NACWA
A Clear Commitment to America's Waters

April 14, 2010

Leif Hockstad
U.S. Environmental Protection Agency
Climate Change Division (6207J)
1200 Pennsylvania Ave, NW
Washington, DC 20460
Via Email: Hockstad.Leif@epa.gov

Re: NACWA Comments on Wastewater Treatment Emissions Estimates in EPA's Draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008*

Dear Mr. Hockstad:

The National Association of Clean Water Agencies (NACWA) has reviewed Section 8.2, *Wastewater Treatment*, of the U.S. Environmental Protection Agency's (EPA) draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008* (*Draft Inventory*) and offers the following comments and technical information. NACWA represents the interests of nearly 300 publicly owned wastewater treatment agencies nationwide, serving the majority of the sewered population in the U.S. NACWA members are very much aware of the growing importance of global climate change and are already engaged in efforts to reduce greenhouse gas (GHG) emissions. The wastewater treatment category of the *Inventory* consistently ranks in the top categories for nitrous oxide and methane emissions in the U.S., although the emissions are much smaller in magnitude than for the highest ranked categories. The wastewater category is broad, including publicly owned treatment works (POTWs), septic systems, and industrial wastewater treatment systems. Our review focused on the portion of the wastewater treatment emissions from POTWs, which are a fraction of the total wastewater treatment emissions.

NACWA submitted comments on the three previous *Inventories*, and we appreciate EPA's response to these comments and the Agency's willingness to work with NACWA to refine the GHG emissions estimates for POTWs. Some adjustments have been made in past years to the methods used to calculate GHG emissions from POTWs, and NACWA has supported these changes. No significant changes were made between the 2007 and 2008 *Inventories*, however, and NACWA believes that the *Inventory* emission calculation methods could still be improved to more accurately reflect actual emissions from POTWs.

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In the past, the *Inventory* has been used only for information purposes, not for regulation. However, in EPA's proposed *Prevention of Significant Deterioration and Title V GHG Tailoring Rule* ("Proposed Tailoring Rule"), the methods for calculating GHG emissions in the *Inventory* were cited as the methods that a facility must use to calculate whether the threshold for regulation of GHG emissions under the Clean Air Act (CAA) is exceeded. If EPA plans to use the *Inventory* in its regulations, then it is especially important that the *Inventory* calculation methods accurately reflect actual emissions from facilities. However, the *Inventory* calculation methods may not be the best tool for regulatory compliance. As NACWA pointed out in its comments to EPA on the Proposed Tailoring Rule, the *Inventory* is meant to provide a nationwide estimate of emissions from broad categories of facilities, not emissions from individual facilities. In addition, the methods used to calculate emissions in the *Inventory* for POTWs differ from the methods that POTWs must use to calculate their emissions under the *Mandatory Reporting of Greenhouse Gases Rule*. NACWA believes that the Agency must determine one calculation method to be used in all of its GHG-related regulations, rather than requiring facilities such as POTWs to use different calculations for different regulations.

In the comments below, NACWA presents recommendations for changes that should be made to the *Draft Inventory* to improve its estimates of emissions from centralized treatment facilities. NACWA recommends that whenever possible, the domestic sources of emission should be broken down into septic system and centralized treatment sources. For the nitrous oxide emissions estimates, NACWA urges EPA to consider published literature values of nitrogen loading rates to POTWs, and to collect its own data if necessary to verify these rates. In addition, several changes need to be made to the equations used to calculate nitrous oxide emissions to fix typographical errors and to make the values calculated by EPA reproducible.

Wastewater Treatment Emissions Summary

Tables 8-6 and 8-7 in the *Draft Inventory* provide a summary of methane and nitrous oxide emissions, showing total emissions as well as the separate contributions from domestic and industrial wastewater treatment. NACWA recommends that the domestic emissions be broken down into emissions from septic systems and from centralized systems. In Table 8-9, the methane emissions from industrial sources are broken down according to each industrial sector, but no similar division is shown for domestic sources. Septic systems contribute most of the methane emissions from domestic sources, while centralized systems are shown to be responsible for all of the nitrous oxide emissions. Given these significant differences, dividing domestic emissions between septic and centralized systems would more clearly illustrate and summarize the emission sources.

Domestic Wastewater Nitrous Oxide Emission Estimates

The *Draft Inventory* calculates nitrous oxide emissions from POTWs using estimated nitrogen loadings to wastewater that are based on reported annual protein consumption. This is the methodology used in the Intergovernmental Panel on Climate Change (IPCC) protocol document[1] (*IPCC Guidelines*). Expressed as nitrogen (N), the estimated nitrogen loading rate to POTWs for domestic sources is:

(32.4 kg consumed protein/capita-year) x (0.16 kg N/kg protein) x (1.4 factor for non-consumed protein)
= 7.26 kg N/capita-year

[1] IPCC, *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Prepared by the National 18 Greenhouse Gas Inventories Programme, Eggleston H.S., Buenida L., Miwa K., Ngara T., and Tanabe K. (eds.) 19 Published: IGES, Japan, 2006.

Changing the units of this value to grams of nitrogen on a daily basis results in:

$$(7.26 \text{ kg N/capita-year}) \times (1000 \text{ g/kg}) \times (1 \text{ year}/365 \text{ days})$$
$$= 19.9 \text{ g N/capita-day}$$

The nitrogen loading rate is further increased by a factor of 1.25 to account for industrial and commercial contributions, as follows:

$$1.25 \times (19.75 \text{ g N/capita-year})$$
$$= 24.9 \text{ g N/capita-day}$$

Comparison of EPA's Estimated Nitrogen Loading Rates to Published and Surveyed Rates
NACWA believes that both of the above loading rates are too high, and that EPA needs to conduct more research to determine more accurate loading rates to use in the *Inventory*. As NACWA has pointed out in its previous comments on the *Inventory*, the rates currently used in the *Draft Inventory* are higher than rates presented in standard references such as Metcalf & Eddy[2]. Metcalf & Eddy report per capita nitrogen loading rates to wastewater of 15 g N/capita-day, a value usually considered the "industry standard" by POTWs. These values are supported by a wealth of data and have been widely confirmed in U.S. practice. The type of data used in Metcalf & Eddy represents all domestic sources of nitrogen, including meal production and consumption, the use of other nitrogen containing compounds, and both residential and commercial sources.

In NACWA's comments on the *Draft Inventory* for 1990-2007, we presented the results of a literature review to find other nitrogen loading rates. In addition, NACWA conducted a survey of measured total nitrogen loading rates for 48 wastewater treatment facilities throughout the U.S., with a total service population of over 17 million people. Since these data are from measurements of nitrogen loading to the POTW, the nitrogen loading rate includes all sources (residential, commercial, and industrial) for the service communities represented. All of the nitrogen loading rate values are summarized in Table 1. The literature review results and table of survey data are included again for your reference in Attachments A and B, respectively.

Table 1. Summary of nitrogen loading values to POTWs.

Reference	Nitrogen Loading Rate (g N/capita-day)
EPA *Draft Inventory* – Domestic Sources	19.9
EPA *Draft Inventory* – Domestic, Industrial, and Commercial Sources	24.9
Metcalf & Eddy – "Industry Standard"	15
Literature Review – Range of Reported Values	6-22.7
Literature Review – Average of Reported Values	13.3
NACWA Data	15.1

[2] Tchobanoglous, G., F.L. Burton, and H.D. Stensel, *Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy, Inc.* 4th Edition, McGraw-Hill, New York, 2003.

The nitrogen loading values found in the literature review average 13.3 g N/capita-day, which is even less than the value 15 g N/capita-day reported by Metcalf & Eddy. The average nitrogen loading value found in the NACWA survey of POTWs was 15.1 g N/capita-day, which agrees almost exactly with the Metcalf & Eddy value. The value used in the *Draft Inventory* of 19.9 g N/capita-day for domestic sources only falls within the upper part of two ranges found in the literature review, while the derived value of 24.9 g N/capita-day for all sources is above all of the published values and is also above the highest value found in the NACWA survey of POTWs. EPA's own references cite values of 11.2, 12, 6-17, and 8.16-22.7 g N/capita-day, which are all lower than the nitrogen loading rate for all sources used in the *Draft Inventory*. NACWA believes that the value used in the *Inventory* should be closer to the average nitrogen loading value from the available literature, rather than in the very upper part of a range of values.

If the *Inventory* methodology is used to convert only the per capita protein consumption into per capita nitrogen loading, without the additional factors to account for non-consumed protein and non-domestic sources, the result is:

$$(32.2 \text{ kg protein/capita-year}) \times (0.16 \text{ kg N/kg Protein}) \times (1{,}000 \text{ g/kg}) \div (365.25 \text{ days/yr}) = 14.1 \text{ g N/capita-day}$$

This value is extremely close to the value found in the NACWA data and to the average value from the literature survey. EPA makes two assumptions to convert this value of protein consumption (expressed as N) into the nitrogen contribution from domestic sources:

1. All of the protein consumed is excreted; and
2. The protein consumed is multiplied by the 1.4 factor for non-consumed protein to represent other sources of nitrogen in domestic wastewater.

The first assumption, that all protein consumed is excreted, is not clearly stated in the *Draft Inventory*, but it appears to be made based on the equations and values reported. EPA should clarify whether or not this assumption is made. If the assumption is not made, then the fraction of consumed protein that is excreted should be reported in the *Inventory*.

The result of these two assumptions translates into a loading rate of 19.9 g N/capita-day from domestic sources. While protein consumption may be a reasonable "starting point" for the estimation of per capita nitrogen loading, the factors used to convert per capita protein consumption to per capita nitrogen loading may be overly conservative. The actual per capita POTW influent total nitrogen value may instead be:

1. A fraction of the reported per capita protein consumption (expressed as N), due to less protein being excreted than is consumed, with some additional nitrogen from non-consumed protein;
2. Accurately predicted by the per capita protein consumption and the factor of 1.4 is too high for the addition of non-consumed protein to the wastewater; or
3. A combination of the two scenarios above.

Modifying the nitrogen loading rates used in the *Draft Inventory* to account for these scenarios may result in more agreement between the calculated rates and the rates cited in the literature and verified with the NACWA survey.

Recommendations for Modifying EPA's Estimation Methodology
While it may be reasonable to use per capita protein consumption as an index of potential changes in POTW influent per capita nitrogen values over the years, the factors used to convert per capita protein consumption data into per capita POTW influent nitrogen values should be adjusted to reflect real-world data. EPA has agreed in the current *Draft Inventory* that "obtaining data on the changes in average influent N concentrations to centralized treatment systems over the time series would improve the estimate of total N entering the system, which would reduce or eliminate the need for other factors for non-consumed protein or industrial flow." NACWA urges EPA to work to obtain the appropriate data to justify changes to the *Inventory*, either to adjust the factors applied to convert protein consumption to influent nitrogen values, or to change the calculation to a purely data-based approach.

EPA noted in the current *Draft Inventory* that "the dataset previously provided by NACWA was reviewed to determine if it was representative of the larger population of centralized treatment plants for potential inclusion into the inventory." However, EPA concluded that "this limited dataset did not represent the number of systems by state and the service populations served in the United States." NACWA disagrees with this conclusion. The literature review documented peer-reviewed nitrogen loading values that are widely used and accepted by the wastewater sector. NACWA conducted the survey of measured nitrogen loading rates at POTWs to determine if the values published in the literature continue to be appropriate. The agreement between the measured values and the literature shows that the literature values are valid. NACWA believes that the literature – including EPA's own publications – provides sufficient information to allow changes to be made to the *Inventory* emissions calculations methods.

If EPA judges the peer-reviewed literature values to be insufficient proof for changing the *Inventory*, NACWA suggests that the information submitted provides EPA with a strong argument to conduct its own study of nitrogen loading rates to centralized treatment plants. EPA should have enough data available through its National Pollution Discharge Elimination System (NPDES) permitting program to determine an appropriate and justifiable nitrogen loading rate. The NPDES permitting program is nation-wide in scope and long-term in its nature, which would allow changes to be made in emissions estimates over the time series represented in the *Inventory*. Since EPA believes that further data of a broader and more representative scope are required before changing the *Inventory*, the NPDES database would certainly suffice as it represents every central POTW in the U.S. We urge EPA to conduct this analysis if it believes that further evaluation is needed to justify the standard, well-accepted nitrogen loading values documented in the literature.

NACWA believes that using the literature nitrogen loading values or EPA-collected values from U.S. POTWs would better reflect the actual emissions from POTWs in the U.S. than the current methods based on the *IPCC Guidelines*. The *IPCC Guidelines* do not necessarily reflect actual conditions at POTWs throughout the U.S. This is illustrated by the emission factor ("EF_1") of 3.2 g N_2O/person-year for plants with no intentional denitrification, used in the *Draft Inventory* and in the *IPCC Guidelines* to calculate nitrous oxide emissions from centralized wastewater treatment plants. This value was obtained from a single study of a very small wastewater

treatment plant (1.06 million gallons per day, or MGD) in a small university town in New Hampshire. The population of this town is 12,500 during the school year, but drops to 6,200 in the summer months, during which most of the measurements for this study were made. If the IPCC can use this single study to define an emission factor that is used for centralized treatment facilities all over the world, certainly EPA can justify changing the nitrogen loading rate for facilities in the U.S. based on multiple literature values and data that it can collect from POTWs across the nation.

Recommendations for Revisions to the Emissions Equations

NACWA recommends that several changes be made to the equations on page 8-13 used to calculate the nitrous oxide emissions from domestic wastewater and to the definitions of the factors used in these equations on page 8-14:

1. In the $N_2O_{WOUT\ NIT/DENIT}$ equation (line 44, page 8-13), the $F_{IND\text{-}COM}$ factor should be moved outside of the square brackets. This is a typographical error rather than an error that affects the calculations.
2. In the $N_2O_{EFFLUENT}$ equation (line 45, page 8-13), the US_{POP} factor should be multiplied by the WWTP factor, as it is in the $N_2O_{WOUT\ NIT/DENIT}$ equation, since septic system users should not be included in the amount of effluent discharged to aquatic environments. NACWA recommends that any nitrous oxide contributions from septic systems be calculated in a separate equation if they are even included in the *Inventory*.
3. The units provided in the definitions of N_2O_{TOTAL}, N_2O_{PLANT}, $N_2O_{NIT/DENIT}$, and $N_2O_{WOUT\ NIT/DENIT}$ (lines 2-7, page 8-14) should be Gg, not kg, since conversions are made to Gg in the equations used to calculate these values.
4. The value of 269 Tg N for N_{SLUDGE} (line 37, page 8-14) appears to be an error, resulting in a negative value for $N_2O_{EFFLUENT}$. The value of 141 Gg N found in the Annex in Table A-193 (page A-231) is a more appropriate magnitude. However, even substituting this 141 Gg N value for N_{SLUDGE} does not result in a N_{TOTAL} value that agrees with the value of 15.9 Gg N_2O in Table 8-7. EPA should review the equation for $N_2O_{EFFLUENT}$ and all of the values used in it for accuracy.

Thank you for consideration of our comments on the *Draft Inventory*. Please contact me at 202/296-9836 or *cfinley@nacwa.org* if you have any questions about NACWA's comments.

Sincerely,

Cynthia A. Finley

Cynthia A. Finley
Director, Regulatory Affairs

Attachments

Attachment A

References in literature for nitrogen per capita loading rates.

Reference	Value (g N/ capita-day)	Comments
U.S. EPA, *Manual: Nitrogen Control*, EPA/625/R-93/010 Office of Research and Development, Office of Water, Washington DC 20460, September 1993.	12	Residential contribution.
U.S. EPA, *Manual: Nitrogen Control*, EPA/625/R-93/010 Office of Research and Development, Office of Water, Washington DC 20460, September 1993.	8.16-22.7	Based on raw influent wastewater characteristics of per capita pollutant generation rates of 0.18-0.25 lb/capita/day (BOD). The pollutant relationship between BOD and TKN was defined as 0.1-0.2 TKN/BOD. (Table 2-2, p. 26)
U.S. EPA, *Systems Manual: Onsite Wastewater Treatment*, EPA/625/R-00/008 Office of Research and Development, Office of Water, Washington DC 20460, February 2002.	6-17	Total nitrogen loading value from Table 3-7, Constituent Mass Loadings and Concentrations in Typical Residential Wastewater. This applies to typical residential households with standard water-using fixtures and appliances.
U.S. EPA, *Systems Manual: Onsite Wastewater Treatment*, EPA/625/R-00/008 Office of Research and Development, Office of Water, Washington DC 20460, February 2002.	11.2	Total nitrogen loading value contributions by source in Table 3-8. Estimates 0.6 g/person/day from the garbage disposal, 8.7 g from toilets, and 1.9 g from bathing, sinks, and appliances for the total of 11.2 g/person/day of nitrogen.
Metcalf & Eddy, Inc., *Wastewater Engineering: Treatment, Disposal, Reuse*, 2nd Edition, McGraw-Hill Book Company, NY, 1979.	15	"Normal domestic wastewater." Range of 10-18 g N/capita-day, with complete grinding of food waste.
Metcalf & Eddy, Inc., *Wastewater Engineering: Treatment, Disposal, Reuse*, 3rd Edition, McGraw-Hill Book Company, NY, 1991.	12	"Normal domestic wastewater" without contribution from ground kitchen waste. Range of 9 to 14 g N/capita-day.
Metcalf & Eddy, Inc., *Wastewater Engineering: Treatment, Disposal, Reuse*, 4th Edition, McGraw-Hill Book Company, NY, 2003.	9-22	Value for the United States was obtained from Table 3-14, p. 184 of typical wastewater constituent data for various countries.

Henze, M. and A. Ledin, "Types, Characteristics and Quantities of Classic, Combined Domestic Wastewaters," in *Decentralized Sanitation and Reuse: Concepts, Systems and Implementation*, Lens, P., G. Zeeman, and G. Lettinga Ed, IWA Publishing, London, 2001.	14	Values for Denmark and USA reported to be similar to range from 14 to 19 g N/capita-day.
Matsui, S., M. Henze, G. Ho, and R. Otterpohl, "Emerging Paradigms in Water Supply and Sanitation," in *Frontiers in Urban Water Management: Deadlock or Hope*, Maksimović, C and J. A. Tejada-Guibet Ed., IWA Publishing, 2001.	13	Household wastewater.
Average Value	**13.3**	
Low Value	**6**	
High Value	**22.7**	

Attachment B

Nitrogen loading data from wastewater treatment facilities in the U.S. (The names, cities, and other information about the treatment facilities are not included in this table, but this information can be provided by NACWA if needed.)

State	Service Population (End of Data Period)	Nitrogen Loading (g/person-day)	Period of Data Record
CA	95,000	15.2	1995-2000
CA	80,000	11.0	1995
CA	102,000	16.6	1985-1986
CA	25,800	13.3	1993
CA	200,000	14.4	1988
CA	60,000	16.3	1994
CA	360,000	9.1	1983
CA	35,900	11.4	1995
CA	965,185	15.0	2007
CA	1,337,912	17.0	2007
CA	127,658	13.0	2006
CA	156,759	17.0	2006
CT	18,585	16.8	1998-2005
CT	5,400	20	
CT	12,980	14.1	1999-2001
CT	17,650	16.8	
CT	49,815	13.2	2002-2003
FL	187,320	15.6	1990-1999
IA	-	19.07	
IL	67,500	10.6	1999
MA	2,060,000	15	1986-1987
MA	89,589	15.4	2000
MA	6,986	11.8	2001-2006
MA	9,000	14.1	1997-2000
MN	52,150	7.0	1998
MT	139,200	14.53	2000-2005

MT	31,700	10.44	2003
MT	33,000	9.99	2004
MT	35,700	11.80	2005
NC	800,000	14.53	2007
NE	3,350	16.80	Dec. 2007
NH	17,000	20.0	2005
NJ	192,089	15.9	1999-2001
NM	-	16.8	2002-present
NV	600,000	16.80	2007
NY	26,622	22.7	1997-1999
NY	26,000	16.5	Jan. 2004- July 2007
OR	2000	19.5	2000-2004
OR	2000	15.9	1994-2000
OR	60,000	20.43	2005-2006
PA	900,000	9.7	2005
RI	139,000	19.1	1997-1998
TX	875,355	13.2	1996-2005
VA	300,818	15.9	2007
VA	273,356	15.9	July 2005 – June 2006
VA	361,582	14.5	FY 1990-2007
VA	115,000	19.1	2004-2006
VA	412,700	11.53	2001-2003
VA	82,000	18.16	2003-2006
WA	96,500	16.3	April-Oct. 2007
Average Value		**15.1**	
Low Value		**9.1**	
High Value		**22.7**	