BEFORE THE ENVIRONMENTAL PROTECTION AGENCY

Petition for Rulemaking to Revise the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills

The Environmental Integrity Project ("EIP"), Harahan/River Ridge Air Quality Group, Californians Against Waste, South Baltimore Community Land Trust, California Communities Against Toxics, Texas Campaign for the Environment, Black Warrior Riverkeeper, Chesapeake Climate Action Network, Idaho Conservation League, Clean Air Task Force, Sierra Club, Environmental Defense Fund, RMI, Industrious Labs, Javian Baker, and Gilda Hagan-Brown (collectively, "Petitioners") respectfully submit this petition for rulemaking to the U.S. Environmental Protection Agency ("EPA" or the "Agency") for revision of the New Source Performance Standards ("NSPS") and Emission Guidelines ("EGs") for municipal solid waste ("MSW") landfills under section 111 of the federal Clean Air Act ("CAA"). Specifically, Petitioners seek revision of Subpart XXX (the NSPS) and Subpart Cf (the EGs) to 40 C.F.R. Part 60. Because EPA emissions standards issued under CAA Section 112, called the National Emissions Standards for Hazardous Air Pollutant ("NESHAP"), cross-reference the NSPS and EGs for MSW landfills, Petitioners also petition EPA for a rulemaking to revise the NESHAP for MSW landfills at 40 C.F.R Part 63, Subpart AAA to the extent necessary to incorporate its revisions to the Section 111 rules.

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I. Introduction.

Municipal solid waste landfills are the third largest source of anthropogenic (human-caused) methane emissions in the United States. Methane is a powerful climate-altering greenhouse gas with about 80 times the global warming potential of carbon dioxide over a 20-year time period. [1] The International Panel on Climate Change ("IPCC") recently warned that, based on existing trends, global warming is expected to reach 1.5° C within the next twenty years, even in the lowest emission scenarios.[2] Rapid and substantial reductions in greenhouse gas emissions are critical to limiting these impacts: limiting global warming to 1.5° C will require immediate action, including a reduction in global methane emissions by 34% from 2019 levels by 2030.[3] The Biden Administration has acknowledged the urgent need to slash methane emissions by, among other things, joining the Global Methane Pledge, by which countries commit to reduce global methane emissions 30% from 2020 levels by 2030.[4]

In 2021, U.S. landfills emitted approximately 3.7 million metric tons of methane according to the U.S. Environmental Protection Agency's ("EPA's" or the "Agency's") most recent Greenhouse Gas Inventory.[5] This is likely undercounted because the data is drawn from the Greenhouse Gas Reporting Program ("GHGRP"),[6] which overestimates the performance of landfill gas capture systems and does not account for large methane plumes shown in aerial surveys.[7] Even as reported, though, EPA's landfill methane has the warming power of about 295 million metric tons of greenhouse gases over a 20-year time horizon.[8]

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[1] Intergovernmental Panel on Climate Change ("IPCC") *Climate Change 2021: The Physical Science Basis* 1017. (2021), https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf .
[2] IPCC, *Climate Change 2023 Summary for Policymakers* 4, 12 (Mar. 2023), https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCCAR6SYRSPM.pdf..
[3] *Id*. at 22.
[4] *Fact Sheet: President Biden Tackles Methane Emissions, Spurs Innovations, and Supports Sustainable Agriculture to Build a Clean Energy Economy and Create Jobs*, The White House (Nov. 2, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/02/fact-sheet-president-biden-tackles-methane-emissions-spurs-innovations-and-supports-sustainable-agriculture-to-build-a-clean-energy-economy-and-create-jobs/#:~:text=President%20Biden%20is%20unveiling%20a,and%20promote%20U.S.%20innovation%20andhttps://www.whitehouse.gov/briefing-room/statements-releases/2021/11/02/fact-sheet-president-biden-tackles-methane-emissions-spurs-innovations-and-supports-sustainable-agriculture-to-build-a-clean-energy-economy-and-create-jobs/#:~:text=President%20Biden%20is%20unveiling%20a,and%20promote%20U.S.%20innovation%20and. [hereinafter "Fact Sheet"].
[5] EPA, *Inventory of Greenhouse Gas Emissions and Sinks: 1990-2021* 7-6 (2023), https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf.
[6] EPA's inventory uses data from GHGRP combined with a "scale-up factor" to account for landfills that do not meet GHGRP's reporting threshold. *Id*.
[7] *See* Revisions and Confidentiality Determinations for Data Elements Under the Greenhouse Gas Reporting Rule, 88 Fed. Reg. 32852, 32860, 32877-9 (proposed May 22, 2023) (to be codified at 40 C.F.R. pt. 98).
[8] Greenhouse gases are calculated using the IPCC's most recent 20-year global warming potential of 79.7. IPCC, *supra* note 1. Carbon dioxide equivalents for methane in this petition are expressed using this global warming potential unless otherwise noted. As explained in more detail below, it is more appropriate for EPA to analyze the impact of methane reductions over a 20-year period than a 100-year period due to the urgency of cutting emissions within this period and for the time period over which costs are assessed.

Despite the significance of these emissions, the nationwide standards for the control of landfill emissions issued by EPA fall short of meeting the required best demonstrated technology for controlling methane from municipal solid waste landfills. During its last review of Clean Air Act standards for landfills, the EPA identified feasible and cost-effective technologies for reducing landfill methane but did not issue standards based on them.[9] In fact, our analysis suggests that two practices that EPA has declined to require - upgrading flare technology and early expansion of landfill gas capture systems – can reduce landfill methane by a combined 466,000 metric tons of methane year[10] or about 37 million metric tons of carbon dioxide equivalents (CO2e) per year. Further, this can be achieved at a cost of only $385-630 per ton of methane reduced or $5-8 per ton of CO2e reduced. [11]

In the absence of EPA leadership, state governments are issuing landfill emission control rules that are stronger than federal requirements. Three states – California, Oregon, and Maryland - have issued landfill methane standards that require more and better pollution control systems and stronger monitoring requirements than EPA's, with Washington expected to finish a rule in early 2024.[12] California, in May 2023, started soliciting stakeholder input on additional improvements to its landfill methane rules.[13] Canada's environmental agency issued a proposed regulatory framework for public comment in April 2023 that contemplates standards stronger than EPA's. [14]

Technology for the measurement of landfill methane has also advanced greatly in recent years, as demonstrated by data collected by Carbon Mapper and others. Indeed, EPA has recognized the importance of these advances in its recent proposed updates to landfill emission reporting requirements for the GHGRP and has likewise proposed to integrate advanced methane monitoring technologies in its recent proposed updates to oil and gas standards under Section 111 of the Clean Air Act. [15] These technological advances present an enormous opportunity for EPA to improve emission reduction strategies at landfills, building from its previous work and practices from other sectors.

In August of 2024, EPA is legally required under the Clean Air Act to reassess whether its standards require the best systems of emission reduction for landfills. However, EPA should not wait until it is compelled to act. The Agency can and should immediately commence a

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[9] Memorandum from E. Rsch. Grp., Inc. on Clean Air Act Section 112 (d)(6) Tech. Rev. for Mun. Solid Waste Landfills to Allison Costa and Andy Sheppard, EPA, Off. of Air Quality Planning & Standards, at 29-30, 31-32, 36-41, 44-45 (June 25, 2019) [hereinafter "2019 Technology Review Memo"] (Attachment A).
[10] See *infra* Table 2 (400,000 metric tons methane reductions per year for expansion after 1 year) and Table 3 (66,000 metric tons methane reductions for flares at 99% destruction efficiency).
[11] See *infra* Tables 2 and 4.
[12] California pioneered this effort, finalizing their rules in 2010, with Oregon following in 2021 and Maryland finalizing their rules in June of 2023. Washington is currently conducting a rulemaking. *See* Section II.B.
[13] *Landfill Methane Regulation Meetings and Workshops*, California Air Resources Board, https://ww2.arb.ca.gov/our-work/programs/landfill-methane-regulation/meetings.
[14] ECCC, *Reducing Canada's Landfill Methane Emissions: Proposed Regulatory Framework*, Government of Canada, https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/reducing-landfill-methane-emissions.html [hereinafter "ECCC Proposed Regulatory Framework"].
[15] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. 74702, 74707 (proposed December 6, 2022) (to be codified at 40 C.F.R. pt. 60).

rulemaking to revise and strengthen its nationwide Clean Air Act standards for landfills. Given the significant climate-warming emissions from this sector, the existence of better control requirements, developments from other jurisdictions, and EPA's clear authority to revise its standards, EPA should commence a rulemaking to revise its regulations as soon as possible. Among other revisions, EPA should:

- Treat methane as the proxy pollutant for landfill gas rather than non-methane organic compounds;
- Adopt lower emission thresholds for the installation of gas collection and control systems, which will require smaller landfills to install and operate systems;
- Require installation and expansion of gas capture systems within one year after waste is placed, rather than the more extended time frames currently allowed;
- Improve design planning procedures for gas collection and control systems and mandate best practices to boost collection system performance;
- Solicit information on the effectiveness of landfill well "autotuning" systems, a relatively recent technological development;
- Require phase-out of unenclosed flares and mandate a minimum 99% methane flare destruction efficiency;
- Improve upon and create new monitoring and testing requirements to gather data more representative of source emissions and system performance;
- Require detection and repair of leaks from equipment components, allowing operators to use a wide selection of EPA-approved advanced methane detection technologies;
- Establish requirements for methane reduction through effective cover practices; and
- Allow the use of organics diversion as an alternative compliance mechanism and prescribe criteria for states to consider and approve requests to use this option.

We appreciate EPA's consideration of these important issues and offer more detail on the importance of and need for updated landfill pollution standards below, along with additional specifics related to these recommendations

II. Factual Background.

A. Emissions from Municipal Solid Waste Landfills.

Municipal solid waste landfills ("MSW landfills" or "landfills") are where most peoples' household garbage ends up. At these landfills, the breakdown of waste, especially organic waste, forms landfill gas, which EPA considers to be comprised of about 50% methane, 50% carbon dioxide and less than 1% non-methane organic compounds by volume.[16] The methane portion of the gas is produced by the decomposition of organic components of municipal solid waste, such as paper, yard trimmings, and food scraps under anaerobic (oxygen-free) conditions.[17] The rate of decay, and rate of methane production, is influenced by multiple factors, including the type of

[16] Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59332, 59336 (Aug. 29, 2016) (codified at 40 C.F.R. pt. 60).
[17] *See* EPA, *Basic Information about Landfill Gas*, EPA (Apr. 21, 2023), https://www.epa.gov/lmop/basic-information-about-landfill-gas#collecting.

waste, moisture content, and conditions at the landfill.[18] As discussed in more detail below, site conditions, especially relating to the type and depth of cover placed on top of waste at a landfill, have significant effects on landfill emissions.

Aerial studies conducted between 2016 and 2021 have revealed a great deal of information about landfill methane emissions. These studies show that landfill methane is emitted in large plumes as well as smaller, more diffuse emissions from throughout the landfill's surface.[19] Additionally, multiple studies utilizing satellite, drone and aerial monitoring have found that MSW landfills are leading "super emitters" of methane.[20]

Figure 1: California Air Resources Board graphic showing that landfill emissions can include large plumes and smaller diffuse emissions spread over the surface of the landfill.[21]

In general, emissions (and often odors) are controlled at landfills by installing a gas collection and control system that sucks gas from the waste mass through a system of pipes and

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[18] *See Landfill Gas Primer-An Overview for Environmental Health Professionals*, Agency for Toxic Substances and Disease Registry Table 2-1, (Nov. 2001), https://www.atsdr.cdc.gov/hac/landfill/html/ch2.html.

[19] *See* Riley M. Duren et al., *California's Methane Super-Emitters*, Nature (Nov. 6, 2019), https://www.nature.com/articles/s41586-019-1720-3 ; *see* Xinrong Ren et al., *Methane Emissions from the Baltimore-Washington Area Based on Airborne Observations: Comparison to Emission Inventories,* AGU:-JGR Atmospheres (Aug. 9, 2018), https://doi.org/10.1029/2018JD028851); *see* Air Quality Technical Advisory Committee, *Methane Overflight Study Overview* 26, (Mar. 9, 2023), https://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Advisory%20Committees/Air%20Quality%20Technical%20Advisory%20Committee/2023/3-9-23/AIRBORNE%20METHANE%20AQTAC%20MEETING%20230309.pdf.

[20] For example, California contracted with NASA's Jet Propulsion Laboratory to locate top methane point sources for single sites in the state from 2016 to 2018. This study found that the largest methane emitters in California are a subset of landfills. *See* Duren et al., *supra* note 19. Similarly, in Winters 2015 and 2016 a mass balance aircraft flight was used to quantify methane emissions from the Baltimore-Washington area. This study found that 25% of the methane emissions were from landfills. "Based on the observations in winter 2015, the observed total CH4 emission from the landfills in Maryland are greater than the U.S. EPA's GHGRP emission rate by a factor of 1.8 and the state of Maryland CH4 inventory by a factor of 2.0." Ren et al, *supra* note 19. Maryland subsequently corrected errors in its inventory.

[21] California Air Resources Board, *Landfill Methane Research Workshop: Methane Remote Sensing for Leak Identification and Mitigation* 8 (Dec. 5, 2022), https://ww2.arb.ca.gov/sites/default/files/2022-12/Methane%20Remote%20Sensing.pdf.

routes it to flares or other devices that combust the gas, converting methane to less-potent carbon dioxide, or "treat" the gas by removing moisture and other elements so that it can be used to generate electricity.[22] Importantly, in addition to addressing emissions, landfills and collection and control systems must be operated properly in order to prevent landfill fires.[23]

B. Recent State Rulemakings to Reduce Landfill Methane.

When EPA last revisited its Clean Air Act ("CAA") section 111 standards for landfills in 2016, only one state in the U.S. – California – had a stronger set of requirements on the books. In the past two and a half years, however, three additional states have issued final or draft landfill methane standards that are substantially more stringent than EPA's. All of these regulations are based in part on California's rules, which were issued in 2010. Oregon finalized a landfill methane rule in October 2021 establishing even more protective requirements than California's and Maryland issued a rule on June 2, 2023 that blends aspects of the Oregon and California rules.[24] In Washington, the state legislature passed a law in early 2022 adopting several aspects of California's landfill methane rules, leaving some details to be finalized in regulations. Washington's Department of Ecology expects to finish its rule in April 2024.[25]

The state regulatory model requires more effective methane emission reductions technologies and practices than EPA's in many ways. These differences are described in more detail in Section V of this petition below. Although Oregon and Washington have not estimated the pollution reductions that will be achieved by their regulations, California and Maryland have. California has stated that 30 additional landfills have installed controls that are required under the state rules but would not be required under the EGs.[26] In 2021, California estimated that its landfill methane rule reduced greenhouse gases by 1.8 million metric tons of CO2e per year.[27] Maryland estimates that its new standards will reduce greenhouse gases from 32 affected

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[22] EPA, *supra* note 17.
[23] Fed. Emergency Mgmt. Agency, *Landfill Fires: Their Magnitude, Characteristics and Mitigation* 2 (2002), https://www.sustainable-design.ie/fire/FEMA-LandfillFires.pdf.
[24] Control of Methane Emissions from Municipal Solid Waste Landfills, COMAR 26.11.42.01 et. seq. (June 2, 2023). Because the Maryland regulations were issued recently, we are attaching the proposed rule, 49:28 Md. R. 1119 et. seq. (Dec. 30, 2022), at Attachment B. The proposed rule was finalized with non-substantive changes, primarily for purposes of clarification and to correct typographic errors, in the June 2, 2023 Maryland Register at https://2019-dsd.maryland.gov/MDRIssues/5011/Assembled.aspx#_Toc136352054.
[25] Washington Department of Ecology, *Chapter 173-408 WAC Landfill Methane Emissions* 35 (May 4, 2023), https://ecology.wa.gov/DOE/files/4f/4fe0bd3b-b571-4805-a1ef-41ea7e0825ce.pdf.
[26] California Air Resources Board, *California State Plan for Municipal Solid Waste Landfills*, app C. at C-1 (May 25, 2017); *see also* 2019 Technology Review Memo, *supra* note 9, at 17.
[27] California Air Resources Board ("CARB"), *2021 Annual Report to the Joint Legislative Budget Committee on Assembly Bill 32*, at 11 (2021). This estimate is based on the installation of gas collection and control systems that would not otherwise have been required, modifications to existing gas collection and control systems to meet the new requirements, and improved efficiency at the remaining gas collection and control systems that already existed when the regulation was adopted. In 2009, CARB estimated that the LMR would reduce emissions by 1.5 million metric tons of CO2E based on newly installed GCCS at 14 landfills and improved efficiency at 92 landfills. CARB, *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills* IV-6 (2009) [hereinafter "CARB Staff Report"]. These numbers were revised in 2013, noting that three landfills had submitted GCCS design plans and four landfills that were thought to be uncontrolled had existing GCCS in place. CARB, *Annual Report 35*, at 17 (2021). California used 100-year global warming potentials in its estimates.

landfills by about 25%-51%.[28] Maryland further estimates that 9 of these landfills will be required to operate gas controls for the first time and 13 more might be required to, depending on the results of on-site sampling.[29]

C. Canada's Recently Proposed Regulatory Framework for Landfill Methane.

Canada's environmental agency, the Environment and Climate Change Canada ("ECCC"), has also recently issued a proposed regulatory framework for addressing landfill methane. Like the U.S.,[30] Canada announced support for the Global Methane Pledge, which is demonstrated, in part, by the Government of Canada's *Faster and Further: Canada's Methane Strategy*, which includes the waste sector.[31] ECCC issues its proposed regulatory framework in April 2023 for public comment.[32] Many of the concepts address in the proposed regulatory framework proposed by ECCC are similar to those in this petition, and ECCC also relied on the California and Oregon state regulations in drafting their proposed regulations.[33] ECCC aims to finalize the regulations in the second half of 2024.[34]

III. Legal Background.

A. Regulatory History of CAA Section 111 Standards for Landfills.

EPA first issued New Source Performance Standards ("NSPS") and Emissions Guidelines ("EGs") for municipal solid waste landfills in 1996.[35] Between 1996 and 2016, no major revisions of the rule were made until 2016 based on a 2014-2015 review of NSPS and EGs for landfills.[36] EPA finalized its most recent revision of the NSPS and EGs for landfills in

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[28] Maryland Department of the Environment, *Technical Support Document for COMAR 26.11.42 – Control of Methane Emissions from Municipal Solid Waste Landfills*, app.A at 5 (2022), https://mde.maryland.gov/programs/regulations/air/Documents/Technical%20Support%20Document%20-%20Control%20of%20Methane%20Emissions%20from%20MSW%20Landfills%20-%20Final%20w%20appendices.pdf. This estimate is based on a global warming potential of 28 for methane.
[29] *Id.* at 2.
[30] *See* Fact Sheet, *supra* note 4.
[31] ECCC Proposed Regulatory Framework, *supra* note 14.
[32] *Share Your Thoughts: Proposed Regulatory Framework for Reducing Canada's Landfill Methane Emissions*, Government of Canada (Apr. 18, 2023), https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/consultations/proposed-regulatory-framework-reducing-landfill-methane-emissions.html. *See also* ECCC Proposed Regulatory Framework, *supra* note 14.
[33] ECCC Proposed Regulatory Framework, *supra* note 14, at nn. 2-3.
[34] *Id*.
[35] EPA, Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills, 61 Fed. Reg. 9905 (Mar. 12, 1996) (codified at 40 C.F.R. pts. 51, 52, and 60); Standards of Performance for Municipal Solid Waste Landfills, 79 Fed. Reg. 41796, 41804 (July 17, 2014) (codified at 40 C.F.R. pt. 60).
[36] Technical corrections and testing amendments were made in 2000. EPA, *Municipal Solid Waste Landfills: New Source Performance Standards (NSPS), Emission Guidelines (EG) and Compliance Times: Rule Summary*, EPA (Mar. 29, 2023), https://www.epa.gov/stationary-sources-air-pollution/municipal-solid-waste-landfills-new-source-performance-standards#rule-history. Revisions were proposed in 2002, 2006, 2014, 2015 and a supplemental proposal published in 2015 before the final rules were published in 2016. *Id*.

2016.[37] Under these rules, any landfill constructed, modified, or reconstructed after July 17, 2014 is a new source subject to the NSPS and landfills that were last constructed, modified, or reconstructed on or before July 17, 2014 are subject to the EGs.[38]

B. Standard for Emission Control: The Best System of Emission Reduction.

Under CAA section 111, once EPA lists a source category, EPA must establish "standards of performance," or NSPS, for emissions of air pollutants from new sources (including modified and reconstructed sources) in the source category.[39] The NSPS are national requirements that apply directly to the sources subject to them. When EPA establishes a standard for emissions of an air pollutant from new sources within a category, it must also, under CAA section 111(d), address emissions of that same pollutant by existing sources—but only if they are not already regulated under the National Ambient Air Quality Standards ("NAAQS") program or the National Emission Standards for Hazardous Air Pollutants ("NESHAP") program.[40] For existing sources, EPA must "prescribe regulations" that require "[e]ach state … to submit to [EPA] a plan … which establishes standards of performance for any existing stationary source for" the air pollutant at issue, and which "provides for the implementation and enforcement of such standards of performance."

Both the NSPS and EGs must "reflect the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated''(the "BSER").[41] When it is not feasible to prescribe or enforce a standard of performance under CAA section 111,[42] EPA may issue "design, equipment, work practice or operational standards," commonly referred to as work practice standards, reflecting the "best technological system of continuous emissions reduction."[43] EPA has previously "applie[d] these concepts [BSER and

[37] Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. 59276, 59279 (Aug. 29, 2016) (codified at 40 C.F.R. pt. 60); Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59332, 59334 (Aug. 29, 2016) (codified at 40 C.F.R. pt. 60).
[38] Rather than update Subpart WWW of 40 C.F.R. §60, EPA chose instead to establish a new subpart for its update to the NSPS, Subpart XXX, to apply to MSW landfills for which construction, reconstruction, or modification commenced after July 17, 2014. The EGs in 40 C.F.R. §60, Subpart Cf, replaced those in Cc, as any source constructed before July 17, 2014 (which includes May 30,1991), are existing. Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59341-59342.
[39] 42 U.S.C. § 7411(b)(1)(b) (1970).
[40] *See id.* § 7411(d)(1)(A)(i)-(ii); *West Virginia v. EPA*, 142 S. Ct. 2587, 2601 (2022).
[41] 42 U.S.C. § 7411(a)(1); *West Virginia v. EPA*, 142 S. Ct. at 2601, 2612.
[42] "[T]he phrase 'not feasible to prescribe or enforce a standard of performance' means any situation in which [EPA] determines that (A) a pollutant or pollutants cannot be emitted through a conveyance designed and constructed to emit or capture such pollutant, or that any requirement for, or use of, such a conveyance would be inconsistent with any Federal, State, or local law, or (B) the application of measurement methodology to a particular class of sources is not practicable due to technological or economic limitations." 42 USC § 7411(h)(2).
[43] *Id*. § 7411(h)(11). In 1977, Congress amended section 111(b) to require new source standards reflecting "the best technological system of continuous emission reduction." Clean Air Act Amendments of 1977, Pub. L. No. 95- 95, § 109(c)(1)(A), 91 Stat. 685, 699-700 (1977). In 1990, Congress restored the original "best system of emission reduction" for this provision. Clean Air Act Amendments of 1989, Pub. L. No. 101-549, § 403(a), 104 Stat. 2399, 2631 (1990). This change had important implications for EPA's authority to include non-technological factors in a BSER determination.

best technological system of continuous emissions reduction] in an essentially comparable manner because the system of emission reduction the EPA [was evaluating were] all technological."[44]

Recognizing the CAA as a technology-forcing statute, the D.C. Circuit has found that EPA may adopt standards that "hold [an] industry to a standard of improved design and operational advances, so long as there is substantial evidence that such improvements are feasible and will produce the improved performance necessary to meet the standard."[45] A technology may be feasible, or "adequately demonstrated," under the NSPS even if EPA lacks emissions data from the use of that technology on the designated facility.[46] While "EPA may not base its determination that a technology is adequately demonstrated . . . on mere speculation or conjecture, . . . EPA may compensate for a shortage of data through the use of other qualitative methods."[47] Importantly, this includes "reasonable extrapolation" based on the performance of the technology in other industries.[48] Thus, EPA may look to innovations in the oil and gas industry when setting standards for landfills as Commenters recommend below.[49] The performance of technology used in other countries may also be considered.[50] EPA may not reject a technology under CAA section 111 solely on the basis that it is governed under another statute.[51]

In most contexts, EPA has broad discretion when determining BSER so long as it does not impose exorbitant environmental or economic costs.[52] EPA considered a cost-effectiveness of up to $1,970 per ton of methane reduction to be reasonable in its recently proposed CAA section 111 rules for the oil and gas industry.[53]

EPA has typically taken the same approach to setting NSPS and EGs for landfills, stating in its first set of landfill rules that "[s]ection 111(d) requires emission guidelines for existing sources to reflect a similar degree of emission reduction [as the standards of performance for

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[44] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74706. Throughout this petition, any reference to the best system of emission reduction or BSER should be understood to encompass the best technological system of continuous emission reduction as well. Likewise, all references to "standards of performance," "standard" or "standards" also encompass design, equipment, work practice, or operational standards.
[45] *Sierra Club v. Costle*, 657 F.2d 298, 402 (D.C. Cir. 1981).
[46] *Lignite Energy Council v. EPA*, 198 F.3d 930, 933-934 (D.C. Cir. 1999) (affirming EPA NOx standard for industrial boilers based on EPA's extrapolation of a control technology's performance on utility boilers.)
[47] *Id.* at 934.
[48] *Id*.
[49] *See id.*
[50] *Id.* at 934 n.3.
[51] *See New York v. Reilly*, 969 F.2d 1147, 1153 (D.C. Cir. 1992) (finding that EPA did not justify its failure to include a lead-acid battery ban in section 111(b) and (d) rules for incinerators by relying on the existence of strict RCRA provisions "against the burning of lead-acid batteries" and plans to address the issue under CERCLA, because "the mere existence of other statutory authority which might undergird EPA's final stance is insufficient to justify the omission of the battery ban.")
[52] *Lignite Energy Council*, 198 F.3d at 933.
[53] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74718.

new MSW landfills].”[54] Thus, EPA may also impose technology-forcing standards under the EGs for landfills so long as the required improvements are feasible[55] and the costs are not exorbitant.[56]

C. EPA Has Authority to Revise the NSPS and EGs Without Delay.

EPA can and should immediately commence a rulemaking to revise and strengthen its CAA section 111 emission standards for landfills. The Agency has inherent authority to begin revising its regulations at any time so long as it follow the proper procedures. In addition, CAA section 111(b) requires EPA to take action on the NSPS by 2024.

EPA, like all agencies, has inherent authority to revise its regulations so long as it follows certain requirements.[57] The revision cannot exceed the statutory delegation of authority to the agency from Congress, must comply with all applicable procedural requirements and must adequately explain the rationale for the change.[58] Therefore, EPA may begin revising its CAA section 111 regulations for landfills immediately and without waiting until it is compelled to do so.

Under section 111(b) of the CAA, EPA must “review and, if appropriate, revise” the NSPS “at least every 8 years.”[59] Once EPA has established NSPS for a particular pollutant for a category of new sources, it must also address the EGs.[60] EPA last revised the EGs and NSPS for landfills on August 29, 2016. Therefore, no later than August 29, 2024, EPA must again “review and, if appropriate, revise” the NSPS and EGs for landfills.

IV. EPA’s Current CAA Section 111 Standards Do Not Represent the Best System of Emission Reduction.

EPA’s requirements for the control of landfill emissions do not meet the standard of control mandated in CAA section 111. The current NSPS and EGs do not reflect the best system of emission reduction (“BSER”). EPA has long identified a “well-designed and well-operated

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[54] Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Waste Landfills, 61 Fed. Reg. at 9913-14. *See West Virginia v. EPA*, 142 S. Ct. at 2601-02 (explaining that EPA sets EGs “by again determining, as when setting the new source rules, ‘the best system of emission reduction . . . that has been adequately demonstrated for [existing covered] facilities.”)

[55] *See Sierra Club v. Costle*, 657 F.2d. at 364.

[56] *See Lignite Energy Council*, 198 F.3d at 933.

[57] *Motor Vehicle Mfrs. Ass’n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 57 (1983) (quoting *Permian Basin Area Rate Cases*, 390 U.S. 747, 784 (1968)).

[58] *Nat’l Cable & Telecomms.Ass’n v. Brand X Internet Servs.*, 545 U.S. 967, 981-82 (2005).

[59] 42 U.S.C. § 7411(b)(1)(B).

[60] *Id*. at § 7411(d); *West Virginia v. EPA*, 142 S. Ct. at 2601-2602; 40 C.F.R § 60.22(a) (requiring EPA to issue a “a draft guideline document “[c]oncurrently upon or after proposal” of NSPS and to finalize the guideline document after public notice and comment, and “upon or after promulgation” of NSPS). Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Section Climate Review, 87 Fed. Reg. at 74708 (“[W]hen the EPA establishes NSPS for a source category, the EPA is required to issue EGs to reduce emissions of certain pollutants from existing sources in that same source category.”)

gas collection and control system" as the BSER for landfills.[61] However, as explained below, EPA has identified technologies and practices during its most recent CAA rulemaking that would optimize the effectiveness of the gas collection and control system ("GCCS"), thereby comprising part of BSER. Yet the Agency's standards are not based on the level of control that could be achieved by those techniques. Further, additional measures for improving the design and operation of the GCCS are required under state regulations, particularly in the State of Oregon[62], making these part of the BSER as well. Lastly, EPA must assess whether its December 2022 proposed rule for the oil and gas sector identifies BSER for the detection and repair of fugitive emissions and large methane plumes at landfills.[63]

A. <u>EPA Has Identified Components of the BSER During its CAA Rulemakings for Landfills But the Current Standards Are Not Based on Those Technologies.</u>

EPA has identified several components of BSER for landfills through its own CAA reviews but did not issue standards based on those technologies. During EPA's two most recent CAA rulemakings for landfills, the Agency identified feasible practices and technologies for reducing landfill methane, some of which are accompanied by data demonstrating their cost-effectiveness. However, EPA's current section 111 emission standards are not based on these control measures. In addition, during EPA's 2014-2016 rulemaking, the Agency dismissed a practice that it acknowledged would reduce methane for a reason that the D.C. Circuit held in 1992 was insufficient to justify a technology's omission. Lastly, more stringent and effective standards for wellhead monitoring were set forth in EPA's 1996 NSPS rule. These standards were weakened without justification over time, and the earlier requirements constitute BSER with respect to wellhead performance.

1. <u>The 2019 Technology Review.</u>

EPA's 2019 technology review process, conducted when the Agency was considering whether to update its landfill emission standards under section 112 of the CAA, identified feasible technologies and practices for reducing landfill methane that should be, but are not, incorporated in the section 111 standards.[64] For two of these, there is data showing these technologies have a cost-effectiveness far below the threshold of $1,970 per ton of methane reductions that EPA found to be reasonable in its recently proposed CAA section 111 rules for the oil and gas industry.[65]

During this review, EPA's consultants found that use of enclosed flares and earlier expansion of existing gas control systems are feasible and can reduce methane and greenhouse

[61] *See, e.g.*, Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 80 Fed. Reg. 52100, 52110, 52113, 52115 (Aug. 27, 2015) (codified at 40 C.F.R. pt 60); Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills, 61 Fed. Reg. at 9914.
[62] *See* Or. Admin. R. 340-239-0110,- 0200, -0500 (2021).
[63] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74708-74711.
[64] *See* National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 84 Fed. Reg. 36670, 36688-99 (July 29, 2019) (codified at 40 C.F.R. pts. 60, and 63).
[65] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74718.

gases on a cost-effective basis. However, the Agency declined to issue standards based on these techniques because it found that they were not cost-effective for reducing HAP. After finding that enclosed flares with a destruction efficiency of 99.5% efficiency could cost up to $417,000 per metric ton of HAP eliminated, EPA decided this was not a cost-effective pollution control method for HAPs.[66] But landfills emit much more methane than HAP and the same technology had a cost-effectiveness of up to $327 per ton of methane,[67] which converts to a maximum of $490 per ton of methane at 99% destruction efficiency.[68] This is far below the $1,970 per ton of methane thresholds that EPA accepted as reasonable for the oil and gas industry. Similarly, EPA's consultants found that requiring earlier expansion of existing gas control systems had a cost-effectiveness of $127.46 to $149.42 per metric ton of methane reduced,[69] but EPA concluded that the practice was not cost-effective for HAP reduction.[70] The NSPS and EGs are not intended for the control of HAP, however, and the docket for the 2019-2020 Section 112 rulemaking demonstrates that enclosed flares operating at a 99% destruction efficiency and early expansion of GCCS is part of BSER for landfills.[71]

The use of horizontal collection systems was also found to be feasible and "well-established,"[72] during the 2019 review with some cost data provided - in cost per foot of system.[73] However, the cost-effectiveness of installing horizontal collectors was not analyzed.

2. EPA's Impermissible 2014 Dismissal of Landfill Cover as BSER.

EPA also baselessly dismissed an effective reduction technology during its 2014-2016 rulemaking to update its CAA section 111 standards. During that process, EPA recognized that biocovers and cover practices can reduce methane emissions from landfills but declined to issue standards based on landfill cover because it is addressed under a different statute (the Resource Conservation and Recovery Act).[74] In a case that is still controlling law, the D.C. Circuit held in 1992 that this is not a legally valid basis for omitting a technology in a CAA section 111 review.[75] As described in more detail in Section VI below, landfill cover practices are also part of BSER.

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[66] National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 84 Fed. Reg. at 36688*; See also* 2019 Technology Review Memo, *supra* note 9, at 46.
[67] At 99% destruction, this would be up to $490 per ton of methane and $19.60 per ton CO2e (25 global warming potential) and $6.10 per ton CO2e (79.7 global warming potential).
[68] See *infra* Table 4.
[69] 2019 Technology Review Memo, *supra* note 9, at 39, 41**.**
[70] National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 84 Fed. Reg. at 36688.
[71] *Id*.; 2019 Technology Review Memo, *supra* note 9, at 31-32, 46-47.
[72] 2019 Technology Review Memo, *supra* note 9, at 23.
[73] *Id*. at 40.
[74] Standards of Performance for Municipal Solid Waste Landfills, 79 Fed. Reg. at 41804.
[75] *See New York v. Reilly*, 969 F.2d at 1153 (D.C. Cir. 1992) (finding that EPA did not justify its failure to include a lead-acid battery ban in section 111(b) and (d) rules for incinerators by relying on the existence of strict RCRA provisions "against the burning of lead-acid batteries" and plans to address the issue under CERCLA, because "the mere existence of other statutory authority which might undergird EPA's final stance is insufficient to justify the omission of the battery ban.")

3. EPA's Weakening of Previous Standards for Wellheads.

Lastly, EPA over time weakened its requirements for corrective action based on wellhead monitoring, which is used to measure the performance of the gas collection system and to prevent fires. Prior versions of the EGs and NSPS required corrective action based on monitored levels of oxygen and nitrogen and a temperature standard of 131º F. Over time, as described in Section V.D.2 below, EPA increased the temperature thresholds and removed the oxygen and nitrogen standards without justification. The older and more protective version of these standards forms part of the BSER for landfills.

B. At Minimum, the BSER Is Reflected by the Most Stringent State Requirements.

The BSER is a technology-forcing standard that must be based on technologies and practices that achieve the greatest possible reduction in emissions so long as the measures are feasible to implement[76] and the costs are not exorbitant.[77] In addition, section 111 requires that EPA shall, when "when revising standards under this section, consider emission limitations and percent reductions achieved in practice."[78]

The existing regulatory requirements of individual states are clearly feasible and "limitations achieved in practice,"[79] especially in the present case where California's rules were issued in 2010 and Oregon's were finalized in October 2021. The ways in which state regulations are stronger, and designed to achieve greater reductions, than EPA's are discussed in more detail in Section V and summarized below.

- Lower thresholds for the installation of GCCS, requiring the operation of controls at more landfills.
- More robust requirements for the design of GCCS and clear requirements that the systems must be operated according to a GCCS design plan.
- Required active gas collection system rather than passive collection system. (California.)
- Required phase-out of flares that are not enclosed and do not achieve a 99% methane destruction efficiency.
- Surface methane monitoring that covers more of a landfill's surface and requires corrective action at a lower threshold averaged across multiple points at the landfill in addition to EPA's higher threshold based on a single measurement.
- Reporting of surface methane concentrations below the threshold for corrective action and more precise requirements for meteorological conditions under which monitoring must occur. (Oregon and Maryland require reporting of values over 100 ppm.)
- More frequent performance testing of the GCCS.
- Requirements to monitor for and repair equipment leaks.

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[76] *See Sierra Club v. Costle*, 657 F.2d. at 364.
[77] *See Lignite Energy Council*, 198 F.3d at 933.
[78] 42 U.S.C § 7411(b)(1)(B).
[79] *See id*.

The most stringent of each of these requirements constitutes the BSER.

C. EPA Must Assess Whether Programs Proposed for the Detection and Repair of Fugitive Emissions and Large Methane Plumes in the Oil and Gas Industry Constitute BSER for Landfills.

EPA may base BSER for landfills on "reasonable extrapolation" of the performance of technology in other industries.[80] This allows EPA to draw from its recent experience assessing technologies for the control of methane emissions from the oil and gas industry. EPA's most recent regulatory action in that process is its December 6, 2022 proposed regulations under CAA section 111 (hereinafter "Proposed Oil and Gas Rule").[81] As described in Section V.C. below, EPA has proposed to require detection and repair of fugitive emissions, established a program for identifying and correcting the largest leaks, and established programs to encourage the development of advanced detection technologies.[82] EPA must assess whether the development of similar programs to detect and control fugitive emissions and large leaks from landfills constitutes BSER for those emissions.

V. EPA Must Revise Its CAA Section 111 Rules To Promulgate Standards Based on a Truly Well-Designed and Well-Operated Gas Collection and Control System.

EPA must revise its CAA regulations as soon as possible to adopt new and stronger standards that constitute BSER for the control of methane emissions from landfills. In its rulemaking, EPA should treat methane, rather than non-methane organic compounds, as the proxy for landfill gas. In addition, EPA has long recognized "a well-designed and well-operated gas collection and control system" as the best system of emission reduction ("BSER") under CAA section 111.[83] There are many ways in which the performance of a GCCS can be optimized at landfills to maximize emission reductions. Petitioners present recommendations below for requiring GCCS at more landfills and mandating system installation and expansion earlier following waste disposal. We also recommend revisions for improving the design and performance of landfill GCCS. Following this, we set forth recommendations for emissions monitoring and testing, outlining needed improvements to EPA's existing requirements as well as new practices that should be adopted. Our final sections address important and proven methane reduction practices that EPA's CAA regulations do not address in any way: landfill cover, landfill cell design, and organics diversion.

A. EPA Should Treat Methane, Instead of Non-Methane Organic Compounds, as the Proxy Pollutant for Landfill Gas.

EPA should use methane as the surrogate for total landfill gas in its CAA section 111 rules for landfills rather than non-methane organic compounds ("NMOC"). Pollution controls for methane emissions also limit NMOC, volatile organic compounds ("VOCs"), and other

[80] *Lignite Energy Council*, 198 F.3d at 934.
[81] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. 74702.
[82] *See id.*
[83] *See, e.g.*, Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 80 Fed. Reg. at 52115; Standards of Performance for Municipal Solid Waste Landfills, 61 Fed. Reg. at 9914.

pollutants. However, methane constitutes a larger portion of landfill gas and is a more appropriate proxy.

EPA first adopted regulations treating NMOC as the surrogate for landfill gas in 1996,[84] and "NMOC was selected as a surrogate for [landfill gas] emissions because NMOC contains the air pollutants that at that time were of most concern due to their adverse effects on public health and welfare."[85] However, EPA, the Biden Administration,[86] and the U.S. Congress have now all identified reducing methane emissions as an important goal. Methane constitutes about 50% of landfill gas[87] and is a powerful greenhouse gas causing the climate to warm. In addition, treating methane as the primary surrogate will reduce complexity and some of the administrative burden on the Agency. EPA's methods for estimating NMOC require that uncontrolled methane must first be calculated before NMOC can be estimated.[88] Setting the threshold for installing controls at a landfill based on methane rather than NMOC will be more simple and involve fewer steps.

As explained in more detail below, multiple states and Canada are also recognizing the importance of slowing global warming by issuing new rules setting emissions standards for landfill methane.

Lastly, the true benefits of many emissions control practices are more obvious when methane is the focus of a cost-efficiency analysis.[89]As an example, in the 2019 Technology Review Memo, EPA's consultants found that reducing the threshold for installing gas controls from 50 Mg/yr NMOC to 34 Mg/yr NMOC had a cost effectiveness of $29,882 per metric ton of NMOC.[90] However, the same change had an estimated cost effectiveness of $189.65 per metric ton of methane and $7.59 per metric ton of CO2e because landfill gas is primarily methane and carbon dioxide.[91] This is an example of how tighter methane driven standards would reduce multiple pollutants and make cost comparisons easier.

B. Requirements for Gas Collection and Control Systems (GCCS).

EPA has long identified a "well-designed and well-operated GCCS" as the BSER for landfills under its CAA section 111 rules.[92] However, GCCS is required at more landfills under some state regulations because those states have lower size and emission rate thresholds requiring installation. In addition, there are practices relating to design and operation of GCCS

[84] Standards of Performance for Municipal Solid Waste Landfills, 61 Fed. Reg. 9905.
[85] *See* Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59281.
[86] *See, e.g.*, White House Office of Domestic Climate Policy, *U.S. Methane Emissions Reduction Policy* 3 (2021), https://www.whitehouse.gov/wp-content/uploads/2021/11/US-Methane-Emissions-Reduction-Action-Plan-1.pdf; 42 U.S.C. § 136 (2022) (methane reduction program of the federal Clean Air Act added in August 2022).
[87] "LFG is typically composed of 50-percent methane, 50-percent CO2, and less than 1-percent NMOC by volume." Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59336.
[88] 40 C.F.R. § 60.764(a)(1)(i)(A), Equation 1; *see also* EPA, *Emission Factor Documentation for AP-42 Section 2.4 Municipal Solid Waste Landfills Revised* (Aug. 1997), https://www.epa.gov/sites/default/files/2020-10/documents/b02s040.pdf.
[89] *See Landfill Gas Primer-An Overview for Environmental Health Professionals*, *supra* note 18.
[90] 2019 Technology Review Memo, *supra* note 9, at 17, 41.
[91] *Id*. (This is based on the global warming potential of 25 used by EPA's consultants.)
[92] *See, e.g.*, Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 80 Fed. Reg. at 52115; Standards of Performance for Municipal Solid Waste Landfills, 61 Fed. Reg. at 9914.

that are in place at many landfills and/or required under state laws but not required by EPA. These superior practices can achieve greater reductions than those on which EPA's current standards are based and constitute BSER.

1. <u>EPA Must Require GCCS at More Landfills by Lowering Size and Emission Rate Thresholds Requiring Installation.</u>

EPA must revise its CAA regulations to require GCCS at smaller landfills. The Agency has previously recognized that emission reductions are achieved by reducing the size and emission rate thresholds that trigger the requirement to install GCCS.[93] Canada and multiple states in the U.S. have issued or are issuing rules that set lower size and emission rate thresholds for installation of GCCS at landfills and Oregon has the lowest of those thresholds.[94] Therefore, EPA must revise its regulations to adopt the control thresholds set forth in Oregon's regulations.

a. *EPA's Current Thresholds.*

EPA's current thresholds triggering the requirement to install GCCS are based primarily on the design capacity and emissions rate of the landfill. Under the CAA section 111 rules, a GCCS is required if an active[95] landfill meets the following criteria: (1) a design capacity greater than or equal to 2.5 million Mg[96] and 2.5 m^3; (2) a NMOC emission rate of 34 Mg/yr or more ;[97] and (3) the operator does not demonstrate that surface methane emissions concentrations are below 500 ppm. [98]

EPA does not have a comprehensive set of data on how many U.S. landfills trigger these control requirements. While the Agency has proposed an important GHGRP update to include this important information, EPA's publicly available databases do not currently distinguish between landfills with mandatory GSSC, which is subject to performance and monitoring requirements, and voluntary GCCS, which is not subject to performance standards and operated primarily to generate revenue. EPA's Landfill Methane Outreach Program estimates that 609 landfills of 1,381 for which data was available (an additional 1,256 landfills did not have sufficient data available) may be subject to federal regulations.[99] However, despite the lack of

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[93] Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59334 (EPA revising the NSPS to lower the emission rate threshold from 50 mg/year to 34 mg/year).

[94] Canada's proposed regulatory framework sets a threshold even lower than Oregon by establishing a threshold of 664 metric tons (which is 602.371 tons), which is less than Oregon. Canada also sets this as the only threshold instead of a range, as Oregon does in its regulations. ECCC Proposed Regulatory Framework, *supra* note 14.

[95] Closed (on or before September 27, 2017) landfills have a threshold of 50 Mg/year and a Tier 4 surface emissions concentration of 500 ppm or greater. 40 C.F.R. § 60.33f(b)(ii) (2020). Landfills that closed after September 27, 2017 must install a GCCS if NMOC is equal or greater than 34 Mg/year but below 50 Mg/year, unless they can demonstrate that surface emissions are less than 500 ppm. 40 CFR § 60.33f(a).

[96] A megagram is one metric ton.

[97] This threshold applies under Subparts XXX and Cf. *See* 40 C.F.R. § 60.33f(a)(3), 60.762(b)(1) (2016). Subpart XXX (NSPS) applies to landfills commencing construction, reconstruction, or modification after July 17, 2014. 40 C.F.R. §60.760(a) (2016). Subpart Cf (EGs) applies to landfills for which construction, reconstruction or modification was commenced before May 30, 1991. 40 C.F.R. §60.32c(a) (1996).

[98] This exemption – based on surface methane measurements – is available only for landfills with a NMOC emissions rate under 50 mg/yr. 40 C.F.R. § 60.35f(a)(6), .764(a)(6) (2016).

[99] *LMOP Landfill and Database*, EPA (last visited Apr. 19, 2023) https://www.epa.gov/lmop/lmop-landfill-and-project-database.

hard data on the number of landfills currently operating GCCS that is subject to enforceable performance requirements, it is clear that state thresholds are lower and, if applied nationwide, would require more landfills to operate GCCS, leading to emission reductions.

b. *Control Thresholds in State Rules.*

The thresholds requiring installation of controls in the States of California, Oregon, Maryland, and Washington[100] are primarily based on the amount of waste in place at a landfill and the amount of heat input or methane generated by a landfill.[101] California's control thresholds of 450,000 ton of waste in place and 3.0 MMBtu/hr heat input were established in 2010 based on the California Air Resources Board's ("CARB's") finding that these amounts correlate with the smallest quantity of landfill gas necessary to operate a flare without supplemental fuel.[102] Like EPA, California allows a landfill operator that meets these thresholds to avoid installing a GCCS if measured methane at the landfill's surface is below a certain level.[103]

Oregon based its control thresholds partly on California's, but Oregon has a lower threshold and a higher threshold. Oregon's lower threshold of 664 metric tons of methane generated per year was calculated based on California's heat input threshold of 3.0 MMBtu/hr.[104] Oregon then converted the value of 664 metric tons of methane to a waste-in-place threshold of 200,000 tons based on the worst-case scenario for precipitation amount (since moisture speeds up decomposition and methane production). [105] Thus, Oregon's lower thresholds are 200,000 ton of waste in place and 664 metric tons of methane generated per year. The operator of a landfill that meets these thresholds may avoid the obligation to install a GCCS based on measured surface methane concentrations. [106]

[100] Although not yet final, the State of Washington established the threshold by statute. *See* Wash. Rev. Code § RCW 70A.540.70(1)(a), (2)(a) (2022).
[101] Cal. Code. Regs. tit.17 C.C.R. §95463 (2010); Or. Admin. R. 340-239-0100 (2021); Control of Methane Emissions from Municipal Solid Waste Landfills, COMAR 26.11.42.04(2).
[102] CARB Staff Report, *supra* note 27, at ES-5, V-1, V-2. https://ww3.arb.ca.gov/regact/2009/landfills09/isor.pdf [hereinafter "CARB ISOR"]. ; Methane generation is calculated using the first order decay model published in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, incorporating a coefficient for methane generation potential specific to California's waste composition and a coefficient for methane generation potential that varies according to the amount of annual rainfall, as outlined in USEPA's Greenhouse Gas Reporting Program (current version – proposed revisions would change this). To convert the methane generation rate to heat input capacity, California assumed that gas collection and control systems have a collection efficiency of 75%. *Id*. at A-29; *CARB's Landfill Gas Tool*, CARB (last updated Sept. 24, 2021), https://ww2.arb.ca.gov/resources/documents/carbs-landfill-gas-tool.
[103] Cal. Code. Regs. tit.17 § 95463(b)(2)(B) (2010).
[104] State of Oregon Dep't of Environmental Quality, *Landfill Gas Emissions Rulemaking 2021 Discussion Questions* 2 (2021), https://www.oregon.gov/deq/Regulations/rulemaking/RuleDocuments/LFG2021ac2DP.pdf. Most conversions discussed in this section assume a GCCS collection efficiency of 75%.
[105] State of Oregon Dep't of Environmental Quality, *Discussion Responses Landfill Gas Emissions 2021 Rulemaking Advisory Committee Meeting* #3, at 2 (2021), https://www.oregon.gov/deq/Regulations/rulemaking/RuleDocuments/lfg2021ac3DR.pdf [hereinafter "OR Discussion Responses"].
[106] Or. Admin. R. 340-239-0100(6)(b).

Oregon's rules also include a higher threshold at which a landfill may not avoid the obligation to install a GCCS based on sampled surface methane levels. This higher level is 7,755 metric tons of methane per year.[107] When a landfill generates this much methane (and has over 200,000 tons of waste in place), GCCS must be installed regardless of surface methane levels.[108] Oregon calculated the 7,755-ton threshold to correspond with the NESHAP threshold of 50 mg/yr NMOC.[109] The state of Washington established thresholds similar to California's by statute in 2022.[110] Maryland's rules set control thresholds of 450,000 tons of waste in place and 664 metric tons of methane generation per year.[111]

Table 1: Comparison of Size and Emission Thresholds Requiring Installation of GCCS				
EPA	California	Oregon	Washington	Maryland
Design capacity ≥2.5 million metric tons[112] and 2.5 m^3; NMOC emission rate ≥34 Mg/yr; Surface methane≥500 ppm	Waste in place ≥ 450,000 tons Heat input ≥ 3.0 MMBtu/hr – Surface methane≥200 ppm	Waste in place ≥200,000 tons CH4 generation≥ 664 metric tons; Surface methane≥ 200 ppm --------OR--------- Waste in place ≥200,000 tons CH4 generation ≥ 7,755 metric tons (no surface methane component)	Waste in place ≥450,000 (active sites or ≥750,000 tons (closed sites) Heat input ≥ 3.0 Surface methane≥200 ppm	Waste in place ≥ 450,000 tons CH4 generation≥ 664 metric tons Surface methane≥200 ppm

While the thresholds are all expressed using different units and conversion between units requires assumptions about gas properties, it is clear that the state thresholds are lower than EPA's. California, Oregon, and Maryland have all estimated that their rules require GCCS at more landfills than federal rules. California identified 30 additional landfills required to operate GCCS[113] and Oregon identified 8.[114] Maryland estimates that its rule will require controls at least 9 additional landfills and may also require controls at an additional 13, depending on the results of on-site measurements.[115] Oregon's waste-in-place threshold is the lowest, requiring GCCS at more landfills. Thus, Oregon's thresholds constitute the BSER for installation of GCCS.

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[107] Or. Admin. R. 340-239-0100(7).
[108] *Id.*
[109] E-mail from Heather Kuoppamaki, Senior Air Quality Engineer, Oregon Dep't of Env't Quality, to Sara Brodzinsky, Staff Engineer, Env't Integrity Project (Apr. 10, 2023) (on file with Author).
[110] State of Wash. Leg., H. B. Rep., H.1663 (2023). Washington requires GCCS at landfills that (1) meet or exceed 450,000 tons of waste for active landfills and 750,000 tons of waste in place for closed landfills (2) meet or exceed a heat input of 3.00 MMBTU/hr; and (3) do not demonstrate surface methane levels below 200 ppm. Wash. Rev. Code §§ 70A.540.70(1)(a)(2), (2)(a).
[111] COMAR 26.11.42.01.
[112] A megagram is one metric ton.
[113] CARB, *California State Plan for Municipal Solid Waste Landfills*, *supra* note 26; *see also* 2019 Technology Review Memo, *supra* note 9, at 17.
[114] Oregon Department of Environmental Quality, Rulemaking, Action Item I: Landfill Methane Rules 10 (2021), https://www.oregon.gov/deq/EQCdocs/100121_I_LandfillMethane.pdf.
[115] Maryland Dep't of the Environment, *supra* note 28. This estimate is based on a global warming potential of 28 for methane.

As shown in Table 1 above, EPA and the states all allow landfill operators that meet or exceed the control thresholds to avoid installing GCCS based on surface methane concentrations measured at individual locations on the landfill's surface However, the states require these levels to be below 200 ppm in order to avoid GCCS installation while EPA allows it at levels below 500 ppm.[116]Oregon's thresholds, which constitute BSER, include this 200 ppm for its lower set of size and emission rate thresholds.

In addition to the critical function of controlling landfill methane, an effective GCCS can also reduce odors from a landfill, potentially addressing quality of life for landfill-adjacent communities. Multiple states require GCCS installation to minimize offsite odors. According to ERG, the Minnesota Pollution Control Agency has indicated that it is common in Minnesota for active landfills below the 2.5 million Mg size threshold to install GCCS to address nuisance conditions."[117]

c. *Canada's Proposed Regulatory Framework Thresholds.*

Canada's proposed regulatory framework contemplates a control threshold for active landfills with more than 100,000 metric tons of waste in place or that accepted more than 10,000 metric tons of municipal solid waste per year once regulations go into effect and, for closed landfills, 450,000 metric tons of waste in place.[118] This would be coupled with a methane generation threshold of 664 metric tons, based on "the most stringent North American threshold."[119] Canada is also considering an exemption from implementing methane controls based on surface methane measurements and these thresholds would vary based on certain factors, including whether a landfill is active or closed.[120]

d. *Recommended Control Thresholds.*

EPA must revise its CAA section 111 regulations for based its standards on Oregon's control thresholds, which requires that a GCCS must be installed if a landfill falls into one of the following categories :

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[116] 40 C.F.R. § 60.35f(a)(6), .764(a)(6); Cal. Code. Regs. tit.17 § 95463(b)(2)(B). Oregon makes the option unavailable landfills generating over to "bioreactor" landfills, where moisture is intentionally introduced to speed decomposition and methane production. *Compare* Or. Admin. R. 340-239-0100(6)(a)-(b) (landfills emitting 664-7,755 tons**)** *with* Or. Admin. R. 340-239-0100(7) (landfills emitting over 7,755 metric tons of methane) and Or. Admin. R. 340-239-0100(8) (bioreactor landfills).
[117] 2019 Technology Review Memo, *supra* note 9, at 16.
[118] ECCC Proposed Regulatory Framework, *supra* note 14.
[119] *Id*; Or. Admin. R. 340-239-0100(6).
[120] Landfills without a GCCS where path-integrated methane concentrations at the surface are below 200 ppm·m (or below 200 ppmv surface methane concentrations when using ground-based monitoring to verify drone-based results) would be required instead to continue monitoring once per year until the landfill closes or the control threshold is exceeded. *Id.* Closed landfills where path-integrated methane concentrations at the surface are below 200 ppm·m (or below 200 ppmv surface methane concentrations when using ground-based monitoring to verify drone-based results would have no further obligations or monitoring requirements under the proposed regulatory framework. *Id.* Closed landfills with a GCCS may also be exempt from operating their GCCS if they can demonstrate that the landfill no longer generates a sufficient amount of methane to recover and destroy or utilize in a cost-effective manner. *Id*.

(1) Has 200,000 tons or more of waste in place, generates less than 664 metric tons of methane per year, and does not demonstrate surface concentration of methane of 200 ppm or lower; or
(2) Has 200,000 tons or more of waste in place and generates greater than 7,755 metric tons of methane per year.

Methane generation expressed in tons per year must be calculated based on prescribed methods because continuous monitoring technology is not widely available for landfill methane emissions. Oregon's rules incorporate by reference methods from EPA's GHGRP program for calculating methane generation. When revising its section 111 rules for landfills, EPA would have to decide whether to also incorporate the GHGRP methods by reference or whether to issue a separate set of methods for estimating methane generation. Petitioners plan to submit detailed recommendations on this in the future.

With respect to the surface methane monitoring part of the threshold, EPA should strive to develop a continuous monitoring method that can be used in place of the current approach, which provides only snapshots of methane levels for brief moments on the landfill's surface. Petitioners' recommendations relating to continuous monitoring are discussed in more detail in Section V.C.4 below. EPA should also consider developing an integrated surface monitoring threshold, which would be averaged across multiple locations on the landfill and align with California's integrated surface emissions monitoring standard, discussed below. Lastly, operators should also have to comply with requirements relating to barometric pressure when sampling, as described in more detail in Section V.C.1.d below.

2. EPA Must Require Early Installation and Expansion of GCCS.

In addition to requiring GCCS at smaller landfills, EPA must also revise its CAA regulations to require early and effective installation. As explained below, recent information indicates that methane is being released at landfills earlier than previously thought, necessitating action to collect landfill gas earlier. In addition, it is feasible to install and expand GCCS earlier than required under EPA's current regulations and EPA's consultants have previously found early expansion of GCCS to be cost-effective in a range far below the threshold that EPA proposed to find reasonable in its recent draft rule for the oil and gas industry. Therefore, EPA must require earlier installation and expansion of GCCS.

a. *New Information Indicates That Methane Is Being Released Earlier After Waste Disposal Than Previously Thought.*

Recent information suggests that landfill methane is generated sooner after waste disposal than previously thought. On June 21, 2022**,** EPA proposed to revise the decay rate constant used in its first-order decay method for estimating landfill methane under its Greenhouse Gas Reporting Program rules in ways that will estimate higher emissions earlier in a landfill's life.[121] In doing so, EPA explained:

[121] *See* Revisions and Confidentiality Determinations for Data Elements Under the Greenhouse Gas Reporting Rule, 87 Fed. Reg. 36920 (June 21, 2022) (to be codified at 40 C.F.R. pts. 9 and 98).

> [The proposed change] tends to lead to greater calculated emissions from active landfills. . . and to predict that less degradable waste will be in the landfill once the landfill closes (*i.e.*, no longer receives wastes) and the degradable waste that is present in the closed landfill will decompose more quickly. . . . Thus, the proposed [changes] are expected to increase the calculated emissions from active landfills [and] reduce calculated emissions from closed landfills.[122]

This is related to the fact that food waste, which decays more rapidly than other kinds of waste,[123] has become a greater portion of the waste stream over the last decade. EPA estimates that the amount of food waste generated per year increased by 70% between 1990 and 2017.[124] In fact, the Agency recently stated: "food waste decays very quickly in landfills, often before a gas collection [system] is installed." [125]

b. *It Is Feasible and Cost Effective to Install and Expand GCCS Earlier Than Currently Required.*

Presently, EPA's regulations require that a landfill meeting EPA's design capacity threshold must install a GCCS within 30 months (2.5 years) after submitting the first annual report showing that it meets the NMOC rate threshold for control.[126] Once installed, the expansion of a GCCS is governed by operational requirements. The system must be operated to collect gas "from each area, cell, or group of cells in the MSW landfill in which solid waste has been in place for" 5 years if active or 2 years if closed or at final grade.[127]

However, these time frames can be shortened, particularly if a landfill operator is required to design the landfill with gas control in mind from the beginning design stages. EPA states, in its 2021 Landfill Gas Energy Project Development Handbook developed by the Agency's Landfill Methane Outreach Program, that "'early' LFG collection can be implemented within a few months of waste placement."[128]

In addition, EPA's consultant, ERG, concluded in its 2019 Technology Review Memo that it was technologically feasible to reduce these lag times, though certain technology, such as horizontal collectors or passive flares, may be needed for earlier installation.[129] ERG identified two state permits requiring shorter "lag times" (the time between system installation/expansion and the event triggering the duty to do so). For the Central Landfill in Rhode Island (Permit and Gas Management Plan), the GCCS is to be installed within 4 to 12 months after "filling of the

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[122] *Id*. at 37010.
[123] 2019 Technology Review Memo, *supra* note 9, at 9.
[124] EPA, *Downstream Management of Organic Waste in the United States: Strategies for Methane Mitigation* 9 (2022), https://www.epa.gov/system/files/documents/2022-01/organic_waste_management_january2022.pdf [hereinafter "EPA Downstream Management of Organic Waste"].
[125] *Id*.
[126] 40 C.F.R. § 60.33(f)(b)(1), .762(b)(2)(ii).
[127] 40 C.F.R. § 60.34f(a), 60.763(a) (2016).
[128] EPA, *Landfill Gas Energy Project Development Handbook: Best Practices for Landfill Gas Collection System Design and Installation* 4 (revised July 2021), https://www.epa.gov/sites/default/files/2020-03/documents/pdh_chapter7.pdf.
[129] 2019 Technology Review Memo, *supra* note 9, at 29.

new phase" of a landfill because that is when measurable quantifies of gas are expected.[130] ERG also noted the permit for the Cowlitz County landfill in Washington, "bottom-liner horizontal collectors and horizontal interim collectors" are to be installed "initially when possible."[131]

Gas collection infrastructure must be installed within 6 months of "initial waste placement" in future landfill cells under a 2022 Consent Decree reached between the Michigan Department of the Environment, Great Lakes, and Energy and Arbor Hills Landfill, Inc.[132]

ERG also demonstrated that it is economical to expand GCCS earlier than required under EPA's current rules and that system expansion is actually more cost-effective after 2 years than 3. ERG analyzed the cost-effectiveness of reducing expansion lag times from 5 years to 2 or 3 years, finding a cost-effectiveness of $127.46/metric ton of methane for 2 years and $149.42/metric ton of methane for 3 years.[133] Petitioners analyzed the cost-effectiveness of expansion after 1 year, estimating that it is also cost-effective at $140/metric ton of methane. These results are presented in Table 2 below. Petitioners present greenhouse gas reductions using a 20-year global warming potential of 79.7 in addition to the 100-year global warming potential of 25 that ERG used in its analysis. The 20-year global warming potential is most appropriate for analyzing the impact of methane rules because of the urgent need to slash methane emissions in the near term and because it is more consistent with the time period over which costs are assessed. [134]

Table 2: Reduction and Cost-Effectiveness Summary of Earlier GCCS Expansion*

Scenario	**Reduction in tons methane**	**$/metric ton Methane**	**$/metric ton CO2e GWP: 25**	**$/metric ton CO2e GWP: 79.7**
Expansion After 1 Year (Recommended)*	400,000	$140	$5.6	$1.8
Expansion After 2 Years*	300,000	$130	$5.2	$1.6
Expansion After 3 Years	120,000	$150	$5.9	$1.9

*Estimates for 1 year time frame calculated by Environmental Integrity Project (EIP).[135] Estimates for 2 and 3 year time frames from 2019 ERG Technology Review.[136]

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[130] *Id*. at 22.
[131] *Id*. The Cowlitz County landfill also installed an enclosed flare in April of 2015, and "[l]andfill gas collected from vertical and subsurface horizontal collection piping is directed" to the enclosed flare. Southwest Clean Air Agency, Air Discharge Permit No. 15-3157 (Dec. 8, 2015).
[132] Consent Judgment at 27, *Mich. Dep't. of Env't. Great Lakes & Energy v. Arbor Hills Landfill, Inc.*, No. 2020-0593 CE, https://www michigan.gov/egle/-/media/Project/Websites/egle/Documents/Multi-Division/Arbor-Hills/2022-03-07-arbor-hills-consent-judgment.pdf (Attachment C).
[133] 2019 Technology Review Memo, *supra* note 9, at 41.
[134] For example, one-time capital costs for landfills (e.g. purchase of a flare) were annualized over 15 years. Memorandum from Eastern Rsch. Grp, Inc. to Hilary Ward on Updated Methodology for Estimating Cost and Emission Impacts of MSW Landfill Regulations 6 (June 2015), https://www regulations.gov/document/EPA-HQ-OAR-2014-0451-0077.
[135] The reductions for the 1-year time frame were calculated based on a linear extrapolation of ERG's estimated difference between the 2 and 3-year time frames. Cost-effectiveness values were calculated based on a linear extrapolation of ERG's estimated costs associated with the 2 and 3 year lag times.
[136] 2019 Technology Review, *supra* note 9, at 39, 41.

All of the cost-efficiencies shown are far below the cost-effectiveness threshold of $1,970/ton of methane that EPA proposed to find reasonable for purposes of the BSER determination in its December 2022 proposed rule for the oil and gas industry. [137]

c. *Recommendations.*

EPA should improve its rules in two ways. First, EPA must allow no more than 12 months between the installation or expansion of the GCCS and the event triggering the corresponding duty. Second, EPA should require that new landfills and, where feasible, landfill expansions are designed with GCCS in mind from the initial design phase. Requiring landfill operators to plan for GCCS installation before construction of the landfill begins, rather than when a landfill is approaching the control thresholds, allows the operator to design for gas control from the initial design phase.

For new landfills and expansions where feasible, EPA should require that gas control must be part of the criteria considered in the initial stages of designing a landfill. A landfill operator, or its consulting engineers, can anticipate the year in which a landfill will reach the threshold for installing GCCS from the initial landfill design stage.[138] Planning for gas control during the initial design phase also encourages use of techniques that can optimize gas control - such as electric systems that will eventually connect to control device(s) – and should or must be installed before the full GCCS. Petitioners understand that initial design planning will not be undertaken for all landfill expansions but, for new cells or discrete areas of the landfill where initial design planning is undertaken, early planning for gas control should be required. For "new [landfill] units and lateral expansions," which must be constructed "in accordance with a design approved" by state regulators[139] under Subtitle D rules of the Resource Conservation and Recovery Act ("RCRA"), landfill operators can streamline the design process by considering GCCS design at the same time that it meets the Subtitle D design requirements.

During this early design planning for gas control, landfill operators should be required to estimate when the landfill will reach the thresholds requiring installation of GCCS and be prepared to install a GCCS within 12 months after that date. Operators should also be required to consider whether other measures to control gas – such as such as horizontal collectors, connections to the leachate control system, and electric systems that will eventually connect to

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[137] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74718**.**

[138] While this notion logically amounts to good engineering practices, in its Regional Solid Waste Master Plan, the City of Sioux Falls focused on landfill design and operational issues, including assessments of when certain landfills would be required to install a GCCS. For example, the Master Plan states that "[a]lthough the July 2003 testing indicates that collection and control of landfill gas [at the Sioux Falls Regional Sanitary Landfill] is not currently required under the NSPS, calculations indicate that the threshold for this may be reached in 2004." City of Sioux Falls, *Regional Solid Waste Master Plan* ES 4 (2003), https://www.siouxfalls.org/public-works/landfill/waste-masterplan. While the previous conclusion was predicted from the Tier 2 sampling performed (*Id*. at 61), the Report goes on to make recommendations to improve operations for that specific landfill. The Report then goes on to present its landfill development and long term management plan, which addresses "the present day through 20 years of development, at 5-year time intervals." *Id*. at 68. In that section, they plan that "[a] Landfill Gas Management System will be constructed in year 2013 within portions of Cells 1, 2, 3 and 4." *Id*. at 71.

[139] 40 C.F.R. § 258.40(a) (1991).

control device(s), the vacuum system, and other GCCS elements - can be installed before the full GCCS is required.

3. Improving Collection System Design and Operation.

The GCCS is comprised of a collection system, primarily wells and piping that collect and convey landfill gas, and a control system, which either destroys (e.g. flares) or processes for further use as part of an energy recovery system.[140] The recommendations in this section focus on design and operational improvements that primarily impact the collection portion of the GCCS.

EPA and the states require that landfill operators develop and obtain approval of a design plan for the GCCS prior to installing it. The Agency's rules relating to the GCCS design plan should be improved in several ways, primarily by requiring planning earlier in the landfill's life and compelling landfill operators to submit a more robust set of information in its design plan. EPA should also mandate the use of more effective collection systems, as explained in more detail below, and should solicit comment, in the preamble to its proposed landfill regulations, on the cost and effectiveness of remote wellhead sensing and automated wellhead control valve "tuning" or adjustment.

These are improvements that are demonstrably feasible – because they are included in state rules and/or are in use at existing landfills – and will reduce emissions. Therefore, they constitute BSER for the design and operation of a GCCS.[141]

a. *EPA Must Require the Development and Implementation of More Robust and Comprehensive GCCS Design Plans.*

All landfill emission rules discussed in this petition – EPA's[142] and the states'[143] – currently require landfill operators to develop a GCCS design plan after reaching the control thresholds (rather than early in the landfill's life) and to submit the plan for approval by regulators. This planning is important because the operator must account for site-specific differences, such as climate and precipitation, that will affect the optimal design of the GCCS.[144] As indicated above, EPA should revise its regulations to require an Initial Design Plan, which would be submitted earlier than currently required for a GCCS design plan, for new landfills and, where feasible, landfill expansions. EPA must also require landfill operators to submit a more robust set of information in its plan. Lastly, EPA must expressly require implementation of and compliance with GCCS design plans.

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[140] *See* EPA, *supra* note 128, at 1-3.
[141] *See* Standards of Performance for Municipal Solid Waste Landfills, 79 Fed. Reg. at 41802 (EPA acknowledging in its 2014 proposed NSPS that "the combination of design and operational criteria" in its regulations is necessary to "ensure that the collection system efficiently collects landfill gas and that a [GCCS] meeting these criteria . . . represent[s] BSER for MSW landfills.)
[142] *See, e.g.*, 40 C.F.R. § 60.762(b)(2)(i).
[143] Or. Admin. R. 340-239-0110(1); Cal. Code Regs. tit. 17§ 95464(a) (2010).
[144] *See* EPA, *supra* note 128, at 2.

i. Where Feasible, EPA Should Require an Initial GCCS Design Plan to Ensure Early Planning for Gas Collection and Control.

As described in Section V.B.2 above (early installation of GCCS), for new landfills and expansions where initial design is occurring, EPA should require an Initial GCCS Design Plan, to be prepared before site construction begins. The plan should consider the expected life of the landfill and waste filling practices, and the expected timeframe at which a GCCS will be required. The plan should identify opportunities for early installation of GCCS components such as horizontal collectors, connections to the leachate control system, and electric systems that will eventually connect to control device(s), the vacuum system, and other GCCS elements.

ii. EPA Must Establish More Robust Requirements for the GCCS Design Plan.

A GCCS design plan is already mandated under EPA and state regulations but operators are not required to submit it until after the control thresholds are met. [145] EPA must revise its requirements for this GCCS design plan to require that it include a more complete set of information, as Oregon's landfill methane rule does. For landfill operators that have already submitted an Initial GCCS design plan, those operators should amend or supplement that plan with the additional required information at the time that the landfill meets the control thresholds.

Oregon's rules require that a GCCS design plan address a much more robust set of information than EPA's, including cover properties, gas system management, leachate and condensate management, fill settlement, and "the density of wells, horizontal collectors, surface collectors, or other gas extraction devices" necessary to meet collection requirements.[146]

In addition to incorporating Oregon's requirements for GCCS design plans, EPA should ensure that the design plan includes the following additional assessments and management practices that will ensure the ongoing effectiveness of the GCCS:

1. Evaluation of site-specific considerations that will influence the design considerations:
    a. Local climate conditions, including temperature and precipitation[147]
    b. Landfill geometry[148]
    c. Forecast and plan for waste types accepted at the site, including special wastes, liquids, and construction and demolition debris[149]
    d. Annual waste characterization reports[150]

[145] 40 C.F.R. § 60.767(c) (2016); Or. Admin.R. 340-239-0110(1)(a).
[146] Or. Admin. R. 340-239-0110.
[147] *See* EPA, *supra* note 128, at 2.
[148] *Id*. at 2, 17.
[149] *See id*. at 2 (explaining that types of waste and moisture content affect generation of LFG and potential damage to collectors due to waste mass settling).
[150] EPA, *How to Design and Conduct a Successful Waste Characterization Audit* 6 (Oct. 20, 2011), https://archive.epa.gov/region9/tribal/web/pdf/conducting-waste-characterization2011.pdf (explaining that waste characterization studies are a "foundation for developing Integrated Solid Waste Management Plan or Pollution Prevention Plan").

e. Waste compaction rates[151]

2. Construction phasing and adaptation to site conditions
   a. Survey and assessment of existing GCCS components[152]
   b. Constructability review and construction sequencing that will minimize potential damage to exiting and newly constructed components[153]
   c. Adaptation to expanded site contours, such as raising vertical wellheads as waste height increases in a cell[154]

iii. EPA Must Clearly Require Implementation of the GCCS Design Plan.

EPA must also revise its rules to clearly require implementation of the GCCS design plan. Oregon's rules require the landfill operator to "operate, maintain and expand the gas collection system in accordance with the procedures and schedules in the approved Design Plan."[155] EPA should include the same requirement in its regulations.

b. *EPA Must Require Active Gas Collection Systems.*

Currently, there are two types of gas collection systems that can be installed at an MSW landfill: active and passive.

> Passive systems rely on the natural pressure gradient between the waste mass and the atmosphere to move gas to collection systems. Most passive systems intercept [landfill gas] migration and the collected gas is vented to the atmosphere. Active systems use mechanical blowers or compressors to create a vacuum that optimizes [landfill gas] collection.[156]

EPA's CAA regulations allow for the use of an active collection system or a passive system.[157]A passive system is permitted only if liners that meet design requirements established under RCRA are installed "on the bottom and all sides in all areas in which gas is to be collected.[158]

In 2010, when drafting its landfill methane regulations, CARB found that passive

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[151] *See* Ebun Ayandele et al., *Key Strategies for Mitigating Methane Emissions from Municipal Solid Waste Landfills* 46 (2022), https://rmi.org/insight/mitigating-methane-emissions-from-municipal-solid-waste/ [hereinafter "RMI MSW Report"] (explaining how waste compaction affects generation of LFG).
[152] *See* EPA, *supra* note 128, at 2, 14.
[153] *Id*. at 14
[154] *See id.* at 10.
[155] Or. Admin. R. 340-239-0110(1)(f).
[156] EPA, *Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Municipal Solid Waste Landfills* 10 (June 2011), https://19january2017snapshot.epa.gov/sites/production/files/2015-12/documents/landfills.pdf [hereinafter "EPA Tech Paper"].
[157] 40 C.F.R. § 60.33f(b)(3), 60.762 B)(ii)(D).
[158] 40 C.F.R. § 60.33f(b)(3).

collection systems failed to sufficiently limit methane from escaping into the atmosphere.[159] California requires use of active collection systems and does not allow operators to comply with its rule by using passive collection systems.[160] EPA must revise its regulations to prohibit passive systems, thereby requiring that that landfill gas collection systems use suction to collect gas.

c. *EPA Should Require Horizontal Gas Collection in Cells that Have a Larger Footprint.*

EPA should require the use of horizontal gas collection systems -essentially horizontal piping that can be used in addition to or instead of the traditional vertical pipes – in cells that have a large footprint. Horizontal collection systems have been used at multiple landfills in the U.S. and can be installed earlier than vertical pipes, achieving greater overall methane reduction as noted above. However, proper system design is important in order to prevent problems.[161] The ERG 2019 Technology Review Memo summarizes the advantages of horizontal systems as follows:

> Horizontal collectors work well if they are installed during the filling of a landfill cell, and gas extraction is applied when the cells begin to generate combustible [landfill gas]. U.S. EPA has stated that horizontal collection systems can alleviate many of the practical implementation concerns traditionally associated with early gas collection. Unlike vertical wells, no specialized drilling equipment is required to install these, because the trenches are built as the landfill is filled, and not after. However, special precautions would be required prior to connecting these collectors to an active vacuum to prevent air intrusion into the GCCS. Horizontal wells can achieve higher gas collection efficiencies potentially up to 71 percent, but few quantifications are available.[162]

ERG also describes problems that can occur when using horizontal collectors. These include the difficulty pumping water from horizontal pipes if differential settlement creates low points that become flooded, potential oxygen intrusion in longer pipes, and the need to place 30 to 40 feet of waste on top of horizontal collectors before operating them to reduce the risk of oxygen intrusion.[163] However, it appears that all of these can be avoided if a landfill is properly

[159] Specifically, CARB stated that "Passive systems rely on natural pressure or concentration gradients as a driving force for gas flow and thus have much lower collection efficiencies than active systems. Since these systems do not actively collect, process, or treat landfill gas, but allow methane to be freely vented into the atmosphere, they are not considered to be appropriate gas collection systems for the purpose of the proposed regulation." CARB ISOR, *supra* note 102, at III-5.
[160] Cal. Code Regs. tit. 17 § 95464(b)(1)(C).
[161] 2019 Technology Review Memo, *supra* note 9, at 23-25.
[162] *Id*. at 25.
[163] *Id.* ERG also notes that

> [H]orizontal collectors are more susceptible to oxygen intrusion, and can make compliance with oxygen limits for wellheads challenging. Third, because they are installed in freshly placed waste, horizontal collectors cannot be operated until anaerobic decomposition has begun. Installing LFG collection infrastructure in the active face of the landfill increases workers' exposure to potential hazards as they are forced to monitor and maintain systems in the midst of filling operations.

planned and engineered or by waiting a certain period of time (to avoid problems associated with immediate installation of horizontal pipes).[164]

The feasibility and effectiveness of horizontal collection depends on the cell size and geometry. Horizontal collectors are most effective in large cells that are filled in long, consistent layers. With smaller cells, the interim or final grade is reached more quickly allowing for earlier installation of vertical collectors.[165] For horizontally compact cells that are designed to be filled quicky, EPA should not require use of horizontal collectors.

ERG in the 2019 Technology Review Memo describes horizontal gas collection as "a well-established technology that has been used in the United States since at least 1982 and that saw widespread use in southern California by the early 2000s."[166] EPA should require the inclusion of horizontal GCCS collection pipes in large cells with a large footprint.

d. *EPA Must Require Incorporation of the Gas Collection Systems into Leachate Collection System.*

The leachate collection system at a landfill can also be tied into the GCCS, effectively adding horizontal collectors.[167] An existing leachate collection system can be connected to a GCCS by incorporating GCCS pipes and wellheads that connect to leachate system riser pipes or clean-outs, although the connections may require some retrofits to the leachate collection system.[168] This connection can also be incorporated into the initial system design.[169]

EPA must revise its CAA regulations to require incorporation of a landfill's leachate collection system as horizontal gas collectors in the GCCS unless an operator can demonstrate that this is infeasible.

e. *EPA Must Require That Landfills Incorporate Measures to Address Flooding of Gas Wells.*

EPA must require that landfills are built with systems for the collection and removal of liquids in order to enhance system efficiency.

Gas collection wells cannot capture gas if the well becomes flooded with leachate or condensate.[170] Indicators of a flooded well include a high vacuum pressure with low gas flow, and a drop in header system pressure between wells.[171] As part of monthly wellhead monitoring

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164 *See id*. at 24-25.
165 SCS Engineers, *Technologies and Management Options for Reducing Greenhouse Gas Emissions from Landfills* 22 (Apr. 2008).
166 2019 Technology Review Memo, *supra* note 9, at 23.
167 *Id*. at 23 ("The horizontal collectors may be part of a landfill's . . . leachate collection system.")
168 SCS Engineers, *supra* note 165, at 30; Timothy Townsend et al., *Sustainable Practices for Landfill Design and Operation* 300 (2015).
169 SCS Engineers, *supra* note 165, at 30; Christopher Eden, *Combined Landfill Gas and Leachate Extraction Systems: Technical Guidance Note CPE07/94*, UKPS, Ltd., Undated.
170 Standards of Performance for Municipal Solid Waste Landfills, 79 Fed. Reg. at 41803.
171 EPA, *Landfill Gas Energy Project Development Handbook: Landfill Gas Contracts and Regulations* 5 (July 2021), https://www.epa.gov/system/files/documents/2021-07/pdh_chapter5.pdf.

that already includes pressure measurements, operators should also check the water level in the well.[172] An increase in liquid level should be corrected by pumping out the liquid or another method as warranted by site conditions.[173]

However, removing liquids from the GCCS is a slow process and GCCS flooding should be avoided through preventative measures. The intrusion of water into the landfill should be avoided by following many of the cover best practices outlined in Section VI below.[174] The GCCS design should also incorporate liquid collection and removal methods such as sumps, integration with the leachate collection system, and pumping systems in the design.[175]

f. *EPA Should Request Information on the Efficacy and Cost of Remote Wellhead Sensing and Automated Wellhead Tuning.*

Remote wellhead monitoring can be accomplished by connecting transmitters to sensors mounted on wellheads, logging data such as gas composition, flow rates, pressure, and temperature.[176] These sensors have also been used to automate wellhead "tuning" or adjustment of a wellhead's vacuum control valve using algorithms designed to optimize methane content in extracted gas for landfills with gas to energy projects.[177] This technology allows for more frequent data collection as well as improved GCCS control and efficiency. This is a relatively new technology that, based on our information, is in use at approximately 24 landfills as of May 2021.[178] However, Petitioners' understanding is that EPA may not have data on the effectiveness of this technology.

For this reason, we recommend that the Agency, in the preamble to proposed revisions to the EG and NSPS for landfills, request comment on the cost and feasibility of these technologies.

4. EPA Must Require the Use of Enclosed Flares Achieving a Minimum 99% Methane Destruction Efficiency.

EPA must also revise its regulations to require that GCCS systems use enclosed flares that achieve at least a 99% methane destruction efficiency. Enclosed flares that achieve 99% destruction efficiency are cost effective and feasible, already required in state landfill methane rules, and in use at many landfills in the U.S. according to materials in EPA's rulemaking docket.[179]Therefore, enclosed flares operating at minimum 99% methane destruction efficiency constitutes BSER.

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172 *Id.*
173 SCS Engineers, *supra* note 165, at 28; EPA, *supra* note 171, at 6.
174 EPA, *supra* note 171, at 5.
175 SCS Engineers, *supra* note 165, at 57.
176 EPA, *supra* note 171, at 8.
177 *Id*. at 9; PTP Informatics, *Performance Assessment of Loci Controls* 1 (Apr. 2020); Bill Bingham & Peter Britton, *Automated Landfill Gas Collection Increases Landfill Gas Flow and Quality at Oklahoma City Landfill* 1 (undated).
178 EPA, *supra* note 171, at 9.
179 "Republic Services has approximately 110 enclosed flares in operation[.] […] Waste Management operates approximately 100 enclosed flares[.] […]Looking at GHGRP reporting year 2014 data[…] out of the 599 reported destruction devices, […] 11.8 percent of landfills had at least one enclosed flare installed, and 6.4 percent of landfills reported both an open and enclosed flare installed." 2019 Technology Review Memo, *supra* note 9, at 31.

a. *Feasibility*.

EPA's CAA regulations for landfills allow use of "non-enclosed" (open) flares in addition to the more effective type of technology: enclosed flares.[180] However, enclosed flares can achieve greater methane reduction.[181] Open flares are not as efficient or as easy to monitor as enclosed flares.[182] ERG explains, in its 2019 Technology Review Memo, that enclosed flares "provide greater control of combustion conditions and allow for stack testing. They can also reduce noise and light nuisances."[183] CARB has also found that enclosed flares "can be easily source tested to measure flare destruction and treatment efficiency."[184]

Phase-out of open flares, except in certain circumstances, is required in the California[185], Oregon[186] and Maryland[187] landfill rules. In addition, enclosed flares are already widely used in the U.S., according to information submitted to EPA around 2015 by two large private waste companies. In 2014, Republic Services stated in a comment letter to EPA that it had approximately 160 non-enclosed flares and 110 enclosed flares in operation."[188] Around the same time, Waste Management stated that it "operates approximately 200 non-enclosed flares and 100 enclosed flares."[189]

The states have also set stronger destruction efficiency standards for enclosed flares than EPA has. EPA's rules require that enclosed flares must achieve a 98% reduction of NMOC or reduce the outlet NMOC concentration to less than 20 ppm. [190] California, Oregon, and Maryland require higher destruction efficiency of methane, mandating a 99% methane destruction rate.[191] ERG found in its 2019 NESHAP review that "low emission enclosed flares can achieve up to 99.9 percent destruction efficiency and are commercially available and in use at several MSW landfills"[192].

Therefore, the use of open flares achieving a minimum 99% methane destruction efficiency has been adequately demonstrated.

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[180] 40 C.F.R. § 60.33f(c)(1), 60.763(b)(2)(iii)(A).
[181] ERG concluded that conversion from open to enclosed flares can reduce HAP emission through higher destruction efficiencies. 2019 Technology Review Memo, *supra* note 9, at 47.
[182] *See* CARB ISOR, *supra* note 102, at III-9.
[183] 2019 Technology Review Memo, *supra* note 9, at 31.
[184] CARB ISOR, *supra* note 102, at III-9.
[185] Cal. Code Regs. tit. 17 § 95464(b)(2)(B)(1)-(2) (exception for operators that can demonstrate . . . that the landfill gas heat input capacity is less than 3.0 MMBtu/hr . . . and is insufficient to support the continuous operation of an enclosed flare or other gas control device."
[186] Or. Admin. R. 340-239-0110(2)(c)(B) (phase-out required by Jan 1, 2024).
[187] COMAR 26.11.42.05B(2).
[188] Niki Wuestenberg, Manager of Air Compliance, Republic Servs., Comment Letter on the Advanced Notice of Proposed Ruling Making for Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills 13 (Sept. 15, 2014), https://www regulations.gov/document/EPA-HQ-OAR-2014-0451-0050.
[189] EPA, *Responses to Public Comments on EPA's Standards of Performance for Municipal Solid Waste Landfills and Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills: Proposed Rules*, 282 (2016), https://www.epa.gov/sites/default/files/2016-12/documents/landfill-nsps-eg-2016-rtc.pdf.
[190] 40 C.F.R. § 60.33f(c)(2) (dry basis as hexane at 3% oxygen) (EGs); 40 C.F.R. 60.762(b)(2)(iii)(B) (NSPS).
[191] Cal. Code Regs. tit. 17. § 95464(b)(2)(A)(1),(b)(3)(A)(1); Or. Admin. R. 340-239-0110(2)(b).
[192] 2019 Technology Review Memo, *supra* note 9, at 31.

b. *Cost Effectiveness.*

ERG, in the 2019 Technology Review Memo, summarized emission reductions and a cost-effectiveness range for enclosed flares at 99.5% and 99.9% destruction efficiency for different pollutants. Table 3 and 4 below show ERG's findings based on 99.5% destruction efficiency. Since Petitioners are recommending that EPA require a minimum 99% destruction efficiency in its rules, as the states have done, Petitioners also present reductions and cost-efficiencies for 99% destruction efficiency below. As with the Table 2 above, for early gas expansion of GCCS, greenhouse gas reductions are presented using a 20-year global warming potential of 79.7 as well as ERG's 100-year potential of 25. The reduction estimates in Table 3 correspond with the cost-effectiveness ranges shown in Table 4 below.

Table 3 Summary of Reductions Resulting from Conversion to Enclosed Flares in 2023*				
Scenario	**NMOC (metric tons per year)**	**Methane (metric tons per year)**	**CO_2e (metric tons per year) GWP 25**	**CO_2e (metric ton per year) GWP 79.7**
Incremental reductions for conversion to enclosed flares				
Assuming 99% destruction**	420	60,000	1,650,000	5,270,000
Assuming 99.5% destruction***	630	99,000	2,480,000	7,900,000

*Emission reduction values rounded.
**Values calculated by EIP[193] based on state rules (CA, OR, WA, MD) requiring 99% minimum destruction efficiency.
***Values from ERG 2019 Technology Review Memo[194] except for CO2e at GWP of 79.7.

Table 4 Summary of Incremental Cost Effectiveness for Conversion to Enclosed Flares in 2023				
Scenario	**$/ton NMOC**	**$/ton Methane**	**$/ton CO_2e GWP 25**	**$/ton CO_2e GWP 79.7**
Upper bound cost of conversion				
Assuming 99% destruction*	$77,143	$490	$19.6	$6.1
Assuming 99.5% destruction**	$51,504	$330	$13.1	$4.1
Lower bound cost of conversion				
Assuming 99% destruction*	$38,571	$250	$9.8	$3.1
Assuming 99.5% destruction**	$25,752	$160	$6.5	$2.0

*Values calculated by EIP[195] based on state rules (CA, OR, WA, MD) requiring 99% minimum destruction efficiency
**Values from ERG 2019 Technology Review Memo[196] except for CO2e at GWP of 79.7

[193] The emission reduction associate with 99% was calculated by determining flow to the flare that would result in the estimated emissions at 99.5% and then applying a 99% destruction efficiency to that quantity.
[194] 2019 Technology Review Memo, *supra* note 9, at 44.
[195] The only difference between the two scenarios is the assumed destruction efficiency, therefore the only change in the cost effectiveness calculations between 99% and 99.5% destruction efficiency is the increment of NMOC and methane destroyed. The costs are the same in the two calculations, using the estimates prepared by ERG.
[196] 2019 Technology Review Memo, *supra* note 9, at 44.

A cost-effectiveness range of $254 to $490 per ton of methane (or even higher) for flares at 99% methane destruction efficiency is not exorbitant[197] and is below well below the $1,970 per ton of methane reduction that EPA proposed to find reasonable for BSER purposes in its December 2022 Proposed Oil and Gas Rule. [198] Therefore, the use of enclosed flares meeting a minimum 99% destruction efficiency is adequately demonstrated, cost-effective, and constitutes BSER.

C. EPA Must Revise Its CAA Section 111 Regulations to Improve Requirements for the Detection and Control of Fugitive Emissions.

EPA must revise its CAA section 111 rules for landfills to strengthen requirements for the detection and control of fugitive emissions. Some monitoring of fugitive emissions from a landfill's surface is already required in EPA's surface emissions monitoring provisions. However, these requirements must be strengthened and monitoring requirements should be extended to equipment leaks and other types of emissions from landfills. EPA does not currently require detection and repair of leaks from GCCS components, which is mandatory under state rules and similar requirements exist for the oil and gas industry. EPA must adopt component leak detection and repair requirements. In addition, technological advances create the possibility for even deeper and more cost-effective pollution reductions. EPA should create an alternative compliance framework for leak detection and repair at landfills modeled on the approach taken in the Proposed Oil and Gas Rule to encourage the development of technology to more regularly (or continuously) measure fugitive emissions from landfills. Lastly, EPA should create a program for quickly addressing the largest emissions from landfills, building from similar standards proposed for oil and gas facilities.

1. EPA Must Revise and Strengthen Its Surface Emission Monitoring Requirements.

EPA must strengthen its surface emissions monitoring requirements. The Agency can improve its standards based on leading state rules, which require monitoring to cover more of the landfill's surface and establish a threshold based on the average of samples taken at multiple locations on the landfill. EPA should also add improved reporting requirements, ensure that monitoring occurs only during normal atmospheric pressure conditions, and should assess rule improvements based on the availability of drone and other technologies.

a. EPA's Current Surface Methane Monitoring Requirements.

EPA rules establish requirements for how surface methane monitoring must be conducted in order to assess how a GCCS is performing. With respect to location, operators must monitor the entire perimeter of the area from which the system collects gas and test along a pattern that crosses the landfill at 30 meters (about 100-foot) intervals.[199] Monitoring must also be conducted in locations "where visual observations indicate elevated concentrations of landfill gas, such as

[197] *See Lignite Energy Council*, 198 F.3d at 933.
[198] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74718.
[199]; 40 C.F.R. § 60.36f(c)(1), 60.763(d (2016).

distressed vegetation and cracks or seeps in the cover and all cover penetrations," which EPA interprets as requiring monitoring at "any openings that are within an area of the landfill where waste has been placed and a gas collection system is required."[200] Operators must develop a "surface monitoring design plan" including a topographical map with the monitoring routes and the "rationale for any . . . deviations from the 30-meter intervals."[201]Operators are permitted to exclude dangerous areas, including those with steep slopes, from surface testing.[202] Since monitoring need only be performed in any areas of the landfill where the gas collection system is required, this effectively excludes the working face – meaning the area of active waste disposal - at the landfill.[203]

Surface monitoring must be conducted on a quarterly basis.[204] At closed landfills, annual monitoring may be conducted after three consecutive quarters of no exceedances.[205] Monitoring must be conducted using Method 21 with the probe held 5-10 centimeters above the landfill surface[206] during "typical meteorological conditions"[207] and a wind barrier must be used when wind speeds exceed 4 miles an hour or gusts exceed 10 miles an hour.[208] The coordinates of the location where an exceedance is measured must be recorded using an instrument with an accuracy of at least four meters.[209]

Certain actions must be taken when an exceedance is measured. The first time an exceedance occurs, the landfill operator must perform "cover maintenance or adjustments to the vacuum of the adjacent wells" and recheck at 10 days and one month from initial exceedance to confirm no exceedances continue to occur. If a second exceedance occurs, "additional corrective action" must be taken and the location re-monitored within 10 days.[210] If three exceedances are measured within a quarterly period, a new well or other collection device must be installed within 120 of the initial exceedance unless alternative corrective action is approved.[211]

b. State Rules Are Stronger Than EPA's.

California, Oregon, and Maryland have surface emissions monitoring requirements that are more protective than EPA's and demonstrate the importance and feasibility of stronger EPA requirements in four ways. First, the states require a walking pattern with no more than 25-foot intervals.[212] When compared with EPA's 30-meter (approximately 100 foot) intervals, these states require that more of the landfill's surface is actually traversed and measured by the person

[200] 40 C.F.R. § 60.34f(d), 60.763(d) (2016).
[201] *Id*.
[202] *Id*.
[203] 40 C.F.R. § 60.34f(d); "LFG collection typically begins after a portion of the landfill (known as a "cell") is closed to additional waste placement." EPA, *supra* note 128, at 1-3.
[204] 40 C.F.R. § 60.36f(c)(1).
[205] 40 C.F.R. § 60.37f(f), 60.766(f) (2016).
[206] 40 C.F.R. § 60.36f(c)(3), 60.765(c)(1) (2016).
[207] 40 C.F.R. § 60.36f(a)(c)(3), 60.765(a)(c)(3).
[208] 40 C.F.R. § 60.35f(a)(6)(iii)(a), 60.764(a)(6)(iii)(a).
[209] 40 C.F.R. § 60.36f(c)(4)(i), 60.765(c)(4)(i)(2016).
[210] 40 C.F.R. § 60.36f(c)(3),(4)(i)-(iv, 60.765(c)(1)-(4).
[211] 40 C.F.R. § 60.36f(c)(4)(v), 60.765(c)(4)(v).
[212] Cal. Code Regs. tit. 17 § 95471(c)(1)(B) (2010); Or. Admin. R. 340-239-0800(3)-(a)(B) (2021).

conducting the monitoring.[213] Second, landfill operators must show that surface methane levels averaged across measurements taken within 50,000 square foot gridded sections of the landfill do not exceed 25 ppm (referred to as integrated monitoring) [214] in addition to showing that levels at individual locations do not exceed 500 ppm (instantaneous monitoring). [215]If either the instantaneous or integrated measurements exceed the specified limits, corrective action must be taken and the site re-monitored. California is currently considering reducing its instantaneous threshold to 200 ppm.[216] Third, the states require better reporting of surface methane levels. Maryland and Oregon require submission of a report within 30 days following sampling.[217] California and Oregon require reporting of all instantaneous measurements above 200 ppm,[218] and Oregon requires reporting of instantaneous measurements over 100 ppm.[219] Maryland requires reporting of "all results of surface emissions monitoring" with levels above 100 ppm clearly identified.[220] Fourth, California limits the meteorological conditions under which monitoring can occur: average wind speeds must be less than 5 mph and instantaneous speeds less than 10 mph; and there must have been no measurable precipitation within the preceding 72 hours.[221]

c. *Canada's Proposed Regulatory Framework Is Stronger Than EPA's Regulations.*

The ECCC offers several approaches for identifying measured methane emissions, including path-integrated monitoring that involves a drone-based downward facing methane detector[222] and hand-held methane detectors for measuring surface emission concentrations.[223] Active landfills where path-integrated methane concentrations are below 200 ppm*m (or surface methane concentrations are below 200 ppm where ground based monitoring was used to verify

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[213] California's landfill operators may elect to use a 100-foot interval if compliance is demonstrated for a certain period of time. Cal. Code Regs. tit. 17 § 95471(c)(1)(B) (2010). Oregon further requires that the monitoring include the perimeter of the site. Or. Admin. R. 340-239-0800(3)(a)(A).
[214] Cal. Code Regs. tit. 17 § 95471(c)(3).
[215] Cal Code Regs. tit. 17 § 95471(c)(2).
[216] CARB, *Preliminary Concepts for Potential Improvements to Landfill Methane, Regulation* 12 (May 18, 2023), https://ww2.arb.ca.gov/sites/default/files/2023-05/LMR-workshop_05-18-2023.pdf, [hereinafter "CARB 2023 Presentation on Regulation Improvements"].
[217] COMAR 26.11.42.10.C.(11)(a). Or. Admin. R. 340-239-0700(3)(l) (2021).
[218] Cal. Code Regs. tit. 17 § 95470(b)(3)(J) (2010); Or. Admin. R. 340-239-0700(3)(c)(A).
[219] Or. Admin. R. §340-239-0800(3)(b)(A); COMAR 26.11.42.10(C)(11)(b)(1).
[220] This requirement relates to the instantaneous surface emissions monitoring report. COMAR 26.11.42.10(C)(11)(b)(1).). In semi-annual reports, levels over 100 ppm must be reported. *Id*. 26.11.42.10(C)(3)(a).).
[221] Cal. Code Regs. tit. 17 § 95471(c)(1)(C), (D). Precipitation affects surface emissions because it increases the moisture content of the soil, impeding the oxidation processes (a biological process in which methanotrophic bacteria oxidize methane, transforming it into carbon dioxide) that reduce methane emissions through the cover. Houhu Zhang et al., *Effect of Rainfall on the Diurnal Variations of CH4, CO2, and N2O Fluxes from a Municipal Solid Waste Landfill,* 442 Science of the Total Env't 73 (2013), http://dx.doi.org/10.1016/j.scitotenv.2012.10.041.
[222] Described more fully in ECCC's technical document as using an open-path laser methane detector, with methane concentrations measured in units of ppm*meter (ppm*m) or with a closed path detector measuring methane concentrations in ppmv. Env't and Climate Change Can., *Estimating, Measuring and Monitoring Landfill Methane-Technical Guidance Document* 34 (last updated Apr. 17, 2023), https://drive.google.com/file/d/1fqods0nXDSEUEmZu7nnkHZwXfGtemWPr/view?usp=sharing [hereinafter "ECCC Technical Guidances"]. **(**Attachment D). The methodology also requires that the SEM drone surveys should be conducted over *the entire landfill, including the working face*. *Id*. at 35 (emphasis added).
[223] ECCC Proposed Regulatory Framework, *supra* note 14.

drone-based results) would be exempt from requirements to implement a landfill methane control approach.[224]

Canada's proposed regulatory framework would also require surface emissions monitoring that covers more of the surface of the landfill by dividing the landfill into 50,000 square foot grids for ground-based monitoring.[225] The performance standard of 25 ppm*m for surface methane emission limits in the proposed regulatory framework requires measurement in the spring, summer and fall with a drone-mounted methane detector and only the working face of the landfill is exempt.[226] Ground-based surveys can be used to calculate a ground-based average, not to exceed 25 ppm, the same as California's integrated surface methane limits,[227] in zones of the grid where drone-based exceedances are measured.[228]

d. Recommendations on Surface Emissions Monitoring.

EPA must revise its surface emissions monitoring ("SEM") requirements based on the leading state rules in the following ways:

- Instantaneous surface emission monitoring using a walking pattern of no more than 25-foot intervals. Integrated surface emission monitoring within 50,000 square foot grids across the entire landfill. Integrated (averaged) surface measurements must not exceed 25 ppm.
- If there are no exceedances recorded for four consecutive quarterly monitoring periods, the walking pattern may be increased to 100-foot intervals. Upon detection of any exceedance within the landfill that cannot be remediated within 10 days, the walking pattern would revert to 25-foot intervals.

EPA should also strengthen its SEM reporting requirements to ensure that landfill operators submit monitoring reports within 30 days after sampling, building on requirements in Maryland and Oregon.[229] This report should include all measured SEM values, including but not limited to exceedances, with the map traversed for sampling attached and the latitude and longitude of the location at which each reading was obtained clearly identified.

EPA should continue to allow the use of drone technology for SEM[230] and should update its SEM requirements to take into account the increased capability of drones. Drone technology

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[224] These landfills would monitoring once per year until the landfill closes or the threshold of 732 tons is exceeded. *Id*.
[225] *Id*.
[226] *Id*.
[227] Cal. Code Regs. tit. 17 § 95471(c)(3).
[228] ECCC Proposed Regulatory Framework, *supra* note 14.
[229] Maryland and Oregon require the submission of a report 30 days after sampling if an exceedance is measured or 30 days after the fourth consecutive sampling round if no exceedances are measured. COMAR 26.11.42(c)(11); Or. Admin. R. 340-239-0700(3)(l).
[230] Letter from Steffan M. Johnson, Grp. Leader of Measurement Tech. Grp., Off. of Air Quality Planning and Standards ("OAQPS"), EPA, to David Barron, Chief Tech. Officer, Sniffer Robotics, LLC (Dec. 15, 2022), https://www.epa.gov/system/files/documents/2022-12/Barron%20Sniffer%20Alt%20with%20OTM%2051%20attached_signed.pdf (approving use of Sniffer Robotics

can allow sampling across a large portion of the landfill surface, avoiding potential safety risks to a human operator.[231] As noted by Canada's ECCC, drone surveys can be conducted in areas that "include[] the working face" of the landfill.[232] Drone monitoring can also expedite the creation of a SEM monitoring report that includes the location where samples were taken. EPA should also evaluate new technologies for SEM that may be even more effective than drones.

Lastly, EPA must revise its SEM requirements to ensure that monitoring is conducted when barometric pressure is representative of normal site conditions. Wellheads are operated with respect to atmospheric pressure. Therefore, short-term variability in the local pressure can impact the effectiveness of the GCCS, where the vacuum pressure is set monthly, and thus impacts surface emissions. Emissions decrease when atmospheric pressure rises and increase when the pressure falls.[233] Canada's ECCC cautions in technical guidance that SEM should not be conducted "[i]f atmospheric pressure is rising sharply or is considerably higher than the average for the area."[234] Therefore, SEM conducted during periods of elevated atmospheric pressure would result in atypical measurements.

EPA should ensure that SEM is conducted when barometric pressure is within the range of average daily variation at the site. Landfill operators should be required to (1) submit information showing this range; and (2) record and report the barometric pressure at the site during each sampling event to demonstrate that it is within the required range.

2. EPA Must Adopt Requirements for GCCS Component Leak Detection Monitoring and Repair.

While EPA's SEM requirements, especially if improved, will detect some fugitive emissions from the surface of the landfill, EPA does not require detection and repair of leaks from components of the GCCS.[235] However, the leading state rules do require detection and repair of leaks from GCCS components and Canada is also proposing to do so. This practice is also widely employed in the oil and gas sector. Accordingly, EPA must require equipment leak detection monitoring and repair requirements for landfills. EPA should determine the leak detection and repair is the BSER for addressing fugitive emissions and equipment leaks at landfills. EPA should require landfill operators to submit a leak detection plan identifying critical

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technology as alternative SEM compliance method as Other Test Method 51 ("OTM-51") subject to certain restrictions).

231 *See id*. at 4.

232 ECCC Technical Guidance, *supra* note 222, at 35.

233 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* 22 (2020), https://ww2.arb.ca.gov/sites/default/files/2020-06/CalPoly%20LFG%20Flux%20and%20Collection%20Efficiencies%203-30-2020.pdf; Liukang Xu, et. al., *Impact of Changes in Barometric Pressure on Landfill Methane Emission*, 28 Glob. Biogeochemical Cycles 679, 685(2014), https://doi.org/10.1002/2013GB004571.

234 ECCC Technical Guidance, *supra* note 222, at 30.

235 EPA's current rules require monitoring where the GCCS protrudes from the ground via the mandate to sample at cover penetrations or openings. *See, e.g*. 40 C.F.R. § 60.34f(d). However, state component leak detection and repair is not limited to the location where the equipment meets the landfill's surface and covers any "any equipment that is part of the [GCCS] including, but not limited to: (a) Wells; (b) Pipes; (c) Flanges; (d) Fittings; (e) Flame arrestors;(f) Knock-out drums; (g) Sampling ports;(h) Blowers; (i) Compressors; an ((j) Connectors." *See, e,g*. COMAR 26.11.42.03(B)(4).

information, including components that could leak, and to conduct quarterly monitoring using a hybrid technical approach involving optical gas imaging (OGI) or an approved monitoring technology and Method 21 monitoring.

a. Component Leak Detection and Repair Is Required Under State Landfill Methane Rules and Addressed in Canada's Proposed Regulatory Framework.

California, Oregon, and Maryland require component leak detection in their landfill methane regulations. All three states require that GCCS components under positive pressure must be monitored quarterly for leaks and that any component leak over 500 ppm methane must be repaired within 10 days.[236] Oregon and Maryland require operators to maintain records of any component leak over 250 ppm.[237] California is considering strengthening its rules to "add[] prescriptive requirements for component leak monitoring, and increase[e] stringency to require robust leak detection procedures at all components containing landfill gas."[238]

In Canada, the ECCC's Proposed Regulatory Framework contemplates requiring monthly monitoring (using a portable detector unless a continuous monitoring system capable of detecting such leaks is installed[239]) of the wellheads and components under positive pressure, including any pipelines conveying untreated or upgraded landfill gas. Similar to California, a leak would be defined as a GCCS component location where the measured methane concentration exceeds 500 ppm using a hand-held methane detector.[240] Canada's ECCC contemplates the following with respect to corrective action following a component leak:[241]

- Corrective action must be taken to confirm the source of the leak and undertake necessary repairs;[242]
- The leak must be repaired and methane concentration re-monitored within 30 days after leak was detected;[243] and
- If re-monitoring indicates that the leak has not been repaired, additional corrective action must be completed within six months after the first leak was detected.[244]

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[236] Cal. Code Regs. tit. 17 § 95469(b)(2)(3) (2010). California includes 500 ppm value in definition of "component leak"); Or. Admin. R. 340-239-0600(1)b)(B) (2021);, COMAR 26.11.42.09(B)(7)(a).
[237] Or. Admin. R. 340-239-0600(2)(c); COMAR 26.11.42.09(B)(7)(b).
[238] CARB, *Greenhouse Gas and Criteria Air Pollutant Air Emissions and Gas Collection System Efficiencies at California Landfills* 15 (Dec. 5, 2022), https://www.arb.ca.gov/sites/default/files/2022-12/Landfill%20GHG%20VOC%20and%20GCCS_0.pdf [hereinafter "CARB Presentation"].
[239] The Proposed Regulatory Framework allows operators to submit information on alternative LDAR approaches, which could include a system that continuously measures atmospheric concentrations at the perimeter of the landfill) that demonstrate equivalent outcomes to the regulatory requirements. ECCC Proposed Regulatory Framework, *supra* note 14.
[240] *Id.*
[241] The same corrective action is required for a SEM exceedance.
[242] *Id.*
[243] *Id.*
[244] *Id.*

b. *EPA's Proposed Oil and Gas Rule.*

In December 2022, EPA issued its Proposed Oil and Gas Rule, a supplemental proposal to strengthen, update and expand proposed standards for emission sources in the oil and natural gas sector.[245] In it, EPA proposes to require ground-based monitoring of leaks from equipment components using Method 21 or optical gas imaging ("OGI") technology.[246] The Proposed Oil and Gas Rule generally requires quarterly monitoring, with less frequent monitoring required at less leak prone sites and more frequent monitoring required at larger and more complex sites. The proposal would also allow operators to use advanced methane monitoring technologies as an alternative at varying frequencies depending on their sensitivity.

c. *Recommendations on Component Leak Detection and Repair.*

EPA must adopt requirements for monitoring component leaks in its regulations. EPA should require landfill operators to develop a fugitive emissions monitoring plan[247] that addresses leaks from equipment components. This plan should reflect a comprehensive analysis of every possible component of a landfill that may emit fugitive emissions. The fugitive monitoring plan must cover all of the applicable requirements for the fugitive emission components of the landfill. If continuous monitoring is allowed for leak detection purposes, as it is in the Proposed Oil and Gas Rule, this should be identified in the plan. EPA should also clearly define fugitive emissions from landfills in its revised CAA regulations.[248]

EPA should require component leak detection on at least a quarterly basis, like the states. Canada's ECCC has proposed monthly leak detection,[249] and EPA should consider whether this is a more appropriate frequency. In addition, while the states allow only use of Method 21, EPA should use a hybrid approach involving both Method 21 and OGI or an approved alternative to OGI. EPA allows use of either technology in the Proposed Oil and Gas Rule.[250] In addition, EPA has already issued regulations allowing a wide range of regulated industry sectors to use OGI as an alternative to Method 21 when performing mandatory leak detection.[251] Under this regulation, operators that rely on OGI to detect leaks instead of Method 21 must still use Method 21 for one leak screening per year, in lieu of OGI.[252]

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[245] *See* Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74704. EPA proposes to modify and refine certain elements of the proposed standards in response to comments provided on the November 2021 proposal.
[246] *Id*. at 74705.
[247] *See id.* at 74737.
[248] For example, EPA chose to define "fugitive emissions component" as "any component that has the potential to emit fugitive emissions of methane or VOC at a well site, centralized production facility, or compressor station, including valves, connectors, pressure relief devices, open-ended lines, flanges, covers and CVS not subject to 40 CFR 60.5411b, thief hatches or other openings on a storage vessel not subject to 40 CFR 60.5395b, compressors, instruments, meters, and yard piping." *Id*. at 74736.
[249] ECCC Proposed Regulatory Framework, *supra* note 14.
[250] *See e.g. id*. at 74722 ("The EPA has historically addressed fugitive emissions from the Crude Oil and Natural Gas source category through ground-based component level monitoring using OGI or Method 21.")
[251] 40 C.F.R. § 60.18(a)(2)(g),(h) (1971); *see also* Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. 74702.
[252] 40 C.F.R. § 60.18(h)(7).

3. <u>EPA Should Develop an Alternative Compliance Framework for Leak Detection and Repair Modeled on the Proposed Oil and Gas Rule.</u>

EPA should also develop an alternative compliance framework for fugitive emissions detection and repair modeled on the approach in the Proposed Oil and Gas Rule. To support the development of advanced detection technologies for fugitive emissions monitoring,[253] the Proposed Oil and Gas Rule provides for alternative approaches that include continuous monitoring or alternative emissions measurement methods for periodic screening as approved by EPA. For periodic fugitive emissions monitoring, EPA developed a matrix based on a broad range of technologies that ties frequency to detection limit, requiring more frequent monitoring for less sensitive equipment.[254]In addition, OGI surveys are required for follow up to pinpoint leaks for repair and some options also require regular annual OGI.

The Proposed Oil and Gas Rule also includes provisions for approving alternative test methods. Approved test methods that are broadly applicable are to be posted on EPA's Emissions Measurement Center's website, allowing any owner or operator that meets the applicability requirements to use the alternative method without additional approval by EPA.[255]

EPA should revise its CAA regulations to create a similar alternative compliance framework for the detection and repair of fugitive emissions at landfills, leveraging new developments and technological advances that create possibility for more frequent and comprehensive landfill emissions monitoring and remediation.

4. <u>EPA Should Encourage the Development of Continuous Monitoring Methods for Fugitive Emissions From Landfills.</u>

EPA should encourage the development and testing of technology that can continuously measure methane emissions from landfills. This is particularly important because, currently, EPA allows landfill operators to avoid installing a GCCS based on SEM measurements that provide only snapshots of emission levels at some locations on a landfill's surface.[256] The option to avoid installing a GCCS should be available only based on a demonstration made using continuous sampling data, which would provide a much more complete picture of site emissions.

The Agency should start by reviewing information on continuous monitoring technology summarized by Canada's ECCC in its recent technical guidance document.[257] EPA should also review information that is submitted in response to its recent request, in a rulemaking addressing the GHGRP, for comments "on how . . . methane monitoring technologies, *e.g.*, satellite imaging, aerial measurements, vehicle mounted mobile measurement, or continuous sensor networks, might enhance [GHGRP] emissions estimates[,]" including how such data might be

[253] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74707.
[254] *Id.* at 74741-42.
[255] *Id*. at 74746.
[256] 40 C.F.R. § 60.35f(a)(6), .764(a)(6).
[257] ECCC Technical Guidance, *supra* note 222, at 42.

used to estimate annual emissions.[258] In particular, EPA should consider requiring fence-line monitoring for landfills similar to the requirements for the petroleum refinery industry.[259]

EPA could also develop corrective action requirements associated with continuous monitoring for landfills that are similar to those in the Proposed Oil and Gas Rule. In that rule, EPA prescribes action levels and requires that instruments must be able to measure methane emissions at least one order of magnitude less than the specified action level.[260] If the action level is exceeded, the operator must initiate a root cause analysis to determine the cause and appropriate corrective action and appropriate repairs must be time bound.[261] Measurements are required at least once per 12-hour period, with a rolling 12-month average downtime of less than 10%.[262]

5. EPA Should Develop Standards Focused on Rapid Detection and Mitigation of Large Emissions From Landfills.

EPA should also develop standards for the landfills sector modeled on the Proposed Oil and Gas Rule that aim to quickly detect the largest emission events ("super-emitters") and prioritize them for mitigation. Standards in the Proposed Oil and Gas Rule are designed to quickly identify pollution spikes and require more rapid corrective action than would occur "if a source relied solely on . . . traditional infrequent monitoring and inspection methods."[263] Aerial surveys have documented large methane plumes at landfills.[264] California conducted surveys to detect point sources as well as additional surveys that measured both point and area sources More than 400 landfills were included in the point source survey, finding that landfills were the largest emitters of this type, representing approximately 40 percent of point source emissions in the state.[265] Subsequent surveys in other parts of the U.S. have also detected large methane plumes.[266]

Aerial surveys have already proven effective at reducing large methane plumes at landfills in California and Pennsylvania. The Pennsylvania Department of Environmental Protection estimated that surveys followed by repairs reduced the rate of methane emissions

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[258] EPA, Revisions and Confidentiality Determinations for Data Elements Under the Greenhouse Gas Reporting Rule, 88 Fed. Reg. 32852, 32879 (proposed May 22, 2023).
[259] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74744 ("The EPA is proposing a framework for continuous monitoring Technologies [for the oil and gas sector] that is akin to the fenceline monitoring work practice promulgated by the EPA in 2015 as part of the National Emissions Standards for Hazardous Air Pollutants (NESHAP) for the petroleum refinery sector (80 FR 75178; December 1, 2015)").
[260] *Id*. at 74744-45.
[261] *Id*. at 74745.
[262] *Id*. at 74745.
[263] *Id*. at 74748; *see also* Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards, 79 Fed. Reg. 36880, 36920 (June 30, 2014) (codified at 40 C.F.R. pts. 60, 63).
[264] Duren et al., *supra* note 19, at 2, 36-37; Daniel H. Cusworth et al., *Using Remote Sensing to Detect, Validate, and Quantify Methane Emissions from California Solid Waste Operations*, 15 Env't Rsch. Letters (2020).
[265] Duren et al., *supra* note 19.
[266] RMI MSW Report, *supra* note 151, at 49; Pennsylvania Department of Environmental Protection, Methane Overflight Study Overview (2023), https://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Advisory%20Committees/Air%20Quality%20Technical%20Advisory%20Committee/2023/3-9-23/AIRBORNE%20METHANE%20AQTAC%20MEETING%20230309.pdf.

from landfills by 37% during a recent project.[267] California regulators have similarly found that surveys identifying plumes led to mitigation.[268]

EPA should develop standards to mitigate super-emitters from landfills by requiring aerial monitoring. This should include defining large emission events and, like the Proposed Oil and Gas Rule, should identify mitigation or corrective actions that can be taken in response to detection of such events.

D. Wellhead Monitoring.

EPA's regulations require monitoring at GCCS wellheads for several different parameters. Wellhead monitoring is conducted to monitor system performance, detect leaks, and identify conditions that could cause subsurface fires or explosions. EPA should revise its CAA regulations to adopt standards for temperature, oxygen, and nitrogen that were set forth in earlier rules and then weakened through a series of revisions. These and other parameters should be tied to clear and meaningful requirements for corrective action. EPA should also require more frequent monitoring for these parameters following a fire or thermal event.

1. Background.

Wellhead monitoring is a critically important feature of any regulatory scheme for landfills because it can mitigate or prevent fires and thermal events as well as for gauging system performance. [269] Monitoring parameters include pressure, temperature, and the content of the landfill gas (typically nitrogen or oxygen as well as carbon monoxide, and/or methane). Negative gage pressure, which essentially means suction, at wellheads is required to ensure that the gas collection system is actively collecting gas. However, too much vacuum can cause air intrusion, increasing the risk of fires.[270] The other monitoring parameters are included to detect conditions that could lead to a subsurface fire.

Current pre-indicators of a landfill fire used by landfill operators, independent of regulatory requirements, include changes in the landfill gas composition and increased temperature. As preventive measures, several landfill operators have standard operating procedures that require monitoring of parameters such as temperature and the levels of oxygen, methane, and carbon monoxide at wellheads.[271] The measured wellhead temperature indicates that higher temperatures may exist within the landfill and, when elevated temperatures exist landfill operators often monitor for oxygen at levels as low as 2%.[272] Once a sub-surface fire

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[267] *Id*. at 26.
[268] CARB, *supra* note 21, at 26.
[269] *See, e.g.*, EPA, *Air Emissions from Municipal Solid Waste Landfills-Background Information for Proposed Standards and Guidelines* 9-32, 9-33 (March 1991), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=9100AEYT.pdf; EPA, *Air Emissions from Municipal Solid Waste Landfills-Background Information for Final Standards and Guidelines* 1-8, 1-41, 1-42 (December 1995) https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=2000IN3H.pdf [hereinafter "EPA 1995 Background"].
[270] EPA, *supra* note 128, at 2.
[271] Todd Thalhamer, *Data Evaluation of the Subsurface Smoldering Event at the Bridgeton Landfill* 8-12 (June 2013), https://semspub.epa.gov/work/07/30286004.pdf.
[272] Todd Thalhamer et al., Comment Letter EPA's Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills and Standards of Performance for Municipal Solid Waste Landfills 3 (Oct. 26, 2015),

starts, it can be difficult to extinguish and continue for decades if not controlled.[273] Ongoing monitoring of temperature and gas composition is critical to understanding the status of the subsurface fire and identifying appropriate corrective actions.[274]

2. History of Standards for Temperature, Nitrogen, and Oxygen.

Over time, the CAA rules have been revised to weaken requirements for addressing temperature as well as nitrogen and oxygen content at landfills. A temperature limit of 55 degrees Celsius (131 degrees Fahrenheit) was set in the 1996 NSPS because this temperature was cited by industry as a temperature that indicates that there may be a subsurface problem.[275] Nitrogen levels were limited to 20% with a corresponding oxygen level of 5%.[276] But operators were allowed to set higher parameters if "supporting data [showed] that the elevated parameter [did] not cause fires or significantly inhibit anaerobic decomposition by killing methanogens."[277]

However, landfill operators argued to EPA during a subsequent revision that, due to variability among landfill sites, these thresholds were difficult to meet and that approval of alternative parameters was often delayed, preventing efficient operation of collection systems.[278] Operators further claimed that these standards were unnecessary because landfill operators are already incentivized to reduce the risk of fire and explosions at their sites.[279] Ultimately, the temperature[280] standard was maintained in the 2016 NSPS and the nitrogen and oxygen standards were eliminated. Operators are required to monitor oxygen and nitrogen content but there are no associated reporting thresholds or corrective actions.[281]

In the 2020 revisions to the NESHAP, a higher temperature standard was newly established (145 degrees Fahrenheit) and the rule replicated the NSPS approach to nitrogen and oxygen content, requiring monitoring but no corrective action or reporting.[282] In addition, in the 2020 NESHAP revisions, EPA finalized "minor edits" to the 2016 NSPS and EGs "allowing landfills to demonstrate compliance with the 'major compliance provisions' of the NESHAP in lieu of complying with the analogous provisions in the NSPS and EGs."[283] Subparts XXX[284] and Cf[285], the NSPS and EGs respectively, provide operators the option to comply instead with the

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[273] *Id*. at 1.
[274] *Id*.
[275] EPA 1995 Background, *supra* note 269, at 1-42.
[276] *Id*. at 1-41, 1-42.
[277] 40 C.F.R. § 60.753(c) (1996).
[278] Letter from Waste Management to Hillary Ward, Sector Policies and Programs Division, EPA Off. of Air Quality, at 2 (Sept. 27, 2011), https://www.regulations.gov/document/EPA-HQ-OAR-2014-0451-0017.
[279] EPA, *Landfills NSPS Technical Meeting*, at 3 (Oct. 22, 2012), https://www regulations.gov/document/EPA-HQ-OAR-2014-0451-0003.
[280] 40 C.F.R. § 60.36f(a)(5)(ii).
[281] 40 CFR § 60.766(b)(2)(i)-(ii), (g) (requiring a device that records flow every 15 minutes).
[282] *See* Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59332.
[283] National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 85 Fed. Reg. 17244, 17248 (Mar. 26, 2020) (codified at 40 C.F.R. pts. 60 and 63).
[284] 40 C.F.R. § 60.762(b)(2)(iv), 767(g), (j).
[285] "For approval, a state plan must include provisions for the operational standards in this section (as well as the provisions in §§ 60.36f and 60.37f, or the operational standards in § 63.1958 of this chapter (as well as the provisions in §§ 63.1960 of this chapter and 63.1961 of this chapter), or both as alternative means of compliance, for

NESHAP "major compliance provisions." However, the NESHAP provides no analogous "major compliance provisions" referring back to the EGs and NSPS. Thus, a source may choose to comply with the NESHAP rather than the corresponding provisions of the NSPS and EGs. Practically, this amounts to operators otherwise subject to the NSPS or EGs being allowed to instead comply with the operational standards for the GCCS and the compliance provisions of the NESHAP.

Thus, EPA's CAA rules currently require only monitoring, with no corrective action, for nitrogen and oxygen and allow operators to select whether to use 131 º F (the section 111 standard) or 145º F (the NESHAP standard) as the temperature requiring corrective action.

3. Other Parameters: Pressure, Carbon Monoxide, and Methane Content.

EPA's CAA regulations also address a few additional parameters. Under the EGs, negative gage pressure be maintained at wellheads, with some exceptions.[286] The 2020 NESHAP established enhanced monitoring requirements at wellheads where temperatures exceed 145º F that include carbon monoxide and methane content of the landfill gas at the wellhead and visual observations for evidence of subsurface oxidation such as smoke, ash, or damage to the well.[287]

4. Recommendations.

a. Temperature Standard.

EPA must revise its CAA regulations to clearly establish a temperature standard of 131º Fahrenheit (F). While this is the current standard under the section 111 rules, EPA presently gives landfill operators subject to NESHAP standards the option of complying with the more lenient 145 degree limits available under that rule.[288]

EPA's own analysis of the 2019 NESHAP rule indicates that temperatures below 145 degrees can indicate possible fire hazards. When EPA established the 145 degree standard, it cited a Solid Waste Association of North America ("SWANA") manual of practice for landfill GCCS, which states:

> polyvinyl chloride piping *begins to fail at 145 °F* and fails at 165 °F, *temperatures above 140 °F could indicate aerobic conditions [meaning the presence of oxygen,*

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an MSW landfill with a gas collection and control system used to comply with the provisions of § 60.33f(b) and (c). Once the owner or operator begins to comply with the provisions of § 63.1958 of this chapter, the owner or operator must continue to operate the collection and control device according to those provisions and cannot return to the provisions of this section." 40 C.F.R. § 60.34f; *see also* 40 C.F.R. § 60.36f, 37f, 38f(k) (2016).

[286] The exceptions include instances of fire or increased wellhead temperature, use of a geomembrane or synthetic cover, or at a decommissioned well. 40 C.F.R.§ 60.34f(b), 60.753(b).

[287] National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 85 Fed. Reg. at 17270.

[288] 40 C.F.R. § 60.34f ("a state plan must include provisions for the operational standards in this section (as well as provisions in §§60.36f and 60.37f) *or the operational standards in §63.1958*." (emphasis added)); 40 C.F.R. § 60.36f, 37f, 60. 762(b)(2)(iv)("operate the collection and control devices installed to comply with this subpart in accordance with the provisions of §§ 60.763, 60.765 and 60.766, *or the provisions of §§63.1958, 63.1960, 63.1961*" (emphasis added)); 40 C.F.R. § 60.768(e) (2016).

> *posing a fire risk], and landfill gas temperature over 135 °F indicates a possible subsurface oxidation event (SOE)[rapid and self-sustaining combustion of organic waste that is exposed to oxygen (aerobic conditions)].*[289].

Thus, it is clear from EPA's own rationale that the NSPS and EGs temperature limit of 131 is more appropriate than 145. EPA must remove all text from its CAA regulations that is inconsistent with a 131º F standard.

b. *Negative Pressure and Oxygen or Nitrogen.*

EPA should retain its negative pressure requirements from the 2016 EGs (as required). EPA should also reinstate the 5% oxygen or the 20% nitrogen standard from EPA's 1996 NSPS since exceedance of either oxygen or nitrogen standards can indicate air intrusion.

c. *Corrective Action – Temperature, Pressure, and Oxygen.*

If the prescribed standards for temperature, pressure, and oxygen or nitrogen are exceeded, then corrective action should include repairs or adjustments to the GCCS and any actions necessary to manage the presence or risk of a subsurface fire. In addition, ongoing monitoring and reporting of these parameters along with carbon monoxide content and methane content should be required. This monitoring should continue until the monitored parameters have stabilized to conditions that indicate that methanogenic decay has resumed or the fuel for the fire is exhausted.

d. *Increased Frequency of Wellhead Monitoring Following a Fire or Thermal Event.*

Wellhead monitoring is typically required on a monthly basis. [290] EPA should retain this frequency. [291] However, EPA should require more frequent monitoring of these parameters when there has been a thermal event or fire at an MSW landfill. Once the thermal event or fire has been identified, the operator should monitor the temperature, oxygen, carbon monoxide, and methane content daily until conditions stabilize. Then, for the next 6 months the operator should be required to monitor for oxygen and temperature bi-weekly and prepare a report that conditions have stabilized, demonstrating that further risk of fire and a thermal event is not present. This is warranted given the significant consequences of a landfill fire and the risk to surrounding communities.

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[289] National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 84 Fed. Reg. at 36691 (*citing* SWANA/National Renewable Energy Laboratory (NREL), *Landfill Gas Operation and Maintenance Manual of Practice* 9-8 (1997), https://www.nrel.gov/docs/legosti/fy97/23070.pdf) (emphasis added).
[290] 40 C.F.R. § 60.37f(a)(1)-(3).
[291] EGs requires monthly monitoring of pressure, temperature, oxygen, and nitrogen at wellheads. *Id*. Oregon requires monthly monitoring of the wellhead to determine pressure, temperature and nitrogen and oxygen content of gas emissions. Or. Admin. R. 340-239-0600(3).

E. Control Device Performance Testing.

The EGs and NSPS require minimal demonstration of control device destruction efficiency. For non-enclosed flares, operators must comply with general requirements to operate and maintain the devices according to their design.[292] For other control devices, an initial performance test to determine the destruction efficiency of the control device is required, but no timeline is provided for subsequent tests.[293]

In contrast, California and Oregon's landfill methane regulations require both an initial performance test and subsequent annual testing of GCCS control devices.[294] For control devices that meet performance standards in three consecutive tests, testing frequency is reduced to once every three years, as long as the device stays in compliance.[295] California provides an exception to this requirement for the limited cases where non-enclosed flares are allowed under its regulation because of difficulties with source testing open flares.[296]

EPA should revise its CAA regulations to require more frequent performance testing for GCCS control devices. Specifically, EPA should adopt the same requirements issued by the states of California and Oregon. These states require an initial performance test and subsequent annual performance tests, with an option to reduce the frequency to once every three years for control devices that meet standards for at least three consecutive testing periods.

VI. EPA Must Revise Its CAA Section 111 Regulations to Set Standards Based on the Use of Landfill Cover.

The material placed on top of solid waste at a landfill, referred to as landfill cover, can greatly influence how well methane is controlled. Cover material, design, and application can reduce landfill methane emissions by inhibiting the flow of gases, by removing methane from the gas that is released, and by reducing infiltration of rain and snow melt into the landfill.[297] As discussed in more detail below, cover can also increase the efficiency of the GCCS.

Despite the effect of cover on landfill emissions, requirements for landfill cover are primarily set forth in solid waste regulations issued under RCRA.[298] In fact, EPA acknowledged in its last CAA section 111 rulemaking for landfills that cover can achieve emission reductions.[299] But EPA determined that cover is not BSER because it is addressed in RCRA, which is a legally invalid reason for dismissing a technology. Multiple studies show that cover is a feasible technology that can reduce methane emissions at landfills. Therefore, cover constitutes part of BSER for landfills and EPA must revise its CAA rules to require landfill cover.

[292] 40 C.F.R. § 60.33f(c), 60.762(b)(2)(iii); 40 C.F.R. § 18(d) (1971).
[293] 40 C.F.R § 60.33f(c), 60.762(b)(2)(iii).
[294] Cal. Code Regs. tit. 17 § 95464(b)(4); Or. Admin. R.340-239-0110(2)(f)(A).
[295] Or. Admin. R. 340-239-0110(2)(f); Cal. Code Regs. tit. 17 § 95464(b)(4).
[296] CARB Staff Report, *supra* note 27, at V-4.
[297] Hanson & Yesiller, *supra* note 233, at 22.
[298] *See* 40 C.F.R. § 258.60 (1991).
[299] *See* Section VI.B. for further discussion.

A. Background.

Cover practices differ based on when cover is applied during a landfill's life. Generally speaking, the types of cover (based on landfill life stage) are daily, intermediate and final. Daily cover is applied at the end of daily operations to control scavenging, odors, fires, disease vectors, and litter.[300] Under RCRA regulations, daily cover must be a minimum of six inches of earthen materials unless alternative cover is approved.[301] Intermediate cover is not defined or required under any federal regulations, including RCRA. However, it is defined in some state regulations as twelve inches of material that is applied during an interim period, sometimes 180 days.[302] For final cover, RCRA regulations require that placement of cover must begin within 30 days of a landfill unit's final receipt of waste and closure must completed within 180 days.[303] Once the landfill has been closed, the cover must be maintained and repaired as needed for 30 years.[304] Final cover must consist of 18 inches of impermeable soil[305] and six inches of topsoil to support a vegetative layer.[306] As with daily cover, alternative final covers may also be approved[307] and requirements for cover materials, thickness, and permeability are set forth in RCRA regulations.

Design elements that affect flow of landfill gas through the cover include the type of cover applied and the depth, as discussed above.[308] The flow of gas through the surface of a landfill is referred to as "flux." A CaliforWnia study of landfill gas flux through cover soils found that, in general, soil covers had the lowest fluxes and that alternative covers, in particular highly porous materials with low densities such as autofluff and green waste, had the highest fluxes.[309] The study also found that increased thickness and density of the cover material was correlated with reduced emissions.[310] The overarching conclusion of the California study was that "[h]igh waste in place, high daily waste throughput, and large working face (i.e., active, uncovered waste placement area during operational hours at a landfill, which ranged between 65 and 12,100 m2 in the investigation) likely resulted in high emissions."[311]

300 *See* 40 C.F.R. § 258.21(a) (1991).
301 *Id.*
302 *See e.g.* 39 Tex. Admin. Code § 330.165(2006); Fla. Admin. Code Ann. r. 62-701.500(2015); Cal. Code Regs. tit. 27 § 20700(a) (1997). EPA's Greenhouse Gas Reporting Program defines intermediate cover as "the placement of material over waste in a landfill for a period of time prior to the disposal of additional waste and/or final closure as defined by state regulation, permit, guidance or written plan, or state accepted best management practice." 40 C.F.R. § 98.348 (2009). However, the GHRP does not set any requirements for emissions control and addresses only the reporting of information.
303 40 C.F.R. § 258.60(f), (g) (1991).
304 40 C.F.R. § 258.61(a) (1991).
305 The final cover should have a permeability less than that of the liner system and no greater than 1×10^{-5} cm/sec. 40 C.F.R. § 258.60(a)(1)-(3).
306 40 C.F.R. § 258.60(a).
307 40 C.F.R. § 258.60(b).
308 Generally, coarser textured soils have higher rates of methane oxidation. David Kightley, et. al, *Capacity for Methane Oxidation in Landfill Cover Soils Measured in Laboratory-Scale Soil Microcosms,* Applied & Env't Microbiology 592, 593 (1995), https://doi.org/10.1128/aem.61.2.592-601.1995.
309 Hanson & Yesiller, *supra* note 233, at 13.
310 *Id. at* 350.
311 *Id. at* 3.

Cover, especially when using low-permeability materials like clay, can also reduce the infiltration of rain into a landfill.[312] This delays the release of methane because increased moisture accelerates the process of decomposition.[313] Limiting entry of precipitation into a landfill also reduces the risk of wellhead flooding, which can significantly inhibit collection system efficiency, as described above in Section V.B.3.e.

1. Landfill Cover Operational Practices.

Cover management practices can be critical for controlling landfill emissions, particularly during the daily and intermediate phases, which typically control gas less effectively than final cover.[314]

In general, earlier application of thicker cover will help to decrease emissions and minimize exposed surface during daily operations.[315] CARB recently analyzed the correlation between methane emissions measured at California landfills and conditions at those landfills, including age, cover type, and waste depth. Its results showed that the percent of a landfill under final cover had the strongest negative correlation with methane emissions.[316] In addition, three of the five recommendations that CARB developed following the assessment relate to cover. These are:

> (1) for daily cover: "minimize [the] area and duration of coverage [and] install intermediate cover within days – not weeks - of waste placement;[317]
> (2) for intermediate cover: "increase thickness up to 1 meter (about 3 feet)" with fines content over 30%, and minimize area; and[318]
> (3) for final cover, thickness of over 150 cm (about 4.9 feet), fines over 60%, clay over 12%, plasticity over 20%. [319]

Thus, early application of more effective cover materials is an effective methane control practice.

One simple way that EPA can improve its regulations is to require interim or intermediate cover, which is not mandated even under RCRA regulations but is required by some states. As

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[312] *See* Jyoti K. Chetri & Krishna R. Reddy, *Advancements in Municipal Solid Waste Landfill Cover Systems: A Review*, 101 J. Indian Inst. Sci. 557 (2021), https://doi.org/10.1007/s41745-021-00229-1.
[313] 5 IPCC, *2006 IPCC Guidelines for National Greenhouse Gas Inventories: Waste*, 3.16 (Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara, & Kyoto Tanabe, eds., 2006), https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html; 2019 Technology Review Memo, *supra* note 9, at 18.
[314] Multiple studies have examined and shown that landfills with intermediate and final cover better control emissions. One such example includes Teapot Dome, where the area of daily cover accounted for 15.5% of the total covered area (the rest was intermediate cover), while at Redwood landfill, the percentage of daily cover was only 0.2%. Those researchers speculate that a large fraction of methane was probably emitted from the areas with highly permeable daily covers at Teapot Dome disposal site. Zhenhan Duan, et. al, *Efficiency of Gas Collection Systems at Danish Landfills and Implications for Regulations*, 139 Waste Mgmt. 269, 275 (2022), https://doi.org/10.1016/j.wasman.2021.12.023.
[315] CARB Presentation, *supra* note 238, at 9..
[316] *Id*. at 6-7.
[317] *Id*. at 9.
[318] *Id*.
[319] *Id*.

noted above, some states require application of interim cover after 180 days[320]but other states require it earlier. In Maryland, "weather permitting," intermediate cover must be placed within one month of completion of a lift of waste.[321] In Oregon, intermediate cover is required where no waste will be placed for at least 2 months.[322]

When possible, compaction of soil is also an effective operational practice. Compaction reduces soil permeability. It also "allows . . . the [GCCS] to capture more LFG without drawing oxygen into the landfill. Drawing oxygen into the landfill can [increase the risk of] subsurface oxidation events and fire hazards."[323]

Lastly, ensuring trash-to-trash contact at either the daily or intermediate cover phase helps to ensure the flow of leachate and landfill gas between lifts within a cell.[324] Practically, this can be achieved by peeling back or otherwise removing the intermediate cover.[325] Peel-back of daily cover should be considered if feasible, which will primarily depend on whether the cover is sufficiently thick and compacted. Peeling back or removing cover can conserve space in the landfill and allow for the re-use of cover material. Peeling back or removing cover also allows leachate to drain through the waste cell and avoids flooding that can impede the flow of landfill gas leading to a buildup of methane hotspots in successive layers of waste.[326]

2. Effect on GCCS Efficiency.

Cover can boost the collection efficiency of a GCCS by reducing the amount of gas that escapes into the air instead of entering the collection system. A final cover results in the highest collection efficiency, followed by intermediate cover, followed by daily cover, which yields the lowest collection efficiency.[327] Studies have found that landfills with a well-designed final cover, liner, and GCCS can have a collection efficiency as high or over 90%.[328] In addition, ensuring that intermediate and final cover are placed sooner will improve the GCCS collection efficiency sooner in those areas, improving the efficiency of the system overall.[329]

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[320] 39 Tex. Admin. Code § 330.165(2006); Fla. Admin. Code Ann. r. 62-701.500 (2015) ; Cal. Code. Regs. tit. 27 § 20700(a).
[321] COMAR 26.04.07.10(c)).
[322] Oregon DEQ, *Solid Waste Landfill Guidance: Section 9 (Operations)* 9-10, https://www.oregon.gov/deq/FilterDocs/SWGuidance09.pdf.
[323] RMI MSW Report, *supra* note 151, at 49.
[324] *Id*.
[325] *Id*.
[326] *Id*. at 23.
[327] 2019 Technology Review Memo, *supra* note 9, at 28.
[328] *See* Kurt Spokas, et al., *Methane Mass Balance at Three Landfill Sites: What is the Efficiency of Capture by Gas Collection Systems?*, 26 Waste Mgmt. 516 (2006), https://doi.org/10.1016/j.wasman.2005.07.021; R. Huitric & D.Kong, *Measuring Landfill Gas Collection Efficiencies Using Surface Methane Concentrations*, Solid Waste Ass'n of N.A. 30th Landfill Gas Symposium, (2006).
[329] 2019 Technology Review Memo, *supra* note 9, at 29 (*quoting* 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, Version 2.2 (Jan. 2009), https://www.scsengineers.com/wpcontent/uploads/2015/03/Sullivan_SWICS_White_Paper_Version_2.2_Final.pdf.

3. Methane Oxidation and Biocovers.

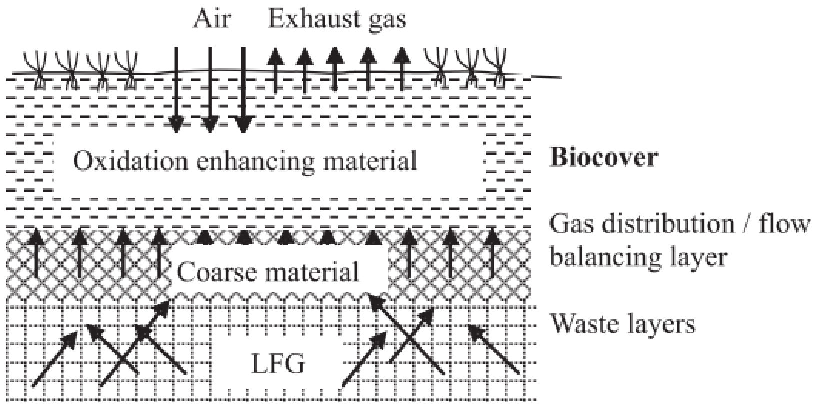
Landfill cover can also be used to directly reduce methane before it enters the air through oxidation, a biological process in which methanotrophic bacteria oxidize methane, transforming it into carbon dioxide.[330]Cover material is one of the primary factors influencing methane oxidation because oxidizing bacteria cannot live in certain materials, such as geomembranes. Numerous factors[331] can influence methane oxidation in landfill cover soils, including the cover material, moisture, temperature, texture, and daily/interim cover maintenance. Temperature plays a critical role as methane oxidation is minimal below 5° Celsius (about 40° Fahrenheit).[332]

While oxidation generally occurs in most soils, biocovers—an engineered bioactive layer promoting conditions that enhance and support oxidation by methanotrophic bacteria—can be applied above existing landfill covers to improve methane oxidation and reduce emissions of methane.[333] Biocovers typically consist of a layer of oxidizing material spread over a layer of coarse materials that promotes even distribution of the gas. [334] The design of biocovers promotes methane oxidation because biocover has greater porosity and thermal insulation than traditional landfill cover.[335] Biocovers can be used alone during the early stages of a new landfill, as a supplement to a GCCS to capture fugitive emissions or to reduce emissions at closed landfills.[336] Research has also shown that biodegredation of NMOC occurs with biocovers, including a reduction in VOCs.[337]

For reference, the design of an ideal biocover system is presented in **Figure 2** below:

[330] Mohammed Abushammala, et al., *Methane Oxidation in Landfill Cover Soils: A Review*, Asian J. Atmospheric Env't= 4 (2014), https://doi.org/10.5572/ajae.2014.8.1.001; Muna Albanna, et al., *Methane Oxidation in Landfill Cover Soil; The Combined Effects of Moisture Content, Nutrient Addition, &Cover Thickness*, 6 J. Env't Eng'g & Sci. 191–200 (2007), https://doi.org/10.1139/s06-047.
[331] "Like many soil biogeochemical processes, methane oxidation is affected by the pH of cover soils […] Methanotrophs primarily exist in circumneutral pH soils." Birgit W. Hütsch, et al., *Methane Oxidation in Soil as Affected By Land Use, Soil Ph &N Fertilization,* Soil Biology and Biochemistry (1994), https://doi.org/10.1016/0038-0717(94)90313-1.
[332] Alla N. Nozhevnikova et .al., *Emission of methane into the atmosphere from landfills in the former USSR*, 26 Chemosphere 401(1993), https://doi.org/10.1016/0045-6535(93)90434-7; Dawit Tecle et al., *Quantitative Analysis of Physical and Geotechnical Factors Affecting Methane Emission in Municipal Solid Waste Landfill*,56, Environmental Geology 1135 (2009), https://doi.org/10.1007/s00254-008-1214-3.
[333] *See* Marion Huber-Humer et al., *Biotic Systems to Mitigate Landfill Methane Emissions* 26(1) Waste Mgmt. & Rsch. 33(2008), https://pubmed ncbi.nlm.nih.gov/18338700/.
[334] *See id*; *see also* EPA, Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Municipal Solid Waste Landfills 17 (2011) [hereinafter "2011 EPA Emerging Technologies Report"]. In 2011, EPA estimated that a biocover could reduce methane emissions by 32% and would cost $48,000/acre. *Id.* at 9, 17.
[335] Huber-Humer et al., *supra* note 333.
[336] 2019 Technology Review Memo, *supra* note 9, at 26 (*quoting* Helene Hilgeret al., *Reducing Open Cell Landfill Mane Emissions with a Bioactive Alternative Daily Cover* (June 2009), https://www.osti.gov/servlets/purl/971176).
[337] 2019 Technology Review Memo, *supra* note 9, at 27; Hanson & Yesiller, *supra* note 233, at 23.

Figure 2: Conceptual diagram of a biocover landfill system[338]



In their Proposed Regulatory Framework, Canada also includes an engineered biocover system, biofilter or other device utilizing thermal or biological oxidation processes that can demonstrate 90% destruction efficiency as a requirement for methane destruction.[339] It is worth noting that Canada included this requirement alongside flares and a GCCS in its list of methane destruction devices or treatment systems as being part of an operator's landfill methane control approach design. The Proposed Regulatory Framework also includes monitoring requirements to ensure methane destruction via oxidation is maintained in biosystem designs.[340]

B. <u>EPA's Previous Statements on Landfill Cover as a Control Measure.</u>

As stated above, EPA's CAA regulations do not set forth cover requirements for controlling landfill methane. These rules require cover maintenance and monitoring cover integrity and implementing cover repairs "as necessary on a monthly basis," as procedures for compliance with the surface methane limits.[341] However, they do not set requirements for cover materials or timing of application. EPA has previously acknowledged landfill cover as an effective methane control measure but failed to establish cover requirements for reasons that are not legally sound.

In EPA's 2014 proposed rule for the NSPS and EGs revision, the Agency recognized that biocovers and "innovative final cover practices at MSW landfills have the potential for achieving a moderate amount of methane emission reductions," but declined to incorporate cover into the

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[338] Huber-Humer et al., *supra* note 333.
[339] ECCC Proposed Regulatory Framework, *supra* note 14.
[340] Annual in situ testing to monitoring temporal changes to microbial oxidation capacity and of media properties (including, but not limited to, bulk density, organic matter, moisture etc.) and semi annual monitoring of the biocover surface to identify fissures and erosion and to confirm the biocover is properly draining are listed as possible monitoring requirements. *Id.*
[341] "[T]he owner or operator must implement a program to monitor for cover integrity and implement cover repairs as necessary on a monthly basis." 40 C.F.R. § 60.36f(c)(5), 60.765(c)(5). Cover is also mentioned in the EGs and NSPS however (in reference to operational standards for collection and control systems). *See* 40 C.F.R. § 60.34f(b)(2),(d), 60.763(b)(2). Cover is also mentioned in the EGs and NSPS in regard to the design of the GCCS. *See* 40 C.F.R. § 60.769(a)(1), 60.40f(a)(1). However, these requirements are not sufficiently specific to reduce emissions.

regulations because "final cover practices are currently addressed under [RCRA regulations] not under the CAA.[342] As a result, the EPA does not currently consider them to be BSER."[343] This is not an adequate legal justification. First, RCRA itself contradicts this reasoning where Subtitle A states that "[t]he owner or operator of a municipal solid waste landfill unit must comply with any other applicable Federal rules, laws, regulations, or other requirements."[344] Further, neither CAA section 111[345] nor its implementing regulations[346] allow EPA to omit a practice or technology from consideration solely because it is required in EPA regulations issued under a different statute.[347] Thus, the fact that RCRA addresses final cover practices is not an adequate reason for EPA's failure to include cover requirements in its CAA section 111 regulations. If EPA must update its RCRA regulations in order to harmonize them with cover requirements in revised CAA section 111 rules, then EPA should do so.

C. Recommendations.

EPA must revise its CAA section 111 standards for landfills to include cover requirements. First, EPA must require the use intermediate cover, and if necessary, revise its RCRA rules accordingly to include those same intermediate cover requirements. EPA must also include the same RCRA requirements for daily and final cover, with a few improvements discussed in detail below. EPA should also define standard cover material in a way that ensures the oxidation of methane, and does not allow alternative covers unless an operator can demonstrate those covers oxidize methane sufficiently. In addition, engineered biocovers should be required at landfills that do not have a GCCS or where the GCCS has been shut down. Finally, EPA must also include adequate recordkeeping and reporting requirements, including cover design plans in its revisions.

1. Requirements for Daily, Intermediate, and Final Cover.

EPA should revise its CAA regulations to establish requirements for daily, intermediate, and final cover. It is imperative that EPA require use of intermediate cover as even its RCRA regulations currently lack this requirement. For daily and final cover, the existing RCRA requirements[348] can generally be used with a few improvements. EPA must base its CAA requirements on practices that will effectively control methane within the legal standards prescribed in CAA section 111. If it is necessary for EPA to revise its RCRA regulations for landfills to harmonize them with the CAA requirements, then EPA should do so.

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[342] Standards of Performance for Municipal Solid Waste Landfills, 79 Fed. Reg. at 41804.
[343] *Id*.
[344] 40 C.F.R. § 258.3.
[345] *See* 42 U.S.C. § 7411.
[346] The Section 111 implementing regulations are also silent on this issue, and do not state or insinuate that practices addressed under other regulations cannot be considered BSER under Section 111. *See* 40 C.F.R. §60.1 et. seq.
[347] *See New York v. Reilly*, 969 F.2d at 1153 (finding that EPA did not justify its failure to include a lead-acid battery ban in section 111 rules for incinerators when it cited strict RCRA provisions "against the burning of lead-acid batteries" and plans to address the issue under CERCLA, stating that "the mere existence of other statutory authority which might undergird EPA's final stance is insufficient to justify the omission of the battery ban.")
[348] 40 C.F.R. § 258.60.

EPA must revise its CAA regulations for landfills to require the application of intermediate cover. With respect to timing, EPA should follow Maryland's model and require that intermediate cover must be placed within one month of completion of a lift of waste.[349] This would be a conservative approach given that CARB recently recommended that intermediate cover should be applied "within days – not weeks - of waste placement."[350] EPA should also require the use of oxidizing materials for intermediate cover and establish requirements relating to permeability, including compaction of soil.[351]

For daily cover, EPA should generally adhere to existing RCRA requirements with three exceptions. First, the use of alternative materials (other than soil) is addressed in more detail in Section VI.C.2 below. Second, daily cover applied to a landfill area where a GCCS is installed should be compacted in order to decrease permeability.[352] Third, peel-back or removal should be required where feasible if daily cover impedes gas flow or leachate flow within a cell.[353]

For final cover, RCRA regulations should be incorporated with the following exception. Final cover should be required on parts of the landfill that have reached their final contours instead of allowing the installation of final cover "only when the entire landfill has reached capacity and is no longer accepting waste for disposal."[354]

2. <u>Cover Materials.</u>

Under EPA's current regulations, use of alternative material (other than soil) is allowed for daily cover and this has resulted in the use of inappropriate materials, such as automotive shredder fluff, that cannot be expected to control odor, impede gas flow, reduce stormwater infiltration, or remove methane through oxidation.[355]

EPA should establish default standards for cover material. The standards should require that cover material should consist of soils, with minimum requirements for permeability in covers that will be in place for an extended period of time (intermediate and final covers) to reduce the permeability of the cover. Selection of soils should also consider properties that would promote oxidation such as texture, porosity, and pH.

Alternative cover should rarely, if ever, be used. EPA's regulations should require that alternative cover may be used only upon approval by the appropriate agency following a demonstration by the landfill operator that the material is at least as effective as standard cover. The demonstration must show that alternative cover is as effective as standard cover at reducing methane flux, by showing that it either oxidizes methane or that it is as impermeable as standard

[349] COMAR 26.04.07.10(E).
[350] CARB Presentation, *supra* note 238 at 9.
[351] *See e.g.* RMI MSW Report, *supra* note 151, at 49.
[352] *Id*.
[353] *Id*.
[354] *Id*.
[355] For example, the Alabama Department of Environmental Management allows the use of autoshredder fluff as alternative daily cover for the Arrowhead Landfill in Uniontown, Alabama. Ala. Dep't of Env't Mgmt, Solid Waste Disposal Facility Permit, No. 53-03-Arrowhead Landfill (2023) at 8, 15. However, CARB found that "[t]he highest methane fluxes were generally from alternative daily covers and in particular from autofluff. These thin, highly porous daily covers provided low resistance to methane flux." Hanson & Yesiller, *supra* note 233, at 5.

cover. The operator should also show that the alternative does not contribute to hazards in the landfill such as emissions of hazardous air pollutions.[356]

3. General Maintenance Best Practices.

In addition to the requirements above, EPA should also establish more specific requirements for cover maintenance and repair than the generalized requirements currently set forth in its CAA regulations.[357]

- Ongoing maintenance: monitor, maintain, and repair the cover in all portions of the landfill on an ongoing basis.[358]
- Erosion control: cover materials must be stabilized to prevent erosion.[359]
- Integrity of cover on side slopes: Ensure integrity and effectiveness of cover on side slopes using practices such as benching to allow regular access for maintenance and installing biocover where slopes are too steep to allow for compaction.[360]

4. Biocovers.

EPA should also require the use of biocovers under the NSPS, EGs, and NESHAP. An engineered biocover should be required at landfills that have no GCCS or where a GCCS has been shut down. In addition, landfill operators at which a GCCS is operated should be required to address the feasibility of using a biocover in the cover design plan and the cover operations and maintenance plan.

The biocover should consist of two layers: a gas distribution layer and an oxidation layer. The gas distribution layer should be comprised of gravel, broken glass, sand, or similar coarse material.[361] The oxidation layer should consist of soil, compost, mulch, peat or other organic material with demonstrated oxidizing capacity.[362] The oxidation layer should be stabilized with vegetation to prevent erosion and help to control moisture in the cover.[363]

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[356] A study of landfill cover practices in California found that not only were methane fluxes higher through alternative daily covers, but that the flux of non-methane volatile organic compounds (NMVOCs) through alternative daily cover was higher also. While the research did not distinguish between emissions generated by the landfill waste and the cover, the authors theorized that alternative covers such as autofluff and contaminated soil covers could act as sources of NMVOCs. Hanson & Yesiller, *supra* note 233, at 336.
[357] *See, e.g.*, 40 C.F.R. § 60.765 ("The following procedures must be used for compliance with the surface methane operational standard . . . The owner or operator must implement a program to monitor for cover integrity and implement cover repairs as necessarily on a monthly basis.")
[358] RMI MSW Report, *supra* note 151, at 49.
[359] *Id*.
[360] *Id*. at 50.
[361] Huber-Humer et al., *supra* note 333;; Bala Yamini Sadasivam et al., *Landfill Methane Oxidation in Soil and Bio-based Cover Systems: a Review*, 13(1) Revs. in Env't Sci. and Bio/Technology 79 (2014), https://doi.org/10.1007/s11157-013-9325-z.
[362] Sadasivam et al., *supra* note 361.
[363] Huber-Humer et al., *supra* note 333.

5. <u>Recordkeeping and Reporting Requirements.</u>

EPA should establish recordkeeping and reporting requirements to ensure compliance with cover requirements for landfills. Specific recommendations are set forth below.

- Daily and intermediate cover operations and maintenance records:
    - Operator must daily record the depth of cover applied and the materials used in a Daily Cover Log. The Daily Cover Log must also include:
        - The cells at which daily cover is applied;
        - Any repairs made to the cover;
        - Any odors noted; and
        - Note that peel back was performed during waste disposal.
    - Operator must maintain an Intermediate Cover Log and record the depth of cover applied and materials used. The Intermediate Cover Log must include:
        - The cells at which intermediate cover is applied;
        - Any repairs made to the cover;
        - Any odors noted; and
        - Note that peel back was performed during waste disposal.
- Operators must record deviation and malfunction reports for when the cover system malfunctions.
- For MSW landfills with a Title V permit, the operator must include in their Semi Annual reports the materials used for daily, intermediate and final cover and also include any malfunctions or deviations from compliance in the Semi Annual report.
- The Annual Report must include:
    - The materials used for daily, intermediate and final cover;
    - Most recent topographic map of the site showing the areas with final cover and a geomembrane and the areas with final cover without a geomembrane with corresponding percentages over the landfill surface;
    - Amount of waste in place;
    - Daily waste acceptance rate;
    - Annual rainfall amount for the area in which the landfill is located;[364]
    - Annual temperature range (e.g. highest summer temperature and coldest winter temperature) for the area in which the landfill is located;[365] and
    - If applicable, the most recent waste characterization study or analysis performed.

VII. EPA Should Require that Landfill Cells Are Designed to Minimize the Active Face.

As described above, EPA's current CAA regulations for landfills include requirements for the design of the GCCS but do not address the design of the landfill cells themselves. In response to the recent findings by CARB about the origin of large landfill emission plumes, EPA should require that, where feasible, landfills and landfill cells are designed to minimize areas that are difficult to effectively control.

[364] RMI MSW Report, *supra* note 151, at 19, 51.
[365] *Id.*

Specifically, EPA should require that landfills are designed to minimize the landfill's active face, sometimes also called the working face. This is the area where active waste disposal is taking place. The active face is difficult to effectively cover, difficult to monitor unless using a drone or other automated technology, and more difficult for GCCS installation than other areas of the landfill. For these reasons, this area should be minimized.

As described in Section VI.A. above on cover practices, CARB recently reviewed the results of airborne measurements of landfill methane conducted in California. These airborne methane surveys were conducted from 2016 to 2018, with supplemental surveys in the following years. They showed large, persistent plumes of landfill methane were emanating from areas of activity on the landfill, including the active face, areas with on-going construction, and gaps in intermediate cover.[366] This is likely at least partly related to the fact that active waste disposal activities inherently make the active face difficult to cover. Minimizing the active disposal area (working face) can result in decreased emissions from the exposed waste.[367] After analyzing the correlation between these measurements and landfill conditions, CARB recommended to "limit the area of active waste placement (working face)"[368] in addition to improving cover practices and limiting the placement of wet waste on the landfill.[369]

The active face is also exempted from the areas of the landfill at which surface methane monitoring must occur under EPA[370] and state regulations.[371] This is likely because of potential safety risks to the person performing the monitoring in addition to the difficulty that would be involved in taking corrective action in response to exceedances. While some gas collection technology, such as horizontal collectors, can be in newer cells where there is active waste placement, this poses risks that must be addressed through engineering and planning, as described in Section V.B.2.c above.[372] Requiring that landfills be designed to have the smallest active face possible at any given time would help to minimize these obstacles to effective monitoring and emissions control.

VIII. EPA Must Revise Its Regulations to Allow Organics Diversion as an Alternative Compliance Mechanism.

EPA must revise its CAA regulations to allow the use of organics diversion as an alternate compliance mechanism. EPA has recognized multiple times that diversion of organic materials is an effective way to reduce landfill methane. It is possible that all landfill operators will not be able implement an organics diversion program, but many will. In fact, a landfill

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[366] Duren et al., *supra* note 19, at 2, 36-37; Cusworth et al., *supra* note 264.
[367] RMI MSW Report, *supra* note 151, at 48.
[368] CARB Presentation, *supra* note 238.
[369] Hanson & Yesiller, *supra* note 233, at 351; CARB Presentation, *supra* note 238, at 9.
[370] *See e.g.* 40 C.F.R. § 60.34f(d) (requiring monitors at "opening … within an area of the landfill where waste has been placed and a [GCCS] is required.") The GCCS is required to be operated such that it collects gas from each area, cell or group in which solid waste has been in place for 5 years at an active landfill. 40 C.F.R. §60.34f(a)(1),60.763(a)(1). Operators are permitted to exclude dangerous areas, including those with steep slopes, from surface testing, which amounts to excluding the working face**.** 40 C.F.R. § 60.34f(d), 60.763(d).
[371] In its alternative compliance options, California and Oregon allow operators to request "alternative walking patterns to address potential safety and other issues, such as: steep or slippery slopes, monitoring instrument obstruction and physical obstructions" and " exclusion of dangerous areas from surface inspection." Cal. Code Regs. tit. 17 § 95468(a)(4),(5); Or. Admin. R. 340-239-0500(1)(c),(d).
[372] *See* 2019 Technology Review Memo, *supra* note 9, at 22-25.

operator requested this option during the development of Maryland's landfill methane rule.[373] To encourage those that are able to divert organics, EPA must identify organics diversion as an alternate compliance mechanism and establish rules for state, local, and tribal agencies to consider and approve landfill operator plans to divert organic waste rather than landfilling it.

A. Background.

Organic waste – primarily food scraps and yard waste -decaying under anaerobic conditions (without oxygen) is what produces methane emissions at landfills.[374] Organics diversion is a practice that avoids generation of methane in the first place by diverting these materials away from landfills. EPA has recognized organics diversion as a method of reducing landfill methane, stating that "[m]ethane generation at landfills is reduced proportionally to the amount of organic waste diverted."[375] In fact, in 2013, the EPA estimated that composting and anaerobic diversion practices each achieve a 95% methane reduction efficiency when compared to landfilling organic waste.[376]

B. EPA's Previous Statements on Organics Diversion as a Control Measure.

EPA has considered organics diversion in its previous CAA rulemakings. In the preambles to its final section 111 rules, issued in 2016, EPA declined to mandate organics diversion, stating that it was instead including surface methane measurements, called the " Tier 4" option, in the determination of whether a GCCS must be installed, in part to encourage organics diversion.[377] In its 2016 response to comments for that rulemaking, EPA stated that "[the Agency] continues to believe that source separation and other approaches to reducing the volume of organic materials landfilled can be effective in reducing emissions of landfill gas and strongly encourages their use."[378] However, EPA noted the following barriers to treating organics diversion as part of the BSER standard:

> the complexity and local nature of waste management; limited processing and transfer capacity for organic wastes; the multifaceted and regional nature of the solid waste management industry; and, behavioral changes needed among waste generators (individuals, businesses, and industries) to divert their organic wastes from landfills.[379]

[373] *See* Memorandum from Prince George's County, Maryland, to Maryland Department of the Environment ("MDE"), at 2 (Oct. 10, 2022), https://mde.maryland.gov/programs/regulations/air/Documents/Landfills%20Comments%20Received/DoE%20comments.pdf (Attachment E).
[374] RMI MSW Report,¸*supra* note 151, at 17-18.
[375] EPA Tech Paper, *supra* note 156, at 21. https://19january2017snapshot.epa.gov/sites/production/files/2015-12/documents/landfills.pdf. *See also* 40 C.F.R. § 258.20.
[376] EPA, *Global Mitigation of Non-CO2 GHGs Report: 2010-2030 Landfills* III-6, (2013) https://www.epa.gov/sites/production/files/2016-06/documents/mac_report_2013-iii_waste.pdf (entire report available at https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/global-mitigation-non-co2-ghgsreport-2010-2030).
[377] Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59279 ; Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59334.
[378] EPA, *supra* note 150, at 46.
[379] *Id.*

In the preamble to its proposed 2019 NESHAP rule, EPA determined that mandating waste diversion programs is not technically feasible because alternative disposal facilities are usually run by or involve third parties (not the landfill owner).[380] EPA also stated that, while a landfill owner could ban materials from its landfill, "it would not be feasible for the landfill owner or operator to enforce such bans, because policing the content of every truck passing the gate of a landfill is economically unreasonable and technically impracticable."[381]

The purported barriers identified by EPA in previous rulemakings pose challenges only in the context of mandatory organics diversion. If EPA were to identify organics diversion as an alternative compliance mechanism, it would allow landfill operators to create organics diversion programs where feasible. If organics diversion is infeasible, landfill operators could choose to comply with the other requirements in the rules. A little more than half of landfills are owned and operated by county governments, [382] which typically have broad authority over waste disposal practices in their jurisdiction as well as the ability to develop new disposal facilities. Some private landfill operators will be able to co-locate a composting or other organics diversion facility on the same property as the landfill. These operators could elect to divert organic waste from landfills rather than meeting certain other requirements in the regulations.

In addition, banning and/or reducing organic waste would not be as difficult as EPA has posited. States and local jurisdictions are increasingly requiring or encouraging diversion. As of 2021, eight states had laws on the books for keeping food scraps out of landfills and eighteen states had laws targeting yard waste according to the U.S. Composting Council.[383] Landfill operators that are already planning or undertaking organics diversion efforts would likely appreciate guidance from EPA on how the emission reductions from these programs can count toward mandatory requirements to reduce landfill methane. For example, during Maryland's landfill methane rulemaking, officials in Prince George's County, which operates a composting facility and two landfills**,** requested that the Maryland Department of the Environment allow the county to use its waste diversion program for compliance and "define how [the alternative compliance provision in the state rule] applies," stating that "our program, designed to reduce food waste entering the landfill will have a much more significant impact[] than improving the [landfill gas] system in areas of the landfill already complete."[384]

[380] National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 84 Fed. Reg. at 36686.
[381] EPA Responses to Public Comments, *supra* note 189, at 46.
[382] *Why Some Landfills are Becoming Privatized, While Others Remain Public*, Waste360 (Sept. 18, 2018), https://www.waste360.com/landfill-operations/why-some-landfills-are-becoming-privatized-while-others-remain-public. This reports notes that "[i]ncreasingly, more municipal solid waste (MSW) landfills are becoming privatized, now controlling the bulk of waste in the U.S. Today, about half of them are privately owned, with industry controlling 85 to 90 percent of permitted capacity."
[383] *Organics Bans & Mandates* U.S. Composting Council (last updated June 2021), https://www.compostingcouncil.org/page/organicsbans.
[384] *See* Memorandum *supra* note 373, at

C. Recommendations.

1. EPA Should Allow Organics Diversion as an Alternative Compliance Mechanism.

EPA should revise its CAA regulations to allow operators, with agency approval, to divert organic matter from a landfill as an alternate compliance mechanism. EPA already allows compliance alternatives in its regulations. For example, when SEM compliance monitoring exceeds the 500 ppm threshold three times within a quarter, the operator must install a new well or quarterly device unless an "alternative remedy" is approved "such as upgrading the blower, header pipes or control device."[385]

The state regulatory model for landfill methane allows agencies to approve "alternative[s] to compliance measures, monitoring requirements, test methods and procedures." [386] An operator's request for a compliance alternative must be in writing, may not be implemented without written approval, and the operator seeking approval must demonstrate that (1)"[o]ff-site migration of landfill gas is being, and will be, effectively controlled[;]" and (2) "the proposed alternatives provide an equivalent level of methane emission control, as compared with the methane controls that would have been required."[387] Further, in Oregon, the state agency "may not approve use of an alternative compliance option unless it determines the proposed alternatives will provide an equivalent level of methane emission control and effectively control off-site migration of landfill gas."[388]

EPA's regulation should be more narrowly tailored to allow only demonstrated alternatives. It is important that EPA's regulations expressly identify organics diversion as a potential alternative compliance method. For landfill operators that seek to reduce methane emissions through composting and other organics diversion programs, this will help to provide certainty that the project, if properly implemented and supported with documentation, can be approved.

2. EPA Should Establish Criteria for State Agencies to Apply When Considering Approval.

EPA should require that any request by a landfill operator to use organics diversion as a compliance alternative must be approved by the appropriate state, local, or tribal regulatory agency based on a determination. EPA should establish criteria for the information that must be submitted by the operator and the factors that an agency should assess in considering whether to approve a request. In general, agencies should be required to determine that the organics program or plan will achieve methane reductions equivalent to those that would have resulted from the landfill's compliance with the regulatory requirements. A factor in the determination should be whether there are assurances that the facility to which organic waste is diverted is or will be well-operated, will actually achieve emission reductions, and will not be a nuisance to nearby communities. When a landfill operator proposes to co-locate an organics diversion facility on the

[385] 40 C.F.R. § 60.36f(c)(4)(v).
[386] *See, e.g,* Or. Admin. R. 340-239-0500(1).
[387] Or. Admin. R. 340-239-0500(2).
[388] *Id*.

same site, the organics diversion facility itself can be subject to operational requirements. EPA should establish a clear regulatory framework for how agencies are to make this decision.

Among other things, EPA's regulations should establish a methodology for estimating methane emission reductions resulting from diverting organic waste from a landfill. Given that all official landfill emissions data is estimated based on methodology developed by regulators, EPA can also estimate methane reductions from diverting organic waste instead of landfilling it.[389]

Organics diversion is a demonstrated method of reducing landfill methane emissions and will be feasible for many landfill operators. EPA must revise its CAA section 111 regulations to allow organics diversion as an alternate compliance mechanism.

IX. EPA Must Revise Its CAA Section 112 Regulations to the Extent Necessary to Incorporate Its Revisions to the CAA Section 111 Regulations for Landfills.

EPA's regulations issued under section 112 of the CAA known as the NESHAP, cross-reference its CAA section 111 rules in some places[390] and vice versa.[391] To the extent that it would be necessary for EPA to revise the NESHAP at 40 C.F.R. Part 63 Subpart AAA in order to incorporate the Agency's revisions to the NSPS and the EGs, Petitioners hereby petition the EPA to so revise 40 C.F.R. Part 63 Subpart AAA.

X. Conclusion.

EPA's current NSPS and EGs for landfills do not reflect the best system of emission reduction required under section 111 of the CAA. The Agency leaves millions of tons of greenhouse gas reductions unobtained if it does not strengthen the emission standards for the country's third largest methane source. At a time when the world's leading scientists are warning that methane emissions must be slashed as soon as possible to stave off the worst effects of climate change, EPA must improve these regulations.[392] EPA will be compelled to act in August 2024, but it is fully authorized to commence a rulemaking now to revise and strengthen both the NSPS and the EGs for landfills. Petitioners hereby respectfully petition EPA to do so.

Thank you for your time and consideration of this petition.

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[389] As an example, Australia already has developed methods for quantifying greenhouse gas reductions from composting and other diversion projects for use in an official emissions reduction credit program. Australian Government, Federal Register of Legislation, Carbon Credits (Carbon Farming Initiative – Source Separated Organic Waste) Methodology Determination 2016, https://www.legislation.gov.au/Details/F2016L00098 ; *see also Source Separated Organic Waste*, Australian Clean Energy Regulator: Emissions Reduction Fund (Oct. 14, 2022), http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-industry/landfill-and-alternative-waste-treatment-methods/source-separated-organic-waste.

[390] *See e.g*. 40 C.F.R. § 63.1959(a) (incorporating by reference from the NSPS certain methods for calculating the NMOC emissions rate).

[391] *See, e.g.,* 40 C.F.R. § 60.762(b)(iv)(allowing an operator to choose to comply with several provisions of the section 112 standards instead of sections of the NSPS).

[392] *See* IPCC, *supra* note 2, at 22.

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Respectfully submitted,

Leah Kelly, Senior Attorney
Haley Colson Lewis, Attorney
Environmental Integrity Project
1000 Vermont Ave. NW, Suite 1100
Washington, D.C., 20005
Email: lkelly@environmentalintegrity.org (Kelly)
Email: hlewis@environmentalintegrity.org (Lewis)
Phone: (202) 263-4448 (Kelly)
Phone: (202) 263-4449 (Lewis)

Lisa Karlin
Jenny Zimmer
Harahan/River Ridge Air Quality Group
River Ridge, Louisiana 70123

Gilda Hagan-Brown
Resident of Waggaman, Louisiana

Javian Baker
Resident of Waggaman, Louisiana

Carlos Sanchez
Zero Waste Organizer
South Baltimore Community Land Trust
10 16th Ave Unit 19762
Brooklyn, Maryland 21225

Nick Lapis
Director of Advocacy
Californians Against Waste
9211 11th St., Suite 502
Sacramento, California 95814

Jane Williams
Executive Director
California Communities Against Toxics
Rosamond, California

Robin Scheider
Executive Director
Texas Campaign for the Environment/TCE Fund
3100 Richmond #290
Houston, Texas 77098

Charles Scribner
Executive Director
Black Warrior Riverkeeper
712 37th Street South
Birmingham, Alabama 35222-3206

Anne Havemann
General Counsel
Chesapeake Climate Action Network
6930 Carroll Ave #720
Takoma Park, Maryland 20912

Will Tiedemann
Regulatory Conservation Associate
Idaho Conservation League
710 N 6th Street
Boise, Idaho 83702

Darin Schroeder
Methane Legal & Regulatory Director
Clean Air Task Force
114 State Street, 6th Floor
Boston, Massachusetts 02109

Neil Carman, Ph.D.
Lone Star Chapter
Clean Air Director
Sierra Club
2101 Webster St Suite 1300
Oakland, California 94612

Peter Zalzal, Distinguished Counsel & AVP
for U.S.
Clean Air Policies
Edwin LaMair, Attorney
Environmental Defense Fund
2060 Broadway, Ste. 300
Boulder, CO 80302

John Coequyt
Director of US Government Affairs
RMI
2490 Junction Pl #200
Boulder, Colorado 80301

Katherine Blauvelt
Circular Economy Campaign Director
Industrious Labs
530 Walnut Street, Suite 200
Cincinnati, Ohio 45202