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Via e-mail
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RE: Comments on EPA's Draft Revised Chapter 2, Section 2.4 of the AP-42 Compilation (for Municipal Solid Waste Landfills)

The Environmental Integrity Project ("EIP"), Sierra Club, and the Chesapeake Climate Action Network (collectively, "Commenters") respectfully submit the comments below on EPA's draft Chapter 2, Section 2.4 of its AP-42 Compilation of Air Pollutant Emission Factors ("Draft Revised Chapter") for municipal solid waste ("MSW") landfills.[1] Our comments address EPA's proposed revisions as well as its proposal not to revise parts of the Draft Chapter. We appreciate the opportunity to submit these comments.

Section 130 of the federal Clean Air Act, 42 U.S.C. § 7430, compels EPA to review and, if necessary, revise the methods – also referred to as "emissions factors" – used "to estimate the quantity of emissions of carbon monoxide [("CO")], volatile organic compounds [("VOC")], and oxides of nitrogen [("NOx")] from sources of such air pollutants" at least every 3 years. EPA's current Chapter 2, Section 2.4 of the AP-42 Compilation ("1998 Chapter") is over 25 years old and EPA has acknowledged in a subsequent draft revision, proposed in 2008, that the 1998 Chapter contains errors.

Commenters appreciate the time and effort that EPA has put into the proposed revisions as set forth in the Draft Revised Chapter. We are especially appreciative of the considerable time and effort that EPA has put into its proposed revisions to the methods for estimating landfill emissions under the Greenhouse Gas Reporting Program, some of which are incorporated into the Draft Revised Chapter. However, additional revisions are necessary and must be made in the final revised version of AP-42 Chapter 2, Section 2.4 ("Final Revised Chapter"). The specific revisions that are necessary are described in more detail below.

[1] EPA, *Draft AP 42, Fifth Edition, Volume I, Chapter 2, Section 2.4: Municipal Solid Waste Landfills* (Jan. 2024) (Clean Version), *available at* https://www.epa.gov/system/files/documents/2024-01/c02s04_1_2024_clean.pdf.

I. The Final Revised Chapter Must Include Revised Default Concentrations of VOC and NMOC in Landfill Gas.

In the Draft Revised Chapter, EPA has not proposed to include revisions to the default concentrations of NMOC and VOC beyond a small and unexplained increase of 5 ppmv in the default concentration of NMOC (from 595 to 600). EPA has access to and has reviewed a large amount of test data since the 1998 Chapter was finalized. This data, which is representative of more recent waste placement patterns and incorporates more data than was available for the 1998 Chapter, should be used to update these default concentrations. This is particularly important for VOC, which may trigger additional permit or regulatory control obligations as an ozone precursor.[2]

EPA must revise the default concentrations for VOC and NMOC to account for more recent data, which indicates that both VOC and NMOC default values should be significantly higher than in the 1998 Chapter.

A. Background on Default Concentrations of NMOC and VOC in Landfill Gas.

The existing 1998 Chapter includes default concentrations for 46 compounds found in landfill gas and total non-methane organic compounds. These defaults were developed based on a review of test data from landfills collected between 1987 and 1996 and approximately 80% of those tests were conducted over 30 years ago (at least 47 of the 60 tests were conducted before 1994).[3] In the chapter, EPA notes that defaults are only provided for compounds for which sufficient data was available and that there are additional compounds found in landfill gas. The default NMOC concentrations relied on test data from just 5 landfills for co-disposal sites and 18 landfills for sites with no or unknown co-disposal.

Included with default NMOC concentrations for landfills are an estimated percentage of those NMOC that are VOC. For sites with a history of co-disposal of MSW with non-municipal solid waste, the default assumption is that VOC constitutes 85% of NMOC or 2,060 ppmv as hexane. For sites with no or unknown co-disposal history, the current default assumption is that VOC constitutes 3% of NMOC or 235 ppmv as hexane.[4] This percentage, according to the chapter's background report, was derived by subtracting the default concentrations of organic compounds with no or minimal photoreactivity from similarly derived NMOC concentrations.[5] The report also notes that this default VOC concentration should be used with caution as the percentage is heavily influenced by the default concentration of ethane, which relied on test data from only 9 sites with concentrations ranging from 21.9 ppmv to 1,802 ppmv.[6]

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[2] *See, e.g.,* 40 C.F.R. § 52.21(b)(i)(b)(1) (VOC as ozone precursor for purpose of Prevention of Significant Deterioration program).
[3] EPA, *Emission Factor Documentation for AP-42 Section 2.4 Municipal Solid Waste Landfills Revised*, at Appendix A (Aug. 1997), *available at* https://www.epa.gov/sites/default/files/2020-10/documents/b02s04_0.pdf [hereinafter "1998 Background Document"].
[4] The VOC percent of NMOC for no or unknown co-disposal history cited in the 1998 Chapter and Draft Revised Chapter is inconsistent: 39% of 595 ppmv is 232 ppmv. The (unexplained) revision of the default NMOC concentration to 600 ppmv in the draft chapter reduces the difference – 39% of 600 ppmv is 234 ppmv.
[5] 1998 Background Document at 4-21.
[6] *Id*.

In 2008, EPA published a draft update to AP-42 Chapter 2.4 ("Draft 2008 Chapter") which included an expanded set of default concentrations for compounds found in landfill gas at landfills where the majority of waste had been placed on or after 1992. This category was intended to encompass landfills subject to RCRA subtitle D regulations which apply to landfills accepting waste on or after October 9, 1991.[7] A review of annual waste in place data reported to the GHGRP showed that, as of 2022, this would apply to 87% of the reporting landfills (977 of 1,123 facilities).[8]

These new default concentrations incorporated a larger set of compounds found in landfill gas: 167 specific compounds as well as total NMOC. The default NMOC concentration was developed using test data from 44 landfills, more than double the number of tests that were available for the no/unknown co-disposal NMOC default concentration in the 1998 Chapter. Because of the data quality and large number of test reports, EPA proposed to give the proposed NMOC emission factor in the Draft 2008 Chapter an A rating, higher than the B and D ratings for the NMOC factors in the 1998 Chapter.[9]

To determine the default VOC concentration for the Draft 2008 Chapter, EPA relied on site-specific tests that had measurements of both total NMOC and speciated data on the constituents of the landfill gas. For the 34 test reports that included both types of data, EPA subtracted the concentrations of seven compounds that it determined are commonly found in landfill gas but known to have negligible chemical photoreactivity. This resulted in a default VOC concentration of 835 ppmv as hexane (99.7% of the default NMOC concentration, 838 ppmv as hexane), more than three times greater than the default VOC concentration established for the no or unknown disposal category.[10]

After the Draft 2008 Chapter was released, landfill operators provided EPA with additional test data: 242 complete test reports from 116 landfills.[11] This data was used to evaluate concentrations of NMOC and other pollutants and determine residual risks associated with the MSW Landfill National Emission Standards for Hazardous Air Pollutants (NESHAP).

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[7] EPA, *Background Information Document for Updating AP-42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills*, at 1 (Sept. 2008), *available at* https://www.epa.gov/sites/default/files/2020-10/documents/d02s04.pdf [hereinafter "2008 Background Document"]

[8] EPA, *Envirofacts GHG Query Builder: Subpart HH - Municipal Solid Waste Landfills: Tables Hh_hist_yr_waste_qty and Hh_ann_waste_disposal_qty*, accessed February 21, 2024, https://enviro.epa.gov/query-builder/ghg.

[9] 2008 Background Document at 14.

[10] *Id*. Specifically, EPA excluded methyl chloroform (CAS 71556), acetone (CAS 67641), methylene chloride (CAS 75092), tetrachloroethylene (CAS 127184), chlorodifluoromethane (CAS 75456), dichlorodifluoromethane (CAS 75718), and ethane (CAS 74840).

[11] Memo from Andy Sheppard to Docket ID No. EPA-HQ-OAR-2002-0047 regarding Residual Risk Modeling File Documentation for the Municipal Solid Waste Landfill Source Category at Section 7 (May 20, 2019) [Included as Appendix 1 to EPA, *Residual Risk Assessment for the Municipal Solid Waste Landfills Source Category in Support of the 2019 Risk and Technology Review Proposed Rule* (May 2019), *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2002-0047-0091] (Attached hereto as Attachment A).

B. EPA must Revise and Increase the Default Concentrations of NMOC and VOC in Landfill Gas.

Instead of proposing to revise the default VOC and NMOC concentrations in the Draft Revised Chapter, EPA proposes to retain these default values, which were developed using a dataset consisting largely of at least 30-year-old data, with essentially no revision.[12] In doing so, it is proposing to determine that revision of these concentrations is not necessary.[13] However, this is incorrect. EPA must revise the default concentrations of VOC and NMOC based on the more recent and robust data available to the Agency and provided in these comments.

EPA proposes to retain default NMOC and VOC concentrations as is in the 1998 Chapter for landfills with co-disposal and with no or unknown co-disposal despite the existence of a more recent and robust dataset. Its proposal ignores the dataset used in its Draft 2008 Chapter to establish a third category of landfills, landfills with the majority of waste placed after 1992. This dataset is larger and more complete than the one used in the analysis supporting the two categories used in the 1998 Chapter. In its 2019 Residual Risk Assessment for the NESHAP for MSW landfills, EPA used this larger and more complete dataset for its analysis rather than the dataset used to develop the current chapter, finding that "the 1998 Final AP-42 is outdated and has very few HAP emission factors."[14]

As noted above, the data used to develop the proposed concentrations in the Draft 2008 Chapter included 44 test reports used to determine the average concentration of NMOC and 34 test reports used to determine the portion of NMOC that are VOC. The second dataset, which was submitted to EPA after the Draft 2008 Chapter was released, included a total of 120 test reports that can be used to determine the average NMOC concentration and 56 reports that included both NMOC concentrations and speciated data, allowing for a calculation of the VOC portion of NMOC.

Table 1 below shows relevant concentrations of NMOC using the expanded dataset and Table 2 shows the information for VOC. These concentrations are comparable to the values calculated for the Draft 2008 Chapter.[15]

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[12] As stated above, EPA has proposed to increase the default NMOC concentration for landfills with no or unknown co-disposal from 595 ppm to 600 ppm. Draft Revised Chapter at 2.4-11. However, this change is unexplained, and it appears that this revision may be for purposes of rounding.

[13] *See* 42 U.S.C. § 7430 (requiring EPA to revise methods for estimating emissions for VOC, NOx, and CO if it determines it is necessary to do so).

[14] Memo from Andy Sheppard to Docket ID No. EPA-HQ-OAR-2002-0047 regarding Residual Risk Modeling File Documentation for the Municipal Solid Waste Landfill Source Category at Section 7 (May 20, 2019) (Attachment A).

[15] The data shown in Tables 1 and 2 were calculated by EIP using test data included in Appendix C to Memo from Andy Sheppard to Docket ID No. EPA-HQ-OAR-2002-0047 regarding Residual Risk Modeling File Documentation for the Municipal Solid Waste Landfill Source Category at Section 7 (May 20, 2019). See Attachment B for the spreadsheet showing EIP's calculation details.

Table 1: NMOC Concentrations (ppmv as hexane) in Draft 2008 Chapter Dataset and Post-2008 Dataset

	Draft 2008 Chapter Dataset	Post-2008 Dataset
Number of test reports used in analysis	44	120
Minimum NMOC concentration	31	14
Maximum NMOC concentration	5,387	11,667
Mean NMOC concentration	838	756
95% Confidence Interval	240	217

Table 2: VOC as percent of NMOC in Draft 2008 Chapter Dataset and Post-2008 Dataset

	Draft 2008 Chapter Dataset	Post-2008 Dataset[16]
Number of test reports used in analysis	34	56
Minimum % VOC	95%	0.00%
Maximum % VOC	100%	100%
Mean % VOC	99.7%	95.3%
95% Confidence Interval	0.3%	5%

EPA also acknowledges, in a statement in the Draft Revised Chapter, that VOC are the primary component of NMOC. In the section of the Draft Revised Chapter on enclosed combustors/flares, Tables 2.4-4 and 2.4-5 compare NMOC and VOC emissions from these sources. EPA states, in that section, that based on a "review of data from [sources cited in] references 74-104, affirm [sic]the effect of compounds with low or no photochemical reactivity is less than 50 ppm [landfill gas]."[17] EPA's acknowledgement that there is only a 50 ppm difference between NMOC and VOC concentrations in landfill gas is directly at odds with EPA's proposal to retain default VOC values that are about 360 ppmv lower than the default NMOC concentrations.[18]

The more recent data described above indicates that the default concentrations for NMOC and VOC in landfill gas should be much higher than in the existing 1998 Chapter. This is particularly important for VOC, which can trigger additional legal obligations in permit review processes and certain rulemakings, such as the VOC Reasonably Available Control Technology

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[16] The supplemented dataset includes three tests from the 2008 dataset (TR-199, TR-293a, TR-293b) for which both NMOC and speciated concentration data were available but that were not included in the 2008 VOC fraction analysis. The effect of excluding these tests from the 2008 analysis was minimal (0.1%). The supplemented dataset also includes two test reports where the reported concentrations of nonphotoreactive organic compounds were greater than the reported total NMOC concentration. For these two tests, the %VOC is conservatively assumed to be 0.

[17] Draft Revised Chapter at footnote j to Tables 2.4-4 and 2.4-5.

[18] EPA's proposed default concentrations for the "no or unknown co-disposal category" are 600 ppm for NMOC and 235 ppm for VOCs. For the category with co-disposal, the proposed default concentrations are 2,420 ppm for NMOC and 2,060 ppm for VOC.

("RACT") review process.[19] EPA must revise the default concentration values for NMOC and VOC in landfill gas to account for more recent data.

C. The Final Revised Chapter Should Continue to Encourage Site-specific Testing with Speciated NMOC Concentrations.

EPA should continue to acknowledge the variability in measured NMOC and VOC concentrations. Operators should be encouraged to use site-specific test data when calculating emissions. The Draft Revised Chapter appropriately retains the following statements of caution from the 1998 Chapter:

> It is important to note that the compounds listed in Tables 2.4-1 and 2.4-2 are not the only compounds likely to be present in LFG. The listed compounds are those that were identified through a review of the available literature. The reader should be aware that additional compounds are likely present, such as those associated with consumer or industrial products. Given this information, extreme caution should be exercised in the use of the default VOC weight fractions and concentrations given at the bottom of Table 2.4-2.[20]

The 1998 Chapter and Draft 2008 Chapter also include statements about variability in the test data:

> *In 1998:* Available data show that there is a range of over 4,400 ppmv for total NMOC values from landfills…For emissions inventory purposes, site-specific information should be taken into account when determining the total NMOC concentration.[21]

> *In 2008:* Available data show that the range of values for total NMOC in LFG is from 31 ppmv to over 5,387 ppmv, and averages 838 ppmv…For emissions inventory purposes, site-specific information should be taken into account when determining the total NMOC concentration, whenever available.[22]

There is also significant variability in the NMOC values in the post-2008 dataset, ranging from 14 ppmv to 11,667 ppmv.

EPA should continue to note the variability of the dataset in the Final Chapter and to encourage the use of site-specific concentrations when possible.

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[19] *See, e.g.*, 42 U.S.C. § 7511a(b)(2)(C)(VOC RACT required for major stationary sources in areas designated as in moderate nonattainment for ozone standards).

[20] Draft Revised Chapter at 2.4-5.

[21] EPA, *AP 42, Fifth Edition, Volume I, Chapter 2, Section 2.4: Municipal Solid Waste Landfills* at 2.4-4 (Nov. 1998), *available at* https://www.epa.gov/sites/default/files/2020-10/documents/c02s04.pdf [hereinafter "1998 Chapter"]

[22] Draft 2008 Chapter at 2.4-7.

II. Methodology for Estimating Methane Generation.

In the Draft Revised Chapter, EPA has proposed to incorporate by reference the first order decay method for calculating methane generation from the Greenhouse Gas Reporting Program (GHGRP) (40 CFR Part 98 Subpart HH). EPA has also updated its Landfill Gas Emissions Model ("LandGEM") tool to include relevant default values consistent with EPA's proposed revisions in the Draft Revised Chapter.

Commenters support this proposed revision to the methane generation equation method and the associated changes to LandGEM. The changes to LandGEM are particularly important as this is the tool that is used by practitioners, who need the adjusted default values in order to estimate emissions for purposes of, among other things, permit applications.[23] In addition, incorporation of Equation HH-1 results in two significant improvements. First, it establishes methodological consistency with EPA's GHGRP and some state regulations for landfill methane control.[24] Second, it allows for the updates to the GHGRP methods to be incorporated into the AP-42 approach to methane generation.

However, this change does not address the problem with one variable – L_0 – being based on an error when it was developed. In addition, the updated LandGEM tool is missing important default options. LandGEM should allow for incorporation of the full range of options for characterizing waste as provided for in Equation HH-1 and the supporting Table HH-1.

A. <u>The Draft Revised Chapter Does Not Correct the Error Regarding L_0 Identified in EPA's Draft 2008 Update.</u>

In Equation 1 of the 1998 Chapter, the variable L_0 (representing volume of methane per unit mass of waste) is used to characterize the methane generation potential of the waste in the landfill.

In the Draft 2008 Chapter, EPA proposed to incorporate an adjustment factor of 1.3 (or 100 ÷ 75) in Equation 1, increasing the value of L_0. EPA made this adjustment because L_0 had been determined using the amount of gas collected by a landfill's GCCS rather than all gas generated in the landfill.[25] GCCS do not collect all gas generated by decomposition of the waste and the adjustment factor increases L_0 based on an assumption that the site-wide collection efficiency is 75%.

Equation HH-1 incorporates multiple variables instead of just one to characterize the same concept, the methane generation potential, using the method described by IPCC in their

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[23] *See, e.g.,* Texas Commission on Environmental Quality, Air Permit Reviewer Reference Guide, Municipal Solid Waste Landfills (MSWLF) And Transfer Stations, APD-ID 14 (April 2021) p. 7, https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/mswlf_guide.pdf ("TCEQ prefers using the LandGEM (landfill gas emission model) for determining emissions.")

[24] *See, e.g.,* COMAR 26.11.42.11(D)(1)(a) (Maryland landfill methane regulations incorporating Equation HH-1 by reference as part of threshold for installing controls).

[25] Draft Revised Chapter at 2.4-5; 2008 Background Document at 5, 76-77.

2006 Guidelines for National Greenhouse Gas Inventories.[26] As described in the technical support document for EPA's promulgation of Subpart HH of the Greenhouse Gas reporting program, L_0 (representing mass of methane per unit mass of waste) is determined using the following formula:[27]

$$L_0 = DOC \times DOC_F \times MCF \times F \times \frac{16}{12}$$

Where:
L_0 = methane generation potential (Mg methane / Mg MSW)
DOC = degradable organic carbon (Mg carbon /Mg MSW)
DOC_F = the fraction of DOC that is dissimilated or degraded
MCF = a methane correction factor to account for any aeration of the waste that would cause aerobic rather than anaerobic decomposition
F = the fraction of generated landfill gas that is methane
16/12 = the ratio of the molecular weights of methane and carbon

To summarize this equation: L_0, the methane generation potential referenced in EPA's 1998 Chapter, correlates to four different variables making up the methane generation potential as referenced in EPA's GHGRP (in GHGRP Subpart HH, relating to MSW landfills). Of these four variables, DOC is the only one for which EPA currently provides a range of values. Table HH-1 allows only one value for the other variables (DOC_F, MCF, and F) but provides that the DOC value can vary according to the composition of the waste stream.[28]

To equate this L_0 when represented as mass to L_0 when represented as a volume, as in the 1998 AP-42, it is necessary to convert mass to volume as in Equation 1 of the Draft Revised Chapter.

For bulk waste – the option in Table HH-1 that assumes uniform waste composition and does not incorporate any distinctions in types of waste accepted at the landfill – the current GHGRP value is 0.20 and revisions to the GHGRP proposed in 2022 decrease the bulk waste DOC to 0.17. The existing DOC, together with the default values for the remaining variables that describe the methane generation potential, results in a methane generation potential equivalent to the 100 m^3 methane/Mg of waste used in the 1998 Chapter.[29] The proposed revision to Table HH-1 would result in a bulk waste L_0 of 86 m^3 methane/Mg of waste, an even lower value.

GHGRP also allows operators to select a Modified Bulk MSW option which groups waste into three categories: bulk MSW, inerts, and construction & demolition (C&D) waste. The

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[26] Intergovernmental Panel on Climate Change, *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* Vol. 5, Ch. 3, at 3.9 (Apr. 2007), *available at* https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf.
[27] EPA, *Technical Support Document for the Landfill Sector: Proposed Rule for Mandatory Reporting of Greenhouse Gases*, at 10 (Feb. 2009), *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2008-0508-0034.
[28] Specifically, Table HH-1 specifies a value of 0.5 for DOC_F, 1 for MCF, and 0.5 for F.
[29] EPA, *Mandatory Greenhouse Gas Reporting Rule: EPA's Response to Public Comments Volume No. 36 Subpart HH—Landfills*, at 57 (Sept. 2009) *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2008-0508-2253.

bulk MSW DOC value using this scheme is higher (0.31), and results in an L_0 value of 158 m^3 methane/Mg waste, although operators using this category will also designate some portion of the waste as inerts and C&D waste, lowering the overall DOC. The proposed revision to Table HH-1 reduces this value to 0.27, resulting in an L_0 of 137 m^3 methane/Mg waste for bulk MSW within the Modified Bulk MSW category. An additional option, waste composition, allows operators to select DOC values from a list of eight waste categories, using DOC values recommended by IPCC.[30]

The most recent assessment of the validity of Equation HH-1 for Bulk MSW relied only on a comparison with methane generation as determined by another method with results that have not been verified by measured emissions. The 2022 proposed revisions to the GHGRP Bulk MSW values for L_0 (and another variable, k) are based on a comparison of methane generation calculated using two methods provided for in Subpart HH: 1) first order decay, as described above, and 2) back-calculation of methane generation using measured quantities of landfill gas collected by the Gas Collection and Control Systems (GCCS) and assumed collection-efficiencies based on cover types across the landfill.[31] Although the back-calculation method incorporates a measured value (collected landfill gas), the estimated collection efficiency, discussed in more detail below, incorporates multiple assumptions and approximations. While the revised DOC value provides more consistency between the two GHGRP reporting methods, they have not been evaluated against measurements of site-wide emissions at landfills.

Overall, EPA's proposed incorporation of Equation HH-1, in lieu of the previous Equation 1, is an improvement. However, EPA should develop a rating for this equation to evaluate its reliability. EPA typically assigns ratings to emission factors to assess whether they are highly representative of emissions, moderately representative of emissions, or minimally representative of emissions.[32] EPA should develop a rating for the methane generation equation to describe how representative it is of actual methane generation at MSW landfills.

In developing this rating, EPA should consider recent comparisons of methane generation and emission estimates using first order decay to other methods. These comparisons include the multivariate analysis conducted in support of the proposed revisions to the GHGRP as well as comparisons of reported emissions to observed emissions from airborne measurements of landfill emissions. Studies that EPA should review are listed below.

- Cusworth et al, *Using remote sensing to detect, validate, and quantify methane emissions from California solid waste operations*, 2020 Environ. Res. Lett. 15 054012. https://doi.org/10.1088/1748-9326/ab7b99

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[30] Intergovernmental Panel on Climate Change, *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* Vol. 5, Ch. 2, at 2.14-2.15 (2006), *available at* https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf.

[31] Memo from Meaghan McGrath, Kate Bronstein, and Jeff Coburn, RTI International, to Rachel Schmeltz, U.S. EPA regarding Multivariate analysis of data reported to the EPA's Greenhouse Gas Reporting Program (GHGRP), Subpart HH (Municipal Solid Waste Landfills) to optimize DOC and k values at 3-4 (Jun. 11, 2009), available at https://www.regulations.gov/document/EPA-HQ-OAR-2019-0424-0081.

[32] EPA, Air Emissions Factors and Quantification, *AP-42: Compilation of Air Emissions Factors, Introduction,* at 10, *available at* https://www.epa.gov/system/files/documents/2024-01/introduction_2024.pdf.

- Duren, R.M., Thorpe, A.K., Foster, K.T. et al. *California's methane super-emitters*. Nature 575, 180–184 (2019). https://doi.org/10.1038/s41586-019-1720-3

- Hanson, J.L., Yesiller, N., Maheim, D.C. *Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills*. Report prepared for The California Air Resources Board and The California Department of Resources Recycling and Recovery (March 25, 2020). https://ww2.arb.ca.gov/sites/default/files/2020-06/CalPoly%20LFG%20Flux%20and%20Collection%20Efficiencies%203-30-2020.pdf

- Ren, X., Salmon, O. E., Hansford, J. R., Ahn, D., Hall, D., Benish, S. E., et al. (2018). *Methane emissions from the Baltimore-Washington area based on airborne observations: Comparison to emissions inventor*ies. Journal of Geophysical Research: Atmospheres, 123, 8869–8882. https://doi.org/10.1029/2018JD028851.

B. EPA Should Incorporate Defaults for use of the "Modified Bulk MSW" and "Waste Composition" Options for DOC and k Values Rather than Only "Bulk Waste."

The updated LandGEM model incorporates the bulk waste option for DOC but does not provide defaults for the modified bulk MSW or waste composition options for characterizing the waste's methane generation potential and decay rate. In practice, alternatives to the bulk waste option are frequently used by facilities when reporting to the GHGRP. Less than half (46%) of the landfills that reported waste placement in 2022 used the bulk waste option to report the composition of waste accepted at the facility.[33] The LandGEM tool should incorporate these additional defaults, rather than requiring operators who wish to provide this more detailed waste characterization to enter user-specified values.

III. EPA Should Revise the Default Collection Efficiency in the Final Revised Chapter to be Consistent with its Approach in the GHGRP Program.

The Draft Revised Chapter does not include proposed revisions that would update the default GCCS collection efficiency. Instead, EPA proposes to maintain a default collection efficiency of 75% for sites that lack a site-specific collection efficiency, citing a typical range of 60-85%, and provides no guidance on how to determine a site-specific value other than through a comprehensive surface sampling program.[34] The default collection efficiency, which assumes a single site-wide value, is based on the professional judgment of landfill operators rather than

[33] EPA, *Envirofacts GHG Query Builder: Subpart HH – Municipal Solid Waste Landfills: Table hh_waste_qty_details,* accessed on February 21, 2024, https://enviro.epa.gov/query-builder/ghg.
[34] Draft Revised Chapter at 2.4-5.

testing.[35] EPA should not retain this approach in the Final Revised Chapter but, instead, should require default collection efficiencies that account for cover type and whether a GCCS is or is not subject to regulations regarding its performance.

A. EPA Should Require Landfill Operators to Use Area-Specific Default Collection Efficiencies Tied to Cover Type as it Does in the GHGRP.

Landfill collection efficiencies can vary greatly. Studies evaluating collection efficiencies have measured efficiencies ranging from 35% to over 90% and found that collection efficiency was correlated with cover type (the lowest collection efficiencies are associated with daily cover and the highest with final cover at closed landfills).[36] This is further corroborated by a recent large-scale study of landfills in California which found that the most significant factor affecting the flux of landfill gases through the landfill surface was cover type, with the lowest fluxes through final covers and higher fluxes through intermediate and daily cover, particularly alternative daily cover.[37]

The GHGRP incorporates variability in collection efficiency within a landfill by associating the areal coverage of the GCCS and each of three general categories of cover type present in the landfill (daily, intermediate, and final) with collection efficiency. Operators determine the site-specific collection efficiency by calculating the weighted average of collection efficiencies across the landfill for each of these four surface types, [38] as described in Table HH-3.[39] The default collection efficiencies are 0% for areas not under the influence of a GCCS, 60% for areas with daily cover, 75% for areas with intermediate cover, and 95% for areas with final cover.

EPA should require operators to use this approach when estimating collection efficiency in the Final Chapter. The GHGRP approach is more specific to actual conditions at a landfill that affect collection efficiency than a sitewide default that does not take cover into account and will, therefore, be more accurate.

If EPA incorporates methodology for determining site-specific collection efficiencies, this should include a review of the comprehensive study of landfill emissions conducted by Dr. James L. Hanson et al in 2020, Estimation and Comparison of Methane, Nitrous Oxide, and

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[35] SCS Engineers for Solid Waste Industry for Climate Solutions (SWICS), *Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills, Ver 2.2*, at 10 (Jan. 2009), *available at* https://www.scsengineers.com/wp-content/uploads/2015/03/Sullivan_SWICS_White_Paper_Version_2.2_Final.pdf [hereinafter "SCS Engineers Report"].

[36] EPA, *Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Municipal Solid Waste Landfills* at Section V.A (June 2011), *available at* https://www.epa.gov/sites/default/files/2015-12/documents/landfills.pdf; SCS Engineers Report at Sections 3.3 and 3.4.

[37] James L. Hanson & Nazli Yesiller, Cal. Polytechnic State Univ., *Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills* at Section 5.3 (2020), *available at* https://ww2.arb.ca.gov/sites/default/files/2020-06/CalPoly%20LFG%20Flux%20and%20Collection%20Efficiencies%203-30-2020.pdf.

[38] Table HH-3 to Subpart HH of Part 98, Title 40.

[39] An option to use a default collection efficiency of 75% for all areas of the landfill covered by the GCCS is also included where cover information is not available. 40 C.F.R. § 98.343I (explanation of CE factor).

Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills.[40]

Default collection efficiencies by cover type should clearly define each category, particularly intermediate cover and alternative covers. Intermediate cover is not clearly defined in Table HH-3, leaving the thickness and composition of covers in this category open to interpretation. With respect to alternative covers, the 2020 study of California landfills showed that alternative covers, particularly alternative daily covers, result in higher flows of gas through the surface. Definitions describing the cover materials and thickness typically associated with each category would support consistent application of emission factors.

B. EPA Should Require Lower Default Collection Efficiency Values for Landfills with Unregulated GCCS as it Has Proposed to Do in the GHGRP.

Additional factors have been shown to influence collection efficiency, including the regulatory status of the landfill. In an analysis of collection efficiencies reported by Maryland landfill operators for the state's 2017 Greenhouse Gas Inventory, EIP found that collection efficiencies were lower for GCCS at unregulated landfills than at regulated landfills: the average of reported collection efficiencies at the four regulated landfills in the state (76%) was much higher than the average of collection efficiencies reported by operators at unregulated landfills (55%).[41] When comparing the collection efficiencies only at open landfills, removing closed landfills from the analysis, the difference is even greater (69% for regulated landfills and 39% for unregulated landfills). A subsequent analysis of collection efficiencies reported for 2020 at both open and closed Maryland landfills found a similar trend, with average reported collection efficiencies of 74% and 54% for regulated and unregulated landfills, respectively.[42]

While the collection efficiencies reported in Maryland's Greenhouse Gas Inventory use a different method for calculating collection efficiency from the GHGRP method described above, this same relationship holds true when comparing collection efficiencies calculated according to the methods described in Table HH-3.[43] EPA conducted a review of collection efficiencies reported to GHGRP by the subset of landfills in Maryland with GCCS that also report to the GHGRP and found the same trend. In reporting year 2017, the regulated landfills had an average reported collection efficiency of 81% compared to 68% for unregulated landfills. EPA attributed

[40] James L. Hanson & Nazli Yesiller, Cal. Polytechnic State Univ., *Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills* (2020), *available at* https://ww2.arb.ca.gov/sites/default/files/2020-06/CalPoly%20LFG%20Flux%20and%20Collection%20Efficiencies%203-30-2020.pdf

[41] Maryland's Greenhouse Gas Inventories are available at https://mde.maryland.gov/programs/air/ClimateChange/Pages/GreenhouseGasInventory.aspx. The 4 Maryland landfills that do have federally regulated collection systems and their reported collection efficiencies in 2017 are: (1) Eastern Landfill in Baltimore County; (2) Millersville Landfill in Anne Arundel County, (3) Brown Station Road Landfill in Prince George's County; and (4) the closed Sandy Hill Landfill in Prince George's County.

[42] *Id*.

[43] For the Maryland Greenhouse Gas inventory, collection efficiency is calculated as the quantity of collected methane, determined by measured flows through the collection system, divided by the quantity of generated methane, as calculated by the LandGEM model.

this difference to periodic surface methane concentration monitoring (and corresponding corrective actions taken when measurements exceed 500 ppm) conducted at regulated landfills.[44]

SCS Engineers, in their evaluation of collection efficiencies, has also acknowledged the important distinction between the collection capabilities of regulated and unregulated GCCS. In an evaluation performed for the Solid Waste Industry for Climate Solution ("SWICS"), SCS has stated:

> [A] site with a collection system that is used solely for energy recovery may not be capable of achieving as high a collection efficiency as compared to one that is compliant with NSPS regulations because it is difficult to maximize gas quality when trying to achieve the highest level of gas collection.[45]

In recognition of the difference between regulated and unregulated system collection efficiencies, EPA has proposed to incorporate revised default collection efficiencies into the GHGRP for unregulated landfills that do not conduct regular surface methane concentration monitoring that is 10% lower for all cover types.[46] EPA should incorporate this same distinction in the default emission factors for collection efficiency in the Final AP-42 Chapter.

IV. Control Devices.

A. Background on Control Devices at MSW Landfills and Characteristics of Landfill Gas.

Once landfill gas has been collected by the GCCS, the gas is routed to a control device for destruction. Flares are a common control device and may be open or enclosed. A 2019 analysis by ERG estimated that 37% of flares at regulated landfills are enclosed.[47] Other methods for controlling emissions of collected landfill gas include landfill gas-to-energy projects such as electricity generation, direct use of the gas as fuel, and upgrading the gas to produce a natural gas equivalent fuel.

Emission factors for the destruction efficiency of flares and engines, including internal combustion engines, gas turbines, and steam turbines, are presented in the Draft Revised Chapter in Table 2.4-3 and secondary compounds (meaning emissions from destruction devices) expected to be emitted as a result of the combustion of landfill gas are presented in Tables 2.4-4 and 2.4-5.

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[44] Memo from Liz Goodiel, U.S. EPA/ORD to Docket ID. No. EPA-HQ-OAR-2019-0424 regarding Technical Support for Supplemental Revisions to Subpart HH: Municipal Solid Waste Landfills at 6 – 8 (Nov. 21, 2022) *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2019-0424-0256.

[45] SCS Engineers Report at 16.

[46] EPA, Revisions and Confidentiality Determinations for Data Elements Under the Greenhouse Gas Reporting Rule, Proposed Supplemental Rule, 88 Fed. Reg. 32852, 32861(May 22, 2023); Memo from Liz Goodiel, U.S. EPA/ORD to Docket ID. No. EPA-HQ-OAR-2019-0424 regarding Technical Support for Supplemental Revisions to Subpart HH: Municipal Solid Waste Landfills at 6 – 8 (Nov. 21, 2022) *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2019-0424-0256.

[47] Memo from Eastern Research Group, Inc. to Allison Costa and Andy Sheppard, EPA, OAQPS regarding Clean Air Act Section 112(d)(6) Technology Review for Municipal Solid Waste Landfills, at 43 (June 25, 2019) *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2002-0047-0082 [hereinafter "ERG NESHAP Memo"]

According to the Landfill Methane Outreach Project (LMOP), there were approximately 550 gas-to-energy projects in operation in the U.S. as of 2021, with about 70% generating electricity, 17% using the landfill gas directly, and 13% treating the gas to create a product comparable to natural gas.[48] Reciprocating internal combustion engines are the most common technology (296) used at the electricity generating projects, followed by combined heat and energy projects (34) and gas turbines (29).[49]

Landfill gas is different from natural gas. The methane content, and resulting heat content, of landfill gas is typically lower than found in natural gas. In the LMOP Project Development Handbook, EPA uses a heating value of 500 Btu/scf for typical landfill gas.[50] In AP-42 Chapter 3, Section 1, EPA provides a heating value of 400 Btu/scf for landfill gas. Both of these values are significantly lower than the natural gas heating value of 1,020 Btu/scf.[51]

In addition, there are contaminants in landfill gas, notably siloxanes and sulfur compounds, that leave deposits in engines and impede the efficiency of combustion.[52] Siloxanes – silicon compounds found in several consumer and industrial products – form silicon dioxide when burned which coats and damages engine parts and reduces combustion efficiency.[53] Siloxanes can also foul catalytic controls, impeding their use as emission controls.[54]

The distinction between natural gas and landfill gas is recognized in AP-42 Chapter 3 Section 1 where turbines are assigned emission factors for NOx and CO (Table 3.1-1), for VOC and other criteria pollutants (Table 3.1-2b), and for additional pollutants (Table 3.1-6) based on fuel type. This includes a specific category for turbines using landfill gas as fuel (SCC 20300801).

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[48] EPA, *LFG Energy Project Development Handbook*, at 1-6 (Jan. 2024) *available at* https://www.epa.gov/system/files/documents/2024-01/pdh_full.pdf [hereinafter "LMOP PDH"].
[49] LMOP PDH at 3-1.
[50] LMOP PDH at 1-2.
[51] EPA, *AP 42, Fifth Edition, Volume I, Chapter 3, Section 3.1: Stationary Gas Turbines* at footnote h to Table 3.1-1, footnote c to Table 3.1-2b and footnote c to Table 3.1-6 (Apr. 2000), *available at* https://www.epa.gov/sites/default/files/2020-10/documents/c03s01.pdf [hereinafter "AP 42 Section 3.1"]
[52] LMOP PDH at 3-2 and 3-3; New Jersey Department of Environmental Protection, *State of the Art (SOTA) Manual for Municipal Solid Waste Landfills* at 3.18-9 – 3.18-10 (May 6, 2023) *available at* https://dep.nj.gov/wp-content/uploads/boss/state-of-the-art/landfills-sota-manual-final_042723.pdf.
[53] LMOP PDH at 3-3; Solid Waste Association of North America, *A Compilation of Landfill Gas Field Practices and Procedures* at II-18 (Aug. 2011), *available at* https://www.regulations.gov/document/EPA-HQ-OAR-2002-0047-0129.
[54] EPA, NESHAP for Reciprocating Internal Combustion Engines, 74 Fed. Reg. 9698, 9706 (Mar. 5, 2009); California Air Resources Board, *Guidance for the Permitting of Electrical Generation Technologies – Appendix B: Supporting Material for BACT Review For Electrical Generation Technologies* at B-29 – B-30 (Nov. 15, 2001) *available at* https://ww2.arb.ca.gov/resources/documents/electrical-generation-technology-guidance); South Coast Air Quality Management District, *Draft Staff Report: Proposed Amended Rule 1110.2 – Emissions from Gaseous- and Liquid-Fueled Engines, Proposed Amended Rule 1100 – Implementation Schedule for NOx Facilities: Appendix D* at D-2 and D-4 (Sept. 2019) *available at* http://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/1110.2/rule-1110-2-draft-staff-report---final.pdf?sfvrsn=6.

B. EPA Must Establish Default Concentrations for VOC Emissions from Control Devices.

In the Draft Revised Chapter, EPA does not propose to address a major deficiency in the 1998 Chapter relating to emissions from stationary combustion sources: the lack of default values for VOC emissions from turbines and internal combustion engines. Emission factors for secondary pollution from these sources [Table 2.4-4 (Metric Units) and 2.4-5 (English Units)] include emission factors for NOx, CO, and particulate matter. However, EPA fails to include emission factors for VOC despite ample evidence that control devices at MSW landfills emit VOC.

In the AP-42 chapter on Stationary Combustion Sources, Chapter 3, EPA acknowledges that VOC are produced as secondary products of combustion by turbines and reciprocating internal combustion engines (RICE).[55] VOC are emitted as a result of inefficient combustion regardless of the fuel burned – when the fuel is not burned or only partially burned during the combustion process – and may be unreacted, trace constituents of the gas or byproducts of the combustion process.[56] This is of particular concern for landfill gas, which is known to contain contaminants that leave deposits on engines, resulting in inefficient combustion, as noted above. To quantify VOC emissions associated with these types of sources, Chapter 3 of the AP-42 compendium incorporates default concentrations for VOC emissions from turbines and reciprocating internal combustion engines in Tables 3.1-2a, 3.2-1, 3.2-2, and 3.2-3 based on evaluations of source test reports.[57]

EPA has also indicated that it reviewed, but did not revise, default concentrations for secondary compounds emitted by RICE by posting online a spreadsheet for this source in the website addressing the Draft Revised Chapter. The spreadsheet indicates that 11 source tests were reviewed for this source type and notes that the default concentrations were not revised because "NOx emissions vary by engine type (which was not noted in the test reports), the sample size is too small for engines, there are variations in landfill waste composition and quantity, and weather characteristics." (This explanation is provided for the decision not to revise emission factors for NMOC and CO as well).[58] The spreadsheet does not provide information on the test reports reviewed. However, in the 2008 update to the NESHAP for RICE (EPA-HQ-OAR-2008-0708), standards for RICE used at landfills were established and test reports from more than 30 sites operating RICE powered by landfill gas are included in the rulemaking docket that could supplement the test reports used in the review.

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[55] AP 42 Section 3.1 at 3.1-2; EPA, *AP 42, Fifth Edition, Volume I, Chapter 3, Section 3.2: Natural Gas-fired Reciprocating Engines* at 3.2-2 (Aug. 2000), *available at* https://www.epa.gov/sites/default/files/2020-10/documents/c03s02.pdf [hereinafter "AP 42 Section 3.2"].
[56] AP 42 Section 3.1 at 3.1-4; AP 42 Section 3.2 at 3.2-3.
[57] References used in development of emission factors are detailed in EPA, *Emission Factor Documentation for AP-42 Section 3.1 Stationary Gas Turbines* at Section 3.2 (Apr. 2000) available at https://www.epa.gov/sites/default/files/2020-10/documents/b03s01.pdf and EPA, *Emission Factor Documentation for AP-42 Section 3.2 Natural Gas-fired Reciprocating Engines* at Section 3.2 (July 2000) available at https://www.epa.gov/sites/default/files/2020-10/documents/b03s02.pdf.
[58] EPA, *Chapter 2, Section 4 Reviewed but Not Revised Emission Factors (xlsx)* (Jan. 12, 2024), available at https://www.epa.gov/air-emissions-factors-and-quantification/draft-emissions-factors-ap-42-chapter-2-section-4, last visited March 11, 2024 (Spreadsheet attached hereto as Attachment C).

i. Formaldehyde should be identified as a distinct VOC of concern.

Formaldehyde is among the VOC emitted as byproducts of combustion and has been documented as a pollutant of particular concern from engines used in landfill gas-to-energy projects. As noted above, contaminants in landfill gas form deposits in the engines, impairing their function, which increases byproducts like formaldehyde.[59]

Multiple states have reviewed data on formaldehyde emissions from engines burning landfill gas as fuel and require operators to account for these emissions. The North Carolina Department of Environmental Protection issued a letter in 2016 requiring that RICE combusting landfill gas include an estimate of formaldehyde emissions in their emission inventories, providing an emission factor of 0.0331 lb/MMBtu (expressed as 1.107 E-03 lb/bhp-hr).[60] The New Jersey Department of Environmental Protection requires engines at landfill gas-to-energy projects to conduct stack tests for formaldehyde emissions. An average of 0.06 lb/MMBtu of formaldehyde was measured over 23 stack tests conducted at engines landfill gas-to-energy projects in New Jersey, as reported in 2018.[61]

A landfill operator proposing a single gas-to-energy project in North Carolina estimated potential formaldehyde emissions from the project at as much 65 tons per year and as much as 2.5 pounds per hour.[62]

Consideration of formaldehyde emissions is also important for determining total VOC emissions. This is especially true in light of the fact that formaldehyde emissions are not accounted for in some other related regulations. VOC testing requirements included in the Standards of Performance for Stationary Spark Ignition Internal Combustion Engines exclude formaldehyde from VOC calculations.[63] VOC emission factors that do not consider data from stack tests specifically measuring formaldehyde and other aldehydes will be incomplete.

Formaldehyde emissions may pose serious health risks and these emissions must be accounted for in the Final Chapter. Formaldehyde is not only a VOC, contributing to the formation of ozone, but it is also a hazardous air pollutant. The Agency for Toxic Substances and Disease Registry (ATSDR) has determined that inhaling formaldehyde concentrations above 0.04

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[59] LMOP PDH at 3-3.

[60] Letter from Sheila Holman, Director North Carolina Department of Environmental Quality, Division of Air Quality regarding Emission Estimate of Formaldehyde from Spark-Ignited Engines Firing Landfill Gas (Aug 19, 2016) [Included as Attachment 3.3 to Black Creek Renewable Energy LLC Gas-to-Energy Facility Air Emission Inventory – Reporting Year 2020 (June 23, 2021), available at https://edocs.deq.nc.gov/AirQuality/DocView.aspx?id=455323&dbid=0&repo=AirQuality]. (Holman letter attached hereto as Attachment D).

[61] Calculated from test data provided in Kenneth Ratzman, *Formaldehyde Emissions from Landfill Gas & Natural Gas Engines, Marama Air Toxics Workshop* at 7, 8 (Aug. 21-23, 2018), *available at* https://s3.amazonaws.com/marama.org/wp-content/uploads/2018/08/26123212/03_Ratzman_NJ_Engine_Testing.pdf. (Attached hereto as Attachment E).

[62] Black Creek Renewable Energy, LLC Application Review – Renewal with Title III Modification, Review No. 10148T02, at 6, 7 (Attached hereto as Attachment F).

[63] 40 C.F.R. § 60.4241(h) ("For purposes of this subpart, when calculating emissions of volatile organic compounds, emissions of formaldehyde should not be included.")

ppm in the short-term (less than 14 days) and 0.008 ppm in the long term (more than 365 days) could lead to adverse health effects. EPA's Integrated Risk Information System (IRIS) assessment has assessed the chemical as a "probable carcinogen," noting increased incidence of nasal cancers in mice and supported by limited studies in humans. Chronic exposure to formaldehyde levels of 0.08 $\mu g/m^3$ has a cancer risk of 1 in a million.[64]

EPA must develop a default concentration for formaldehyde emissions from devices combusting MSW landfill gas in order to properly account for emissions of total VOC.

C. EPA must Account for VOC, NOx, and CO Emissions from Combustion Devices Operating at Low Loads and Low Temperatures.

The proposed revisions to AP-42 Section 2.4 provide single emission factors for NOx, CO, and PM for all operating conditions for internal combustion engines (SCC 50100421), boiler/steam turbines (SCC 50100423), and gas turbines (SCC 50100420) in Tables 2.4-4 and 2.4-5. In the AP-42 chapter on Stationary Combustion Sources, EPA acknowledges that the operating load for turbines and reciprocating internal combustion engines, as well as ambient temperature and humidity, affects the emission rates from the engines.[65] For reciprocating engines, the observed effect of operating load on NOx and CO emissions was sufficient for EPA to incorporate two load-based emission factors for these pollutants in Section 3.2.[66] EPA must provide emission factors to account for variability in emissions based on operating conditions or should specify the operating conditions for which the emission factors apply.

D. EPA Must Account for the Lower Performance of Open Flares.

In the Final Revised Chapter, EPA must revise its emission factor for open flares to recognize lower performance of open flares when compared with enclosed flares.

In the Draft Revised Chapter, EPA proposes to maintain its existing approach of relying on data from enclosed flares to characterize the destruction efficiency of all flares, including open flares.[67] This is inappropriate because the performance of open and enclosed flares is different. A technology review conducted by Eastern Research Group in 2019 in support of updates to the NESHAP for landfills found that there are several factors that can reduce the destruction efficiency of open flares. A 2012 technical report on the design and operation of open flares recommended that controlling operating parameters such as the heating value of the flared

[64] ATSDR, *Toxicological Profile for Formaldehyde* (July 1999) available at https://www.atsdr.cdc.gov/toxprofiles/tp111.pdf; EPA, *Formaldehyde IRIS Summary* (Oct. 1, 1989), *available at* https://iris.epa.gov/static/pdfs/0419_summary.pdf.
[65] AP 42 Section 3.1 at 3.1-2 to 3.1-4; EPA, *Emission Factor Documentation for AP-42 Section 3.1 Stationary Gas Turbines* at 3.6 (Apr. 2000); AP 42 Section 3.2, at 3.2-3 and Tables 3.2-1, 3.2-2, 3.2-3. The discussion addresses the impacts of these conditions on NOx and CO. The same processes that affect CO emissions (inefficient combustion) also affect VOC emissions (see AP 42 Section 3.1 at 3.1-4 and AP 42 Section 3.2 at 3.2-3), and VOC emissions would therefore be impacted by these conditions as well.
[66] AP-42 Section 3.2, August 2000, p 3.2-3 and Tables 3.2-1, 3.2-2, 3.2-3, EPA, *Emission Factor Documentation for AP-42 Section 3.2 Natural Gas-fired Reciprocating Engines* at 3.8 (July 2000).
[67] 1998 Chapter, Table 2.4-3; Draft Revised Chapter, Table 2.4-3.

gas and the exit velocity be controlled to optimize destruction efficiencies.[68] However, the NESHAP technical review noted that this report focused on air-assisted and steam-assisted flares and did not include non-assisted flares which are typically in use at landfills.[69]

A study conducted at University of Alberta, which evaluated non-assisted flares, such as those used at landfills, found that, while the assumed 98% destruction efficiency can be achieved, operating conditions including wind, ambient pressure, and the methane content of the gas impact the destruction efficiency that is achieved in practice.[70] In its supplemental proposed revisions to GHGRP Subpart HH, EPA has acknowledged that flares do not always operate at optimal conditions, such as when temperatures are below design values, and has clarified that these impacts should be accounted for in the estimate of controlled emissions from landfills with GCCS by revising the definition of $f_{Dest,n}$, the fraction of hours during the year that the nth destruction device is operating.[71]

E. EPA Should Account for Periods When Flares Are Not Functioning Properly, as it Does in the GHGRP.

Accounting for periods when flares are non-functioning is also incorporated into variable $f_{Dest,n}$, used in the existing GHGRP emission estimation methods. $f_{Dest,n}$, the fraction of hours during the year that the nth destruction device is operating, is incorporated in Equations HH-6 and HH-8, which estimate controlled emissions.

EPA should consider establishing methods to account for periods during which flares are not operating or are operating poorly, as it does in the GHGRP.

F. EPA Must Clarify the Effect of the Proposed New Enclosed Flare Emission Factor on Existing Emission Factors.

In the Draft Revised Chapter, EPA has proposed to add new emission factors for secondary compounds from enclosed flares (SCC 50300601) but does not explain the effect of this on its existing emission factors for devices that include flares.[72] Instead, the existing emission factors remains designated for both waste gas flares (SCC 50100410) and destruction devices (SCC 50300601). Additionally, footnote c to Table 2.4-4 notes that "where information on equipment was given in the reference, test data were taken from enclosed flares."[73] If the emission factors are, in fact, based on data from another source type (enclosed flares), EPA should assess whether they should be applied to open flares.

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[68] EPA, *Parameters for Properly Designed and Operated Flares: Report for Flare Review Panel (Draft)* (Apr. 2012).
[69] ERG NESHAP Memo at 32.
[70] *Id*; Kostiuk et al, University of Alberta Flare Research Project Final Report, September 2004, pp 236-237
[71] 88 Fed. Reg. 32852, 32878 (May 22, 2023); Memo from Liz Goodiel, U.S. EPA/ORD to Docket ID. No. EPA-HQ-OAR-2019-0424 regarding Technical Support for Supplemental Revisions to Subpart HH: Municipal Solid Waste Landfills at 4 (Nov. 21, 2022*) available at* https://www.regulations.gov/document/EPA-HQ-OAR-2019-0424-0256.
[72] Draft Revised Chapter at 2.4-13 and 2.4-14.
[73] *Id*.

In the Final Revised Chapter, if EPA finalizes the new emission factors for enclosed flares, the Agency should clarify whether the existing emission factors are intended to apply only to open flares. It should also revise the emission factors, as appropriate, to clearly state that they should be used for open flares.

V. Source Classification Codes

A. In the Final Revised Chapter, EPA Should Incorporate by Reference Information for Landfill-associated SCCs that are Provided in Other AP-42 Sections.

The list of SCCs does not include at least one source type associated with landfills and for which EPA has developed an emission factor: 20300801 (Internal Combustion Engines – Electric Generation – Landfill Gas – Turbine).[74] EPA should correct this omission and provide guidance on the distinctions between 20300801 and SCC 50100420 (Waste Disposal; Solid Waste Disposal – Government; Municipal Solid Waste Landfill; Landfill Gas (LFG) Energy Recovery: Turbine) which is included in the Draft Revised Chapter.

B. The Revised Final Chapter Should Explain MSW Landfill-related SCCs and Clarify the Distinction between the Government, Industrial, Commercial, and Institutional categories.

The inclusion of source classification codes (SCCs) in Section 2.4.5 is helpful for mapping the included emission factors to SCCs to be used in emission inventory reporting. However, the list is incomplete and does not clarify whether there is a distinction between government, institutional, industrial, and commercial devices, as indicated in the SCC database but not in the listed emission factors. For example, the SCC database designates four codes for fugitive emissions according to these categories (50100402 [Government], 50600601 [Commercial], 50700601 [Institutional], and 50300603 [Industrial]), [75] but the Draft Revised Chapter includes only two (50100402 and 50300603).[76] Similar examples are:

- There are SCCs for turbines (as well as microturbines) in each of these categories along with a separate SCC for turbines powered by landfill gas but classified at SCC level one as "Internal Combustion Engine" rather than "Waste Disposal." For all of these potential turbine categories, the Draft Revised Chapter lists only one (for the Solid Waste Disposal – Government category).

- The database also includes four SCCs for internal combustion engines and the chapter includes only one (for the Solid Waste Disposal – Government category).

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[74] AP 42 Section 3.1 at 3.1-10 and 3.1-16.
[75] EPA, *Source Classification Codes (SCCs)*, accessed March 12, 2024, *available at* https://sor-scc-api.epa.gov/sccwebservices/sccsearch/; EPA, *Introduction to Source Classification Codes and their Use for EIS Submissions* at 8, *available at* https://sor.epa.gov/sor_internet/registry/scc/SCC-IntroToSCCs_2021.pdf.
[76] Draft Revised Chapter at Section 2.4.5.

It would likely avoid confusion for landfill operators if EPA were to add explanations to the Final Revised Chapter regarding (1) the distinction between the sector categories; and (2) how operators are to use the codes provided in the chapter when reporting to the Emissions Inventory System.

Thank you for considering our comments.

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Index of Attachments

Attachment	Title
A	Memo from Andy Sheppard to Docket ID No. EPA-HQ-OAR-2002-0047 regarding Residual Risk Modeling File Documentation for the Municipal Solid Waste Landfill Source Category at Section 7 (May 20, 2019)
B	Spreadsheet showing Environmental Integrity Project Analysis of VOC and NMOC Default Values Based on Data from Appendix C to memorandum regarding Residual Risk Modeling File Documentation for the Municipal Solid Waste Landfill Source Category (xlsx)
C	EPA, Chapter 2, Section 4 Reviewed but Not Revised Emission Factors (xlsx) (Jan. 12, 2024)
D	Letter from Sheila Holman, Director North Carolina Department of Environmental Quality, Division of Air Quality regarding Emission Estimate of Formaldehyde from Spark-Ignited Engines Firing Landfill Gas (Aug 19, 2016)
E	Kenneth Ratzman, Formaldehyde Emissions from Landfill Gas & Natural Gas Engines, Marama Air Toxics Workshop (Aug. 21-23, 2018)
F	Black Creek Renewable Energy, LLC Application Review – Renewal with Title III Modification, Review No. 10148T02