Report

from the
CHESAPEAKE BAY FOUNDATION

SEWAGE TREATMENT PLANTS: THE CHESAPEAKE BAY WATERSHED'S SECOND LARGEST SOURCE OF NITROGEN POLLUTION

Most Plants Don't Utilize Available Technology To Reduce Nitrogen Pollution

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The Chesapeake Bay Foundation
gratefully acknowledges the review of this document by the
Chesapeake Bay Program,
Maryland Department of the Environment,
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The conclusions contained in this report are those of the
Chesapeake Bay Foundation and may not necessarily reflect the views of
the reviewing organizations.

BACKGROUND

For 20 years, Chesapeake Bay scientists have known that nitrogen pollution is the most significant problem facing the Bay, degrading habitat for key plants and animals in the Bay's ecosystem, including underwater grasses, crabs and oysters. In 2003, the Chesapeake suffered one of the largest "dead zones" (areas of low or no dissolved oxygen) on record, stretching at one point 150 miles from Baltimore to the York River. Excess nutrients were one of the leading culprits along with climatic factors. Low dissolved oxygen levels are also a problem in many tributaries. Existing dissolved oxygen standards, adopted by the Bay states under the federal Clean Water Act, are violated routinely. As a result of nitrogen pollution, the Chesapeake Bay now functions at barely one-quarter of its estimated potential.

In 1998, a majority of the mainstem of the Bay and major parts of its tidal tributaries were added to Virginia and Maryland's "Impaired Waters List" (also known as the EPA's "Dirty Waters List"). Earlier this year the Chesapeake Bay Program determined that water quality would improve and substantial progress could be made toward removing the Bay from the "Dirty Waters List" if nitrogen pollution was reduced by 110 million pounds per year.

Nitrogen entering the Bay from sewage treatment plant (STP) effluent, agriculture, air deposition and urban runoff, and other sources stimulates "blooms" (population explosions) of microscopic plants called algae. While they are alive and drifting in the water column, the algae decrease water clarity, blocking sunlight from underwater Bay grasses. When algae die, they sink to the bottom, and the bacterial process of decay removes oxygen from the water.

Wastewater discharged from sewage treatment plants is the second largest source of nitrogen pollution to the Chesapeake Bay[1]. When approximately 12 million of the 16 million residents of the watershed flush their toilets, the wastewater goes to STPs, which discharge into the Chesapeake Bay and its tributaries.

There are 304 "significant" STPs in the watershed, which discharge 1.5 billion gallons of wastewater each day. These plants contribute about 52 million pounds of nitrogen pollution annually to the Bay and its tributaries. To date, <u>more than two-thirds of those plants do not use any technologies to remove nitrogen pollution,</u> and only ten plants are currently reducing nitrogen pollution to state-of-the-art levels, according to the most recent data available (2002).

[1] Agriculture contributes 42% of the nitrogen loading and is the largest source of nitrogen pollution to the Bay. CBF is working on both the voluntary and regulatory fronts to secure the necessary nitrogen reductions from agriculture.

STPs that do not include nutrient removal technologies have wastewater discharge concentrations of approximately 18 milligrams of nitrogen per liter (18mg/L) or more. With advanced applications of Nutrient Reduction Technology (NRT) or Biological Nutrient Removal (BNR), plants can reduce discharge concentrations to 3 mg/L or less. Upgrading the watershed's "significant" STPs with advanced BNR would reduce their collective discharge of nitrogen from 52 to 13 million pounds. <u>This 39-million-pound reduction alone would account for more than one-third of the 110 million pound/yr nitrogen reduction goal that scientists believe will make substantial progress toward meeting the commitments of *Chesapeake 2000*, the current multi-jurisdictional Bay agreement</u>.

EPA has recently confirmed that the states currently have the authority and obligation to set permit limits for nitrogen pollution from STPs. To date, however, the states have written few permits with such limits.

STPs BY STATE

Table 1 presents the number of "significant" STPs by jurisdiction. The definition differs slightly by state, but in general, a "significant" discharger either:

- Discharges more than 0.5 million gallons per day (MGD);
- Discharges less than 0.5 MGD but is located below the fall line and therefore has a more direct impact on water quality in tidal tributaries or the Bay main stem;
- Discharges 0.4 MGD or more in Pennsylvania.

Table 1: Number of STPs by Jurisdiction

Jurisdiction	# Of Significant Facilities
DC	1
Maryland	65
Virginia	81
Pennsylvania	123
West Virginia	9
Delaware	3
New York	22
TOTAL	**304**

STP ASSESSMENT

The Chesapeake Bay Foundation conducted a review of the most recent STP data available from the Chesapeake Bay Program (2002 reports) from Maryland, Virginia, Pennsylvania, and the District of Columbia. The loads from the STPs in these four jurisdictions are about 94% of the total nitrogen load from all STPs in the Bay watershed.

Each plant was evaluated based on the annual average concentration of total nitrogen in the plant's discharge. A plant was rated as "Excellent" if it achieved 3 mg/L or less, "Good" if the nitrogen pollution was between 3.1 to 5 mg/L, "Needs

Improvement" if it ranged from 5.1 to 8 mg/L, and "Unsatisfactory" if it discharged > 8.1 mg/L. Table 2 presents the total number of "significant" dischargers in each total nitrogen concentration grade category by state.

Bay Program models show that significant reductions in nitrogen pollution from agriculture, air deposition, stormwater management and STPs, will still not be enough to achieve the *Chesapeake 2000* goal. That is why CBF scientists believe it is critical that STPs decrease their total nitrogen concentrations to 3 mg/L or less. Table 2 shows that about 96% of the plants do not meet the 3 mg/L concentration level.

Table 2: Number of Plants by Total Nitrogen Concentration (annual average)

State	Excellent	Good	Needs Improvement	Unsatisfactory	Data Not Available
	< 3 mg/L	3.1 – 5 mg/L	5.1 – 8 mg/L	> 8.1 mg/L	
DC			1		
MD	5	9	17	32	2
VA	2	5	15	59	
PA	3	7	13	97	3
Total	10	21	46	188	4

While some improvements at STPs have been made since 2002, and other improvements can be expected in the next few years, *Chesapeake 2000* commitments cannot be met and the health of the Chesapeake Bay cannot be significantly improved without tremendous improvements in removing nutrients by all nitrogen load sources. This includes implementing state-of-the-art technology at "significant" STPs.

NITROGEN LOADS AND CONCENTRATIONS FROM STPs

When analyzed by the concentrations of nitrogen and the volume of wastewater discharged into the Chesapeake Bay, it is clear that the few plants operating to remove nitrogen pollution to the 3 mg/L concentration level treat only a very small percentage of total STP wastewater.

Figure 1: Volume of Wastewater Discharged by Total Nitrogen Concentration

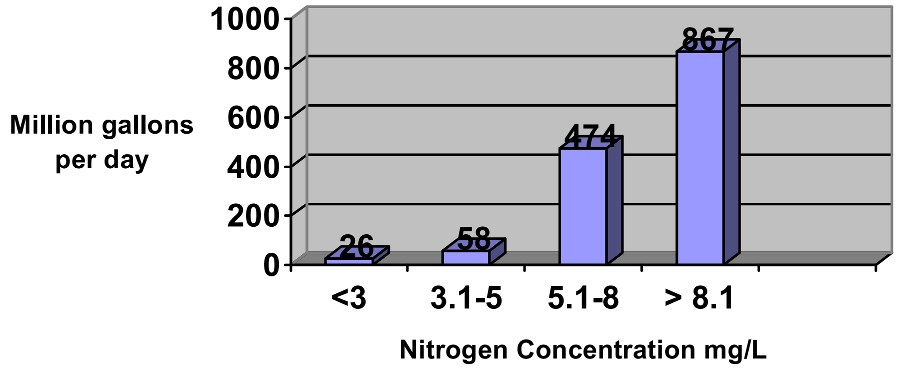

Figure 1 shows that less than 2% of the wastewater flow is treated to the 3 mg/L concentration level, which CBF believes will be necessary to restore the Chesapeake Bay.

An important point about nitrogen loads from STPs is that with the watershed's population projected to grow by 1 million to 17 million people by 2010, the associated nitrogen load from STPs will increase unless the plants reduce the total nitrogen *concentration* in their discharges.

Table 3 clearly illustrates the necessity for reducing nitrogen concentration in order to significantly reduce nitrogen loads (total pounds) to the Bay. The table compares the amount of flow (million of gallons of wastewater discharged per day or MGD) and total nitrogen loads (pounds per year) within each concentration category. For example, compare the “Needs Improvement” and “Unsatisfactory” categories. Note that while the “Unsatisfactory” category has approximately twice as much flow, its total nitrogen load is more than 4 times higher than the “Needs Improvement” category. This explanation is simple: plants in the “Unsatisfactory” category do a much poorer job of removing nitrogen from their discharges. “Unsatisfactory” plants contribute 61% of the flow from all of the Bay’s STPs, yet they contribute 80% of the total nitrogen load. Reducing their concentrations to 3 mg/L would slash their contribution to the Bay’s nitrogen load by 85%.

Table 3: Total Nitrogen Flow (MGD) and Load (pounds per year) by Concentration Category

	EXCELLENT (< 3 mg/l)		GOOD (3 – 5.0 mg/l)		NEEDS IMPROVEMENT (5.1 – 8 mg/l)		UNSATISFACTORY (> 8.1 mg/L)		TOTAL FLOW	TOTAL LOAD
	Flow	Load	Flow	Load	Flow	Load	Flow	Load		
DC					312.0	6,177,288			**312.0**	**6,177,288**
MD	8.8	72,065	35.6	461,272	65.5	1,425,576	228.1	8,458,235	**337.9**	**10,417,148**
VA	1.5	6,912	12.5	157,269	62.5	1,239,889	421.2	21,821,442	**497.8**	**23,225,512**
PA	16	47,708	10	128,304	34	767,887	218	10,777,520	**277.5**	**11,721,419**
Total	**26.0**	**126,685**	**58.4**	**746,845**	**473.9**	**9,610,640**	**866.8**	**41,057,196**	**1,425.1**	**51,541,367**

STPs– TOTAL NITROGEN LOAD BY COUNTY

Appendix A provides a listing of STPs by state, grouped by average nitrogen discharge concentrations for 2002. The 10 plants that are achieving 3 mg/L total nitrogen or less are listed in Table 4. Clearly, the record of these 10 plants demonstrates that total nitrogen concentrations of 3 mg/L or less can be achieved with currently available technology. For some plants, space limitations may make achieving this goal more difficult.

Table 4: STPs Achieving Average Total Nitrogen Concentrations Less Than 3 mg/L – 2002 data

State	Facility	County	Flow (MGD)	TN Concentration (mg/L)	TN Load (Pounds per year)
MD	Fort Meade	Anne Arundel	1.8	2.3	12,222
	Chesapeake Beach	Calvert	0.7	2.6	5,350
	MD Correctional Inst.	Washington	1.0	2.5	7,126
	Taneytown	Carroll	0.6	2.7	4,771
	Broadneck	Anne Arundel	4.8	2.9	42,595
VA	Farmville	Prince Edward	0.9	0.5	1,488
	Remington Regional	Fauquier	0.6	2.9	5,424
PA	Marysville	Perry	0.6	0.7	1352
	Upper Allen Township	Cumberland	0.5	1.6	2,436
	Gregg Township	Union	0.7	2.9	5,906

STP – NITROGEN LOAD AND CONCENTRATION BY COUNTY

These data are presented in Appendix B. There are 15 counties with STP discharges to their waterways of over a million pounds of nitrogen per year.

- The 50 plants in the counties with STP discharges of over a million pounds generate 597 MGD of wastewater, or 42% of the total flow from STPs, and over 29 million pounds, or 56% of the total nitrogen load from STPs each year.
- The average concentration of these plants is 17.4 mg/L, well into the "Unsatisfactory" category.
- Most of these large plants are concentrated in densely populated areas, so their combined effluents contribute a great deal of stress to local waterways as well as to the Bay.

These plants have the potential to play powerful roles in cleaning up the Chesapeake system, if they are made priorities for upgrades. For example, in Maryland the two plants with the most loads both discharge into Baltimore area waters. In Virginia, plants in Alexandria, Arlington, and Fairfax join Blue Plains in the District of Columbia to discharge to the Potomac. Also in Virginia, the waterways of Hampton Roads receive a large collective load of nitrogen from plants in Hampton, Newport News, Virginia Beach, Norfolk, Portsmouth, Chesapeake, and Suffolk. In Pennsylvania, the Lancaster - York - Dauphin County area generates a great deal of the flow and load.

UPGRADING STPS - THE TECHNOLOGICAL FIX: NRT/BNR

NRT/BNR technology was developed as a cost-effective way to reduce nutrient pollution in the Chesapeake Bay watershed in the 1980s. At the plants that have this technology, it has proven to be very effective. Sewage treatment plants that do not use NRT technology for nitrogen removal will discharge, on average, 18 mg/L or more of total nitrogen in their effluent. Fortunately, NRT/BNR technology is available to reduce nitrogen effluent concentrations to 3 mg/L (average concentration over the course of a year). This level of treatment is currently considered "state-of-the-art."

Although the design, construction, and operation of BNR facilities are complex, the underlying science of how they work is fairly simple. NRT and BNR use microorganisms like bacteria to break down the organic material that contains nitrogen in wastewater. In general, the water is pumped through a succession of tanks, alternating between ones that contain oxygen and ones that do not. Within each tank are bacteria specifically suited for survival under those conditions. The bacteria within the aerobic tanks (those containing oxygen) have the ability to break down organic nitrogen and ammonia into nitrate (a process referred to as "nitrification"). Then the organisms in the anoxic tanks (those without oxygen) further break down the nitrate into nitrogen gas by stripping the oxygen from the nitrates (a process referred to as "denitrification"). The nitrogen gas escapes harmlessly into the atmosphere.

To date, most STPs that have implemented NRT/BNR technology are not designed to operate at peak effectiveness and do not reduce effluent nitrogen concentrations to 3 mg/L. There are no watershed-wide requirements to reduce nitrogen pollution, **and the states have, except in a few instances, failed or refused to impose adequate, enforceable total nitrogen effluent limits on STPs**. For example, in Virginia, sewage treatment plants that have accepted state cost-share money to install NRT/BNR are required only to reduce nitrogen total concentrations to 8 mg/L, and there is no incentive to go further.

As we work to reduce nitrogen loading from all sources, it is critical that STPs implement these upgrades to achieve their share of the overall reductions. After achieving their share, additional reduction of nitrogen pollution by STPs could alleviate the need for even more expensive reductions that municipalities need to undertake to reduce stormwater runoff from urban areas, which includes a significant nutrient component.

THE COSTS OF UPGRADING

While there have been a number of estimates on the cost of upgrading the watershed's STPs, it is very difficult to come up with a firm estimate for costs on which everyone agrees. Maryland's Department of the Environment has estimated the cost of upgrading plants in Maryland at between $5 and $14 per household per year.

The Chesapeake Bay Program assembled a task force of representatives from local, state and federal government, municipal wastewater agencies, and consultants who specialize in nutrient reduction technology. This task force issued a report in November 2002 titled *Nutrient Reduction Technology Cost Estimates for the Point Sources in the Chesapeake Bay Watershed*. The report concluded that the cost for upgrading all of the Bay's "significant" sewage treatment plants to a nitrogen concentration of 5 mg/L and 3 mg/L is $2.7 and $4.4 billion respectively. While the estimated range for these upgrades is large, the costs can be minimized if STPs implement upgrades to the NRT/BNR process while undertaking routine capital improvements.

THE NEXT STEPS

Key steps to achieving the *Chesapeake 2000* nutrient reduction goals are:

- Ensure the implementation of measures to achieve the Chesapeake Bay Program's basin-specific nitrogen reduction goals in each state, achieving as much of each basin's reductions from sewage treatment plants as possible.
- On state and federal levels secure new legislation, regulations, guidance, or policy direction supporting enforceable 3-mg/L total nitrogen permits limits for the most "significant" STPs in the watershed.
- Secure "binding" commitments at either the federal (EPA) or state level (Governor, Secretariat, legislature or state agency) that guarantee widespread implementation of Nutrient Removal Technologies/Biological Nutrient Removal

and nutrient pollution permit limits at sewage treatment plants throughout the Bay watershed.

Clearly, STPs can reduce nitrogen loads significantly by using available technology. This reduction is not occurring throughout the watershed at the rate needed to meet the goals of *Chesapeake 2000* by 2010. The lack of timely action creates the need for binding commitments to serve as the driving force for sewage treatment plant upgrades and increased funding. Such commitments can be achieved in numerous ways, including: state or federal requirements on sewage treatment plant discharges (nitrogen effluent limits or technology requirements); Governors' Executive Orders or state policies issued by Natural Resource or Environmental Protection Secretaries; or new laws, regulations, policies, or guidelines.

CBF is committed to obtaining the nutrient reductions necessary from all sectors, including agriculture, STPs, stormwater runoff, air deposition, and other major contributors of nutrient load, in order to remove the impairment to the Chesapeake Bay. Upgrading wastewater treatment plants with NRT is a reasonable, proportional, and achievable step toward that end.