January 10, 2007

Leif Hockstad
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U.S. Environmental Protection Agency
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Washington DC 20460

Re: NACWA Comments on Wastewater Treatment Emissions Estimates in EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, Draft for Expert Review*

Dear Mr. Hockstad:

As requested in your December 15, 2006 letter, the National Association of Clean Water Agencies (NACWA) has completed a review of the U.S. Environmental Protection Agency's draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, Draft for Expert Review* (*Draft Inventory*). NACWA represents the interests of nearly 300 publicly owned wastewater treatment agencies nationwide. NACWA's members serve the majority of the sewered population in the United States, and collectively treat and reclaim more than 18 billion gallons of wastewater each day. NACWA members are very much aware of the growing importance of global climate change and are already engaged in efforts to reduce greenhouse gas emissions. As more state-wide and national efforts are launched to curb levels of greenhouse gases, EPA's *Inventory* will certainly take on added significance. NACWA appreciates the opportunity to weigh in on these important estimates.

Our review of Section 8.2, *Wastewater Treatment*, of the *Draft Inventory* indicates that the estimates for emissions from wastewater treatment have been over-estimated. Our comments, which are attached, provide explanations for specific factors that are too conservative or require correction. We also provide an analysis of the impact that changing the factors would have on the emissions estimates. These changes would result in a more accurate estimate of actual greenhouse gas emissions from wastewater treatment plants, which would provide a better expected value on which to base the uncertainty analysis for the estimate.

Again, thank you for the opportunity to participate in the expert review of the *Draft Inventory*. Please contact me at 202/296-9836 or *cfinley@nacwa.org* if you have any questions about our review.

Sincerely,

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NACWA
A Clear Commitment to America's Waters

Comments on EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, Draft for Expert Review*

The National Association of Clean Water Agencies (NACWA) has reviewed the wastewater treatment greenhouse gas emission estimates contained in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, Draft for Expert Review* (*Draft Inventory*). Overall, we find that a series of conservative or incorrect factors led to a significant over-estimation of the greenhouse gas emissions from this source. We recognize that uncertainty exists in calculations of this type; however, the objective should be to use "mid-range" estimates so that a "best estimate" of emissions is developed, rather than one which is inherently biased to over-estimate the actual emissions. The *Draft Inventory* also estimates uncertainty assuming that the computed emissions are a reasonable assessment. NACWA believes that conservative assumptions should be considered in the uncertainty analysis, rather than preemptively embedded directly in the base calculation as it appears was done in the *Draft Inventory*.

NACWA's specific comments on the estimates are provided below. The impact of using more "mid-range" assumptions on the greenhouse gas emissions from the domestic wastewater treatment source is also characterized.

Comments on CH_4 Emissions

1. The factor used to convert BOD_5 removed to CH_4 [methane] produced neglects important, well-known phenomena, and over-estimates the CH_4 produced. The development of this discussion is based on process fundamentals presented in several standard textbooks. The standard reference by Grady, Daigger, and Lim[1] will be used as the basis for this development.

   To begin with, a fundamental relationship exists between CH_4 produced and the biodegradable COD [Chemical Oxygen Demand] converted to CH_4. This well known relationship is 0.25 kg CH_4/kg biodegradable COD converted to CH_4. The first correction that must be made is that in any biological process, some of the biodegradable COD removed in the process must be converted into biomass (the bacteria that are responsible for the biochemical conversions). In a typical anaerobic process, about 10% of the COD is converted into anaerobic biomass and 90% is converted into CH_4. While this factor is often neglected from a conservative approach, we will include it in our calculations as we are trying to accurately estimate emissions. Since only 90% of the biodegradable COD removed in the process is converted to CH_4, the correction is as follows:

   0.25 kg CH_4/kg COD converted to CH_4 x
   0.9 kg COD converted to CH_4/kg biodegradable COD removed
   = 0.225 kg CH_4/kg biodegradable COD removed

   Next, biodegradable COD must be converted to BOD_5 [Biochemical Oxygen Demand]. For municipal wastewaters the COD/BOD_5 ratio typically is in the range of 2.2 to 2.4. However, the total COD includes both biodegradable and non-biodegradable components. Thus, a different factor that targets only the biodegradable COD must be used. The conversion between biodegradable COD and BOD_5 is presented in Section 8.6 of Grady, Daigger, and Lim where it is shown that, for municipal wastewater, a typical

[1] Grady, C. P. L., Jr., G. T. Daigger, and H. C. Lim, *Biological Wastewater Treatment*, 2nd Edition, Marcel Dekker, NY, 1999.

value would be 1.7 kg biodegradable COD/kg BOD_5. Using this factor, the CH_4 produced from the BOD_5 removed can be calculated as follows:

$$0.225 \text{ kg } CH_4/\text{kg biodegradable COD removed} \times 1.7 \text{ kg biodegradable COD/kg } BOD_5 = 0.3825 \text{ kg } CH_4/\text{kg } BOD_5 \text{ removed}$$

This compares with the factor of 0.6 kg CH_4/kg BOD_5, which was apparently computed as 0.25 kg CH_4/kg COD x 2.4 kg COD/kg BOD_5. Use of this conservatively high factor results in an over-estimate of CH_4 production from these sources by 0.6 ÷ 0.3825 or 1.57. Even rounding the true CH_4 production factor to a convenient value of 0.4 kg CH_4/kg BOD_5 removed, it is seen that use of the conservative value of 0.6 kg CH_4/kg BOD_5 removed results in an overestimate of CH_4 production by these sources by 50%.

In conclusion, a more appropriate factor to calculate CH_4 emissions from wastewater treated anaerobically is 0.4 kg CH_4/kg BOD_5 removed.

2. The *Draft Inventory* assumes that "anaerobic systems" are used to treat roughly 5% of the domestic wastewater. To our knowledge, true anaerobic systems are seldom, if ever, used in the United States and its territories. In fact, EPA's Clean Water Needs Survey (CWNS) from 2000 shows that the nation's anaerobic lagoons treat less than 1.0 million gallons per day (MGD) as a whole. The *Draft Inventory* includes facultative lagoons, ponds, wetlands, and other natural treatment systems in this "anaerobic" category as well. These facultative systems are not fully anaerobic, and incorporate a combination of aerobic and anaerobic stabilization. An MCF-anaerobic factor of 0.8 is used in the calculation, apparently to reflect the fact that all BOD_5 is removed by anaerobic metabolism in these systems. This unduly conservative approach is perhaps appropriate if uncertainty is included, but inappropriate for a "mid-range" calculation. Typical facultative systems remove about half of the BOD_5 aerobically (through the action of algae that grow in the system), and about half is removed anaerobically. In fact, some carbon is immobilized in these systems through its incorporation into algae. However, neglecting this, a more reasonable value of 0.5 should be used for the MCF-anaerobic factor.

3. For aerobic systems, it is assumed that a significant fraction is "not well managed." We are uncertain of the basis for this assumption, but it should be recognized that the vast majority of the municipal wastewater treatment plants in this country are consistently in compliance with their discharge standards. Furthermore, it is assumed that in these "not well managed" plants, 30% of the influent BOD_5 is stabilized anaerobically. Again, we are unsure of the basis for this estimate, but it is clearly excessive as it would represent a wastewater treatment plant consistently in non-compliance with its discharge requirements. Since such consistent non-compliance would likely result in severe enforcement/regulatory action that will force correction, use of this value is inappropriate. At most, we would think that less than 10% of the plants are "not well managed." This results in a more reasonable, and perhaps still conservative, estimate that 10% of the influent BOD_5 is stabilized anaerobically.

4. The calculations assume complete removal of all influent BOD_5. While from a water quality perspective we wish that this were the case, no treatment plant is 100% efficient. Secondary treatment requires 85% removal and, as mentioned immediately above, the vast majority of the treatment plants in the U.S. are generally in compliance with their BOD_5 discharge requirements. We suggest that 90% is a more reasonable estimate of overall removal performance.

5. A more straightforward calculation of the CH_4 emissions from anaerobic digesters could be made. The present methodology depends heavily on the assumption of 100 gal/person/day for wastewater generation. The CWNS provides estimates of both the total wastewater flow treated at plants with anaerobic digesters and of the total wastewater flow centrally treated in aerobic systems. Using these data, the population served by central plants with anaerobic digesters could be calculated as:

Population served by central plants with anaerobic digesters =
(Flow to central plants with anaerobic digesters ÷ Flow to central plants)
x Population served by central plants

6. The calculation of emissions from anaerobic digesters appears to be missing two necessary unit conversion factors. One is to convert ft^3 of digester gas to m^3. The other is to convert g to Gg. We assume that these conversion factors have actually been included, but if they have not, they are necessary to include. Furthermore, it appears that although the data necessary to calculate these emissions are displayed in a footnote on page 8-7, these emissions were neglected by EPA in the total emissions results in Table 8-7.

Impacts on Estimated CH_4 Emissions

The impact of incorporating the comments presented above on estimated CH_4 emissions from the domestic wastewater treatment source would be quite significant, as follows:

1. The impact of using the more appropriate B_o factor of 0.4 kg CH_4/kg BOD_5, rather than the default value of 0.6 kg CH_4/kg BOD_5, will be to reduce total CH_4 emissions from septic tanks by one-third (i.e., actual emissions are 67 percent of those estimated using the inappropriate B_o value).
2. The combined impact of the comments concerning emissions from the centrally treated aerobic systems source is to reduce emissions from this source to less than 10 percent of those estimated using the highly conservative (and in some cases incorrect) assumptions used for this source.
3. The combined impact of the comments concerning emissions from the centrally treated anaerobic systems source is to reduce emissions from this source to just over one-third of those estimated using the highly conservative (and in some cases incorrect) assumptions used for this source.
4. We assume that the "units" comments made on the emissions from anaerobic digesters source have already been made and just not documented in the reported methodology. Consequently, they will have no effect on the estimated CH_4 emissions from this source.
5. Overall, we estimate that the composite impact of these corrections would be to reduce estimated CH_4 from domestic wastewater treatment by more than 50%. Due to the significance of their impact, NACWA believes these corrections should be made before the *Draft Inventory* is released for public comment.

Comments on N_2O Emissions

Given the timeframe, we have not been able to carefully examine the emission factors for this category of emissions. However, we do have significant comments on the method used to estimate the quantity of nitrogen discharged to wastewater treatment plants, as follows:

1. The draft report estimates nitrogen discharges to wastewater treatment based on reported annual protein consumption. Expressed as nitrogen, the estimate for the domestic sources is as follows:

   42.1 kg protein/person/year x 0.16 kg N/kg protein x 1.4 Factor for Non-Consumption = 9.43 kg N/person/year

This is at odds with per-capita wastewater discharge rates as presented in standard references such as Metcalf & Eddy[2]. Metcalf & Eddy report per capita nitrogen discharge rates to wastewater of 0.015 kg N/person/day. This is converted to a yearly value as follows:

0.015 kg N/person/day x 365 days/year = 5.48 kg N/person/year

The factors presented in the Metcalf & Eddy standard reference, as well as others, are based on actual data, rather than a more tenuous calculation. Thus, they are considered more reliable. Moreover, the use of standard per-capita values for nitrogen discharges would be consistent with the approach used for BOD_5, with which we agree. Use of the more appropriate value based on actual data is a reduction of more than 40%.

2. In the draft document it is assumed that nitrogen discharges to domestic wastewater treatment plants must be increased by 25% (a 1.25 factor) to account for industrial discharges. It is unclear whether this factor is actually needed given the very conservative approach used to estimate direct domestic nitrogen discharges (see Comment 1 immediately above), or whether it is already included in the standard per-capita nitrogen discharges taken from standard references (such as Metcalf & Eddy). As a practical matter, it is impossible to separate the commercial contribution from domestic sewages, whichever methodology is used. Using the protein consumption approach, discharges to both "domestic" and "commercial" sources are inherently considered. Likewise, the values presented in Metcalf & Eddy inherently consider both "domestic" and "commercial" discharges. EPA should be aware that further work is needed to better define nitrogen loadings to domestic wastewater treatment plants.

Impacts on Estimated N_2O Emissions

As with estimated CH_4 emissions, the impacts of the comments presented above on N_2O [nitrous oxide] emissions from domestic wastewater treatment plants are significant, as follows:

1. Using a data-based per-capita nitrogen loading of 0.015 kg/person/day (corresponding to 5.48 kg/person/year) will reduce N_2O emission estimates from effluent discharges by more than 40%.

2. Further reducing wastewater nitrogen loadings by reducing and/or eliminating the correction factor for commercial and industrial discharges would reduce N_2O emission estimates from effluent discharges by 20%.

Thank you for the opportunity to participate in the expert review of the *Draft Inventory*. Please contact Cynthia Finley at 202/296-9836 or *cfinley@nacwa.org* if you have any questions about NACWA's comments.

[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.