

# SEPTIC SYSTEMS AND NITROGEN AND PHOSPHORUS LOADING

## DEFINITION

The Inland Bays Watershed holds 19,890 septic systems. In addition, there are 13,030 septic systems that were replaced by sewer since 1993. These eliminated systems continue to emit effluent, including nutrients, into the Inland Bays. Thus, 32,920 septic systems continue to drain into the ground and surface waters in the watershed. Groundwater nutrient loading from the 13,000 eliminated septic systems is reduced very slowly. It could take as long as 19 years to remove this nutrient load from the groundwater and the Inland Bays.

In 1994, Scott Blaier of DNREC (now with the Department of Agriculture) conducted a project on Moores Lake, in which he determined nitrate reduction in the groundwater over time after septic systems were eliminated from 100 homes. From his data, groundwater lost its nitrate load at a rate of 0.33 mg/l per year (nitrates = 10.68-0.33 year,  $R^2=99.4\%$ ). Nitrates were determined in groundwater over a 19-year time span from 25-31 sites in the Moores Lake area.

## WATER QUALITY IMPACTS & TYPICAL LOADINGS

4,447 pounds of nitrogen (N) enters the bays *each day* from nonpoint sources of pollution. Approximately 1,643 pounds enters the groundwater from septic systems—much of it reaching the bays. A *total* of 1,393 pounds per day—from *all sources*—is permitted under the TMDL.

163 pounds of phosphorous enters the *bay each day* from non point sources of pollution. 119 pounds could enter the groundwater from OSDS sources. A *total* 78 pounds per day—from all sources—is permitted to enter the bays under the current TMDL.

### AQUIFER PARAMETERS TO ESTIMATE LOAD SEPTIC SYSTEMS\*

Size of Inland Bays Watershed	200,702 ac
Hydraulic Conductivity <sup>a</sup> of Columbia Aquifer <sup>b**</sup>	80 ft/day <sup>1</sup>
Hydraulic gradient <sup>c</sup> of Columbia Aquifer	0.0018 ft/ft <sup>2</sup>
Aquifer mixing thickness	67 feet <sup>3</sup>
Aquifer width	93799 feet

\*Information obtained from Whole Basin Reports and Water Supply

\*\*From "Estimate of Nitrate Flux to Rehoboth and Indian River Bays, Delaware, Through Direct Discharge Of Ground Water", 1992. Delaware Geological Survey. Report Number 35.

<sup>a</sup>Hydraulic conductivity is the rate at which water can move through a permeable aquifer

<sup>b</sup>An Aquifer is a geologic formation that is saturated and is sufficiently permeable to transmit water to wells.

<sup>c</sup>Hydraulic gradient is the driving force that moves the water through the aquifer.

<sup>1</sup>Hydraulic Conductivity can range from 0 to 290 ft./day, from DGS Report No. 35

<sup>2</sup>Hydraulic gradient can range from 0.00088 to 0.002 ft./ft., from DGS Report No. 35

<sup>3</sup>Average depth of domestic wells in the Inland Bays

### SEPTIC SYSTEM PARAMETERS USED TO ESTIMATE LOAD FROM SEPTIC SYSTEMS

# of Septic Systems	19890 <sup>a</sup>
# of Septic Systems Eliminated since 1993	13030 <sup>b</sup>
Average Effluent Generated from Single Dwelling	221 gal/day <sup>c</sup>
Average Total Nitrogen Load in Effluent	59.3 mg/l TN <sup>cd</sup>
Average Total Phosphorous Load In Effluent	15.7 mg/l <sup>c</sup>

<sup>a</sup>Determine by Whole Basin Study Chesapeake Team

<sup>b</sup>From The Inland Bays Whole Basin Report

<sup>c</sup>Final Report Red Mill Pond (1994)- Non-point Study on Septic Systems loading to Red Mill Pond  
EPA Estimate is 63 mg/l TN

### HYDROLOGIC PARAMETERS TO ESTIMATE SEPTIC SYSTEM LOAD

Average Total Nitrogen Concentrations in Groundwater	6.33 mg/l TN <sup>a</sup>
Average Total Phosphorous Concentrations in Groundwater	0.01 mg/l P <sup>a</sup>
Average Total Nitrogen Concentrations in Precipitation	2.0 mg/l TN <sup>b</sup>
Average Total Phosphorous Concentrations in Precipitation	0.00 mg/l P <sup>b</sup>
Groundwater Recharge by Precipitation	14 inches per year <sup>b</sup>

<sup>a</sup>Reported by Whole Basin Study Chesapeake Team as referenced from various published sources.

<sup>b</sup>Total Maximum Daily Load (TMDL) Analysis for Indian River, Indian River Bay and Rehoboth Bay, Delaware. December 1998, Delaware Department of Natural Resources and Environmental Control.

### ESTIMATED SEPTIC SYSTEM LOADING RATES FOR NITRATE-N AND TOTAL PHOSPHOROUS<sup>1</sup>

Parameter	Exiting Aquifer	tons/yr	lbs/acre-yr
<b>NITROGEN</b>			
Total Nitrogen Loads From Existing Conditions with Septic Systems	3.1 mg/l TN	1096.7	10.9*
Total Nitrogen Loads From Existing Conditions with No Septic Systems (Comparison) <sup>2</sup>	2.1 mg/l TN	726.4	7.2
Total Nitrogen Loads From Existing Conditions with Septic Systems plus Eliminated Septic Systems (13,000)	3.9 mg/l TN	1331.4	13.3*
<b>TOTAL PHOSPHOROUS</b>			
Total Phosphorous Loads From Existing Conditions with Septic Systems	0.30 mg/l TP	104.8	1.04
Total Phosphorous Loads From Existing Conditions with No Septic Systems (Comparison)	0.07 mg/l TP	143 lbs./yr.	0.001
Total Phosphorous Loads From Existing Conditions with Septic plus Eliminated Septic Systems (13,000)	0.50 mg/l TP	167.0	1.7

\* Estimate of area loading rate for nitrogen is within the range published in "Estimate of Nitrate Flux to Rehoboth and Indian River Bays, Delaware, Through Direct Discharge Of Ground Water", 1992. Delaware Geological Survey.

<sup>1</sup>Calculations were done using a model published (Estimating Ground-Water Quality Impacts from On-Site Sewage Treatment Systems by B. J. Bauman and W. M. Schafer) in On-Site Wastewater Treatment- Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems held at New Orleans, Louisiana, December 10-11, 1984.

<sup>2</sup>For comparative purposes, septic systems load were assumed to be 0.0 mg/l in the model.

ESTIMATED SEPTIC SYSTEM LOADING RATES FOR  
NITRATE-N AND TOTAL PHOSPHOROUS  
WITH REDUCTION FOR SOIL ASSIMILATIVE CAPACITY <sup>1</sup>

Parameter	Exiting Aquifer	tons/yr	lbs/ac/yr
<b>NITROGEN</b>			
Total Nitrogen Loads from Existing Conditions with Septic Systems with 48.4% Reduction due To Nitrogen Loss	2.6 mg/l TN	905.3	9.5*
Total Nitrogen Loads From Existing Conditions with No Septic Systems (Comparison) <sup>2</sup>	2.1 mg/l TN	726.4	7.2
Total Nitrogen Loads From Existing Conditions with Septic Systems plus Eliminated Septic Systems (13,000) with 48.4 % Reduction due to Nitrogen Loss	3.0 mg/l TN	1026.3	10.2*
<b>TOTAL PHOSPHOROUS</b>			
Total Phosphorous Loads From Existing Conditions with Septic Systems with 87% Reduction Due to Absorption	0.04 mg/l TP	13.7	0.14
Total Phosphorous Loads From Existing Conditions with No Septic Systems (Comparison)	0.07 mg/l TP	143 lbs./yr	0.001
Total Phosphorous Loads From Existing Conditions with Septic Systems plus Eliminated Septic Systems (13,000) with 87% Reduction Due to Absorption	0.06 mg/l TP	21.8	0.22

\*Estimate of area loading rate for nitrogen is within the range published in "Estimate of Nitrate Flux to Rehoboth and Indian River Bays, Delaware, Through Direct Discharge Of Ground Water," 1992. Delaware Geological Survey.

<sup>1</sup> Calculations were done using a model published (Estimating Ground-Water Quality Impacts from On-Site Sewage Treatment Systems by B. J. Bauman and W. M. Schafer) in On-Site Wastewater Treatment- Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems held at New Orleans, Louisiana, December 10-11, 1984.

<sup>2</sup> For comparative purposes, septic systems load were assumed to be 0.0 mg/l in the model.

## MANAGEMENT TECHNIQUES & TYPICAL REDUCTIONS

Based on these calculations, septic systems could account for 19 to 45 percent of the nonpoint source load to the Inland Bays.

The potential nitrogen reduction from switching to septic systems is the difference in the nitrogen concentration of the septic effluent (approximately 59.3 mg/l) and the sewer discharge of less than 10 mg/l. This change would result in a 83% reduction in nitrogen (Technical Appendix for *Maryland's Tributary Strategies*, 1996).

## TIMELINE & COSTS

According to a study done on septic system removal from Moore's Lake area in Kent County, Delaware, it was determined that groundwater loads from those septic systems diminish slowly. It could take as long as 19 years to remove this load from the groundwater.

Progress towards eliminating septic systems has begun. The Department of natural Resources and Environmental Control, in conjunction with the Wastewater Facilities Advisory Council, recently awarded more than \$19 million to the Sussex County Council for sewer projects. These projects will eliminate approximately 2,133 septic systems and prevent future septic systems from being installed. These monies augment the \$120 million already spent by the County in the last 20 years. It is anticipated that \$98 million will be spent within the next five years to ultimately eliminate approximately 10,000 additional septic systems (*Sussex Post*, May 10, 2000).

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### INLAND BAYS WATERSHED

*This fact sheet was prepared by the Delaware Department of Natural Resources and Environmental Control's Whole Basin Team, at the request of the Inland Bays Tributary Action Teams, for citizens and stakeholders interested in one of Delaware's most environmentally and economically attractive areas—the Inland Bays and its surrounding lands, surface and ground waters.*

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