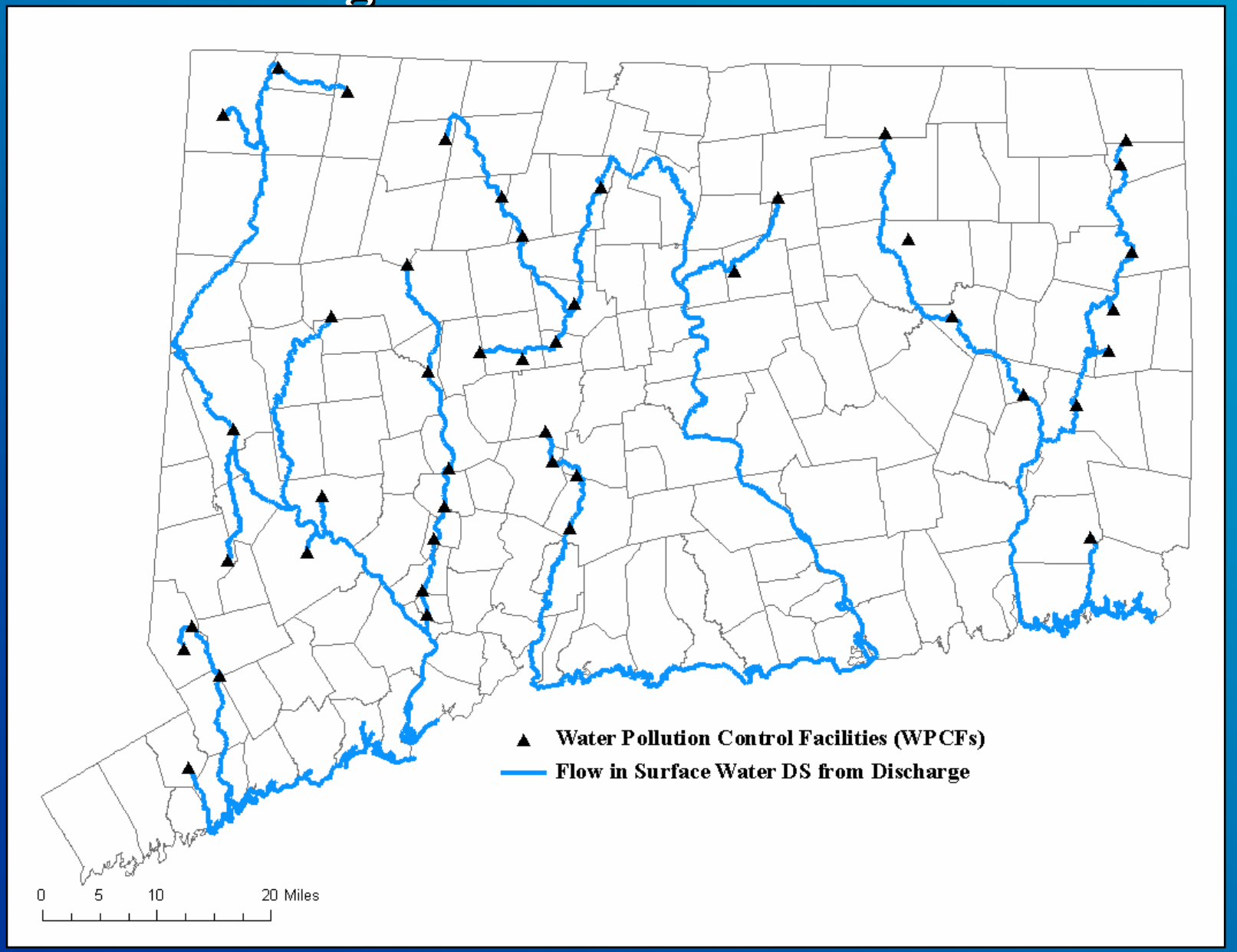
INDICATORS*

Habitat Factors that Affect Biomass Levels in Streams Given Adequate to High Nutrient Supply
▪Open Canopy ▪Shallow Stream Depth ▪Smaller Depth to Width Ratio

Response Variables that Indicate Nutrient Enrichment
▪High Levels of Phosphorus ▪High Levels of Algal Biomass as Chlorophyll *a* ▪pH and Dissolved Oxygen

* EPA (2000) Nutrient Criteria Technical Guidance Manual

METHODOLOGY: Identify Flow in Surface Water DS from Discharge



METHODOLOGY: Identify Indicators of Nutrient Enrichment

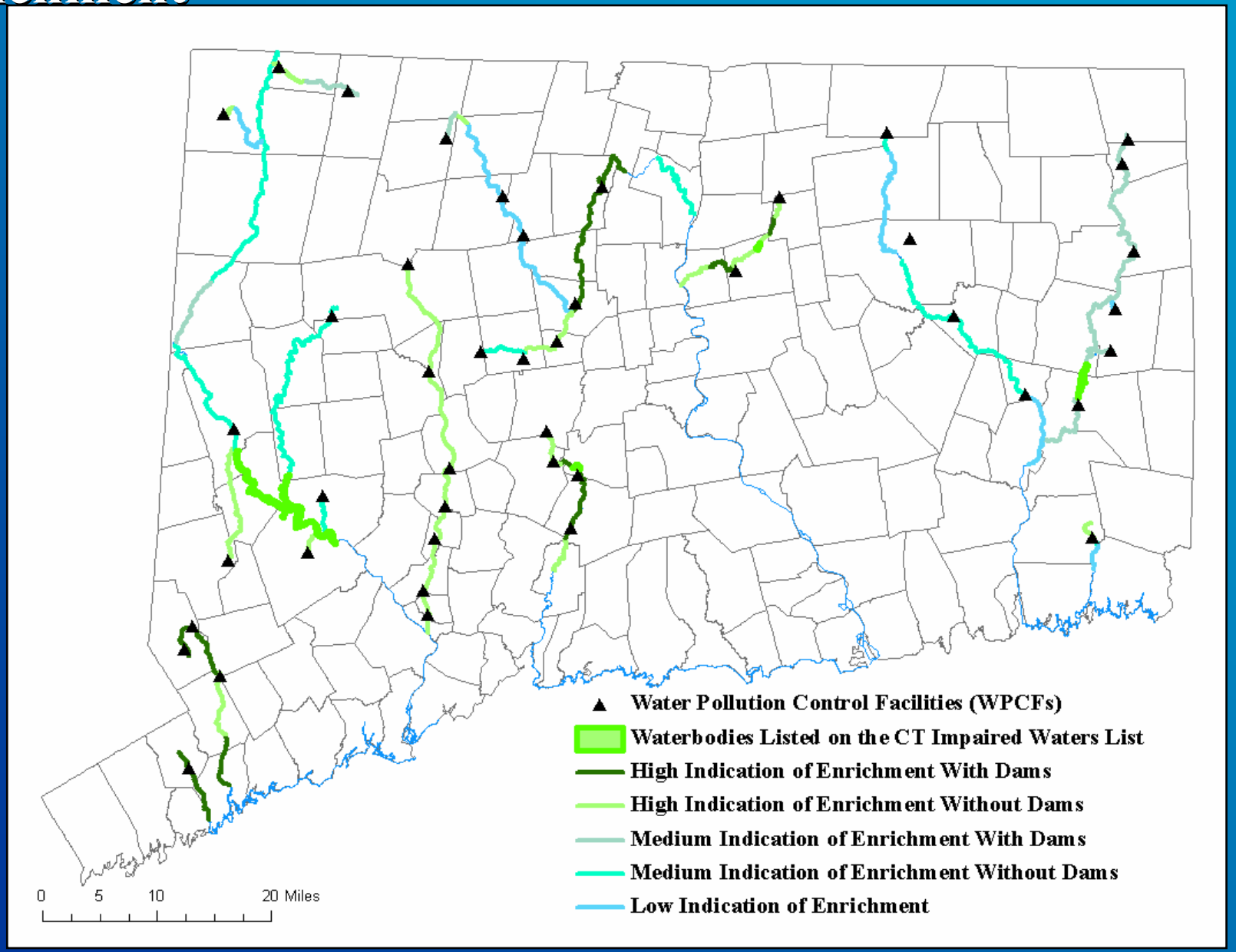
GIS Analysis of Response Variables that Indicate Nutrient Enrichment

Parameter	High Indication of Enrichment	Medium Indication of Enrichment	Low Indication of Enrichment
Seasonal (April – October) Total Phosphorus Concentrations (mg/L)	> 0.1	0.05 – 0.1	< 0.05
Seasonal (April – October) Chlorophyll a – Periphyton (mg/m^2)	> 100	50 - 100	< 50
Seasonal (April – October) Chlorophyll a – Plankton (mg/L)	>30	15-30	<15
Van Dam Trophic State Index – Eutrophentic Species (Presence / Absence)	5 (Eutrophentic)	4 (Meso-Eutrophentic)	< 4

GIS Analysis of Habitat Factors that Affect Biomass Levels

Parameter	Affect Biomass Levels	Do Not Affect Biomass Levels
Dams /Ponded Areas	Present	Absent

METHODOLOGY: Identify Indicators of Nutrient Enrichment



METHODOLOGY: Calculate the Percent Contribution of Discharge to Waterbodies Indicating Nutrient Enrichment

Downstream Waterbody Indication of Nutrient Enrichment	> 20 % Contribution	> 2 % - 20% Contribution	< 2% Contribution
Currently Listed on the 2006 CT 303d Impaired Waters List for Nutrient Impairment	**High**	**High**	**Low**
High Indication of Enrichment With Dams / Ponded Areas	**High**	**Medium**	**Low**
High Indication of Enrichment Without Dams / Ponded Areas	**Medium**	**Medium**	**Low**
Medium Indication of Enrichment With Dams / Ponded Areas	**Medium**	**Low**	**Low**
Medium Indication of Enrichment Without Dams / Ponded Areas	**Low**	**Low**	**Insignificant**
Low Indication of Enrichment	**Insignificant**	**Insignificant**	**Insignificant**

METHODOLOGY: Apply Appropriate Average BMP Seasonal (April through Oct.) Performance Limits

Average Performance Limits Based on the Average Percent Total Phosphorus Load Contribution to Varying Levels of Nutrient Enriched Waterbodies

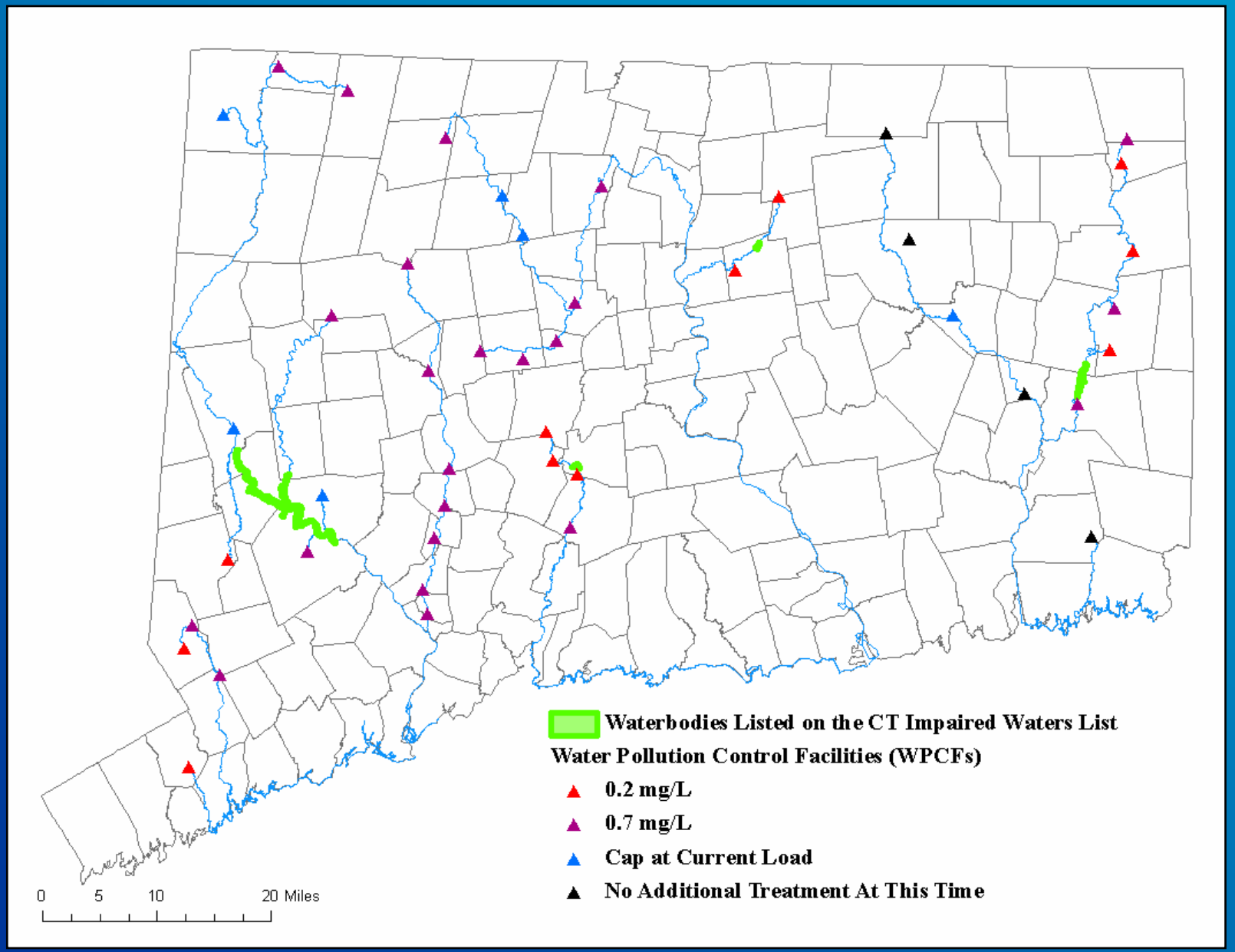
BMP Average Performance	Feasibility
0.2 mg/L	Technically Feasible with Additional Filters and Chemical Addition.
0.7 mg/L	Technically and Economically Feasible with Chemical Addition.
Cap at Current Load	May Need Additional Treatment if Future Expansion is Planned.
Monitor and Reevaluate	No Additional Treatment at this Time. Continue to Monitor and Reevaluate if Necessary.

METHODOLOGY: Apply Appropriate Average BMP Seasonal (April through Oct.) Performance Limits

Average Performance Limits Based on the Average Percent Total Phosphorus Load Contribution to Varying Levels of Nutrient Enriched Waterbodies

Downstream Waterbody Indication of Nutrient Enrichment	> 20 % Contribution	> 2 % - 20% Contribution	< 2% Contribution
Currently Listed on the 2006 CT 303d Impaired Waters List for Nutrient Impairment	0.2 mg/L	0.2 mg/L	Cap at Current Load
High Indication of Enrichment With Dams / Ponded Areas	0.2 mg/L	0.7 mg/L	Cap at Current Load
High Indication of Enrichment Without Dams / Ponded Areas	0.7 mg/L	0.7 mg/L	Cap at Current Load
Medium Indication of Enrichment With Dams / Ponded Areas	0.7 mg/L	Cap at Current Load	Cap at Current Load
Medium Indication of Enrichment Without Dams / Ponded Areas	Cap at Current Load	Cap at Current Load	Monitor and Reevaluate
Low Indication of Enrichment	Monitor and Reevaluate	Monitor and Reevaluate	Monitor and Reevaluate

METHODOLOGY: Preliminary Seasonal Average Performance Limits at WPCFs



METHODOLOGY: Calculate BAC Discharge Export Load

BMP Average Performance	Feasibility
0.2 mg/L	Technically Feasible with Additional Filters and Chemical Addition.
0.7 mg/L	Technically and Economically Feasible with Chemical Addition.
Cap at Current Load	May Need Additional Treatment if Future Expansion is Planned.
Monitor and Reevaluate	No Additional Treatment at this Time. Continue to Monitor and Reevaluate if Necessary.

BAC Discharge Export Load = Concentration * Current (5-Year) Average Flow Rate

IMPLEMENTATION

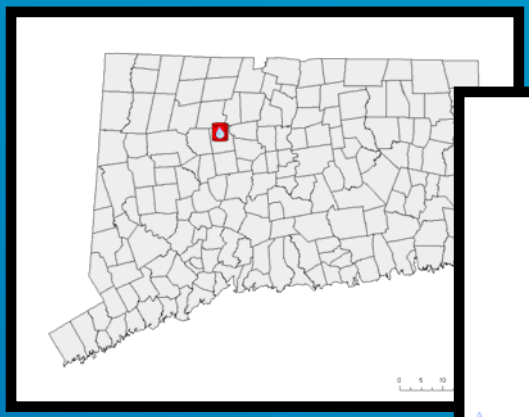
Pick a Location on Any Waterbody In the State and Delineate Watershed

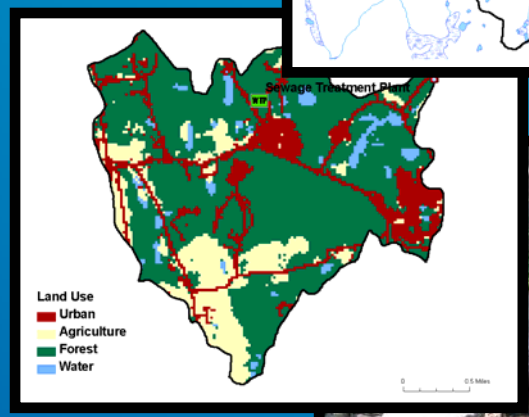
Classify Watershed by Land Use

Apply Best Management Practice (BMP) Land Use and Discharge Export Coefficients

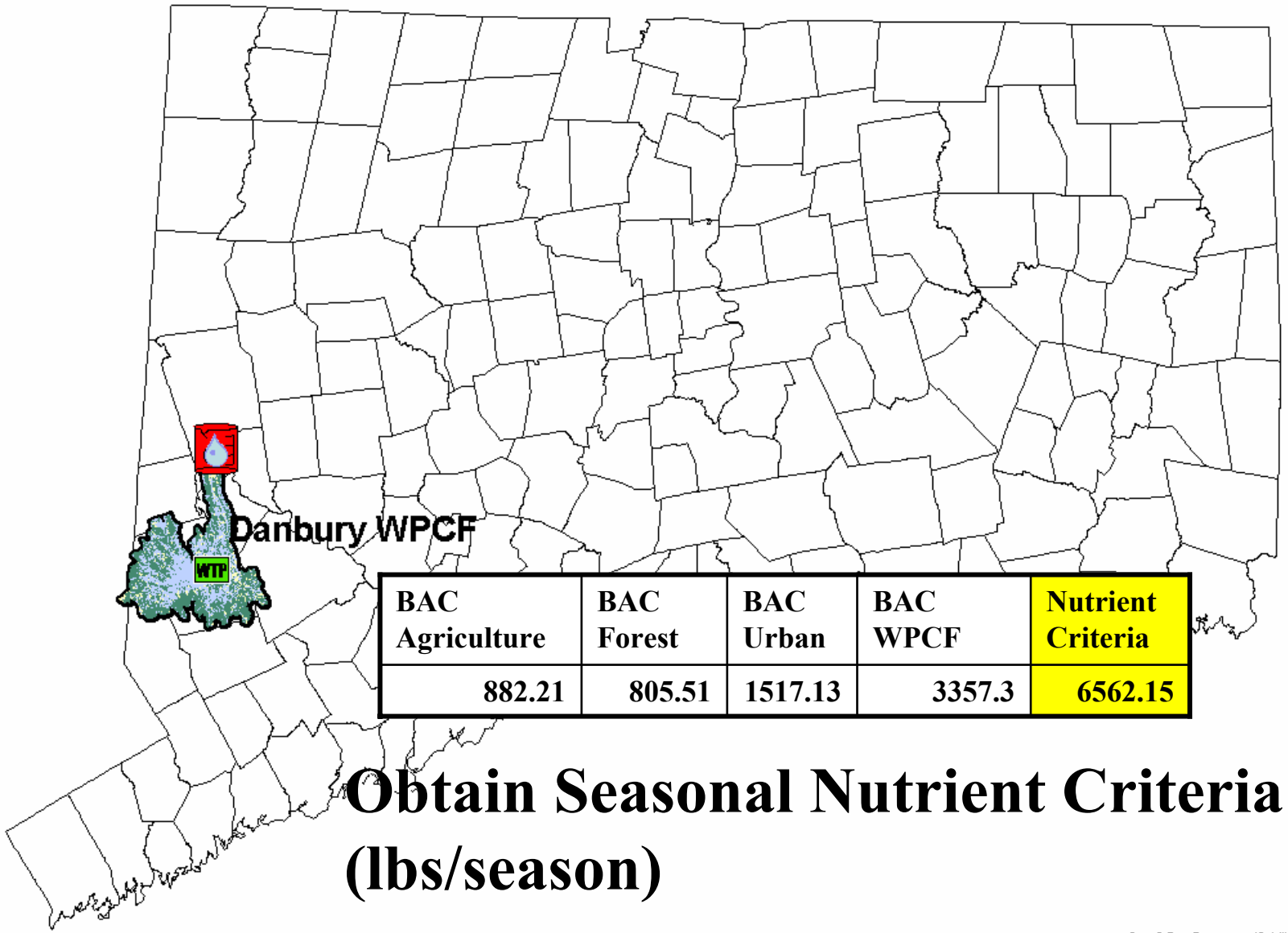
Calculate Best Attainable Condition (BAC) Nutrient Criteria for Watershed

Develop Phosphorus TMDLs and Implement Nutrient Criteria





Pick a location anywhere in the State…

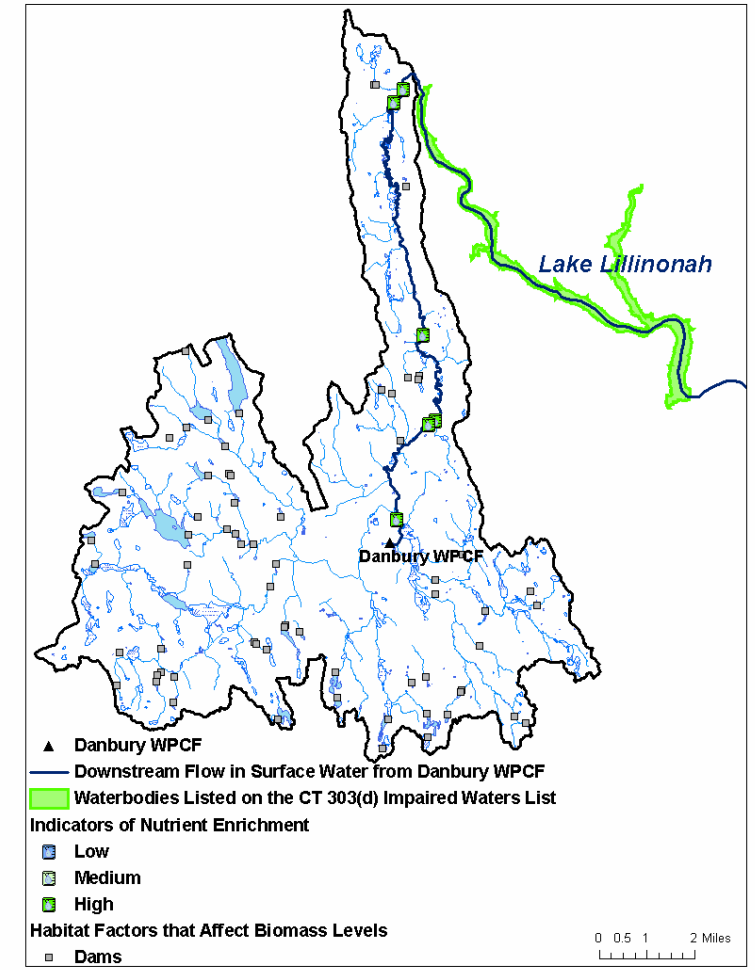


BAC Agriculture	BAC Forest	BAC Urban	BAC WPCF	Nutrient Criteria
882.21	805.51	1517.13	3357.3	6562.15

Obtain Seasonal Nutrient Criteria (lbs/season)

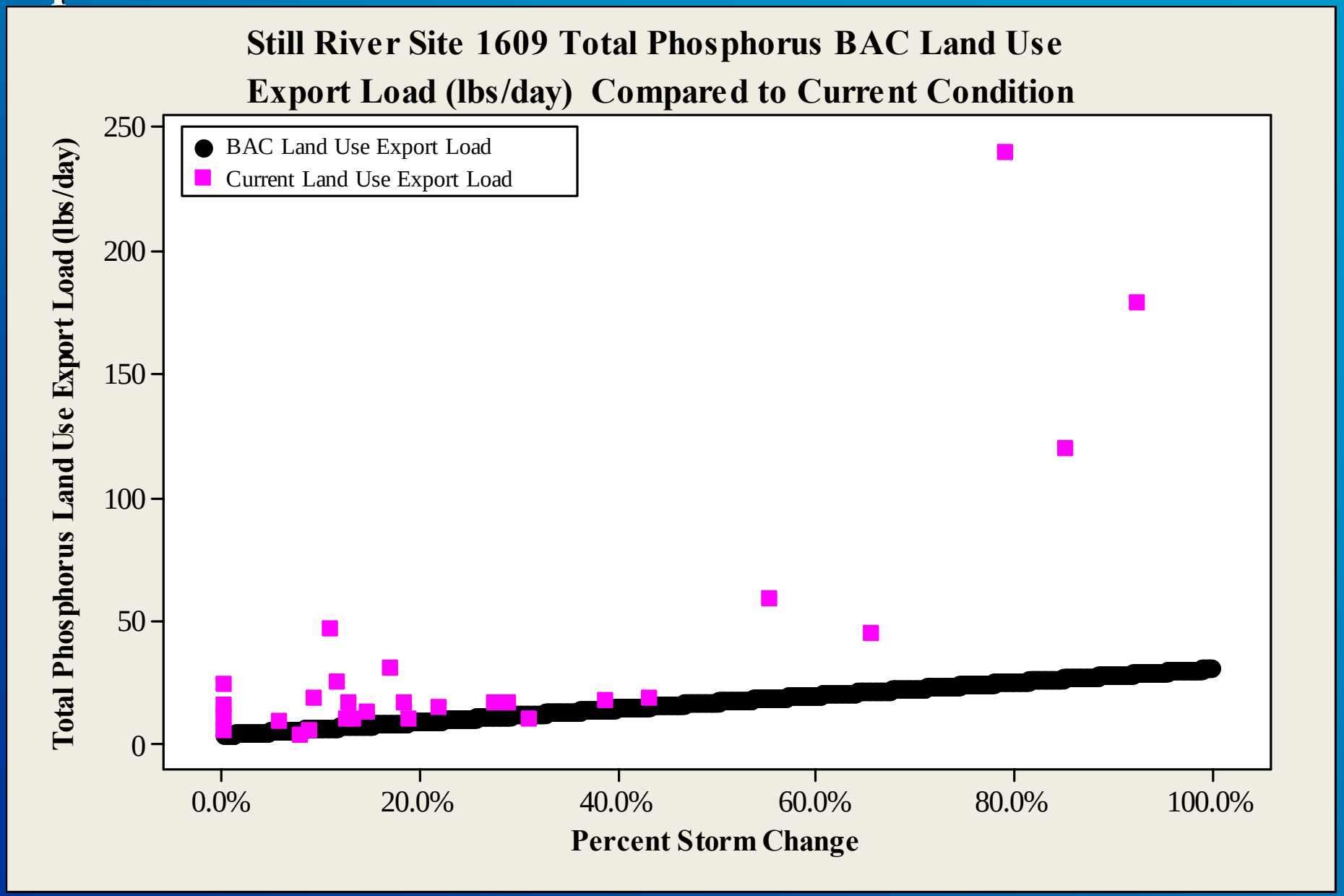
IMPLEMENTATION:
Danbury WPCF BAC Export Load

Permit	Plant	BAC Average Performance Limit	Current (5-Year) Average Flow Rate	BAC Export Load
CT0100145	Danbury WPCF	0.2 mg/L	9.58 mgd	**3357.3 lbs**

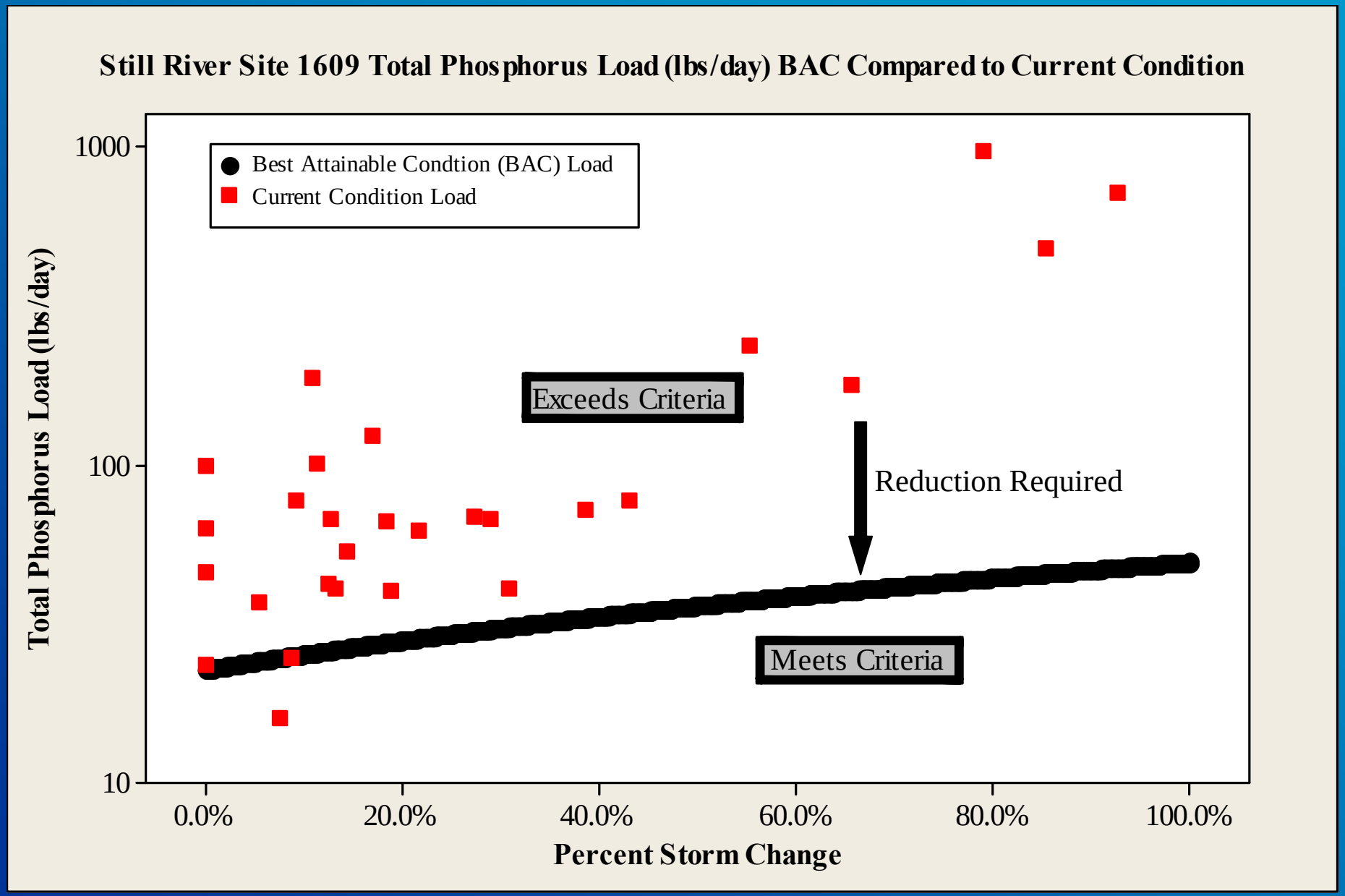


Permit	Plant	Average Seasonal Daily Load (lbs/day)	Downstream Waterbody of Concern	Area Upstream Waterbody (Sq Mi)	~ Average Load at Waterbody Outfall (lbs/day)	% of WPCF Contribution to Phosphorus Load
CT0100145	Danbury WPCF	71.65	Lake Lillinonah	1391.38	573.13	12%
CT0100145	Danbury WPCF	71.65	Limekiln Brook	13.85	84.1	85%

IMPLEMENTATION: Still River BAC Land Use Export Load



IMPLEMENTATION: Still River TMDL



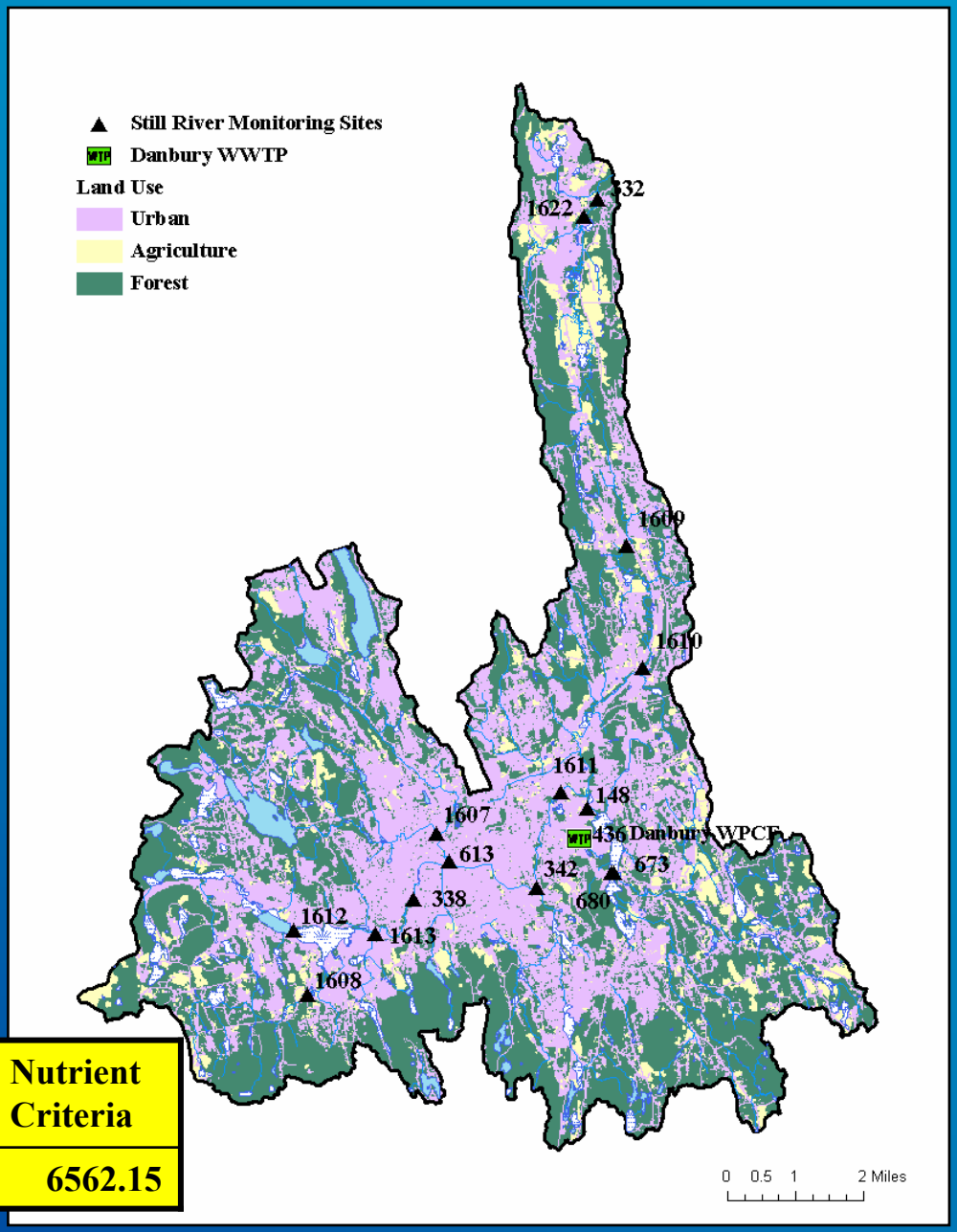
STILL RIVER: Getting Back to BAC

TMDL = WLA + LA + Background + Margin of Safety

WLA = BAC WPCF
LA = BAC Agriculture + BAC Urban
Background = BAC Forest
TMDL = Nutrient Criteria

Load	Average Current Load (lbs/season)	Average TMDL (lbs/season)	Average Percent Reduction
WLA	15046.5	3357.3	78%
LA	4804.4	3204.85	33%
Total	19850.9	6562.15	66%

BAC Agriculture	BAC Forest	BAC Urban	BAC WPCF	Nutrient Criteria
882.21	805.51	1517.13	3357.3	6562.15



QUESTIONS ?

Mary Becker

mary.becker@ct.gov

Department of Environmental Protection

Bureau of Water Protection and Land Reuse

79 Elm Street, Hartford CT 06106

www.ct.gov/dep