
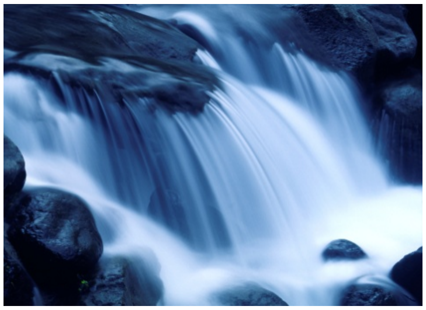

Controlling Nutrient Loadings to U.S. Waterways: An Urban Perspective

October, 2011

Prepared by:

NACWA

A Clear Commitment to America's Waters

With support provided by:

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Foreword

Nutrient pollution in our waterways is perhaps the greatest water quality challenge facing America today. It is a challenge that will require all contributors to the problem to solve it. This report explores what is at stake from the perspective of ratepayers of drinking water, wastewater and stormwater utilities and why policy-makers must consider more effective agricultural nutrient management practices. The municipal wastewater and drinking water community will continue to do its part in addressing the nutrient challenge through cost-effective treatment approaches. But without serious action from the agricultural sector, the problem of nutrient contamination will not be solved.

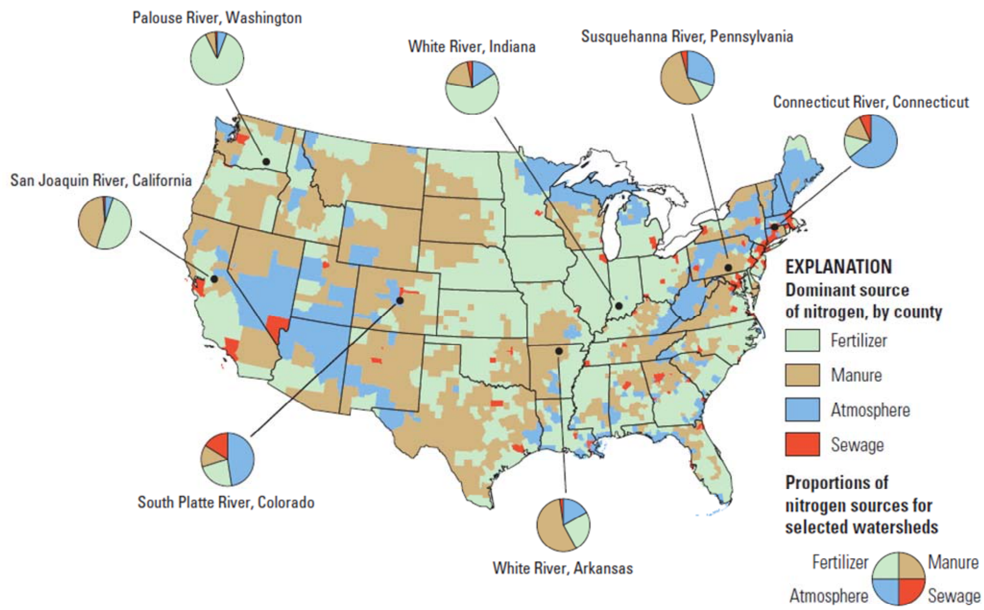
We appreciate the leadership that many in the agricultural community have taken to address this issue seriously and stand ready to partner with the agricultural community at large and local farmers in particular to find solutions.

The report provides what we think are compelling reasons why Congress needs to grapple with this issue as soon as possible. A business as usual strategy is not sustainable for ratepayers and will not achieve desired water quality outcomes.

Contents

Executive Summary

There is broad consensus that nutrients (nitrogen and phosphorus) are significant sources of impairment of rivers, streams, lakes, reservoirs, estuaries, and coastal waters of the U.S. Excessive nutrients in surface and ground water result in significant environmental losses and economic costs across the U.S. We know from multiple sources of data that commercial and manure fertilizers are the predominant sources of nitrogen in most agricultural watersheds, as the map below demonstrates.

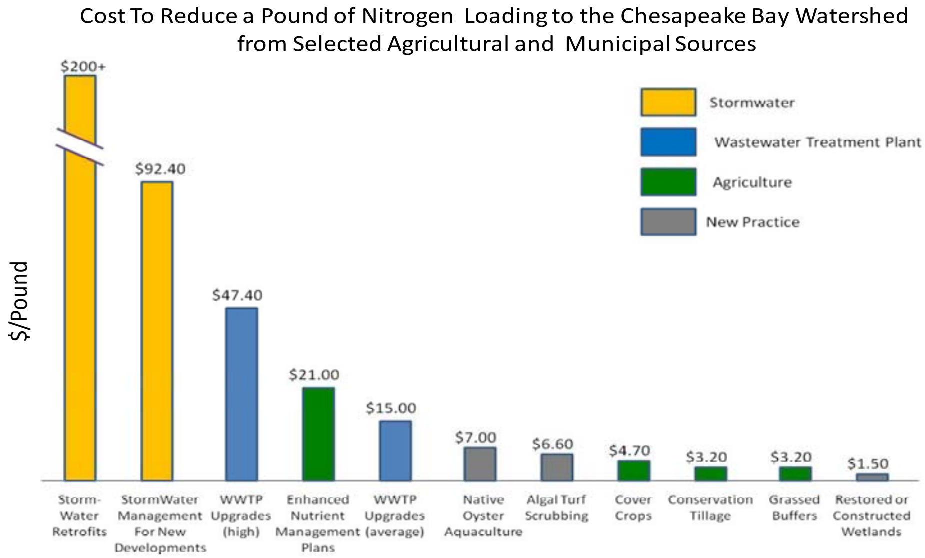


Source: Dubrovsky, N.M., Burow, K.R., Clark, G.M., Gronberg, J.M., Hamilton, P.A., Hitt, K.J., Mueller, D.K., Munn, M.D., Nolan, B.T., Pucket, L.J., Rupert, M.G., Short, T.M., Spahr, N.E., Sprague, L.A., and Wilber, W.G., The *Quality of Our Nation's Water— Nutrients in the Nation's Streams and Groundwater, 1992-2004,* US Geological Survey Circular 1350, 2010

These data suggest that the nation has not paid sufficient attention to agricultural sources of nutrients, especially compared to the nation's direct regulatory focus on reducing nutrients from municipal point sources. Even where nutrient loadings can be reduced effectively through further municipal controls, it is inefficient and inequitable to compel municipal sources to take additional actions in the absence of parallel actions to control agricultural sources. If the nation expects to achieve effective reductions in nutrient loadings and water quality improvements that meet water quality goals, this unbalanced approach to nutrient controls must change. While municipalities will continue to pursue nutrient controls, aggressive and effective control of agricultural sources of nutrients is urgently needed.

It Is Both Cost-Effective and Equitable to Reduce Agricultural Nutrient Pollution

The economics of nutrient loadings reductions in general suggest broad societal benefits through controls on agricultural practices as opposed to much greater reductions in loadings from urban point sources. This is because the cost to remove a pound of nitrogen or phosphorus from farm runoff and drainage is typically 4-5, sometimes 10-20, times less than the cost to remove the same amount from municipal wastewater or stormwater.



Source: CY Jones, Evan Branosky, Mindy Selman, and Michelle Perez, *How Nutrient Trading Could Help Restore the Chesapeake Bay*, WRI Working Paper, World Resources Institute, 2010.

Municipal sources should pay for the majority of loadings reductions in watersheds in which they represent the majority of loadings. Agricultural sources should pay for the majority of loadings reductions in watersheds in which they represent the majority of loadings. Across the population of watersheds impaired by nutrients, agricultural sources cause 3-4 times more impairment than municipal sources. Yet, households and businesses have spent orders of magnitude more of their own money to reduce nutrient loadings from municipal sources than have farmers and ranchers. Further, current federal and state policies treat municipal and agricultural sources very differently: municipal sources are required by law to reduce nutrient loadings while federal and state programs pay farmers to adopt voluntary nutrient controls. Perhaps more important, municipal wastewater ratepayers across America are stretched to the limit of affordability. Forty percent of all U.S. households are already paying more of their income for wastewater management services than the U.S. Environmental Protection Agency (EPA) recommends as affordable. Increasing rates further to remove even more nutrients from municipal sources could crowd out other needed infrastructure improvements and risk backsliding on the hard-earned water quality gains of the past several decades.

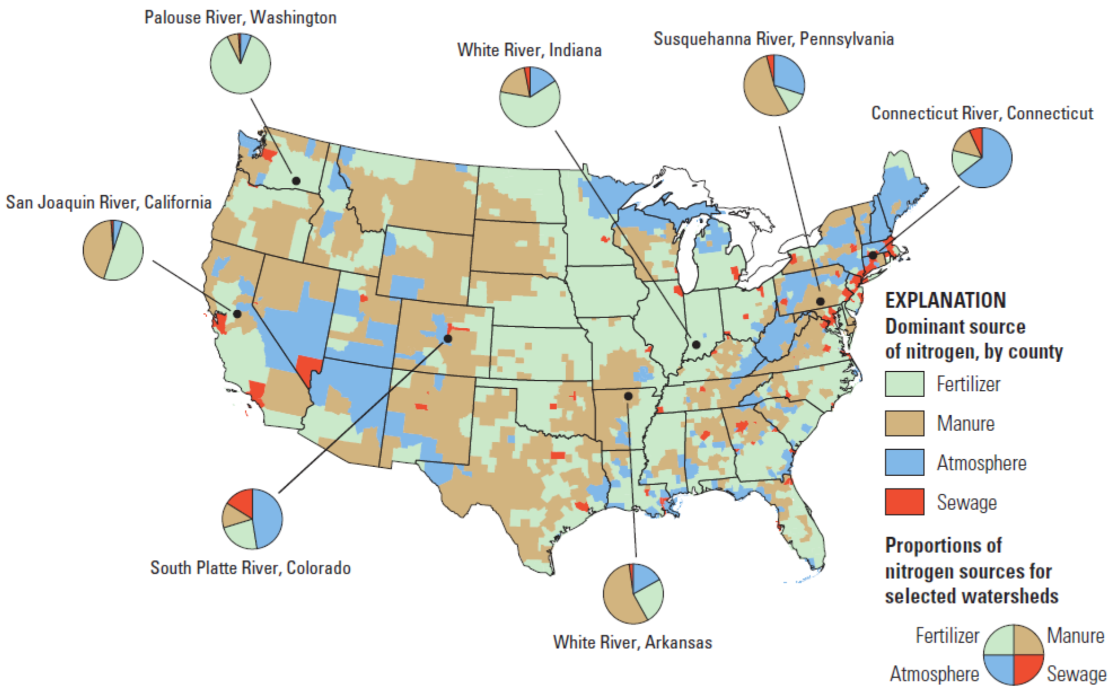
Conclusion

This paper concludes that it is well worth requiring the agricultural community to undertake its share of nutrient controls. Reducing nutrient loadings to U.S. surface waters will trigger a series of ecological and water quality improvements in rivers, lakes, estuaries, and coastal waters. These, in turn, will create healthier ecosystems and a series of environmental benefits. The extent to which these benefits can be captured will be directly related to efforts of stakeholders that demand changes in urban and agricultural practices resulting in high levels of nutrients reaching America's waters. These changes are within reach. The key question is whether the nation can make decisions that promote change while balancing costs appropriately between agriculture, households, and businesses in America's urban and rural areas.

Chapter I —
Effects of Nutrient Pollution and Current Policies to Address Them

There is broad consensus that nutrients (nitrogen and phosphorus) are significant sources of impairment of rivers, streams, lakes, reservoirs, estuaries, and coastal waters of the U.S. [1] Further, there is no dispute that excessive nutrients in aquatic ecosystems can have broad negative effects that lead to unhealthy conditions for fish and shellfish, algal blooms that reduce water-based recreation, impaired recreational and commercial fisheries and shellfisheries, reduced property values, increased processing costs to remove nutrients from drinking water, and where they are not removed from drinking water, risks to human health that include oxygen deprivation (resulting in "blue baby" syndrome), increased incidence of certain forms of cancer, and reproductive problems. [2]

Sources of nutrients are well documented. [3] The predominant source of nitrogen and phosphorus can differ from one body of water to the next, but generally follows predominant land use, as depicted in the graphic below.[4] Commercial fertilizers are the main source of nitrogen in most agricultural watersheds (shown in green). Animal manure (shown in tan) is the major source in watersheds with large populations of confined livestock and in watersheds with extensive rangeland. Atmospheric deposition (shown in blue) is the primary source of nitrogen in undeveloped watersheds. In some urban watersheds, especially where municipal and/or industrial wastewater flows constitute large proportions of stream flow, municipal point sources can be the largest source of nitrogen loadings (shown in red).

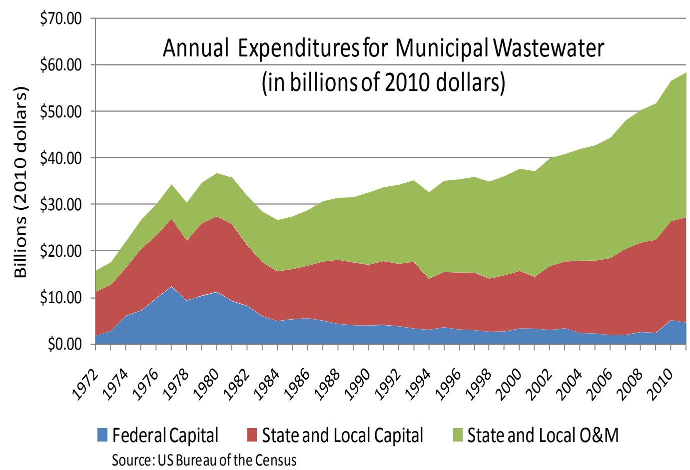


Nitrogen and phosphorus species[5] enter surface waters from both point sources (e.g. municipal wastewater treatment facilities, large stormwater discharges, industrial discharges, and concentrated animal feedlots or CAFOs) and nonpoint sources (e.g. runoff and drainage from farmland, animal grazing lands, and suburban lawns). Nutrients enter groundwater largely from nonpoint sources. Loadings of nitrogen and phosphorus from point sources are regulated under a system of water quality standards, permits, and enforcement actions administered by the states and the EPA. Nonpoint sources are not systematically regulated, nor are percolation of nitrates and phosphates from the land to groundwater. The U.S. Department of Agriculture (USDA) and many states operate voluntary programs in efforts to control these nonpoint sources, but only within the last several years have these programs focused on nutrients.[6] Voluntary state programs such as those in North Carolina, Kansas, or Florida that have established programs specifically designed to control agricultural nutrient run-off, especially from livestock operations, may serve as a model for the future.[7]

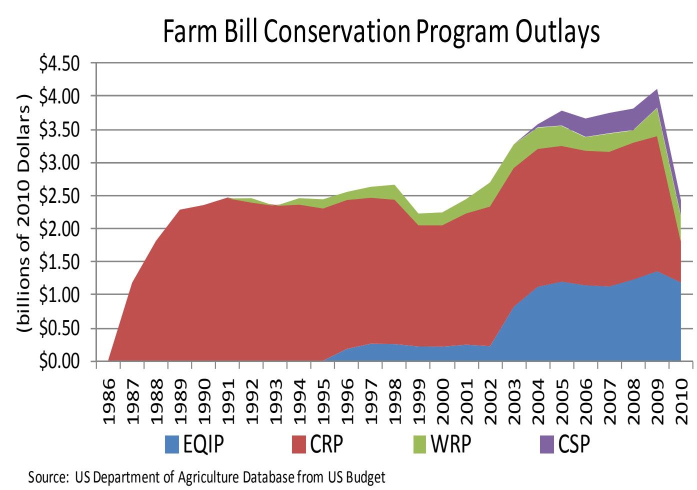
There are significant differences between the regulatory programs under the Clean Water Act (CWA) that address point source pollutant loads and the voluntary programs under Title 2 of the Farm Bill that can address nonpoint source loadings of nutrients to U.S. waters.[8] First, CWA regulations specifically target water quality. Farm bill conservation programs target a variety of conservation-related goals, including soil erosion, habitat restoration, wetlands preservation and water quality. Second, the CWA mandates that communities and businesses take actions and shoulder most of the costs to improve water quality, while the Farm Bill programs are voluntary and provide cost-share payments to agricultural operators as incentives to participate.[9] Finally, CWA programs require federal and state enforcement authorities to take legal actions and impose financial penalties for non-compliance. There are relatively few enforcement measures in Farm Bill conservation programs.

	Point Sources	Non-Point Sources
Regulatory	• NPDES permits for municipal wastewater discharges (including state nutrient numeric nutrient criteria) • NPDES permits for urban stormwater discharges • NPDES permits for industrial discharges • CWA Section 303(d) water-quality limited TMDLs • Concentrated Animal Feedlot Operations controls • State bans on use of detergent phosphates • CAA State Implementation Plans	• CZARA Section 6217 NPS nutrient control plans
Voluntary	• State water quality trading programs	• CWA Section 303(d) water-quality limited TMDLs • Water quality trading programs • CWA Section 319 grants • Farm Bill programs such as EQIP, CRP, WRP,CSP • State nutrient control planning programs, including those that adopt NRCS 590 Standards • CZARA Section 6217 NPS nutrient control plans

Moreover, farm policy can work against objectives for nutrient reduction and, from the perspective of clean water objectives more broadly, makes little economic sense. Title 1 of the Farm Bill provides $5 billion a year in direct subsidies to farmers, the details of which can be quite complicated, but all payments to farmers increase in one way or another if acreage and yield increase.[10] Title 12 Farm Revenue/Crop Insurance programs provide nearly $7 billion a year in federal subsidies (average 2008-2010) that result in cultivation of unused, marginal lands, which require additional nutrient inputs. There can be little dispute that these payments transfer wealth from all taxpayers to farmers, so in essence, farm policy results in American taxpayers paying three times for nutrient pollution: once in the form of Title 1 direct payments and Title 12 insurance/revenue subsidies to farmers that encourage increased fertilizer use to increase yields on ever-higher acreage; a second time in Title 2 conservation payments to farmers to reduce soil erosion and other environmental impacts including nutrient loadings; and a third time in the form of reduced environmental quality, loss of economic benefits, and increased wastewater treatment and drinking water purification costs associated with surface and ground waters polluted by nutrients from agricultural practices.



Clean Water Act. Over the decades since passage of the CWA, U.S. communities and businesses have invested heavily in point source controls. In 2010 alone, public and private expenditures to comply with point source regulations of the CWA totaled $129 billion, which is equivalent to $415 for every person in the U.S. or about 1 percent of the value of all goods and services produced in the U.S. that year.[11] Looking just at public expenditures, the rate of investment in building, operating, and maintaining some 16,000 municipal wastewater treatment facilities nationwide has escalated in real terms from about $15 billion a year at the beginning of the CWA in 1972 to nearly $60 billion a year in 2011.[12] Federal contributions have declined since about 1977 while local capital and particularly operating expenses have risen dramatically, with the effect of sewer rate hikes of 3 percent above the rate of inflation, on average, each year over the last decade.[13] On a cumulative basis, the nation has invested some $1.4 trillion in municipal wastewater treatment facilities since 1972, the great majority (about 90 percent) of which has come directly out of the pockets of people and businesses in communities that generate wastewater.



The Farm Bill. Under authorities in the federal Farm Bill over the period 1985-2008, the USDA has administered multiple voluntary programs accompanied by some $2-3 billion a year in federal subsidies largely through its Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA) to achieve a wide variety of conservation objectives. Fundamentally, these programs are designed to reduce soil erosion and wetlands loss, protect habitat, and improve farm productivity. Only about 10-15 percent of this total is used to control nutrients directly, even as reduced soil loss will have some indirect effect on phosphorus loadings. The largest and most widely used programs include:

Conservation Reserve Program (CRP) —the oldest of the programs, now about $1 billion a year in annual rental payments, usually over 10 years, to producers to replace crops on highly erodible and environmentally sensitive land with long-term resource conserving plantings. Thirty-four states enhance this program with an additional 20 percent match.

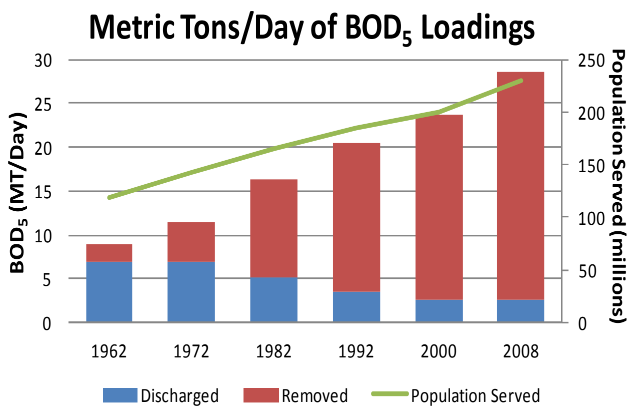
Conservation Stewardship Program (CSP) — the newest of the programs, $200-$300 million a year in financial and technical assistance via 5-year contracts to promote the conservation and improvement of soil, water, air, energy, plant and animal life on tribal and private working lands.

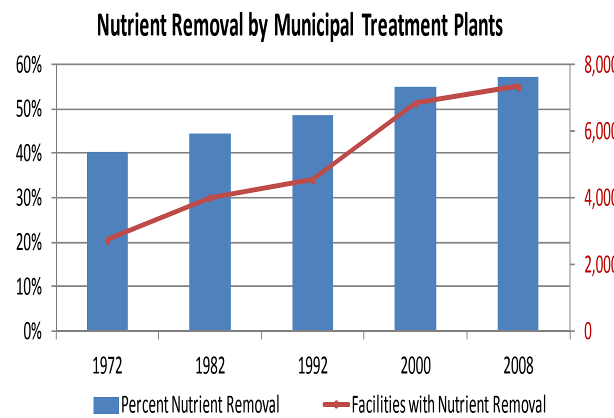
Environmental Quality Incentives Program (EQIP) —about $1 billion a year in financial and technical assistance to producers and land owners to plan and install structural, vegetative, and land management practices on eligible lands principally to alleviate soil erosion. A sub-program, the Agricultural Water Enhancement Program (AWEP) provides some $70-75 million a year to address water quality and quantity concerns on agricultural lands.

Wetlands Reserve Program (WRP) — $300-400 million a year to purchase easements or contracts with land owners to protect or restore wetlands to natural conditions where possible.

Chapter 2 —
How Successful Is Current Nutrient Control Policy?

Over the last 40 years, municipal wastewater utilities have achieved remarkable success in significantly reducing loadings of most pollutants, including nutrients. Compared to the 1960s, when only about half the municipal wastewater treatment plants in the U.S. had minimum levels of pollutant removal, by 2008 nearly all facilities met or exceeded standards resulting in removal of 90 percent of conventional pollutants (e.g. biochemical oxygen demand (BOD_5), suspended solids) entering these facilities, despite a near doubling of the population served during this period.





Also over this period, the municipal sector has steadily invested in nitrogen and phosphorus removal. The number of municipal wastewater treatment facilities with advanced nutrient removal up to the limits of current technology has more than doubled from 2,719 in 1972 to 7,323 in 2008. In 1972, the municipal sector removed only about 40 percent of nutrients in raw municipal wastewater (about 18,000 tons) prior to discharge. By 2008, the sector was removing nearly 60 percent of incoming nutrients (about 49,000 tons).[14]

Soil erosion and wetlands conversion have both declined since the mid-1980s, roughly corresponding to the years during which USDA and state farmland conservation programs have been active and focused on soil erosion.[15] While Farm Bill conservation programs are clearly capable of reducing nutrient loadings to waterways, such reductions are not measured routinely and are, therefore, not well understood. Results of three recent USDA regional assessments of these effects for the Great Lakes Region, the Upper Mississippi River watershed, and the Chesapeake Bay watershed, indicate that much more needs to be done. According to USDA, only about 12 percent of cropped acres in the Great Lakes Region meet full nutrient management criteria for both phosphorus and nitrogen management.[16] For the Upper Mississippi, USDA concludes:

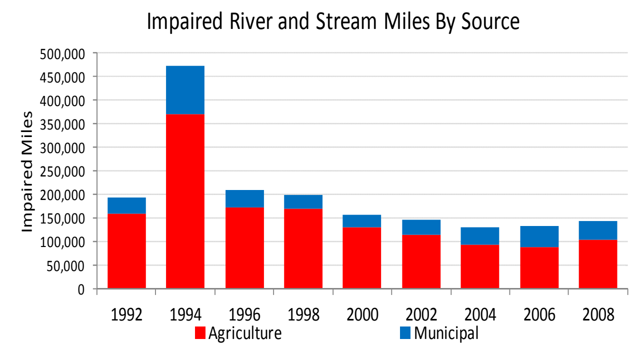
> *" Good progress has been made on reducing sediment, nutrient, and pesticide losses from farm fields through conservation practice implementation in the Upper Mississippi River Basin, but a significant amount of conservation treatment remains to be done to reduce nonpoint agricultural sources of pollution to acceptable levels."*[17]

Specifically with regard to nutrients, the report confirms that 62 percent of cultivated cropland in the basin will require additional nutrient management to reduce the loss of nitrogen or phosphorus from fields. About 51 percent of cropped acres require additional nutrient management to address excessive levels of nitrogen loss to groundwater.

The NRCS study for the Chesapeake Bay watershed comes to much the same conclusion:

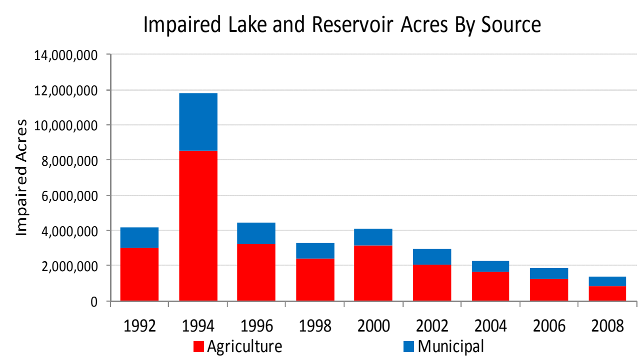
> *Significant improvement is still needed in nutrient management (proper rate, form, timing, and method of application) throughout the region. About 81 percent of the cultivated cropland acres require additional nutrient management to reduce the loss of nitrogen or phosphorus from fields. About 65 percent of cropped acres require additional nutrient management to address excessive levels of nitrogen loss in subsurface flow pathways…*[18]

Every two years, the states and EPA measure the extent to which U.S. waters meet their designated uses. Where they do not, they identify both causes (contaminants) and sources (activities) of impairment. State and EPA data suggest agricultural runoff and drainage consistently impairs, on average, four times more miles of rivers and streams than do municipal discharges.



Source: US EPA ATTAINS Database and 305(b) Reports to Congress

Trends are similar for lakes, ponds, and reservoirs. Agricultural sources have been responsible for nearly three times more degradation of lake and reservoir acreage, on average, than have municipal sources. Like surface waters, groundwater data indicate that agricultural activities are significantly more likely to contaminate aquifers than are urban activities, as measured by concentrations of nitrate that exceeds EPA's Maximum Contaminant Level (MCL) for drinking water of 10 mg/l N.



Source: US EPA ATTAINS Database and 305(b) Reports to Congress

According to the U.S. Geological Survey's National Water Quality Assessment covering more than 5,000 wells, nitrate concentrations exceeded the MCL in samples from 7 percent of domestic wells and in 3 percent of public-supply wells. Water from one or more monitoring wells sampled in 83 percent of the aquifers underlying agricultural land and 52 percent of aquifers underlying urban land had concentrations of nitrate exceeding the safe level for drinking water. [19]

These data suggest that the nation has not paid sufficient attention to agricultural sources of nutrients, especially compared to the nation's intensive regulatory focus on municipal point sources. However low they may be from any given farm and despite initial actions to address nutrient loadings, agricultural acreage continues to increase. As it does, so do nutrient loadings from agricultural activities.

Nowhere is this more apparent than at the watershed scale where people live and work. Iowa, for example, recently prepared a nutrient budget, quantifying both inputs and outputs of both phosphorus and nitrogen for its 68 watersheds. The nutrient budget shows that 8 percent of nitrogen and 20 percent of phosphorus come from industrial and municipal point sources. The remaining 92 percent of nitrogen and 80 percent of phosphorus come from nonpoint sources. Iowa concludes:

> *"To substantially reduce nutrient levels of our waters, the amount of nutrients coming from nonpoint sources like agriculture must be reduced."*[20]

Elevated concentrations of nitrate and nitrites in drinking water in Iowa are having tangible economic impacts. In response to steadily increasing nitrate concentrations in the Raccoon and Des Moines Rivers over the last 25 years, the Des Moines Water Works (DMWW) had to build a $3.7 million nitrate removal facility to avoid violating EPA's 10 mg/l standard for nitrate in drinking water.[21] Since commissioning the facility in 1991, DMWW operated the facility an average of 45 days a year through 2007. Wet weather patterns from 2008-2011 diluted peak nitrate concentrations eliminating the need to run the nitrate facility even though overall nitrate loading of the river (concentration times flow in river) contributing to Gulf of Mexico hypoxia remains high.

Similar examples abound across rural America. In response to elevated nitrate levels in source water attributed to agricultural sources, five small municipal water suppliers in Minnesota have constructed nitrate removal systems. Construction costs resulted in charges of $350 to $1000 per resident. Annual operating costs for these small communities tripled.[22]

Chapter 3 —
The Next Frontier: Further Reductions in Nutrient Loadings

Historically, regulatory agencies have attempted to limit nutrient loadings to the Nation's waterways through narrative standards rather than numerical criteria for nutrient concentrations in surface waters. This is changing rapidly, however, in response to litigation compelling EPA to establish more stringent numerical water quality criteria for nitrogen and phosphorus in Florida, Wisconsin, and the states in the Chesapeake basin. Without a change in approach to nutrient controls, shifting to strict numerical criteria for nutrients will result in continued pressure on point sources — municipal wastewater treatment plants, in particular — to invest in additional and more costly nutrient removal processes. Such an outcome will not solve nutrient loadings problems in the majority of U.S. watersheds and will do little to reverse nutrient contamination of groundwater. Even where nutrient loadings can be reduced effectively through further municipal controls, it is inefficient and inequitable to compel municipal sources to take additional actions in the absence of parallel actions to control agricultural sources.

If the nation expects to achieve effective reductions in nutrient loadings and water quality improvements that meet water quality goals, this unbalanced approach to nutrient controls must change. While municipalities will continue to pursue nutrient controls, aggressive and effective control of agricultural sources of nutrients is urgently needed.

Why Won't Business as Usual Work for Most Watersheds?

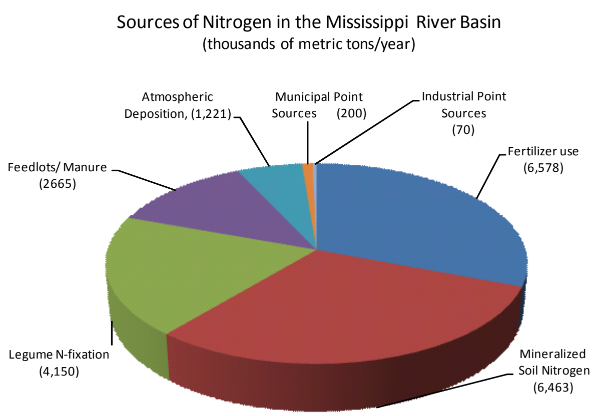
When effluent standards based on conventional wastewater treatment technology under the CWA are unable to produce ambient water quality that meets criteria for designated uses of the receiving water, the CWA provides the states and EPA authority to establish a Total Maximum Daily Load (TMDL) for the pollutant of concern from all sources so that criteria will be met. States then allocate loadings of this pollutant to all point and nonpoint sources. Because this process relies on regulatory power to compel point sources to take actions, they will bear more of the burden of meeting more stringent criteria than will nonpoint sources, whose participation in most states is voluntary. Recall that nutrient loadings from nonpoint sources, such as agriculture are not regulated, so the TMDL process must rely on other tools to achieve loadings reductions from these sources, such as subsidies and technical assistance provided by the USDA, the National Oceanic and Atmospheric Administration (NOAA)'s Coastal Zone Act Reauthorization Amendments program, and state programs. This is true even though these agricultural sources may be responsible for a large portion or even the majority of loadings.[23] The result is load reductions disproportionately allocated to point sources, against which EPA and the states can take legal action, rather than nonpoint sources to which enforceable regulations do not apply.

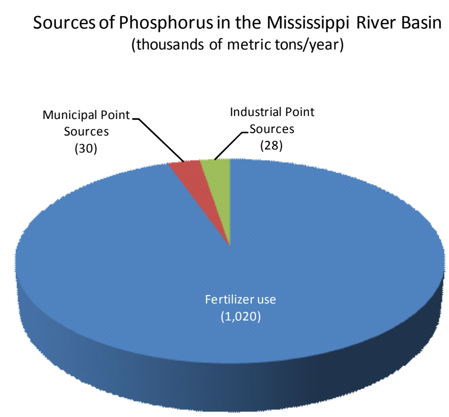
Where there is "reasonable assurance" that nonpoint sources will reduce their nutrient pollutant loadings, a state may allocate more of the needed loadings reductions to nonpoint sources instead of more stringent point source reductions. In their recent review, however, the states and EPA concluded that allocation in the absence of enforcement is unreliable:

> *"States have undertaken and explored different limited approaches to control nonpoint sources. Authority at the federal level for state development of effective, enforceable and transparent nonpoint source accountability is lacking."* [24]

TMDLs that rely on voluntary processes of technical assistance and financial subsidies have been unable to deliver reliable and sustained nutrient loadings reductions from the agriculture sector.[25] Because of the uncertainties associated with results from nonpoint source programs, EPA suggests in its TMDL guidance that it may be necessary to reopen CWA permits and require more stringent limits on point sources in the event that nonpoint sources are unable to reduce their loadings.[26]

In many instances, even zero discharge of nutrients from point sources would not restore waterbodies to their designated uses. In a recent analysis of widespread hypoxia (severe oxygen depletion) in the Gulf of Mexico, which drains 40 percent of the land mass in the U.S., NOAA concluded that because nutrient inputs were so highly dominated by agricultural sources, even if the highest level, tertiary, was installed at every municipal treatment plant in the basin, it would reduce nitrogen loads by only a few percent to the Gulf of Mexico with little to no effect on hypoxia.[27]





Source: Goolsby, D.A., W.A. Battaglin, G.B. Lawrence, R.S. Artz, B.T. Aulenbach, R.P. Hooper, D.R. Keeney, and G.S. Stensland. 1999. *Flux and sources of nutrients in the Mississippi–Atchafalaya Basin. Topic 3 report for the integrated assessment on hypoxia in the Gulf of Mexico. NOAA Coastal Ocean Program Decision* Analysis Series No. 17. Silver Spring, MD: National Oceanic and Atmospheric Administration. (Not measured for N:urban nonpoint sources.; Not measured for P: feedlots/manure and urban non-point sources

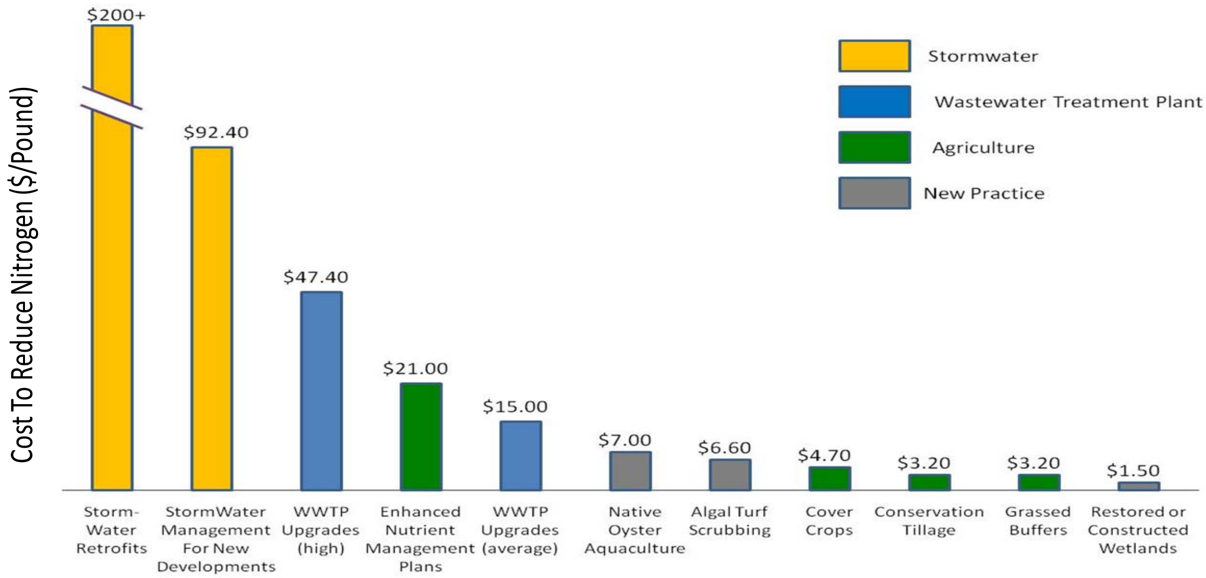
Even in highly urbanized watersheds where urban sources are responsible for a large proportion of nutrient loadings such as the Long Island Sound, which drains portions of New York, Connecticut, Massachusetts, Vermont, and New Hampshire, there is still a basis for a more balanced basin-wide approach. Of the roughly 100,000 tons of nitrogen that enter the Sound each year, about a third comes in as inflow from connecting waters, 42 percent comes from point sources, 13 percent from nonpoint source runoff and drainage, and 12 percent from atmospheric deposition.[28] Despite these figures, Phase III of the Long Island Sound TMDL calls for 98 percent of all nitrogen reduction to come from point sources that discharge directly to the Sound, at a potential cost of $2 billion. In contrast, load reductions required of agriculture are minimal. If point source controls achieve the Sound's target of 58.5 percent reduction in nitrogen loads, water quality will improve greatly, but will still not meet standards for dissolved oxygen everywhere. Despite the municipal expenditures in the billions, in many locations there will be virtually no improvement in dissolved oxygen, so additional measures including some focused on nonpoint sources will be needed in future years.

Where nutrients result in violations of drinking water MCLs under the Safe Drinking Water Act, public water suppliers (and homeowners with well water) have no choice — they must invest in removal technology or alternative source water sufficient to comply with the Act. The burden of compliance falls entirely on households and businesses irrespective of the source of contamination. The Ohio Environmental Protection Agency, for example, ordered the City of Fremont (population: 20,000) in 2008 to solve its problem of high nitrate levels in its drinking water source, the Sandusky River. The city lies in a watershed that is 90 percent agricultural and has struggled with nitrate for several decades usually during heavy spring rains, despite extensive federal and state support to control agricultural sources. The city's best alternative was an upland reservoir, which cost the city $28 million. Had federal and state assistance not been available, the new reservoir would have added about $250 a year to the water bills of each household, or about double current levels. With these subsidies, water rates will still increase by 6 percent a year through 2014, with additional surcharges to cover operations when nitrate concentrations are high.

What is the Most Cost-Effective and Equitable Way to Reduce Nutrient Loadings?

The economics of nutrient loadings reductions in general suggest broad societal benefits through controls on agricultural practices, as opposed to much greater reductions in loadings from urban point sources. This is because the cost to remove a pound of nitrogen or phosphorus from farm runoff and drainage is generally lower than the cost to remove the same amount from municipal wastewater or stormwater. In part this is because controls on the farm require little and in some cases no capital investment, and can result in low maintenance expenses or even operational cost savings. Controls at wastewater and drinking water utilities, on the other hand, are technology and capital intensive, and require significant ongoing energy and labor to operate and maintain.

Actual cost comparisons will vary from location to location, as will the effectiveness of farm versus urban controls (see below), since loadings themselves will vary from place to place. In the Chesapeake Bay, for example, which drains portions of Delaware, Maryland, West Virginia, Virginia, Pennsylvania, and New York as well as the District of Columbia, the World Resources Institute found costs to reduce nitrogen loadings from agricultural nonpoint sources ranging from $1.50 to $22 per pound compared to costs ranging from $15.80 to $47 per pound from municipal wastewater point sources. Reducing a pound of nitrogen loadings from urban stormwater would cost more than $200. To the extent that sufficient loadings reductions are available in the agricultural sector in the Chesapeake Bay watershed and leaving aside regulatory requirements, clearly it will be efficient to reduce these first before seeking additional reductions from municipal point sources or from urban stormwater.[29]



Source: CY Jones, Evan Branosky, Mindy Selman, and Michelle Perez, *How Nutrient Trading Could Help Restore the Chesapeake Bay*, WRI Working Paper, World Resources Institute, 2010.

According to these same studies, even after taking into account all regulatory requirements for municipal point sources and stormwater, significant efficiencies can be captured in achieving the watershed's nitrogen reduction targets through simply implementing existing nutrient management plans, developing new nutrient management plans for acreage without existing plans, using cover crops, practicing conservation tillage, constructing grassy or forest buffers along streams, and restoring or constructing wetlands.

Similar ranges in costs can be expected in most watersheds characterized by agricultural or mixed agricultural/sub-urban land use.[30] That is because to a large degree U.S. households and businesses have invested nearly $1.5 trillion — largely their own money — since the early 1970s to reduce loadings from point sources. These investments have paid off — discharges of organic matter and nutrients nationwide have been reduced by 90 percent and nearly 60 percent respectively. In contrast, farmers have received subsidies from federal programs of only an estimated $5 billion since the mid-1980s, and for voluntary attempts to control nutrient loadings from agriculture that ultimately have proven inadequate.[31]

To extract the next increment of reductions in nutrient loadings from point sources will be very expensive per pound reduced because the least costly increments have already been extracted. The very same households and businesses that have spent more than a trillion dollars to control their sources will be the ones to pay for additional controls out of their own pockets. In the 1990s, for example, sewer ratepayers in Washington D.C. were among the first in the watershed to reduce nitrogen loadings to the Chesapeake Bay voluntarily from more than 14 to 8.5 million pounds a year (40 percent below 1985 levels) at a cost of about $16 million.[32] Subsequently, the same ratepayers voluntarily reduced loadings even further to about 5 million pounds a year (a reduction of another 40 percent from then-current levels) at an additional cost of $100 million. In 2009, EPA required further reductions to 4.4 million pounds a year (another 12 percent, which represents an overall reduction of 0.4 percent of total nitrogen loadings to the Bay), this time at a cost of $900 million to ratepayers.

The opposite is true of agricultural reductions — there is significant potential to remove large loadings of nutrients from agricultural sources at very low costs per pound removed. As important, the nation has not yet required comprehensive agriculture nutrient controls. A shift in that direction would impose relatively low costs per pound removed or per acre, and for many types of nutrient controls, reduced costs of fertilizers would offset or exceed nutrient control costs.

What are the Economic Effects of Alternative Nutrient Controls?

The literature is clear that society is best off when each polluter pays to reduce its own pollution in an amount equal to the damages that pollution causes.[33] Applied to nutrients in U.S. waters, that means that all sources of nitrogen and phosphorus should be asked to pay their fair share to reduce loadings of these elements in proportion to environmental and economic losses associated with impaired receiving waters.[34] Municipal sources should pay for the majority of loadings reductions in watersheds into which they represent the majority of loadings. Agricultural sources should pay for the majority of loadings reductions in watersheds into which they represent the majority of loadings. Unfortunately, it rarely works this way.

Today, agricultural sources are responsible for 3-4 times more impairment of river miles and lake acreage than municipal sources. In part, this is because households and businesses have spent trillions of dollars of their own money to reduce their nutrient loadings. The agriculture community has spent very little of its own money on nutrient controls and federal subsidies have amounted to only an estimated $5 billion. Expenditures on municipal controls have produced tangible water quality improvements, but as a general rule, the same cannot be said for expenditures on agricultural nutrient controls.

From an efficiency perspective, it makes more sense to address agricultural sources first. The incremental cost of reducing nutrients from agricultural sources is typically 4-5, sometimes 10-20, times less than the cost of asking the municipal sector to reduce nutrient loadings even further.

Municipal wastewater ratepayers across America are stretched to the limit of affordability. Forty percent of all U.S. households are already paying more of their household incomes for wastewater management services than EPA recommends as affordable.[35] Increasing rates further to remove even more nutrients from municipal sources will crowd out other needed infrastructure improvements and risk backsliding on the hard-earned water quality gains of the past several decades. In a sample of more than 90 municipal and regional wastewater utilities in 34 states with design flows ranging from 6 MGD to 2,500 MGD, for example, adding nutrient removal would increase sewer rates as much as 134 percent and double the number of communities that would exceed EPA's affordability limits for wastewater, or 2 percent of household income.[36]

Why then don't we ask agricultural sources to do their share? Traditional arguments against asking farmers to pay for nutrient controls include:

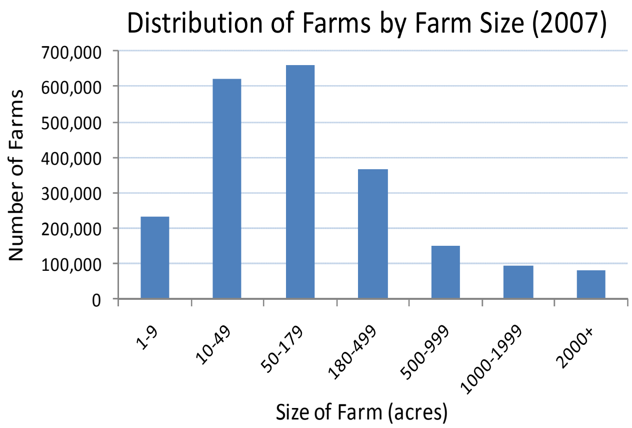
- The cost of agriculture sector nutrient controls is too expensive.
- Most farms are small businesses, so implementing and enforcing controls is difficult.
- Farm incomes are so low that additional cost burdens will put them out of business.

Let's examine each in more detail.

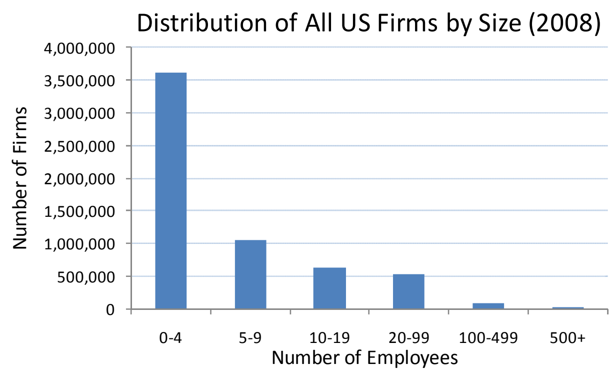
The Cost of Agricultural Nutrient Controls. In most instances, agricultural nutrient controls cost substantially less per pound removed than additional municipal controls. In some cases, agricultural controls generate net savings to farmers. Absolute costs of agricultural nutrient controls will vary from place to place in response to differences in geography, agricultural land use, climate, soil quality, and other factors. Moreover, costs per acre also will vary with reduction targets, scale of operations, location, and other factors. While national estimates are problematic because of this variation, several interesting case studies that control for some of these factors make it possible to examine costs at the watershed and state scales. The Chesapeake Bay example presented earlier in this paper is clear that on a cost-per-pound-removed basis, agricultural Best Management Practices (BMPs) are on average four times less expensive than nutrient removal at municipal wastewater treatment plants and 20 times less expensive than nutrient removal at stormwater control facilities.

EPA's recent analysis of the economic effects of potential statewide nutrient standards in Florida concluded that nutrient management plans for some 1.85 million acres of agricultural land affected by the rule would cost the agriculture sector $21.5 million a year on average, or $11.62 per acre per year.[37] If these plans were successful, fertilizer use could be reduced by about 20 percent and with the average cost of fertilizer at about $60 an acre, farmers would save about $12.00 per acre and come out ahead. In contrast, some 85 communities affected by the rule would have to pay $30 million a year to upgrade their treatment plants to remove nutrients plus another $84 million a year to build and manage community stormwater control facilities.[38] Assuming these two urban populations were the same, each household would pay $538 a year, or about 1.3 percent of median household income, to remove its share of nutrient loadings. Assuming these communities were already paying 1.2 percent of household income for wastewater (the average of the 90-community sample referenced previously), virtually every community in the Florida sample would exceed EPA's affordability criterion for household-level wastewater costs. Households with leaking septic systems would pay about $1,000 a year to reduce their nutrient loads, or the equivalent of 2.2 percent of median household income, also above EPA's affordability criterion.

Farm Size and Ownership. The agricultural community is no less able than the general population of businesses to absorb appropriate environmental controls on the basis of size of entity (see comparison charts below). While there are a great number of small farms in the U.S. (those that operate 50 acres or less), they account for less than two percent of all farmland. By comparison, large farm businesses with 1,000 acres or more operate nearly 70 percent of U.S. farm acres.[39]

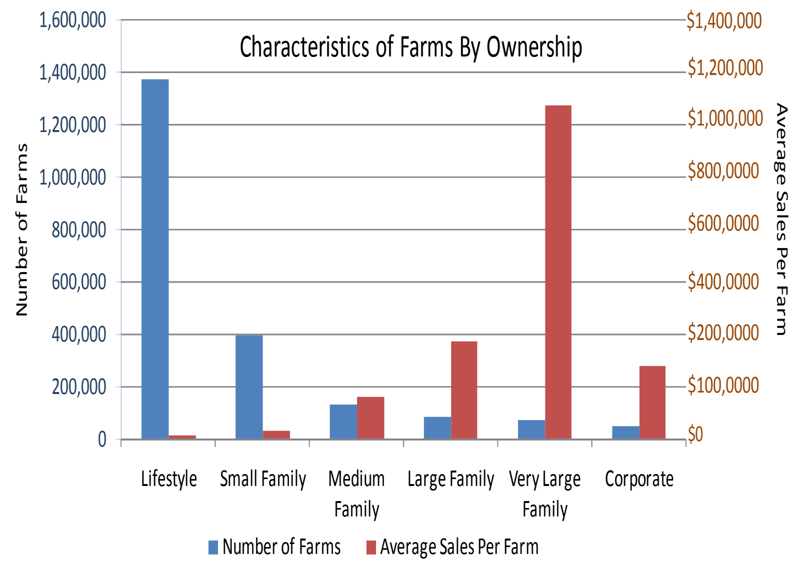


Source: USDA, The Census of Agriculture, 2007



Source: SOURCE: Bureau of the Census, 2008 County Business Patterns

In response to their finding that 65 percent of all U.S. field crop acres failed to apply BMPs for nitrogen fertilizer application, a recent USDA analysis concluded that "a variety of steps can be taken to reduce the relatively large share of nitrogen that is lost from agricultural systems."[40] By targeting existing programs better, the USDA suggests that "Improved management of nitrogen fertilizers, animal manure, and other agricultural inputs can improve overall nitrogen use efficiency and reduce the loss of reactive nitrogen to the environment while maintaining crop yields." Because of the number and diversity of farms, USDA economists suggest more targeted use of technical assistance and financial incentives focused on appropriate fertilizer application, specifically through the existing EQIP program (see description above). But they also suggest other approaches are likely to be successful, including subsidies for off-farm constructed or restored wetlands and vegetative filter strips, fertilizer input taxes, discharge trading/emissions markets, and even regulatory requirements for agricultural BMPs.

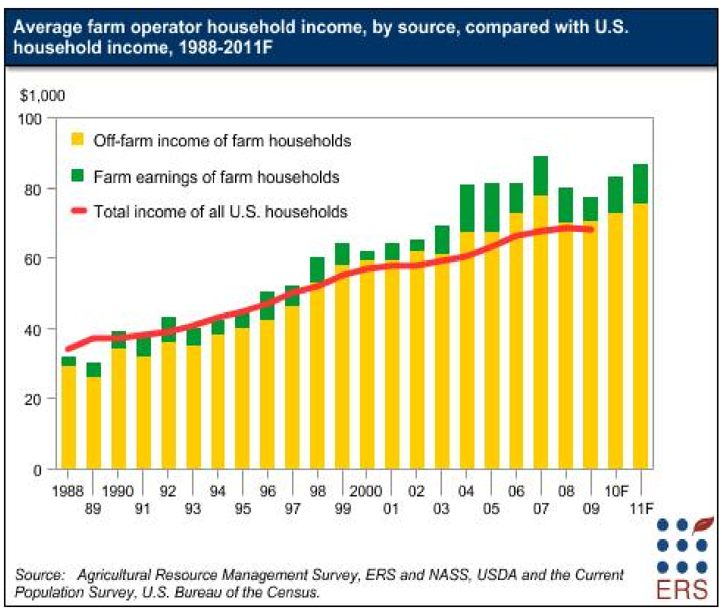


Source: Economic Research Service

It is also important to note that the great majority of small farms that have low sales and therefore the least ability to pay for nutrient controls from farm operations are owned for reasons other than farming, including retirement and lifestyle. A smaller number of much larger corporate and family farmers earn significantly more, which gives them greater ability to handle the costs of nutrient controls. These statistics support USDA's suggestion that they target conservation program resources. A strengthened agricultural nutrient control program that focused on large agricultural sources s could remove significant loadings of nutrients from the nation's waters while minimizing administrative effort.

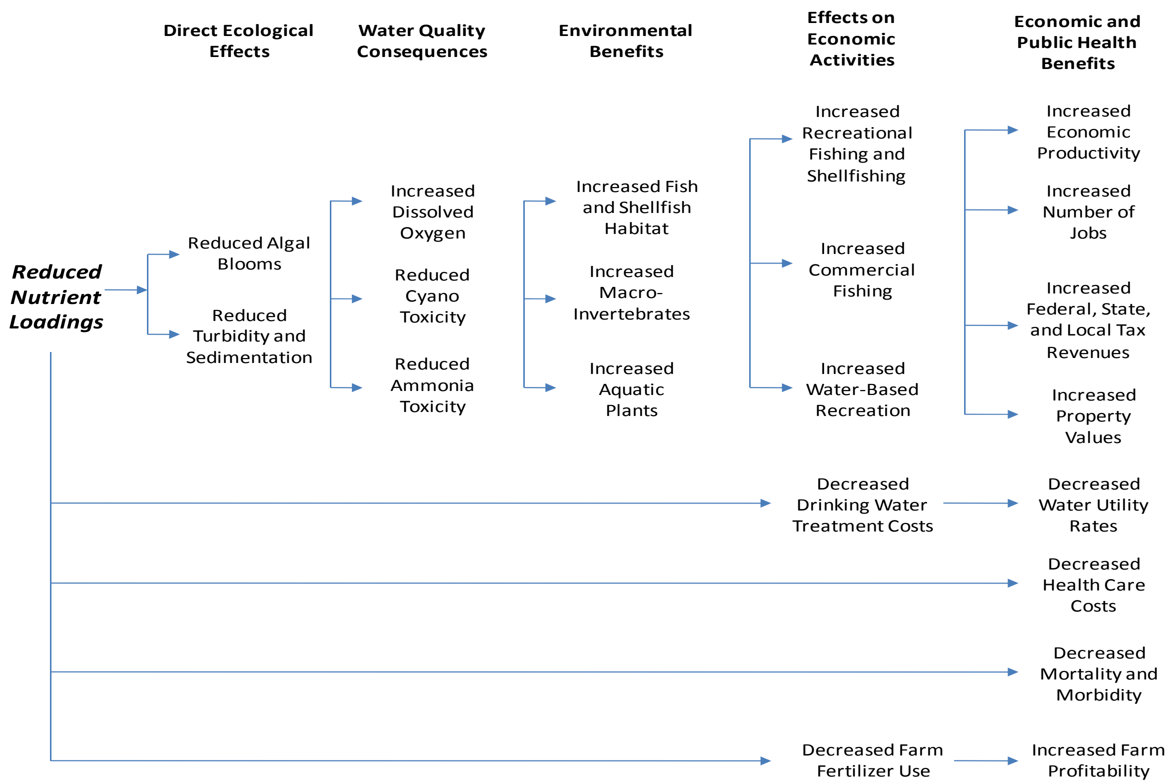
Farm Incomes and Wealth. Farm incomes and wealth alone cannot justify exemption from nutrient controls on the basis of hardship. Farm households make more money (on-farm plus off-farm incomes) on average than non-farm households according to USDA's Economic Research Service, and according to the US Federal Reserve, farmers are four times wealthier (measured as net worth, or assets minus debt) than non-farm households. The median value of wealth for farm households was $534,727 in 2007 compared to $120,300 for all households.[41] Moreover, there are many more, and a much higher percentage of, poor households in the non-farm community than in the farm community.

These comparisons suggest strongly that approaches to nutrient controls and policies regarding who should pay for them embedded within the CWA and the Farm Bill do not reflect economic realities. CWA policies mandate that non-farm households pay for nutrient removal from their own funds with secondary regard for issues of affordability, financeability, or economic impacts. Farm Bill policies encourage farms to reduce nutrient loads by paying them to do so. Yet there is no underlying economic rationale for such a difference. The facts suggest just the opposite — that if the nation is willing to subsidize nutrient controls for farmers on the basis of economic disadvantage, they should be even more willing to do so for non-farm households.



Chapter 4 — Conclusion

It is well worth requiring the agricultural community to undertake its share of nutrient controls. Reducing nutrient loadings to U.S. surface waters will trigger a series of ecological and water quality improvements in rivers, lakes, estuaries, and coastal waters (see diagram below).[42] These, in turn, will create healthier ecosystems and a series of environmental benefits. A healthier environment will attract economic activities that rely on clean water and healthy ecosystems, which will strengthen the economy; create jobs; increase property values adjacent to and near water bodies; and increase local, state, and federal tax receipts. Reduced nutrient loadings also will reduce water purification costs to U.S. water utilities, which will reduce water rate increases to consumers. Self-supplied water consumers will enjoy better health and reduced health care costs from drinking cleaner well and surface waters. To the extent that farmers embrace nutrient management planning that reduces their use of fertilizers with no loss in productivity, farm costs will decline and profitability will increase.[43]



The extent to which these benefits can be captured in any given watershed will be directly related to efforts of stakeholders that demand changes in urban and agricultural practices that result in high levels of nutrients reaching America's waters. These changes are within reach. The key question is whether the nation can make decisions that promote change while balancing costs appropriately between agriculture, households, and businesses in America's urban and rural areas.

It is clear that policy makers can draw on reliable science and years of programmatic experience to design nutrient reduction approaches that are effective. But our agricultural programs must be better used and targeted to assure that nutrient reduction approaches are economically balanced and fair. And against a backdrop of difficult budget decisions facing the nation today and over the next decade, it only makes sense that we use our funding resources wisely, asking all to pay for nutrient control programs in relation to their contribution of nutrients to U.S. waters.

Acknowledgements

NACWA would like to thank the Turner Foundation and the Water Environment Federation for supporting this effort through their generous financial contributions. We would also like to thank Ken Rubin of Rubin Mallows Worldwide for working with NACWA and our review team to research, develop and write the report over these past several months. NACWA thanks the following individuals who participated in our review team:

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Endnotes

[1] State-EPA Nutrient Innovations Task Group, *An Urgent Call to Action*, a report to the Administrator of the US Environmental Protection Agency, August 27, 2009, page 1.

[2] See, for example, Ward, M. H.; deKok, T.; Levallois, P.; Brender, J.; Gulis, G.; Nolan, B. T.; VanDerslice, J (2005). *Drinking water nitrate and health – recent findings and research needs.* Environmental Health Perspectives *115*, 1607-1614.

[3] See: Dubrovsky, N.M., Burow, K.R., Clark, G.M., Gronberg, J.M., Hamilton, P.A., Hitt, K.J., Mueller, D.K., Munn, M.D., Nolan, B.T., Pucket, L.J., Rupert, M.G., Short, T.M., Spahr, N.E., Sprague, L.A., and Wilber, W.G., The *Quality of Our Nation's Water— Nutrients in the Nation's Streams and Groundwater, 1992-2004,* US Geological Survey Circular 1350, 2010. Man's activities, especially the production and application of fertilizers, cultivation of nitrogen-fixing crops, disposal of animal waste, discharge of municipal and industrial wastewaters, and combustion of fossil fuels over the last decade, have significantly increased loadings of nitrogen to surface and ground waters. These same activities have also doubled the rate of phosphorus loadings from the land to waterways.

[4] Ibid.

[5] Several species of nitrogen and phosphorus are of concern. Nitrogen species include ammonia/ammonium, nitrate, nitrite, and organic nitrogen. Phosphorus species include ortho-phosphate and organo-phosphorus compounds.

[6] A handful of states, Maryland being perhaps the most well known, operate what they define as regulatory non-point source control programs, but there is little monitoring and no economic sanctions for non-compliance. Personal communication, Doug Parker, University of Maryland, August 2011.

[7] For details, see: U.S. Department of Agriculture, Natural Resource Conservation Service, Nutrient Management Code 590, August 2006, at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1043135.pdf

[8] Programs (both federal and state) under the federal Clean Water Act and to a lesser degree, Clean Air Act (CAA) address point sources using a regulatory approach. Farm Bill programs, and to a lesser extent, the Coastal Zone Act Reauthorization Amendments address a wide variety of farm-based conservation programs including recently, nutrient controls, by paying farmers and other sources to participate voluntarily.

[9] For additional details on this issue, see, *National Academy of Sciences, Nutrient Control Actions for Improving Water Quality in the Mississippi River Basin and Northern Gulf of Mexico*, Washington DC, 2008, pp 36-37.

[10] The Direct Payment program provides farmers fixed annual payments of 85 percent of the product of base acres of an eligible crop, the farm's direct payment program yield, and the direct payment rate.

The Countercyclical Payments program provide farmers subsidies whenever season-average prices for eligible crops drop below price targets set by USDA or the loan rate for each crop and are equivalent to 85 percent of the product of the direct payment rate, a farm's program yield, and base acreage. Marketing Loans are provided to farmers who pledge their crops as collateral and they are forgiven (with the government taking the crop) if the market price for the crop is below the loan rate. The ACRE program provides farmers a revenue guarantee when crop prices times their yield fall below the guarantee level, with payments as the product of the per-acre revenue shortfall and 85 percent of planted acreage.

[11] Unless noted otherwise, all figures are presented in terms of 2010 dollars.

[12] Private industrial expenditures for water pollution control and abatement also have grown since passage of the Clean Water Act. Compared to about $30 billion a year in 1972, total industrial expenditures to control discharges to water bodies doubled by 1994, the last year that the US Government collected consistent annual statistics. A simple forecast since then suggests that industrial spending to meet Clean Water Act requirements could be as high as $75 billion a year in 2011.

[13] National Association of Clean Water Agencies*, NACWA Service Charge Index*, various years, See: www.NACWA.org.

[14] Figures derived from EPA Needs Surveys 1972 – 2008. Specifically, nutrient removal percentages were assumed for each level of treatment and where appropriate, allowed to increase marginally over time to reflect improved technology —partial treatment (0 percent), less than secondary (5 percent), secondary (15 percent-25 percent), greater than secondary (65 percent-85 percent), and no discharge (100 percent). Nutrient removals reflected these percentages, the proportion the U.S. population served by each level of treatment each year, and the U.S. average per-capita flow.

[15] Cropland erosion is down 40 percent from 3.1 billion tons in 1982 to 1.9 billion tons in 1997. Wetland losses to agriculture are down from 235,000 acres a year in the period 1974-1982 to 19,000 acres a year between 1992 and 2002. Evidence of reductions in agricultural nutrient use and/or loadings, as discussed in the body of this paper, is less compelling. Aside from a marked dip in 2009 (most recent year available), which reflects the broad economic downturn that year, total agricultural fertilizer use in the U.S. has been steady since about 1980 at between 20 million and 23 million nutrient tons a year. See: http://www.ers.usda.gov/Data/FertilizerUse/.

[16] US Department of Agriculture, Natural Resource Conservation Service, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Great Lakes Region*, Conservation Effects Assessment Project (CEAP), August, 2011.

[17] US Department of Agriculture, Natural Resource Conservation Service, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Upper Mississippi River Basin*, Conservation Effects Assessment Project (CEAP), June 2010, Draft.

[18] US Department of Agriculture, Natural Resource Conservation Service, *Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Chesapeake Bay Region*, Conservation Effects Assessment Project (CEAP), October 2010, Draft.

[19] Dubrovsky, et al, op. cit., p. 174.

[20] Iowa Department of Natural Resources, *Protecting and Improving our Water: Iowa's Nutrient Budget,* 2005.

[21] Des Moines Water Works, Fact Sheet: Nutrient Removal Facility, November 2009, accessible through www.dmww.com.

[22] Minnesota Department of Agriculture, *Nitrate Contamination: What is the Cost?*, http://www.mda.state.mn.us/news/publications/protecting/waterprotection/dwps2.pdf

[23] According to the Environmental Law Institute, while most states have some general statutory authority to deal with nonpoint source discharges that can be shown to result in water pollution, many laws of general applicability have exceptions for agriculture. Where state laws exist, they often defer to incentives, cost-sharing, and voluntary programs. See: Environmental Law Institute, Enforceable State Mechanisms for the Control of Non-Point Source Water Pollution,1997.

[24] State-EPA Nutrient Innovations Task Group, op. cit., p.19.

[25] See for example, Robert Adler, *TMDLs, Nonpoint Source Pollution and the Goals of the Clean Water Act*, Center for Progressive Reform, 2008, http://www.progressivereform.org/perspTMDLs.cfm

[26] EPA, *Guidance for Water Quality-Based Decisions: The TMDL Process*, EPA 440/4-91-001, Washington DC, April 1991 (and subsequent revisions thereto).

[27] Goolsby, D.A., W.A. Battaglia, G.B. Lawrence, R.S. Artz, B.T. Aulenbach, R.P. Hooper, D.R. Keeney, and G.S. Stensland, Flux and Sources of Nutrents in the Mississippi-Atchafalaya Basin, Topic 3 Report for the Integrated Assessment on Hypoxia In the Gulf of Mexico, NOAA Coastal Program Decision Analysis Series No 17, Silver Spring MD, National Oceanic and Atmospheric Administration, 1999. Not measured for N: urban non-point sources; Not measured for P: feedlot/manure and urban non-point sources.

[28] NY State Department of Environmental Conservation and Connecticut Department of Environmental Protection, *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound*, December 2011.

[29] Unit removal costs cited here and in similar sources are costs to implement management approaches and install technologies. Actual costs may be somewhat higher to account for programmatic costs that may be needed to induce agriculture interests to participate. All else equal, total costs to control nutrients from agricultural sources can be expected to increase over time as the least-cost approaches are exhausted first.

[30] USDA estimates that costs of nitrogen removal by restoring and/or constructing wetlands ranges from $0.15 to $1.08 per pound removed, on average. Vegetative filter strips cost between $1.83 and $5.45 per pound removed, on average. See: Ribaudo, Marc, Jorge Delgado, LeRoy Hansen, Michael Livingston, Roberto Mosheim, and James Williamson. *Nitrogen In Agricultural Systems: Implications For Conservation Policy. ERR-127*. U.S. Dept. of Agriculture, Econ. Res. Serv. September 2011.

[31] In a comprehensive 2011 survey, USDA found that 65 percent of surveyed farmed land failed to meet all best management practices for nitrogen, resulting in excessive runoff and drainage of nitrogen to local water bodies and other environmental damages. This same survey concluded that current USDA payments were inadequate to induce more widespread adoption of nitrogen BMPs. See: Ribaudo, Marc, Jorge Delgado, LeRoy Hansen, Michael Livingston, Roberto Mosheim, and James Williamson. *Nitrogen In Agricultural Systems: Implications For Conservation Policy. ERR-127*. U.S. Dept. of Agriculture, Econ. Res. Serv. September 2011.

[32] See Testimony of George S. Hawkins, General Manager DC Water, *Nutrient Pollution: An Overview of Nutrient Reduction Approaches*, to the US Senate Committee on Environment and Public Works, Subcommittee on Water and Wildlife, October 4, 2011.

[33] See, for example, the seminal work William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy*, Cambridge University Press, 1988.

[34] Science is clear about urban, agricultural, and other sources of nutrient loadings that contribute to impaired waters, but far less clear on the exact relationship between any one activity and the losses for which it may be responsible. As a result, the TMDL process generally does not attempt to find a societal optima in terms of reducing loads in relation to losses. Instead, it allocates a total load reduction thought to achieve water quality goals to all contributors using a mix of cost-effectiveness, equity, and administrative certainty criteria.

[35] NACWA calculation based on Bureau of the Census data on local government wastewater expenditures and population stratified by household income levels.

[36] Wastewater utility data extracted from the *2010 Annual Financial Survey* of the National Association of Clean Water Agencies (NACWA). Nutrient control costs adapted from US Environmental Protection Agency, *Economic Analysis of Final Water Quality Standards for Nutrients for Lakes and Flowing Waters in Florida*, Washington DC, November 2010.

[37] Some consider these figures to be conservative and final estimates are still under study. For details, see: US Environmental Protection Agency, *Economic Analysis of Final Water Quality Standards for Nutrients for Lakes and Flowing Waters in Florida*, Washington DC, November 2010.

[38] Ibid.

[39] Nigel Key and Michael J Roberts, *Measures of Trends in Farm Size Tell Differing Stories*, Amber Waves, Vol. 5, Issue 5, USDA Economic Research Service, November 2007, http://www.ers.usda.gov/AmberWaves/November07/PDF/Datafeature.pdf

[40] Marc Ribaudo, et. al., op. cit.

[41] US Federal Reserve Board, *2004 Survey of Consumer Finances,* https://www.federalreserve.gov/pubs/oss/oss2/2004/scf2004home.html

[42] Many types of BMPs used to reduce agricultural loadings of nutrients also will reduce soil erosion and create or restore wetlands, adding still greater environmental and economic benefits. Many also will prevent or reduce loadings of pesticides and other farm chemicals from reaching surface and ground water resources. Similarly, stormwater controls that reduce nutrient loadings will have collateral benefits associated with reductions in other pollutants in stormwater.

[43] Nutrient management plans are designed to optimize fertilizer use for yield at least cost. As such, solutions often include application of less fertilizer at the proper times and in the proper form for plant growth. These solutions reduce farm input costs, increase farm revenue, and hence, increase farm profitability. It also may be the case that some farmers are applying too little or the wrong kind of fertilizer, which if corrected, could increase farm input costs and reduce profitability. But, since agricultural nutrient runoff/drainage has been well documented as a widespread source of impairment of surface and groundwater across the U.S., it is logical to assume broadly that nutrient management plans will result in less fertilizer use and consequently, improved water quality and farm profitability.