Nitrogen Load Modeling of Nonpoint Sources in the Oyster River Watershed

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Vanasse Hangen Brustlin
UNH WRRC
Woodard & Curran

Primary Goal: Reduce Nitrogen Inputs to the Great Bay & Oyster River Estuary

- Two Options:
  - Rely entirely on WWTF upgrades.
  - Balance WWTF upgrades with nonpoint source control measures through an Integrated Watershed Plan.

Benefits of an Integrated Watershed Plan

- Meet Water Quality Objectives with ***Sustainable*** Point Source and ***Green*** Non-point Source Improvements.

- Integrate Multiple Permits

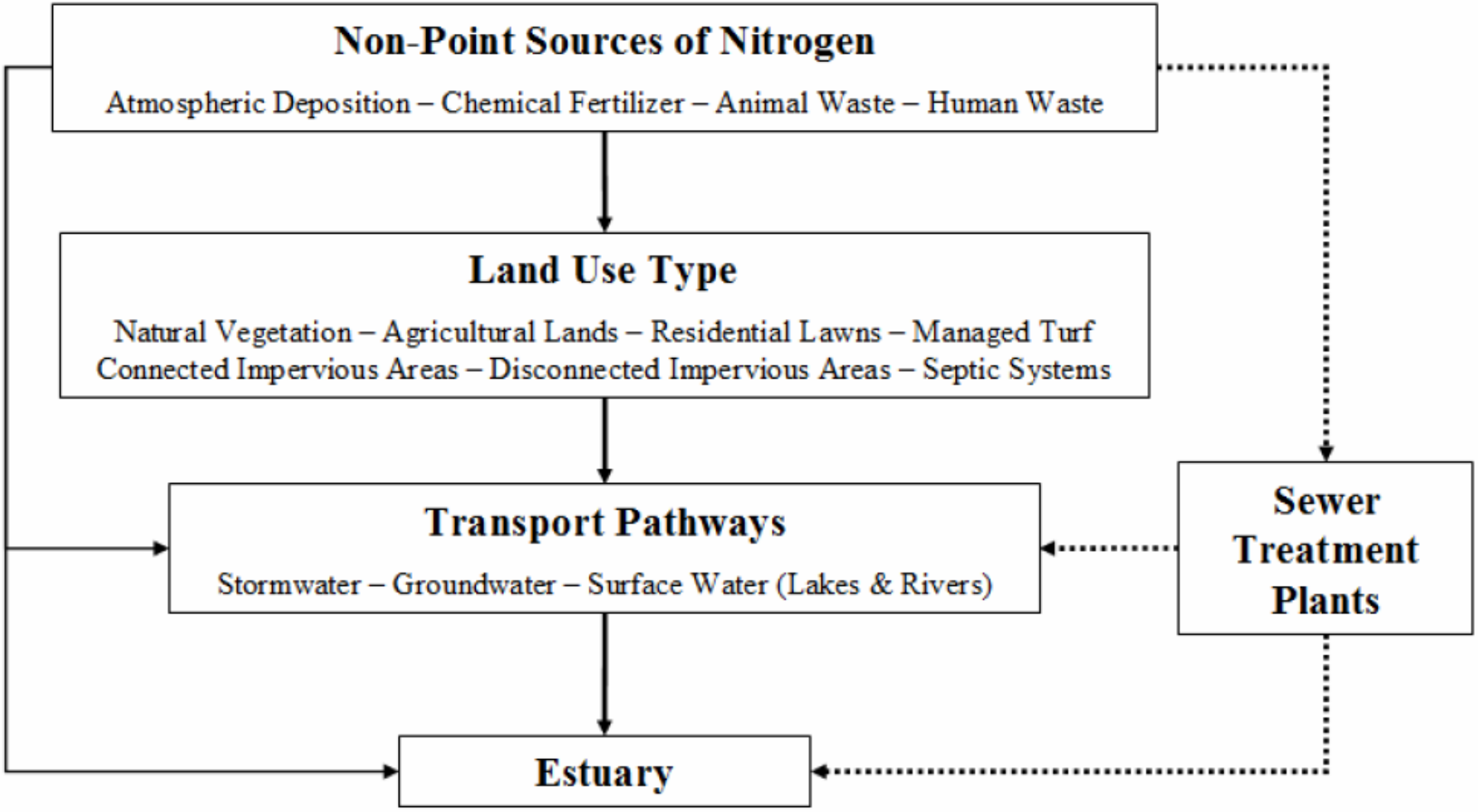
- Identify Cost-Effective solutions.

  Economic-Environmental-Social **triple bottom line approach**

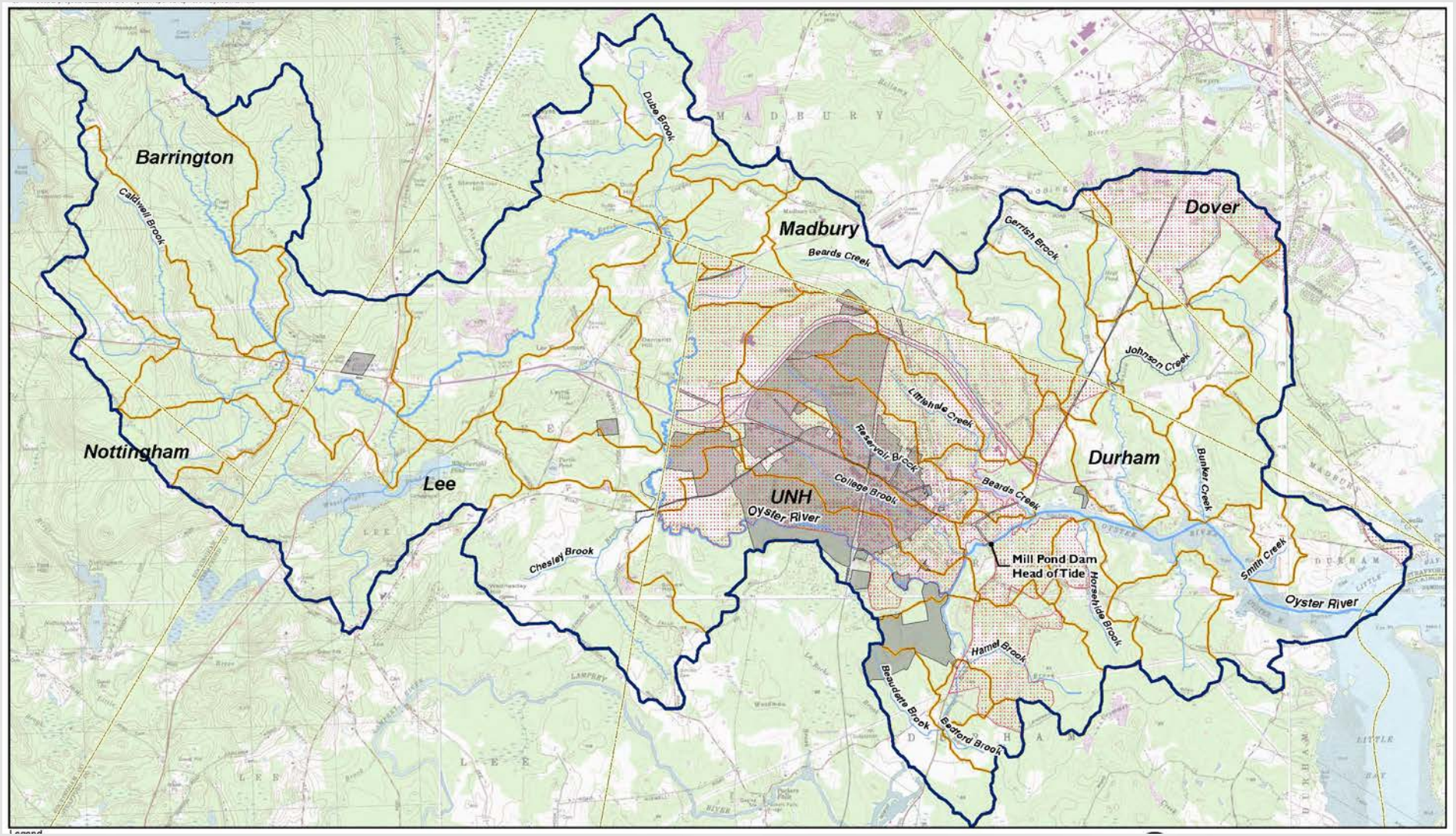
Basics Info of Nitrogen Load Model

- Published by Valiela et al. (1997) to predict NPS loads to Waquoit Bay in the Cape Cod Region.
- Predicts Annual Total Nitrogen Loads delivered to Estuary based on Source Quantity, Load Inputs and Assumed Attenuation along Flow Path.
- Most Appropriate for Use on Watershed Scale.
- NHDES completes Great Bay Nonpoint Nitrogen Pollution Study (GBNNPS) in May 2013: Estimated Model Accuracy of +/- 13 %

Simplified Watershed Nitrogen Loading Model for the Great Bay Nitrogen Non-Point Source Study



Major Subwatershed and Analysis Units



Updated Data for Land Use / Sources

- Impervious Cover:
  - 2010 High Resolution Imagery for Durham
  - UNH Campus GIS Mapping Data
  - Storm Drain System Mapping to determine DCIA and DIA
- Lawn Area
  - Used LiDAR to exclude Tree Canopy and Imp. Cover
  - UNH Campus GIS Mapping Data
  - Conducted Resident Survey to Estimate Fertilizer Usage
- Septic Systems
  - Used Aerial Imagery to Determine Building Counts /Locations
- UNH Manure Application Rate and Locations

Impervious Area

Delineation of Lawn Area

Key Model Assumptions

- Lawn Source Loading Rate
  - Average Fertilizer Rate: 2 lbs/1000ft^2/yr
  - Percent of Lawns Fertilized: 45 %
  - Pro-rated Fertilizer Rate: 39 lb/ac/yr
  - UNH Estimated Fertilizer Rate: 26 lb/ac/yr

Key Model Assumptions

Source	Load Rate
Atmosphere	5.2 lbs/ ac
Septic	10.6 lbs / person /yr
Cows	198 lbs / cow
Horses	88 lbs/ horse
Dogs	1.1 lbs / dog
Agriculture	25 – 57 lbs / ac
Agriculture – UNH manure	80-207 lbs/ac

Compiled Data on IC Load (lb/ac/yr)

Land Use	NLM Model	Chesapeake Bay Model	EPA Draft MS4 Permit	DES Simple Method	UNH SC	EPA Region 1 (M. Voorhees)
Impervious Cover	7.0	11.0	14.1			17.4*
Commercial/ Res Parking				14.7*		
A-Lot Parking					18.2*	

* Much depends on EMC Conc. (~ 2.0 mg/L), Annual Rainfall Volume (varies from 40 inches used in Simple Method, 43 inches by M. Voorhees and 48 inches used by UNH SC) and Annual Runoff Volume.

Key Model Assumptions

- Impervious Cover Sources
  - Atmospheric: 5.2 lb/ac/yr
  - Pet waste: 1.1 lbs/ac/yr
  - Local Sources: 7.8 lbs/ac/yr

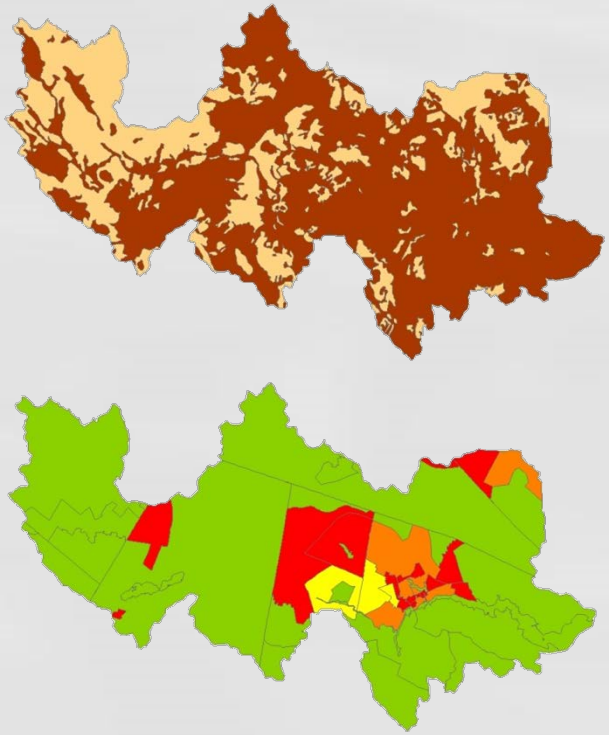
  - TOTAL: 14.1 lbs/ac/yr

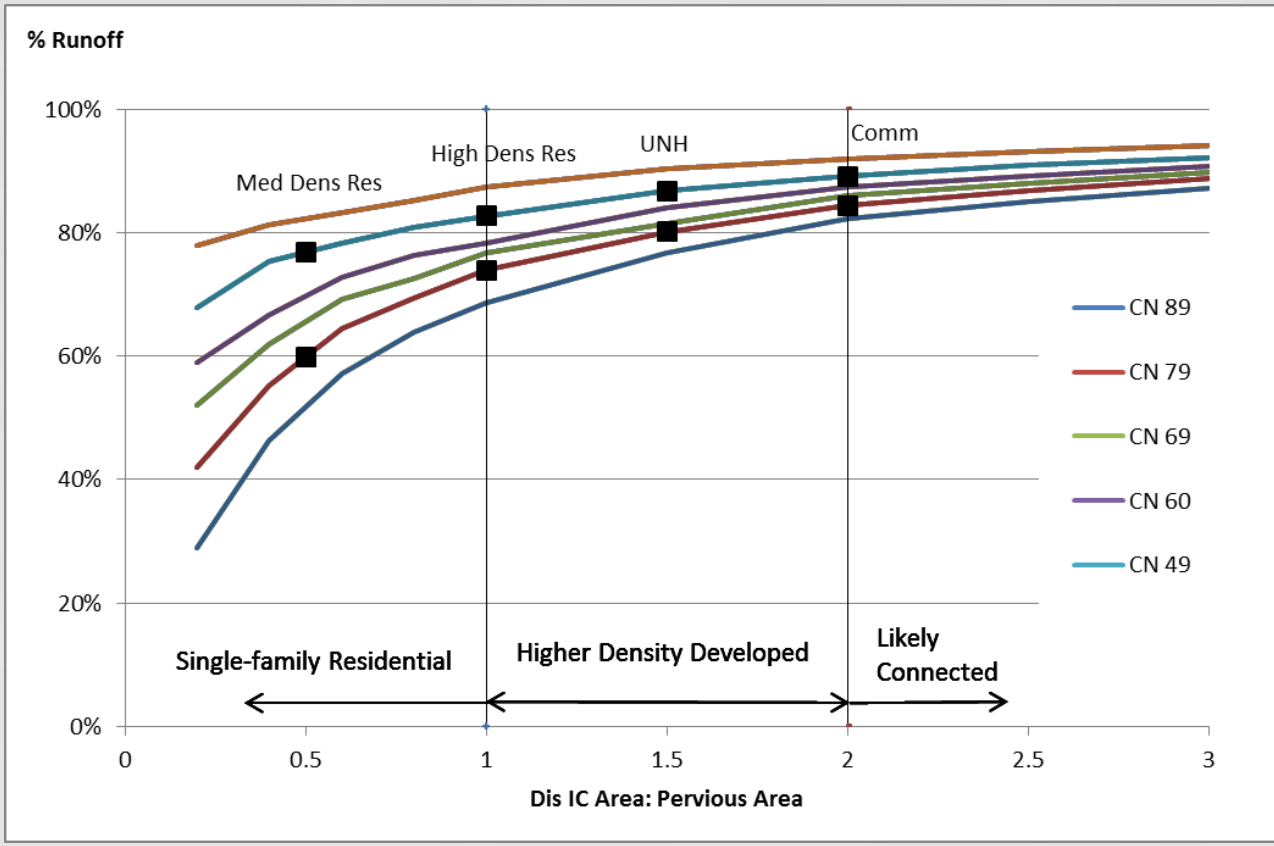
Key Model Assumptions

- Transport Pathway Partitions based on Soil Type

Land Cover	SW	GW
Natural Vegetation	3-13%	87-97%
Pervious Developed Areas	3-15%	87-85%
Disconnected Impervious Cover	54-76%	46-24%
Connected Impervious Cover	100%	0
Septic	0	100%

Disconnected IC Pathway





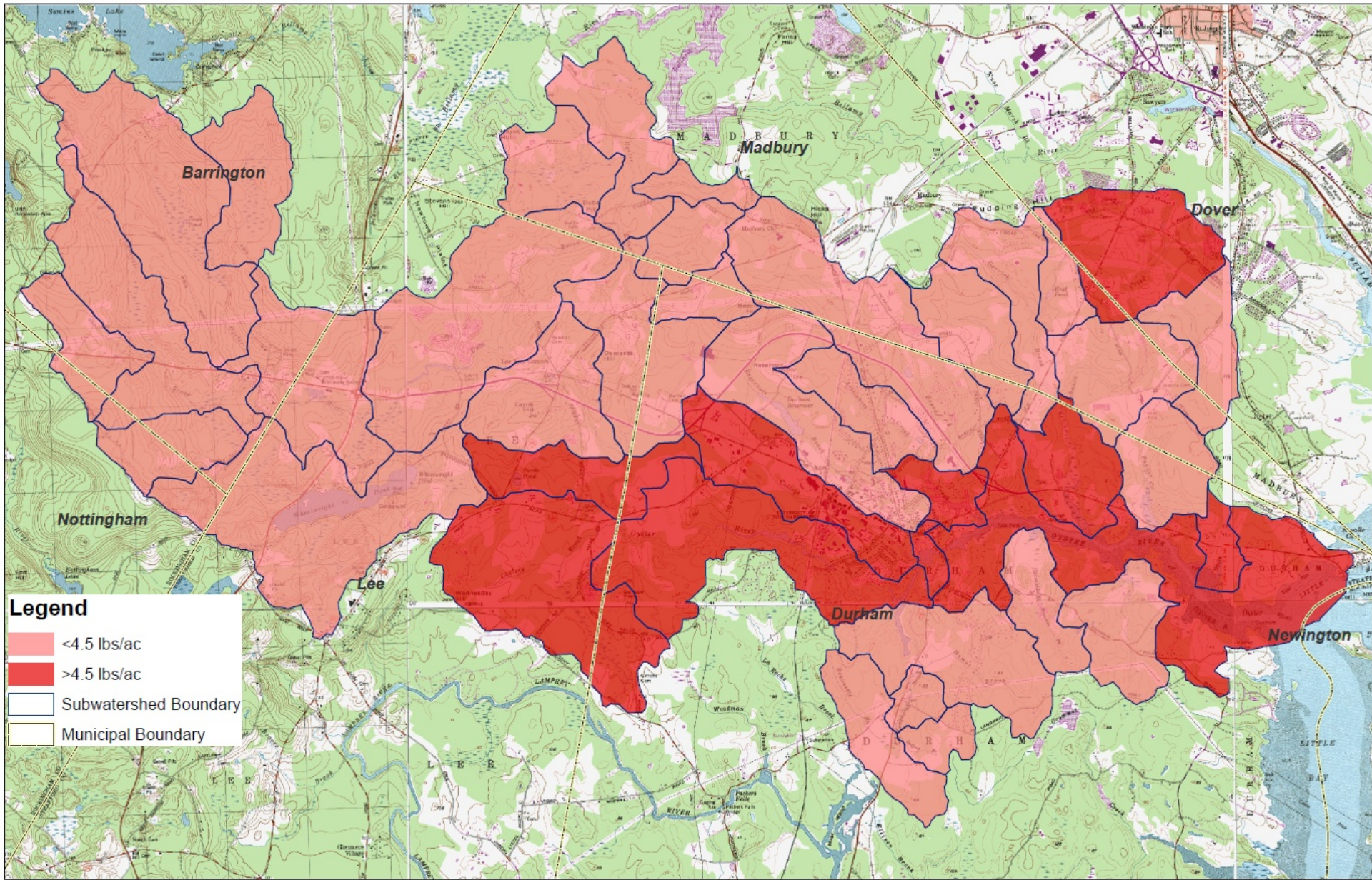
Key Model Assumptions

- Delivery Rates based on Pathway
  - Surface (Stormwater) — 87% Delivered
  - Groundwater
    - Pervious Land covers: — 10% - 16% Delivered
    - Septic — 25% and 60% Delivered

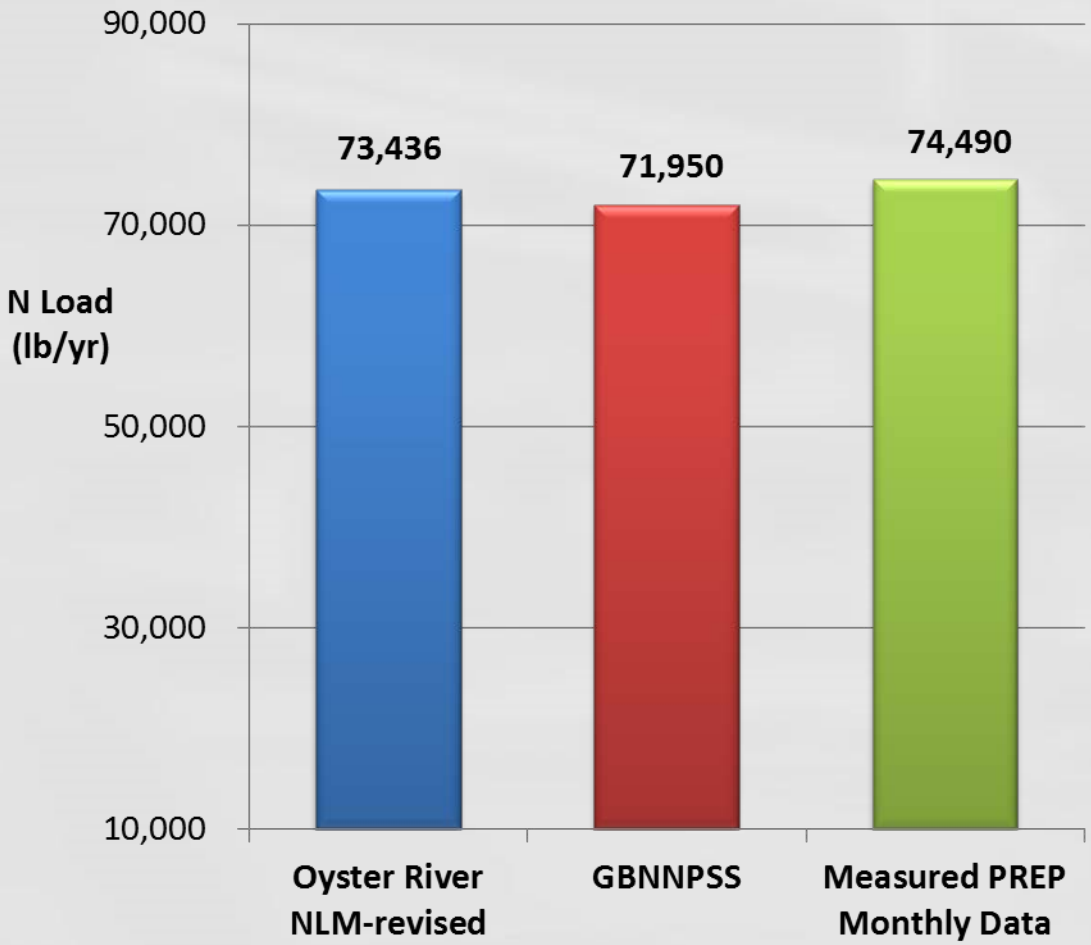
Results – Loads by Land-use/Source

Land use/ Source Input	Load (lb/yr)	Load (%)	Area(ac) or Count	Area (%)
Lawn	15,020	20%	1,470	7%
Impervious Cover	14,420	20%	1,540	8%
Septic	13,950	19%	5,350	na
Agriculture	13,590	19%	1,570	8%
Natural Vegetation	12,100	16%	14,300	73%
Open Water	3,640	5%	740	4%
Managed Turf	710	1%	30	0.2%
Total	73,440		19,660	

Loads by Subwatershed



Comparison of Model vs. Measured Load



- Median TDN Conc. = 0.41 mg/L
- Monthly Sampling at Mill Pond Dam between 2008-2011; 43 samples.
- TN /TDN Ratio of 1.20 based on Lamprey R Data: TN = 0.49 mg/L

Comparison to GBNNPSS

Land Use /Source Input	VHB lb/ac/yr	DES lb/ac/yr
Lawn	10.2	14.6
Impervious Cover	9.4	2.7
Agriculture	8.7	14.5
Septic (people)	2.6	2.9
Managed Turf	23.7	10.3
Natural Vegetation	0.8	0.5
Open Water	4.9	5.0
Total	3.7	3.6

Comparison to Lamprey Data

Watershed	Estimated % Forested Cover	Estimated % Impervious	Source Load (lbs/ac/yr)	Delivered Load (lbs/ac/yr)	Percent Delivered
Oyster River NLM	73 %	8%	14.5	3.7	26%
Lamprey River	80 %	< 5%	11.8	2.2	19%
Wednesday Hill Brook	60 %	12 - 15 %	17.8	4.3	24%
Moonlight Brook	< 50 %	30 - 40 %	12.5	5.0	40%

Model Results vs. WRRC Measured Data

	VHB NLM	UNH WWRC Measured	% Difference from Measured Data	
Tributary	Total N Load Lbs/ac/yr	Est. Total N* Lbs/ac/yr	Drianage Area	Total N Areal Load
Oyster R Headwaters	2.6	1.9	100%	142%
Dube Brook	2.8	2.3	100%	121%
Chesley Brook	3.6	4.8	105%	75%
College Brook	7.1	6.1	100%	116%
Reservoir Brook 2	3.4	4.5	100%	74%
Little Hale	2.4	3.0	121%	80%
Longmarsh Brook	3.1	2.2	155%	139%
Johnson Creek	4.9	4.3	82%	115%
		Average	108%	108%

* UNH WRRC measured TDN Loads converted to Total N load by multiplying by 1.17 to add particulate fraction

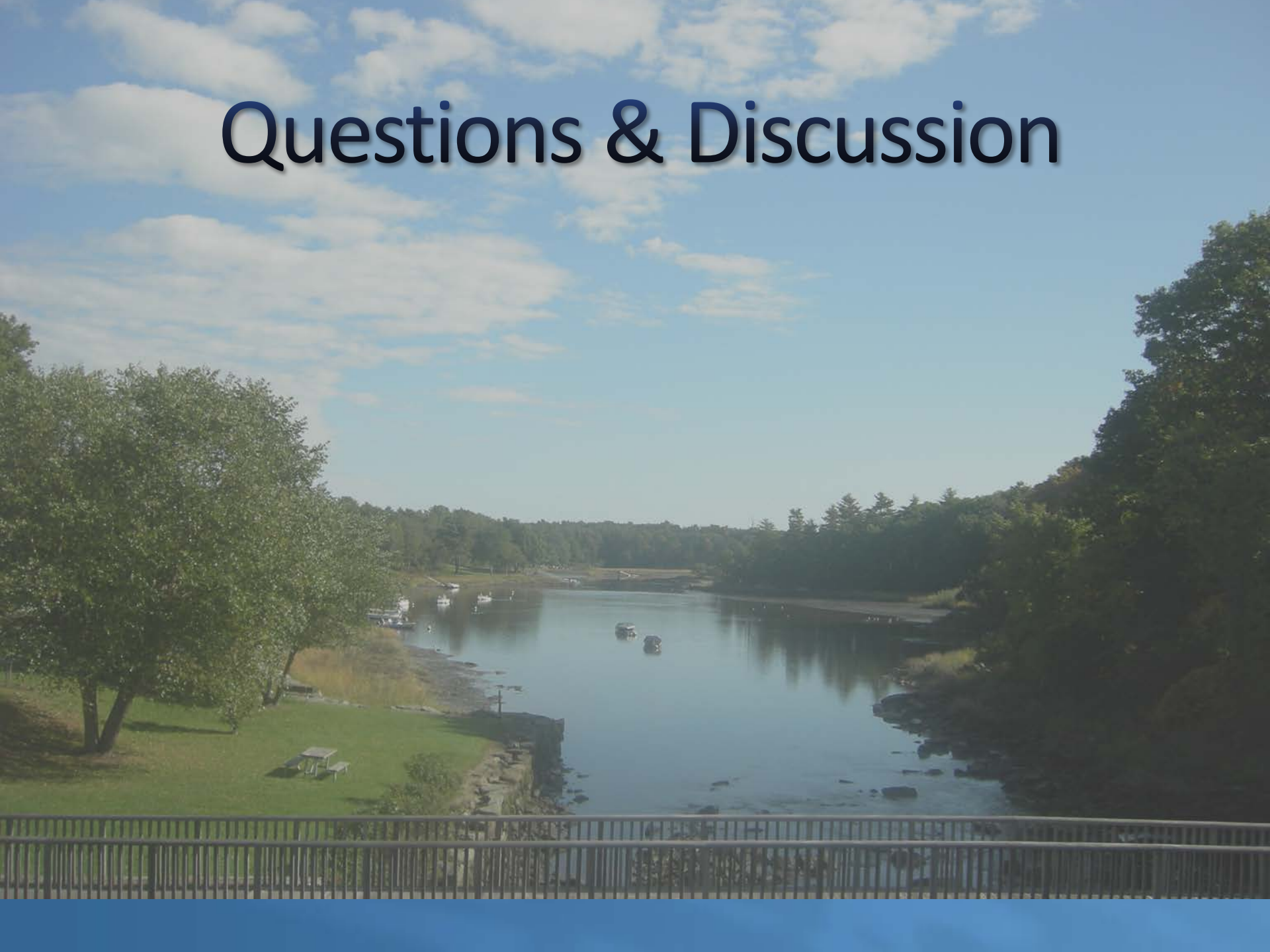
Example Scenarios

Scenario	Deliver Load Difference (lb)	Deliver Load Difference (Tons)
30% Reduction of Durham/UNH Lawn Fertilizer Application	-3,000	-1.5
25% Reduction in UNH Agricultural Fertilizer	-1,470	-0.7
Removal of 20% of Durham Septic	-620	-0.3
20% Conversion of Durham Connected IC to Disconnected IC	-240	-0.1

Next Steps

- Additional Model – Measured Data
- Evaluate Management Measures
- Identify Feasible Options
- Estimate Potential N Reduction Targets

Questions & Discussion



Comparison to GBNNPSS

Land Use /Source Input	Oyster River NLM Delivered Load (lb/yr)	GBNNPSS Delivered Load (lb/yr)	Percent Difference	NLM Area (ac) or Count	DES Area (ac) or Count
Lawn	15,020	12,580	19%	1,470	860
Impervious Cover	14,420	5,770	150%	1,540	2,150
Septic (people)	13,950	18,630	-25%	5,350	6,500
Agriculture	13,590	24,780	-45%	1,570	1,710
Natural Vegetation	12,100	6,720	80%	14,300	14,500
Open Water	3,640	3,070	19%	740	620
Managed Turf	710	410	73%	30	40
Total	**73,440**	**71,950**	**2%**	**19,660**	**19,880**