



Summary of Expert Review Comments and Responses:
Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018

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Responses to Comments Received during the Expert Review Period on the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018*

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Preface

EPA thanks all commenters for their interest and feedback on the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks. To continue to improve the estimates in the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks, EPA distributed draft chapters of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018* for a preliminary Expert Review of estimates and methodological updates prior to release for Public Review. The Expert Review was 30 days by sector and EPA provided experts charge questions to focus review on methodological refinements and other areas needing a more in-depth review by experts. The goal of the Expert Review is to provide an objective review of the Inventory to ensure that the final Inventory estimates, and document reflect sound technical information and analysis.

EPA received 40 unique comments on as part of the Expert Review process. The verbatim text of each comment extracted from the original comment letters is included in this document, arranged by sectoral chapters. EPA's responses to comments are provided immediately following each comment excerpt. The list of reviewers, dates of review and all charge questions distributed to reviewers are included in the appendices to this document.

Chapter 3. Energy

Comment 1: Clarity and transparency of the Energy chapter

Overall, the data is conveyed clearly and concisely. The chapter could use further explanation regarding causes of trends or changes over time.

Response: EPA thanks the commenter for the review of the energy chapter of the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks. In terms of explanation regarding causes of trends or changes over time, Chapter 2 of the National Inventory Report (NIR), not included as part of Expert Review, includes a discussion of recent trends in emissions. Chapter 2 is included in the draft report published for a 30-day Public Review, but we may consider adding some trend context to the guidance memo in future reviews to facilitate review. Section 2.1 has a discussion of recent trends in energy emissions including CO₂ emissions from fossil fuel combustion. Section 2.2 highlights trends by economic sector including with emissions from electricity distributed to economic end-use sectors. The trends discussion in the energy chapter of the NIR (Page 3-8 of the Public Review draft report) has a similar discussion to what is in Chapter 2 and EPA can look into simplifying / improving the discussion across the different chapters for future reports.

Comment 2: Description of N₂O and CH₄ emission factors

It is worth including a concise description of emissions factors in the body of the chapter for N₂O and CH₄.

Response: Annex 3.1 of the NIR includes a complete description of the methodology for estimating CH₄ and N₂O emissions from stationary combustion, and Annex 3.2 includes the discussion for mobile combustion. The methodology discussion in the energy chapter for CH₄ and N₂O emissions does include a brief description of the factors used. However, due to the technology-dependent nature of the factors and the complexity involved, especially across different model years and vehicle types for mobile sources, the details on emission factors are presented in the annex for ease of readability of the main report.

Comment 3: CH₄ leakage

Is CH₄ leakage addressed elsewhere?

Response: Fugitive CH₄ emissions from coal mining are presented in Sections 3.4 and 3.5 of the NIR. Fugitive CH₄ emissions from petroleum systems are presented in Section 3.6, fugitive CH₄ emissions from natural gas systems are presented in Section 3.7 and fugitive CH₄ emissions from abandoned oil and gas wells are presented in Section 3.8 of the NIR.

Comment 4: Increased natural gas use

3-4 (5-20): The chapter claims that natural gas use increased for residential and commercial sectors, but that only explains about half of overall natural gas increase. The power sector had a substantial increase of about 15%, a 74 MMT CO₂ increase from natural gas and a 56 MMT CO₂ decrease for coal in the power sector. This is better addressed after the tables in lines 5-20.

Response: The EPA agrees with the comment and the language in the text has been modified to indicate that the increase in the residential and commercial sectors is total energy use not just direct

natural gas use. This includes increased electricity use, which leads to more emissions from electricity production in the power sector.

Comment 5: Weather impacts on heating and cooling

3-5 (4-11): Was the weather that caused more heating and cooling an anomaly? Trend? Regression to mean (after two mild summer/winters). This is well addressed in Figure 3-6 on page 3-5, and could be stated in the text.

Response: EPA agrees with the comment and the text discussing the 2018 heating degree days was modified to clarify that even though 2018 HHD were higher than in 2017 they were still 5.7 percent below normal. Figure 3-6 was also updated to clarify the derivations from normal.

Comment 6: Transportation share of power use

3-7 (19): How is transportation's share of power use so high? It is similar to the combined power of residential and commercial.

Response: Table 3-8 in the Expert Review draft (pg 3-7) of the NIR includes both direct emissions and emissions from electricity use distributed to the end-use sectors shown, including transportation. The transportation emissions are high because of emissions related to direct energy use. Table 2-12 of the NIR shows the emissions by end-use sector broken out in terms of direct energy use and electricity-related energy use. The table shows that electricity-related emissions from the transportation end-use sector are small.

Comment 7: CH₄ emissions

3-8 (7): If CH₄ emissions are from incomplete combustion / leakage, we should specify. If it's calculated through a bottom-up calculation, we should specify.

Response: More information on CH₄ and N₂O calculations are provided starting on page 3-20 of the Expert Review draft. Furthermore, Annex 3.1 of the NIR includes a complete description of the methodology for estimating CH₄ and N₂O emissions from stationary combustion. The emissions are for only the combustion component of fuel use and represent for the most part incomplete combustion emissions. The calculations are based on an approach of fuel use by combustion technology multiplied by emission factors for that fuel and combustion technology type.

Comment 8: Carbon content of natural gas versus coal

3-10 (20): It is worth adding the approximate carbon content per kWh of natural gas versus coal to explain the impact of transitioning to natural gas.

Response: Page 3-3 of the Expert Review draft includes more information on the carbon content of different fuels, which helps explain the impact on emissions of transitioning from coal to natural gas.

Comment 9: Emissions direction confusion

3-11 (1-8): These lines are confusing; the text suggests there was both an increase and decrease in emissions over timeframe.

Response: EPA agrees with the comment and the text indicating there was a decrease in emissions has been deleted. Emissions from the electric power sector increased from 2017 to 2018.

Comment 10: Increase in CO₂ emissions with respect to cooling and heating degree days

3-13: In Figure 3-11, what explains the increase of residential and commercial CO₂ emissions with respect to cooling and heating degree days between 1997 and 2011?

Response: Figure 3-11 is not meant to highlight long-term trends in residential and commercial energy use and emissions, but rather highlight how some of the annual fluctuations are tied to heating degree day (HDD) and cooling degree day (CDD) changes. To understand the type of trends identified in the question concerning increase in emissions with respect to HDD and CDD between 1997 and 2011 would require a further understanding of energy end use requirements over time. Emissions are generally tied to total energy use and are impacted by building energy efficiency, building stocks, types of energy use and GHG intensity of energy sources. That type of analysis is beyond the scope of the National Inventory Report.

Comment 11: Developing estimates of EV energy use

I have no major comments except for the need to develop bottom-up estimates of energy consumption and GHG emissions from on-road electric vehicles for inclusion in end-use sector values (as well as the table traditionally at the end of Chapter 2 summarizing Transportation-Related GHG Emissions). Proposed methods and data have been outlined in an Argonne National Laboratory Report, Impacts of Electrification of Light-Duty Vehicles in the United States, 2010-2017, available at <https://publications.anl.gov/anlpubs/2018/01/141595.pdf>.

Response: EPA agrees with the comment and energy use and emissions associated with electric vehicle use has been incorporated into the NIR for the transportation electricity end-use sector. The approach is generally consistent with the Argonne report and is outlined in the memo: Browning, L. (2018a). Updated Methodology for Estimating Electricity Use from Highway Plug-In Electric Vehicles. Technical Memo, October 2018.

3.1 Fossil Fuel Combustion: CO₂ from Fossil Fuel Combustion

Comment 12: Clarity and Transparency of CO₂ from Fossil Fuel Combustion Discussion

The methodology is thoroughly explained. If the carbon intensity of different energy sources themselves have changed much over time, it is worth including in Box 3-5 on page 3-17.

Response: The carbon intensity of fossil fuels themselves do not vary that much over time as is further described in Annex 2 of the NIR.

Comment 13: Data Source for Energy Use of U.S. Territories

We're not sure of any other data sources that could be used.

Response: EPA appreciates the response and continues to investigate other data sources of U.S. territory energy use.

Comment 14: GHGRP facility-level combustion emissions data

This data still needs to be updated.

Response: EPA appreciates the response and the GHGRP data has been updated for the Inventory final report. EPA continues to review the use of GHGRP data as discussed in Box 3-4 of the NIR.

3.2 Fossil Fuel Combustion: CH₄ and N₂O from Stationary Combustion

Comment 15: CH₄ and N₂O emission factors for the electric power sector

The CH₄ and N₂O emission factors for the electric power sector are based on a Tier 2 methodology, whereas all other sectors utilize a Tier 1 methodology. For all other stationary sectors, the emission factors used in Tier 1 methods are primarily taken from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Are there other more U.S.-specific CH₄ and N₂O emission factor data sources that could be utilized, especially for natural gas combustion sources?

On Line 5 of 3-14, the text states that CO₂ is estimated in line with Tier 2 methodology. This seems to contradict the first sentence of the question above.

Response: The first sentence in the question above is referencing a Tier 1 methodology used for non-electric power CH₄ and N₂O sources. Line 5 of page 3-14 of the expert review draft is referencing CO₂ emissions (not CH₄ and N₂O) and CO₂ emission estimates for all sources use a Tier 2 approach.

3.2 Fossil Fuel Combustion: CH₄ and N₂O from Mobile Combustion

Comment 16: Update to CH₄ and N₂O factors

The proposed approach of estimating CH₄ and N₂O mobile source EFs directly from annual certification data seems to be a step forward from the current regression-based approach. EPA is commended for this update and improvement.

Response: EPA appreciates the comment and continues to look for ways to improve the accuracy of emission factors used in the analysis.

3.2 Carbon Emitted from Non-Energy Uses of Fossil Fuels

Comment 17: Clarity and transparency of CO₂ from Fossil Fuel Combustion discussion

Stored carbon versus released carbon in non-energy products is well explained in the section.

Response: EPA appreciates the comment and continues to investigate ways to improve the transparency and clarity of the NEU discussion in the NIR.

Comments on gasoline C factor update memo

Comment 18: Speciated gasoline component data

EPA is commended for developing a new method for estimating this EF, particularly in light of the unavailability of NIPER gasoline composition data since 2009. The proposed approach seems to make sense in concept, although it is not clear if the API data can be used to speciate gasoline components or represent changes in gasoline speciation over time.

Response: EPA appreciates the comment and has identified additional data and methodologies relevant to this gasoline C factor update. EPA is still reviewing the additional data and possible

approaches and therefore the gasoline C factor was not updated in this year's final inventory report. EPA is still considering the update for future Inventory cycles and data will be recalculated as needed if factors change.

Comment 19: Speciated gasoline data

EPA's use of the gasoline speciation data collected in conjunction with the API 2010 E10 blending study is supported. It should be recognized that the fuels evaluated as part of the API study are representative of the 2008-2009 timeframe. Ideally, it would be better to generate data from a new or more current nationwide study of the ultra-low sulfur gasoline/BOBs now being used to make E10, but such data are not available, so the API 2010 study is the best alternative. The use of surrogate compounds to represent or estimate the carbon content of different components of US motor gasoline fuels is not recommended.

Response: EPA appreciates the comment and has identified additional data and methodologies relevant to this gasoline C factor update that could be more relevant over time. EPA agrees that use of surrogate compounds to represent gasoline components is not advisable and is considering alternate methods beyond what was outlined in the expert review memo. EPA is still reviewing the additional data and possible approaches and therefore the gasoline C factor was not updated in this year's final inventory report. EPA is still considering the update for future Inventory cycles and data will be recalculated as needed if factors change.

Comment 20: Use of speciation data

The approach outlined in Annex 2 of the expert review memo to develop the speciated gasoline components is generally supported. However, in the Annex, EPA indicated that it picked 2 gasolines from the data supplied by API which it deemed to be representative of winter and summer gasoline fuels. It would have been useful to do a sensitivity analysis of the results based on fuels from the API data set that represented a range of summer gasoline compositions and a range of winter gasoline compositions.

Response: EPA appreciates the comment and has identified additional data and methodologies relevant to this gasoline C factor update that could be used to represent gasoline components and is considering alternate methods beyond what was outlined in the expert review memo. EPA is still reviewing the additional data and possible approaches and therefore the gasoline C factor was not updated in this year's final inventory report. EPA is still considering the update for future Inventory cycles and data will be recalculated as needed if factors change.

Comment 21: Use of EPA Trends Report

The proposed use of the EPA Trends data is an improvement over the status quo. However, it is not clear when the EPA Trends report will be updated. Data on the regular gasoline surveys that was used to produce the Trends data is available on an ongoing basis online at <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/public-data-gasoline-programs> under the heading "Gasoline Batch Report Data." This data seems likely to be more current than the Trends report.

Response: EPA agrees with the comment that the gasoline batch data is more up to date than the EPA trends report data and will consider that as a source of information for updating the gasoline C factor. Furthermore, EPA has identified additional data and methodologies relevant to this gasoline C factor update. EPA is still reviewing the additional data and possible approaches and therefore the gasoline

C factor was not updated in this year's final inventory report. EPA is still considering the update for future Inventory cycles and data will be recalculated as needed if factors change.

Comment 22: Use of EPA Trends Data

The EPA Trends data provide an adequate basis for evaluating and estimating historical changes in the composition of motor gasoline during the 1990 to 2018 time period. In the interest of maintaining data consistency, the use of the EPA Trends data is supported for the full time series under evaluation, not just for years where the NIPER data are not available. There are other sources of data available that EPA could use to “spot check” the patterns observed in the EPA Trends data. The twice-yearly survey of North American motor gasoline properties that has been conducted by the Alliance of Automobile Manufacturers (AAM) for over 20 years is one such example.¹ However, the results of the AAM survey are not freely available to the public.

Response: EPA appreciates the comment concerning the trends data and has identified a source of the data that is more up to date than the EPA trends report referenced in the expert review memo and will consider that as a source of information for updating the gasoline C factor. EPA also appreciates the reference to the AAM survey as a potential source of gasoline composition data. Furthermore, EPA has identified additional data and methodologies relevant to this gasoline C factor update. EPA is still reviewing the additional data and possible approaches and therefore the gasoline C factor was not updated in this year's final inventory report. EPA is still considering the update for future Inventory cycles and data will be recalculated as needed if factors change.

Chapter 4. IPPU

4.16 Phosphoric Acid Production

Comment 23: Phosphoric acid production facility locations

On line 12 of page 4-29, Texas and Louisiana can be removed from the list of states with facilities that use imported phosphate rock for phosphoric acid production. Plants in Texas and Louisiana have been closed permanently.

Response: EPA agrees with this suggested update and has reflected this change in the Final Inventory report.

Comment 24: Phosphate rock used to manufacture elemental phosphorous and other phosphorous-based chemicals

On line 18 of page 4-31, the text indicates that 7 percent of domestically-produced phosphate rock is used to manufacture elemental phosphorous and other phosphorous-based chemicals, rather than phosphoric acid. This percentage was less than 5 percent in 2017.

¹ <https://autoalliance.org/energy-environment/fuel-publications/>

Response: EPA appreciates this clarification and has updated the uncertainty and time series consistency discussion to reflect this information in the Final Inventory report.

Chapter 5. Agriculture

5.2 Manure Management

Comment 25: B₀ values for waste characteristics data

Based on a meta-analysis and some newer literature it seems that the values in Table A-185 on page A-37 may need to be adjusted and perhaps having B₀ value for each species may not be appropriate. For example, values for the liquid fraction of dairy manure and dairy lagoon have B₀ closer to 0.5 which may help explain some discrepancies found comparing on-farm data to estimated data, see discussion below.

Reference	species	methane (m3/kg vs)	HRT (days)	temp	storage type	method
Habtewold et al., 2017	dairy liquid	0.268	160		tank	
Rosenberg and Kornelium, 2017	beef cattle	0.24	40			
Miranda et al.	dairy cattle	0.4 - 0.44			lagoon	
Rico et al	dairy cattle	0.258	90	35	solid fraction	batch reactor lab
Rico et al	dairy cattle	0.307			manure	batch reactor lab
Rico et al	dairy cattle	0.371	45		screened manure	batch reactor lab
Rico et al	dairy cattle	0.604			liquid fraction	batch reactor lab
Rico et al	dairy cattle	0.58			liquid fraction	batch reactor lab

Emissions from Anaerobic Lagoons

Recent research has suggested that methane (CH₄) emissions from liquid manure storage may be greater than is estimated using current USEPA (which follows IPCC) methodology (Wolf et al., 2017; Leytem et al., 2017 Balde et al., 2016; Owens and Silver, 2015; Lory et al., 2010). These discrepancies are likely due to several factors related to management and the factors used in the emissions calculations. The simplified equation used to estimate CH₄ generation from anaerobic lagoons is as follows:

$$CH_4 = VS \times B_0 \times MCF \times 0.67 \times MDP^*$$

*MDP is used in the USEPA equation not the IPCC

Where CH₄ is the emissions in kg month⁻¹, volatile solids (VS) is the amount of VS entering the lagoon (kg), B₀ is the maximum CH₄ producing capacity of the manure (m³ CH₄ kg VS⁻¹), MCF is the methane conversion factor, 0.67 is the density of CH₄ at 25° C (kg CH₄ m⁻³ CH₄), and the MDP is the management and design practices factor utilized by USEPA (0.8). Comparison of on-farm emissions vs. CH₄ estimation utilizing these equations has found that emissions from liquid storage (anaerobic lagoon and tanks storage) are almost double what is estimated using this equation. Emissions estimates are close to those measured on farm in peak summer, but underestimate emissions during the remainder of the year.

There are several factors that could account for these large discrepancies between estimated and measured emissions. The inventories assume that all the liquid is going into a lagoon unless there is mechanical separation in which case that manure VS content is removed from the estimation. On many dairies, the use of earthen settling basins is common, where manure flows through the basin to settle solids before reaching the main lagoon. The settling basins behave differently than the main lagoons and in effect, in many cases, act like small digesters producing large amounts of CH₄ (Leytem et al., 2017; Arndt et al., 2018) yet due to the complexity of the liquid handling systems these are not accounted for in inventory methods. The inventory method also assumes a complete cleanout of the lagoon systems each fall. In many anaerobic lagoons, most of the water is pumped out during the year, however, sludge at the bottom may not be removed in many cases. In addition, the settling basins may be cleaned out very infrequently. Therefore, there is likely unaccounted VS remaining in the system that are available for breakdown over time as well as serving as a constant inoculum, which maintains high levels of CH₄ generation even after the lagoons are pumped out. A lag phase in CH₄ emissions of up to 50 d has been noted in the literature when manure is stored in clean tanks after which CH₄ emissions increase exponentially (VanderZaag et al. 2010a). However, modifying the estimation equation to try and account for VS carryover did not fully account for the discrepancy in CH₄ emissions (Leytem and Arndt personal communication).

When one uses the monthly timestep equation for estimating monthly CH₄ emissions per Mangino et al. (2001), the emissions curve follows a trend that would be expected for a batch reactor with low emissions early in the year then spiking in the summer and then falling again to very low emissions rates in fall and winter. However, on farm research has indicated that emissions from anaerobic lagoon systems has less of a fluctuation in emissions, trending seasonally with temperature, but maintaining higher rates of CH₄ production in spring and fall than indicated using the Magino et al., method. This suggests that the emissions factors used (B₀ or MCF) may underestimate emissions. The B₀ values used in the USEPA (IPCC) emissions estimates were derived from research on the biological activity of CH₄ digesters (Bryant et al., 1976; Morris, 1976; Hashimoto et al., 1981; Hashimoto, 1983) which may not be representative of anaerobic lagoons. The broader microbial community, longer VS residence times, and lower loading rates of uncovered anaerobic lagoons may lead to higher VS degradation rates than those found in anaerobic digesters (Lory et al., 2010). According to a review of the literature, Lory et al. (2010) surmised that a properly operating uncovered anaerobic lagoon can break down solids to a higher degree than is predicted using anaerobic digester models. Therefore, B₀ may underestimate the potential amount of CH₄ generated from these lagoons and therefore underestimate overall CH₄ emissions. Based on their literature search, they reported VS degradation rates of 0.45 to 0.72 kg kg⁻¹ VS added for dairy cows and up to 0.88 for swine. The MCF values may also underestimate emissions. The MCF is strongly influenced by temperature and assumes very little CH₄ production during colder times of the year which may underestimate emissions from anaerobic lagoons, particularly in colder climates. Another factor to consider is the amount of degraded VS that is converted to CH₄ which has also been shown to vary with literature reports ranging from 0.45 to 0.85 m³ kg⁻¹ VS destroyed (Lory et al., 2010). Craggs et al. (2008), also reported a VS removal rate of 59% from an anaerobic dairy lagoon in New Zealand and a biogas production rate of 0.44 (m³ kg⁻¹ VS removed), which is very similar to those estimated by Lory et al. (2010). Therefore, Lory et al., (2010) proposed an alternative estimation method:

$$\text{CH}_4 = \text{VS} \times \text{VSDF} \times \text{B}' \times 0.662$$

Where CH₄ is the emissions in kg year⁻¹, VS is the total volatile solids excreted that is going to the lagoon (kg), VSDF is the fraction of VS broken down in storage (kg VS destroyed kg⁻¹ VS added; 0.57), B' is the volume of CH₄ generated on a VS destroyed basis for the lagoon (m³ CH₄ kg⁻¹ VS destroyed; 0.45 – 0.85), and 0.662 is the density of CH₄ at 25° C (kg CH₄ m⁻³ CH₄). This estimation equation worked well

for an anaerobic dairy lagoon in Idaho, USA (measured on farm = 14,594 kg CH₄ yr⁻¹ vs. estimated 10,495 – 19,824) however this is only one comparison.

It appears as if the current equation for estimating emissions from anaerobic lagoons needs to be updated, however, determining the appropriate factor to change is difficult. One could increase the MCF, however in many cases it may need to be greater than 100% to account for on-farm emissions. The alternative is to increase B₀, recognizing that anaerobic lagoons are more likely to break down more VS, therefore generating more CH₄, than is estimated using the current value. A value of B₀ close to 0.50 may be more representative (for dairy) than the current value of 0.24. However, there still remains a very limited on farm dataset for validating alterations in the equations.

Response: See response to Comment 30.

Comment 26: Estimated volatile solids (VS) and total nitrogen excreted (Nex) production rates by state for cattle (other than calves) and American bison

The values in Table A-187 on page A-40 look a bit high. For example, VS for dairy cattle for Idaho are listed at 2,920 kg/animal/yr. If I use the ASABE 2005 values, this would be 2,582 or if I used the current IPCC default value it would be 2,037.

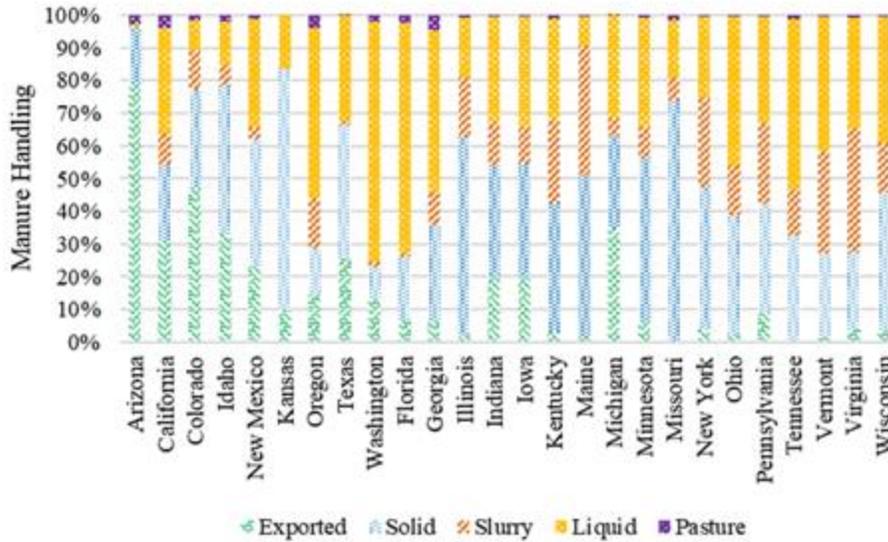
The nitrogen excretion values also look high. I will use Idaho as an example again, the value is 162 kg/animal/year. I calculate 138 kg/animal/year using some of the latest equations and assuming that cows are lactating for 305 days and dry for 60 with a birth weight of 680 (136 kg/animal/year for a birth weight of 600 which I think is closer to reality). Also, I calculate 50 kg/animal/d for heifers while a value of 69 is in the table. Below are the equations and references that I used.

Nitrogen excretion by lactating cattle							
NE = 20.3 + 0.654*NI		Reed et al., 2015					
NE = 7 + 0.710*NI		Yan et al., 2006					
NE = 30 + 0.67*NI		Kebreab 2010					
NE = (DMI *CP *84.1) + (BW x 0.196)		Nennich et al. 2005					
Lactating data averages							
DMI (kg)	CP (%)	NI (g/d)	BW (kg)	N excretion g/d/cow	N excretion kg/d/1000kg	ref	
21.785	16.6	578.6096	600	398.7107	0.664518	Reed et al., 2015	
21.785	16.6	578.6096	600	417.8128	0.696355	Yan et al., 2006	
21.785	16.6	578.6096	600	417.6684	0.696114	Kebreab 2010	
21.785	16.6	578.6096	600	421.7317	0.702886	Nennich et al. 2005	
				413.9809	0.689968	average	
Nitrogen Excretion by Dry cows							
NE = 15.1 + 0.828*NI		Reed et al., 2015					
Dry Cow data averages							
DMI (kg)	CP (%)	NI (g/d)	BW (kg)	N excretion g/d/cow	N excretion kg/d/1000kg	ref	
8.205	15.45	195	690	176.56	0.255884	Reed et al., 2015	
Nitrogen Excretion by heifers							
NE = 15.1 + 0.828*NI		Reed et al., 2015					
NE = (DMI * CP * 78.39) + 51.4		Nennich et al. 2005					
Heifer data averages							
DMI (kg)	CP (%)	NI (g/d)	BW (kg)	N excretion g/d/cow	N excretion kg/d/1000kg	ref	
7.175	14.4	159	531	146.752	0.276369	Reed et al., 2015	
7.175	14.4	159	531	132.3925	0.249327	Nennich et al. 2005	
				139.5723	0.262848	average	

Response: See response to Comment 30.

Comment 27: 2018 manure distribution among waste management systems by operation

I am concerned about the accuracy of the values in Table A-188 on page A-41. The figure below was generated by a post-doc working in the ARS lab in Pennsylvania, based on the ARMS data. It is total mass of manure on dairies in different storage. To me, this distribution looks a lot more realistic for Idaho at least if I assume 100% of the manure exported was a solid. When I did my own “survey” I came up with about 76% of total manure stored as a solid. Discrepancies for other major dairy states are also present compared to this.



There also seems to be other manure data in ARMS so I am a bit perplexed by it. This would obviously have a very large impact on the values calculated and I think more work in this area could be done.

Response: See response to Comment 30.

Comment 28: Methane conversion factors for dry systems

Below are the most recent values in the new IPCC refinement that differ from Table A-191 on page A-45.

Waste Management System	Cool Climate MCF	Temperate Climate MCF	Warm Climate MCF
Cattle deep litter (<1month)	2.75	6.5	18
Cattle deep litter (>1month)	21-26	37-41	73-76
Composting static pile	1	2	2.5
Composting Extensive/passive	1	2	2.5
Dry Lot			2

They also had a new value for pasture of 0.45 but that was assuming you used a B₀ of 19.

Response: See response to Comment 30.

Comment 29: Direct N₂O emission factors

Below are the most recent values in the new IPCC refinement that differ from Table A-193 on page A-47.

Waste management system	Direct N ₂ O EF
Anaerobic Digester	0.0006
Composting intensive	0.005

Composting Passive	0.005
Composting Static (force aeration)	0.10
Liquid/slurry	0.005 w/ cover 0/without
Solid Storage	0.010

Response: See response to Comment 30.

Comment 30: Indirect N₂O loss factors

One basic question here, % of what lost? Total N from the storage? N fed? Below are the most recent values in the new IPCC refinement that differ from what you have in the current table.

Do you account for additives such as Alum that will greatly reduce NH₃ emissions?

Animal Type	Waste Management System	Volatilization Nitrogen Loss
Beef Cattle	Dry Lot	30*
Beef Cattle	Liquid/Slurry	15
Beef Cattle	Pasture	7
Dairy Cattle	Anaerobic Lagoon	35**
Dairy Cattle	Daily Spread	7
Dairy Cattle	Deep Pit	25
Dairy Cattle	Dry Lot	45
Dairy Cattle	Liquid/slurry	48
Dairy Cattle	Solid Storage	30
Poultry	Anaerobic Lagoon	40
Poultry	Liquid/slurry	40
Poultry	Manure with bedding	40#
Poultry	Manure without bedding	48
Poultry	Solid Storage	40
Swine	Anaerobic Lagoon	40
Swine	Deep Pit	25
Swine	Liquid/Slurry	48

*Research shows that ~50% of N fed is lost as NH₃ from feedlots.

**Our on-farm research has shown that 65 percent of total N was lost from lagoon storage over the year (Leytem et al., 2018).

References

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Response: EPA appreciates the commenter’s suggestions to improve the accuracy and clarity of the chapter describing GHG emissions from manure management (Chapter 5.2) and recognizes the commenter’s specific data recommendations to potentially improve emissions estimates. EPA is regularly reviewing literature and available data sources for updated activity data including methane producing potential, volatile solids and nitrogen excretion rates, waste management system usage data, methane conversion factors, and emission factors. Note that volatile solids and nitrogen excretion rates for cattle are reliant on underlying data provided in Chapter 5.1 (Enteric Fermentation), which EPA acknowledges is also an area for potential improvements. EPA appreciates the commenter for confirming known available data and applicable references; EPA will review these items as resources allow. EPA is aware of IPCC’s 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories and plans to review updated methodologies and emission factors as resources allow, as noted in the Planned Improvements section of Chapter 5.2.

Chapter 6. LULUCF

No comments received.

Chapter 7. Waste

Landfill Specific

Comment 31: Pulp and paper industrial wastewater and landfill emissions

NCASI independently calculated pulp and paper industrial wastewater CH₄ emissions given in Table 7-11 on 7-23 of the draft report (the value reported is 0.6 MMT CO₂eq.), and NCASI's result conforms to the pulp and paper result in Table 7-11. NCASI appreciates the high level of quality in the draft report regarding pulp and paper industry wastewater CH₄ emissions.

NCASI calculated CH₄ emissions of 4.5 MMT CO₂eq. from pulp and paper industrial landfills using 2018 EPA GHG reporting program (GHGRP) data. Within the draft report, NCASI could only locate CH₄ emissions from all industrial landfills (15.0 MMT CO₂eq. for 2018 found in Table 7-3 on 7-3). NCASI would appreciate confirmation that the 4.5 MMT CO₂eq. from pulp and paper industrial landfills that NCASI calculated from GHGRP data is the same number EPA is using for their calculations for CH₄ emissions from all industrial landfills.

Response: EPA appreciates the commenter's feedback regarding the accuracy of the pulp and paper industrial wastewater methane emissions estimates. With regard to the emissions estimates for pulp and paper industrial landfills, EPA added text to the section titled "Methodology Applied for Industrial Waste Landfills," within section 7.1 of the Inventory text, to clarify that EPA is currently unable to use the net emissions data directly reported to the GHGRP for industrial landfills because the waste disposal information does not correlate well for all industrial waste landfills accounted for in the Inventory estimates. Therefore, EPA is maintaining our current approach to estimating emissions from industrial waste landfills using production data from the pulp and paper and food and beverage sectors.

Comment 32: Datasets of quantities of industrial food processing waste disposed of in industrial waste landfills

EPA conducted an analyses of industrial food processing waste¹ in 2012. According to that report, although solid waste management data is not available, the primary method for managing solid waste from food processing sector is for utilization. These include animal feed, raw material for other products or direct utilization on agricultural land. Given the report's suggestion that very little food processing waste is landfilled, it would also be unlikely that food processors would spend the own or operate industrial landfills. The little food waste that is generated would more likely be redirected for composting or to a municipal solid waste landfill. This comports with industry experience.

The industry also evaluated the dataset for industrial waste landfills and found that very few of them represent food waste processing landfills. Those that do are primarily sugar facilities. In addition, for facilities that were unclear, we queried a few of the large generators that report under subchapter TT. Based on responses received, none of them are food waste facilities.

Response: EPA notes the information provided by the commenter on industrial food processing waste, including the EPA analyses from 2012. In the next Inventory cycle, EPA will further investigate the prevalence of food-related waste deposited in industrial waste landfills. EPA intends to record any findings from this exercise in a memorandum and if any changes to the methodology or assumptions

for industrial waste landfills are warranted, EPA will implement the changes. Please see the “Planned Improvements” in Section 7.1.

Comment 33: Unpublished waste characterization studies from 1990

EREF has assembled a comprehensive list of waste characterization studies including those evaluated by EPA. They plan on using reliable data from those studies to reevaluate the DOC values for the duration of the period from 1990 onward. This analysis will inform updates to the 2016 paper provided to EPA and reinforce industry’s previous request to update the GHGRP as well as the US GHG Inventory specifically for years 2005-present. EREF expects to conclude its update to the White Paper by February 2020.

We understand that EPA is focused on the period from 1990-2004 because it falls outside the GHGRP timeframe. However, data from waste characterization studies indicate the MSW fraction in the waste stream has steadily declined since around 2000. As previously stated, EREF obtained additional information to further substantiate the steady decline in the MSW fraction of waste disposed of in MSW landfills necessitating updates to the DOC values for 2005 to the present to more accurately represent landfill emissions. Therefore, EPA should extend the time period from 2005 to current. We also request EPA to update the GHGRP with revised DOC values for calculating MSW Landfill emissions.

Response: EPA notes the commenter’s feedback on the decline in the MSW fraction of waste disposed in MSW landfills. EPA looks forward to reviewing the work by EREF to update their 2016 paper. As stated in the Planned Improvements section of Section 7.1 of the U.S. Greenhouse Gas Inventory of Emissions and Sinks, EPA is developing a multivariate analysis using publicly available data directly reported to the GHGRP solving for optimized DOC and k-values across the more than 1,100 landfills that reporting to the program. The results of this analysis could help inform a future GHGRP rulemaking where changes could be made to the default DOC and k-values contained within Subpart HH of the GHGRP which could then be carried over to the Inventory emissions estimates for MSW landfills upon promulgation of any revisions to 40 CFR Part 98.

Comment 34: Decay rate values

The attached article provides information on additional first order decay models for landfill gas production. It describes two Dutch models; one from TNO (The Netherlands Organization of Applied Scientific Research) and another from Afvalzorg (Dutch waste company).

Response: EPA appreciates the articles provided by the commenter and will review them in the context of Planned Improvements to the Inventory estimates.

Comment 35: Scale-up factor methodology for landfills

We find the explanation of the methodology EPA employed to arrive at the scale-up factor to be clear. However, based on reasonable expectations that landfills that do not report under the GHGRP are likely to be smaller, closed sites with declining GHG emissions and that reporting landfills will continue to represent a larger proportion of WIP, we recommend that EPA routinely evaluate and revise the scale-up factor. For example, since starting in 2010, every year fewer landfills report more than the 25,000 MT CO₂eq. Yet, every year, more landfills are included in the GHGRP. This means that more of the waste is covered by reporting facilities on an annual basis.

Year	# of landfills reporting	# of landfills >25k MT CO ₂ eq.	Total MT CO ₂ eq. reported

2010	1235	975	101,920,033
2011	1240	965	93,830,839
2012	1252	961	94,375,699
2013	1278	946	91,159,615
2014	1290	941	90,817,217
2015	1294	935	89,746,871
2016	1300	914	86,905,137
2017	1304	898	86,464,158
2018	1313	896	89,215,401

Again, most landfills that are exempt from the GHGRP requirements are old, small, closed landfills. The potential methane emissions from these sites decrease year over year by approximately 3 percent, on average. Therefore, the emissions contribution from these sites will continue to decrease compared to the sites that report via the GHGRP. The scaling factor must be adjusted to reflect the declining contribution of the exempt sites.

Response: EPA appreciates the commenter’s feedback on the clarity of the methodology used to develop the scale-up factor to account for landfills that do not report to the GHGRP. EPA also agrees with the commenter’s feedback that the scale-up factor should be evaluated on a routine basis. There is a large amount of uncertainty associated with the number of non-reporting landfills and their total waste-in-place and the scale-up factor is our best estimate given the available information. EPA plans to reexamine the scale-up factor for the 1990-2019 Inventory cycle to determine if there are additional landfills reporting to the GHGRP such that the waste-in-place amounts for those landfills can be removed from the scale-up factor assumptions. As the same time, EPA will also account for those landfills that have stopped reporting to the program because they were able to exercise the off-ramp. Any additional information from commenters on landfills that do not report to the GHGRP that could help refine the scale-up factor assumptions are always welcome and appreciated.

Comment 36: Methane oxidation factor

Our previous years’ comments on methane oxidation factor used for the period 1990 – 2004 in the inventory time series remain unchanged and are repeated below. EPA calculates a national estimate of methane generation and emissions using a combination of secondary data sources that detail the annual quantity of waste landfilled and the annual quantity of methane recovered from facilities with landfill gas collection and control systems. EPA applies a 10% oxidation factor to all facilities for the years 1990 to 2004. This ten percent default factor contrasts significantly with the average methane oxidation factor of 19.5 percent applied through use of GHGRP data, to the later years of the time series (2005 to 2016). Importantly, the 19.5 percent average oxidation rate incorporated in the GHGRP, subpart HH emissions data is premised on a more detailed and up-to-date estimation approach than is the default value of 10 percent. It is also a conservative average value, as the GHGRP methodology restricted the maximum oxidation rate to 35 percent.

In its work to review and revise the method for calculating methane oxidation under subpart HH of the GHGRP, EPA acknowledged the need to update the default 10 percent oxidation value. The default value was based on only one field study, at a landfill without gas collection and control, and did not reflect the much higher oxidation values found in numerous subsequent, peer-reviewed field studies. Given the plethora of scientific studies showing methane oxidation to be several times higher than the EPA and

IPCC default value, we strongly recommend EPA apply a revised value (perhaps the average oxidation value from the GHGRP) to the earlier years of the time series.

Response: EPA appreciates the commenter's feedback on the oxidation factor as applied to estimating emissions from MSW landfills. EPA regularly reviews new literature related to landfill methane oxidation and investigated options to adjust the oxidation factor from the 10 percent currently used for 1990 to 2004 to another value or approach such as the binned approach used in the GHGRP (e.g., 10 percent, 25 percent, or 35 percent based on methane flux) or the average oxidation factor across facilities reporting to the GHGRP (approximately 19.5 percent). At this time EPA has decided not to revise the methane oxidation factor for the 1990-2004 time series since such a change will likely result in a noticeable discontinuity in the emissions between 2004 and 2005-2010 (i.e., a jump in emissions between 2004 and 2005) that would need to be investigated and resolved to ensure methodological consistency over the time series and to accurately reflect trends. We continue to advance efforts to improve the methane generation calculations in the landfills section of the Waste Chapter by focusing on improvements to the DOC and k-value per responses to other comments submitted by this commenter, in order to make best use of the available resources across the Inventory compilation process.

Comment 37: Degradable organic carbon (DOC)

Chapter 7 of the draft inventory explains that EPA uses one DOC value of 0.20 to calculate emissions for the years 1990 through 2004, and uses emissions reported through the GHGRP for years 2005 through 2017. The GHGRP allows landfills to use 0.20 for bulk MSW or allows a landfill to further delineate waste streams by accounting for separate shipments of C&D waste, which uses a DOC of 0.08, and separate shipments of inert wastes, which may use a DOC of 0.0. If a landfill delineates in this way, it must use a DOC of 0.31 for its MSW waste volumes, which applies an artificially high DOC to MSW, and inappropriately overestimates emissions. The required DOC value of 0.31 fails to account for the significant volumes of C&D and inert wastes that are incorporated in MSW, and which cannot be separated from the MSW or accounted for distinctly, as can discrete shipments of inert wastes from industrial or C&D recycling facilities.

While we are pleased to learn that EPA plans to revisit the DOC value of 0.20, we question why the Agency is focusing first on the early years of the inventory rather than the later portion of the time series. We believe that the fundamental shifts in the characterization of waste disposed in landfills has occurred in the later portion of the time series and that the research conducted thus far by state agencies and the Environmental Research and Education Foundation (EREF) are illustrative of those changes. We strongly recommend that EPA instead first focus on the second half of the time series and reevaluate the DOC values incorporated in subpart HH of the GHGRP, which underpins the data used for those years of the inventory.

In 2016, the Environmental Research and Education Foundation (EREF) undertook a state-based study of DOC values for both landfills receiving only MSW (MSW Only Landfills) and for Non-MSW Material going to MSW Landfills. EREF updated the 2016 paper in January 2019 with additional information and is again in the process of making further revisions based on new waste characterization information. The DOC guideline recommended by EPA for MSW Only Landfills is 0.31 and the recommended guideline for bulk material (combined MSW, C&D and inert waste streams) going to MSW landfills is 0.20. EREF concluded both of these guidelines over-estimate the amount of organic waste deposited in landfills, which results in inaccurate estimates of landfill gas generation and methane emissions. Furthermore,

neither of the EPA-recommended DOC values have been reviewed in many years. It is time EPA update the DOC values for MSW and Bulk waste and we believe that the most valuable focus would be to reassess the DOC values incorporated in the GHGRP used for inventory years 2005 forward.

EREF reviewed 17 recent waste composition studies for MSW Only Landfills conducted by 13 states and confirmed that waste composition has and continues to change over time, as fewer organic materials are sent to MSW landfills. Since EPA cites the EREF research as a rationale for reassessing DOC values for 1990-2004, the following quotes from EREF clearly suggest that the data strongly suggest reevaluating DOC values used in the GHGRP for years 2005 and later:

All characterization studies had DOC_{MSW} values significantly less than the default value of 0.31, which suggests this value is not representative of real-world conditions for MSW (Table 3; Figure 4). Analysis of U.S. EPA data ... also results in a significantly lower DOC_{MSW} value compared to the U.S. EPA guideline of 0.31, with DOC_{MSW} values ranging from 0.218 in 1994 to a minimum of 0.160 in 2015 (Figure 4; Appendix B). Both the state characterization studies and U.S. EPA Facts and Figures data independently suggest that a DOC guideline value of 0.31 for MSW is not representative of the landfilled MSW stream. ...

The use of a single DOC value as a guideline for all U.S. landfills makes the implicit assumption that waste composition does not change over time or due to location. The results presented here suggest these are not valid assumptions and that, collectively, the use of a static DOC value of 0.31 may lead to inaccurate estimates of landfill gas emissions for landfills that only accept MSW. Because this specific analysis is focused only on MSW materials, one would expect the inclusion of non-MSW materials going to a landfill to impact DOC estimates even more.²

With respect to Non-MSW going to MSW Landfills, EREF finds “a common assumption is that all waste materials entering MSW landfills consist only of MSW materials. As noted previously, MSW Landfills rarely accept MSW exclusively. Rather, most MSW Landfills (landfills in 45 states) are authorized to accept other Subtitle D wastes in addition to MSW.”³ In addition, EREF notes:

Given that a third of incoming waste to MSW Landfills consists of non-MSW materials, there is significant potential for non-MSW materials to impact the relative fraction of organics and degradable organic carbon (DOC) of the MSW Landfill waste stream.⁴

The amount and types of non-MSW Subtitle D organic wastes impact the DOC value for the landfilled waste since it consists of both MSW and non-MSW streams. This combined DOC value (DOC_{SubD}) incorporates degradable organic carbon from all Subtitle D wastes accepted at MSW Landfills (both MSW and non-MSW). ... State waste characterization studies were used to estimate the relative fraction of each organic constituent for C&D and industrial waste ... and DOC for each waste type was calculated using Equation 1b. Based on this analysis the DOC_{SubD} value of landfilled waste is 0.167 (Table 7).⁵

EREF also highlights that the DOC_{SubD} value:

... is lower than the guideline value of 0.20 for bulk waste. It is also lower than the average DOC_{MSW} value of 0.191 computed in the prior section, indicating the inclusion of non-MSW decreases overall DOC. Using the same approach as for the DOC_{MSW} analysis, state-specific organics content and DOC_{SubD} values for all fourteen states with sufficient data were determined

and presented in Table 8, below. ... The results, all for 2013, highlight differences in DOC_{SubD} based on locale and suggest the use of a static 0.20 guideline for bulk waste may lead to inaccurate estimates of methane generation and emissions, especially in some areas.⁶

Thus, EREF concludes as follows:

The average computed DOC value for MSW using state data was 0.191, or roughly three-fifths of the MSW guideline value. The average computed DOC value for bulk waste using state data was 0.167, or roughly four-fifths of the bulk waste guideline. This analysis suggests that the U.S. EPA's guideline DOC values of 0.31 for MSW-only landfills and 0.20 for facilities accepting non-MSW Subtitle D wastes overestimate DOC at these landfills and may result in inaccurate estimates of landfill gas generation and methane emissions.⁷

Based on this review of the DOC values for MSW landfills, the waste sector concludes that the long-standing DOC values developed in the past over-estimate both landfill gas generation and methane emissions. The data provided by EREF confirms that two trends are driving the changes in waste composition at MSW Landfills. First, many MSW Landfills are handling less organic matter now, and we anticipate this trend will continue due to state and local organics diversion goals. Second, the increase of Subtitle D non-MSW waste disposed has altered the DOC for all waste deposited in MSW Landfills. EPA validates these trends in the Inventory's Chapter 6 discussion of carbon sequestration of harvested wood products, yard waste and food waste, which shows a significant reduction in sequestered carbon since 1990 due to reduced volumes of organic wastes disposed in landfills.

Based on EREF's research, we urge EPA to update the DOC values to reflect significant changes in the amounts and types of organic materials being landfilled over the past 20 years. The values now in use are inaccurate and should not be used going forward. We recommend that EPA review and update the DOC values for the entire time series for the 2019 version of the GHG Inventory, and prioritize updates of the DOC values used in calculating GHG emissions under Subpart HH of the GHGRP.

Further, as EPA clearly recognizes that the composition of the waste at MSW Landfills has changed and continues to change, we suggest the Agency add an additional factor, "(5) the composition of the waste" to the sentence on line 42, page 7-2 of the waste chapter that begins: "Methane generation and emissions from landfills are a function of several factors."

² The Environmental Research & Education Foundation (2019). Analysis of Waste Streams Entering MSW Landfills: Estimating DOE Values and the Impact of Non-MSW Materials. Retrieved from www.erefndn.org. pp. 8 - 9.

³ Ibid., p. 10.

⁴ Ibid., p. 11.

⁵ Ibid., p. 13.

⁶ Ibid., p. 14.

⁷ Ibid., p. 15.

Response: As stated in the Planned Improvements section of Section 7.1 of the U.S. Greenhouse Gas Inventory of Emissions and Sinks, EPA is developing a multivariate analysis solving for optimized DOC and k- across the more than 1,100 landfills that report under subpart HH of the GHGRP. This analysis uses publicly available data directly reported to the GHGRP. The results of this analysis could inform updates to the default DOC and k-values used by landfills subject to reporting under subpart HH of the GHGRP in calculating their facility level emissions. For updates to the DOC to be reflected in the

Inventory, the updates also need to be incorporated in Subpart HH of the GHGRP given its direct use in estimating national-level emissions from MSW landfills.

With regard to the suggested text edit, EPA has already reflected the importance of waste composition with the sentence that begins “Methane generation and emissions from landfills are a function of several factors, including (1) the total amount and composition of waste-in-place....”

Comment 38: The k factor (Methane generation rate constant)

Our previous years’ comments on k factors remain unchanged and are repeated below. The waste sector strongly supports EPA’s plans to review these k values against new data and other landfill gas models, as well as assess the uncertainty factor applied to these k values in the Waste Model. We have been concerned that these k-values are outdated and rife with uncertainty, as confirmed by the *Draft AP 42.2.4 Municipal Solid Waste Landfills*, which states:

There is a significant level of uncertainty in Equation 2 and its recommended default values for k and L_0 . The recommended defaults k and L_0 for conventional landfills, based upon the best fit to 40 different landfills, yielded predicted CH₄ emissions that ranged from ~30 to 400% of measured values and had a relative standard deviation of 0.73 (Table 2-2). The default values for wet landfills were based on a more limited set of data and are expected to contain even greater uncertainty.⁸

The waste sector has previously highlighted the significant issues with the k values used in the Draft AP-42 Section 2.4: Municipal Solid Waste Landfills. In fact, EPA has never finalized AP-42 for MSW landfills, despite the k-value issues identified *by EPA* in both AP-42 and the Background Information Document. With uncertainties in CH₄ emissions ranging from -30% to 400% under EPA’s assessment of the LandGEM model, it is difficult to rely on these data. For this reason, we support EPA’s plan to review and resolve the significant problems in the k value data set. However, we also suggest review L_0 value. Although an independent variable, L_0 should be considered in conjunction with k value modifications because it is related to fitting the curve, where the results will be dependent on the assumptions used for the L_0 /DOC.

⁸ U.S. EPA, *Draft AP 42.2.4: Municipal Solid Waste Landfills*, October 2008, p. 2.4-6.

Response: As stated in the Planned Improvements section of Section 7.1 of the U.S. Greenhouse Gas Inventory of Emissions and Sinks, EPA is developing a multivariate analysis solving for optimized DOC and k-values across the more than 1,100 landfills that report under subpart HH of the GHGRP. This analysis uses publicly available data directly reported to the GHGRP. The results of this analysis could inform updates to the default DOC and k-values used by landfills subject to reporting under Subpart HH of the GHGRP in calculating their facility level emissions. As the commenter already acknowledged for updating DOC, for updates to the k-value to be reflected in the Inventory, the updates also need to be incorporated in Subpart HH of the GHGRP given its direct use in estimating national-level emissions from MSW landfills.

Composting Specific

Comment 39: Datasets on industrial composting facilities

The waste sector does not have datasets on industrial composting facilities located in U.S. territories.

Response: EPA appreciates the commenter's feedback on the current lack of datasets on composting facilities in U.S. territories.

Comment 40: Compost emission factor

Our previous years' comments on compost emission factor remain unchanged and are repeated below. In ideal conditions, the composting process occurs at a moisture content of between 50 and 60%, but the moisture content of feedstocks received at composting sites varies and can range from 20% to 80%. It is common for moisture to be added to dry feedstocks prior to the start of composting to optimize the biological process. In the calculation of emissions from composting in the draft chapter, it appears that all incoming wastes were assumed to have a moisture content of 60%. If 60% is not reflective of the actual weighted average of all feedstocks, this will introduce errors in the inventory calculation that could be significant.

We recommend that the calculations be based on waste subcategories (i.e., leaves, grass and garden debris, food waste) and category-specific moisture contents, or ask that further information be provided on the rationale for assuming 60% as the average moisture content of all inbound materials.

Response: EPA notes the commenter's feedback on the moisture content levels used in the calculation of emissions from composting. The calculations for composting are based on IPCC Tier 1 methodology defaults. Under this methodology, the emission factors for CH₄ and N₂O assume a moisture content of 60% in the wet waste. (IPCC 2006) EPA has included this detail to the Methodology section of Section 7.3 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018, as was done in the previous year's inventory report, so that the source of the moisture content is more transparent. In addition, EPA continues to include in the Planned Improvements section of Section 7.3 that EPA is looking into the possibility of incorporating more specific waste subcategories and category-specific moisture contents into the emissions estimates for composting in the United States to improve accuracy. However, to date the EPA has not been able to locate substantial information on the composition of waste at U.S. composting facilities to do so. As additional data becomes available on the composition of waste at these facilities, EPA will consider using this information to create a more detailed calculation of U.S. composting emissions.

Appendix A: List of Reviewers and Commenters

EPA distributed the expert review chapters of the draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018* to a list of ~220 expert reviewers across all sectors of the Inventory. The list below includes names of those expert reviewers who submitted comments as part of the Expert Review Period.

- April Leytem - United States Department of Agriculture (USDA)
- Anne Germain - Waste Management, Republic Services, National Waste & Recycling Association, Solid Waste Association of North America, SCS Engineers, and Weaver Consulting Group
- Barry Malmberg - National Council for Air and Stream Improvement (NCASI), Inc.
- David Lax- American Petroleum Institute (API)
- Jesse Maxwell - Waste Management, Republic Services, National Waste & Recycling Association Solid Waste Association of North America, SCS Engineers, and Weaver Consulting Group
- Jeremy Martin – Union of Concerned Scientists (UCS)
- John Davies – United States Department of Transportation (USDOT)
- Stephen Jasinski – National Minerals Information Center United States Geological Survey (USGS)

Note: Names of commenters are listed in no particular order.

Appendix B: Dates of review

- Energy: October 17 - November 15, 2019
- Industrial Processes and Product Use (IPPU): October 17-November 15, 2019
- Waste: October 17 - November 15, 2019
- Agriculture: October 28 – November 25, 2019
- Land Use, Land Use Change and Forestry (LULUCF): November 13 – December 13, 2019

Appendix C: EPA Charge Questions to Expert Reviewers

To facilitate expert review and indicate where input would be helpful, the EPA included charge questions for the Expert Review Period of the draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018* report. EPA also noted to expert reviewers that while these charge questions were designed to assist in conducting a more targeted expert review, comments outside of the charge questions were also welcome. Included below is a list of the charge questions by Inventory chapter.

Energy

Requests for Expert Feedback for the 1990-2018 Energy Chapter

General Questions:

1. Please provide your overall impressions of the clarity and transparency of the Energy chapter.
2. Please provide any recommendations that EPA can consider to improve the completeness and/or accuracy of the Energy chapter.

Source-Specific Questions:

Fossil Fuel Combustion: CO₂ from Fossil Fuel Combustion

1. Please provide your overall impressions of the clarity of the discussion of trends in CO₂ emissions from fossil fuel combustion. Please provide recommendations for any information that could be added to the discussion to provide additional transparency and clarity.
2. Data for energy use in U.S. Territories comes from the International Energy Statistics provided by EIA. This source has data only through 2014; the years 2015 through 2018 are proxies. Are there other sources of U.S. Territory energy use that could be used?
3. Facility-level combustion emissions data from EPA's GHGRP are currently used to help describe the changes in the industrial sector. Are there other ways in which the GHGRP data could be used to help better characterize the industrial sector's energy use? Are there ways the industrial sector's emissions could be better classified by industrial economic activity type?

Fossil Fuel Combustion: CH₄ and N₂O from Stationary Combustion

1. The CH₄ and N₂O emission factors for the electric power sector are based on a Tier 2 methodology, whereas all other sectors utilize a Tier 1 methodology. For all other stationary sectors, the emission factors used in Tier 1 methods are primarily taken from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Are there other more U.S.-specific CH₄ and N₂O emission factor data sources that could be utilized, especially for natural gas combustion sources?

Carbon Emitted from Non-Energy Uses of Fossil Fuels

1. Please provide your overall impressions of the clarity of the discussion of Carbon Emitted from Non-Energy Uses of Fossil Fuels. Please provide recommendations for any information that could be added to the discussion to provide additional transparency and clarity, especially in relation to linkages with the estimates in the IPPU chapter.

Gasoline Carbon Factor

Gasoline Component Composition:

1. Is the EPA Trends data a good data source for determining gasoline composition? Are there other sources available, including for the full time series 1990-2018 and going forward?
2. Is it reasonable to apply the EPA Trends data across all fuel types (i.e., California fuels not included)?
3. Should the EPA Trends data be used for the full time series or just for years where the NIPER data is not available?
4. If using across the time series, is it reasonable to apply the 1997 results to 1990-1996 and the 2016 results to 2017-2018?

Component Speciation:

1. Is it reasonable to use the API data to speciate gasoline components?
2. Is the approach outlined in Annex 2 of this memo to develop the gasoline speciated components reasonable (see p. 15)?
3. Is the API data representative of different gasoline types? If not, is there a better approach to use?
4. Is the API data representative over time? If not is there a better approach?
5. Are there other gasoline speciation data available?
6. Would it be better to use a representative molecule to represent carbon content of different gasoline components?

Carbon Factor:

1. The carbon factor of each gasoline component is based on a percent by mass and are distributed across the full fuel based on the density of the entire gallon. Should individual densities be used instead? If so is there a good source of data for these densities?
2. The carbon factors are lower than what was found previously; do the updated values seem reasonable?

Heating Value:

1. Is the approach for developing heating values reasonable?
2. Are there other data sources available on heating content?
3. The factor is slightly higher than current factors used; do the update seem reasonable?

Industrial Processes and Product Use (IPPU)

Requests for Expert Feedback for the 1990-2018 IPPU Chapter

General Questions:

1. Please provide your overall impressions of the transparency of the IPPU chapter.
2. Please provide any recommendations that EPA can consider to improve the completeness and/or accuracy of the IPPU chapter.
3. For the source categories included in the expert review draft, is the state of the industry current and accurately described? Are there technologies, practices, or trends that EPA should consider?

Source-Specific Questions:

Minerals

1. **Other process uses of carbonates** - Please provide information on:
 - Data on carbonate use in non-metallurgical magnesium production.
 - Data on carbonate use in the production of ceramics.

Chemicals

2. **Caprolactam, Glyoxal and Glyoxylic Acid Production** - With the inclusion of this new IPPU source category as of the last Inventory, EPA requests feedback on the overall chapter text, assumptions and information on the state of the industry.
3. **Calcium Carbide Production** - Please provide input on data sources and industry information on production to estimate emissions using IPCC methods.
4. **Phosphoric Acid Production:** Please provide input on data sources and assumptions regarding phosphate rock including:
 - Regional production data and the assumption that 2018 regional production was estimated based on regional production data from 2005 to 2011.
 - The carbonate composition of phosphate rock and how it varies depending upon where the material is mined and over time.
 - The disposition of the organic carbon content of the phosphate rock and the assumption that it remains in the phosphoric acid product and is not released as CO₂. This includes feedback on the assumption that all domestically produced phosphate rock is used in phosphoric acid production and it is used without first being calcined.

Metal Production

5. **Zinc Production:** The EPA seeks comments on assumptions applied to determine the split between primary and secondary zinc production based on U.S. Geological Survey national totals. Are other options/data sources available to distinguish between process production totals?
6. **Iron and Steel Production:** The EPA seeks data on carbonaceous material (other than coking coal) consumption and coke oven gas production from merchant coke plants.

Other IPPU Categories

7. **ODS Substitutes** - The EPA seeks comments on possible sources of hydrofluorocarbon (HFC) use that are not reflected, or whose use is modeled lower than actual, as evident from a comparison of the underlying model with data reported under EPA's Greenhouse Gas Reporting Program (GHGRP).

Agriculture

Request for Expert Feedback for the 1990-2018 Agriculture Chapter

General Questions:

1. Provide your overall impressions of the clarity and transparency of the Agriculture chapter.

2. Provide any recommendations that EPA can consider to improve the completeness and/or accuracy of the Agriculture chapter.
3. Provide feedback on the methodologies, assumptions and activity data used to estimate emissions for categories within the Agriculture chapter.

Source-Specific Questions:

4. For the Manure Management source category, is the state of the industry current accurately described? Are there other technologies, practices, trends that we should consider?
5. Are the parameters and discussion of uncertainty within the Manure Management source category estimates adequately reflecting all uncertainties from this industry and the data EPA is currently using?
6. The Manure Management source category relies on national/regional livestock production and management data for calculating emissions estimates from USDA APHIS and NASS. Are there other/newer data sources that EPA should be aware of and consider in the calculating these emissions? Especially for:
 - a. Waste management system data, particularly seasonal changes in emissions from different WMS;
 - b. Maximum methane producing capacity;
 - c. Volatile solids and nitrogen excretion rates;
 - d. Measured emission estimates (by waste management system) to help refine estimates of methane conversion factors.
7. For the Enteric Fermentation source category, is the state of the industry current and accurately described? Are there other technologies, practices, trends that we should consider?
8. The Enteric Fermentation source category relies on national/regional livestock production, diet and management data for calculating emissions estimates. Are there other/newer data sources or methods that EPA should be aware of and consider in the calculating these emissions? Especially for:
 - a. Dry matter/gross energy intake;
 - b. Annual data for the DE, Y_m , and crude protein values of specific diet and feed components for foraging and feedlot animals;
 - c. Monthly beef births and beef cow lactation rates;
 - d. Weights and weight gains for beef and dairy cattle.
9. For the Enteric Fermentation source category and the Cattle Enteric Fermentation Model (CEFM), are the various regional designations of U.S. states (as presented in Annex 3.10) used for characterizing the diets of foraging cattle appropriate? The CEFM is used to estimate cattle CH₄ emissions from enteric fermentation, and incorporates information on livestock population, feeding practices, and production characteristics.

Land Use, Land-Use Change, and Forestry (LULUCF)

Request for Expert Feedback for the 1990-2018 LULUCF Chapter

General Questions:

1. Provide your overall impressions of the clarity and transparency of the categories provided in the attached draft LULUCF chapter.
2. Provide any recommendations that EPA can consider to improve the completeness and/or accuracy of the attached draft LULUCF chapter.
3. Provide feedback on the methodologies and activity data used to estimate emissions for categories within the attached draft LULUCF chapter.

Category-Specific Questions

4. For the Yard Trimmings and Food Scraps category, is the state of the industry current and accurately described? Are there other technologies, practices, trends that we should consider?
5. For the Yard Trimmings and Food Scraps category, are there other data sources that EPA should be aware of and consider in the calculating these emissions? Especially for:
 - C storage, decay rates, etc. for yard trimmings and food scraps
 - Decay rates of food scraps, leaves, grass, and branches
 - National yard waste compositions
 - Precipitation range percentages for populations for the decay rate sensitivity analysis

Waste

Request for Expert Feedback for the 1990-2018 Waste Chapter

General Questions:

1. Please provide your overall impressions of the clarity and transparency of the Waste chapter.
2. Please provide any recommendations that EPA can consider to improve the completeness and/or accuracy of the Waste chapter.

Wastewater Specific Questions:

1. The wastewater source category relies on national production data from a variety of sources for calculating emissions estimates. Are there other data sources that EPA should be aware of and consider in the emissions calculations of this source?
2. Please provide input on any additional sources of wastewater outflow or BOD production that we may consider in our industrial methane emissions calculations. Do our estimates of the type of wastewater treatment systems in use seem reasonable?
3. For domestic wastewater emissions, please provide input on:
 - a. Any additional sources for the N content of sludge, amount of sludge produced, and sludge disposal practices,
 - b. National level data on the type of wastewater treatment systems in operation,
 - c. National level data on the biogas generation and recovery operations,
 - d. The estimates of the percent of BOD removed by aerobic, anaerobic, and other treatment systems for our methane estimates,
 - e. The protein estimates and overall calculations for nitrous oxide. For example, do you have suggestions for developing a country-specific factor, rather than the IPCC default

- factor, to estimate the amount of nitrogen from industrial and commercial sources co-treated with domestic wastewater? and
- f. Sources of data for development of a country-specific methodology for N₂O emissions associated with on-site industrial wastewater treatment operations, including the appropriateness of using IPCC's default factor for domestic wastewater (0.005 kg N₂O-N/kg N).
4. Are there additional industries that are sources of methane or nitrous oxide emissions that should be included in the wastewater inventory? Are there available sources of national-level data for these industries?
 5. Do you have suggestions for improving the discussion of our methodology? Is there any additional information that should be included to provide additional transparency?
 6. Is the state of domestic and industrial wastewater treatment current and accurately described?
 7. As stated in our Planned Improvements, EPA will be incorporating refinements to next year's Inventory based on IPCC's *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* (<https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>). Are there any considerations you would like to bring to our attention, or other refinements that should be included?

Landfill-Specific Questions

1. Please comment on datasets that detail the quantities of industrial food processing waste that is disposed of in industrial waste landfills. The GHGRP dataset for industrial waste landfills includes a snapshot of select food processing facilities, but vastly underestimates the entire food processing sector. The Inventory methodology applies a disposal factor to the annual amount of foods processed. Currently, we do not have a representative data set for this sector with which to improve the methodology.
2. A comprehensive Internet search by state was conducted to identify waste characterization studies published as of July 2018. We plan to conduct analyses to generate DOC values specific to the time frame of 1990 to 2004. This time frame is specified because the Inventory uses directly reported GHGRP net emissions, which incorporate the DOC values allowed under the rule, in years beyond 2004. Please comment and provide information on any additional studies that have not been published on the Internet from 1990 to date that may further these efforts.
3. An analysis is being conducted on decay rate values reported by select UNFCCC Annex 1 countries (e.g. Australia, Czech Republic, France, Germany, Italy, Norway, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom) in their annual National Inventory Reports (NIR), as well as decay rate values used as defaults in first order decay models not used for NIR estimation, as compared to the U.S. Greenhouse Gas Inventory defaults used in the U.S. Waste model. This analysis is specific to the 1990 to 2004 time frame, because the Inventory uses directly reported GHGRP net emissions, which incorporate the decay rate values allowed under the rule, for years beyond 2004. Please comment and provide information on any additional studies and models, other than the ones listed below, that have not been published on the Internet from 1990 to date if any stakeholders have this information available to share.

- LandGEM: (EPA 2005) Landfill Gas Emissions Model (LandGEM) Version 3.02 User's Guide. EPA-600/R-05/047.
 - MSW DST: (NCSU and RTI 2000) Default Data and Data Input Requirements for the Municipal Solid Waste Management Decision Support Tool.
 - WARM: (EPA) Waste Reduction Model (WARM) Tool User's Guide. Version 14 (March 2016).
 - E-PRTR: (ADEME 2003) Outil de calcul des emissions dans l'air de CH₄, CO₂, SO_x, NO_x issues des centres de stockage de dechets menagers et assimiles Available at: https://www.declarationpollution.ecologie.gouv.fr/gerep/download/Annexe_2_Outil_de_calcul_ADEME_des_emissions_dans_lair_CH4_CO2_NOX_SO.pdf
 - MELMod: (Gregory et al. 2004) Review of Landfill Methane Emissions Modelling (MELMod). Submitted to the Department of the Environment, Food, and Rural Affairs.
 - GasSim: (GasSim 2.5 User Manual. 2018)
4. Additional information regarding the scale-up factor methodology used within the latter portion of the Landfills sector time series has been added to the Inventory Annex specific to landfill in response to comments submitted by the UNFCCC. Please comment on the clarity of the more detailed scale-up factor methodology and its explanation and provide information on any portion of the approach that is unclear.

Composting-Specific Questions

Please comments on datasets available on industrial composting facilities located in the U.S. territories of Puerto Rico, Guam, U.S. Virgin Islands, Northern Mariana Islands, and American Samoa. We are aware of composting facilities in Puerto Rico. In order to accurately estimate GHG emissions from these facilities data is needed on the first year of operation, approximate annual quantities processed or number of households serviced, and whether the amount of waste composted is consistent from year to year.