# EPA'S MUNICIPAL SOLID WASTE LANDFILL METHANE EMISSION RULES

An earlier version of this background brief was prepared in support of a convening on methane emissions from landfills conducted by the Harvard Law School Environmental and Energy Law Program in January 2024. The brief was written by Carrie Jenks and Hannah Dobie.

## Introduction

When organic waste in landfills decomposes anaerobically, methane, carbon dioxide, and hazardous pollutants are released. Landfills are the third largest methane emitter in the US and accounted for 17 percent of total US methane emissions in 2019.[1] Reducing methane emissions from landfills will be a critical part of the US contribution to the Global Methane Pledge, the goal of which is to reduce aggregate global methane emissions 30 percent from 2020 levels by 2030.[2]

EPA regulates methane emissions from landfills under Clean Air Act (CAA) section 111. This section of the CAA requires EPA to identify source categories that emit air pollutants that are anticipated to "endanger public health or welfare," and to regulate new and existing sources of those emissions.[3] In setting regulations, EPA must determine the "best system of emission reduction (BSER) . . . adequately demonstrated" and consider cost, non-air quality health and environmental impacts, and energy requirements.[4] Separately, under the Greenhouse Gas Reporting Program (GHGRP) of the CAA, a landfill must also report its emissions if they exceed 25,000 metric tons of $CO_2e$ per year.

This brief discusses EPA's existing regulatory approach to reducing methane emissions from landfills in order to inform discussions on opportunities to update the emission standards, including incorporating advanced remote-sensing technologies and data into the design of, and in compliance with, future policies.

1 US Methane Emissions Reduction Action Plan, The White House Office of Domestic Policy at 6 (Nov. 2021).

2 Fact Sheet: President Biden Tackles Methane Emissions, Spurs Innovations, and Supports Sustainable Agriculture to Build a Clean Energy Economy and Create Jobs (Nov. 2, 2021).

3 42 U.S.C. §7411.

4 42 U.S.C. §7411(a)(1).

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## Regulatory Background

In 1996, under section 111 of the CAA, EPA promulgated the original new source performance standards (NSPS) for new Municipal Solid Waste (MSW) landfills and emission guidelines (EGs) for existing sources.[5] In 2014, EPA began reviewing the 1996 regulations based on changes in the landfill industry and issued new regulations for new and existing sources in August 2016.[6] The 2016 rules were scheduled to be effective on October 28, 2016, but industry petitioned EPA for reconsideration.

On May 31, 2017, EPA, during the Trump administration, reconsidered the rule revisions, delaying their requirements.[7] On August 26, 2019, EPA published a final rule revising the timing for the 2016 EGs for existing landfills, pushing back compliance dates significantly.[8]

Following the 2020 presidential election, the DC Circuit granted the Biden administration's motion to vacate the 2019 rule and remand it to EPA for review.[9] On May 21, 2021, EPA published a final rule establishing a new federal plan to implement the 2016 EGs in the 42 states in which state plans were not submitted and in effect by May 30, 2017.[10]

Under CAA section 111, EPA is required to review and, if appropriate, revise standards of performance at least every eight years. On June 22, 2023, environmental groups submitted a formal petition (NGO Petition) requesting EPA revise the NSPS and EGs for MSW landfills, arguing that EPA has an obligation to reassess the standards by August 2024.[11] On October 31, 2023, over 50 local elected officials filed a separate letter urging EPA to update its landfill emissions standards to incorporate best available technology and practices.[12]

In addition—separate from the CAA section 111 rule—in May 2023, EPA issued a supplemental proposal to amend provisions of the GHGRP to provide for the collection of improved data, including subpart HH

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5 Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59331 (Aug. 29, 2016); Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. 59276 (Aug. 29, 2016).

6 Id.

7 Stay of Standards of Performance for Municipal Solid Waste Landfills and Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 82 Fed. Reg. 24878 (May 31, 2017). Although lawsuits challenged EPA's delays and failure to enforce the Obama-era rules, those cases were voluntarily dismissed once the stay ended. *See, NRDC et al. v. EPA*, No. 17-1157 (D.C. Cir. June 16, 2017); *California, et al. v. EPA*, No. 4:18-cv-03237.

8 Adopting Requirements in Emission Guidelines for Municipal Solid Waste Landfills, 84 Fed. Reg. 44547 (Aug. 26, 2019).

9 *EDF v. EPA*, No. 19-1222 (D.C. Cir. Oct. 25, 2019).

10 Federal Plan Requirements for Municipal Solid Waste Landfills That Commenced Construction On or Before July 17, 2014, and Have Not Been Modified or Reconstructed Since July 17, 2014, 86 Fed. Reg. 27756, 27758–59 (May 21, 2021). EPA-approved state plans: Arizona (one plan covering Pinal County and another covering the state); California (partial approval, partial disapproval); Delaware; New Mexico (one plan covering Albuquerque Bernalillo County and another covering the state); Oregon; South Dakota; Virginia; and West Virginia. Negative Declarations Approved by the EPA: Maine; Rhode Island; Vermont; Washington, DC; Philadelphia, Pennsylvania. Final State Plans and Negative Declarations Submitted to the EPA: Florida; New York. EPA Had Not Received a Final State Plan or Negative Declaration: Alabama; Alaska; Arkansas; Colorado; Connecticut; Georgia; Hawaii; Idaho; Illinois; Indiana; Iowa; Kansas; Kentucky; Louisiana; Maryland; Massachusetts; Michigan; Minnesota; Mississippi; Missouri; Montana; Nebraska; Nevada; New Hampshire; New Jersey; North Carolina; North Dakota; Ohio; Oklahoma; Pennsylvania; Puerto Rico; South Carolina; Tennessee; Texas; Utah; Virgin Islands; Washington; Wisconsin; Wyoming.

11 Petition for Rulemaking to Revise the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills (June 22, 2023) (hereinafter "NGO Petition").

12 Letter to EPA Administrator Regan (Oct. 31, 2023).

for MSW landfills.[13] In the proposal, EPA acknowledged that recent aerial studies indicate emissions are likely underestimated because they do not account for large release events and proposed to account for those events.[14] Commenters provided information on the quantification capabilities of advanced monitoring technologies to detect and quantify landfill emissions, and the ability of top-down monitoring data to improve reporting accuracy and completeness.[15]

## Clean Air Act Section 111: Best System of Emission Reduction (BSER)

Under the Clean Air Act, EPA must establish standards that 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 non-air-quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated."[16] EPA has long identified a "well-designed and well-operated gas collection and control system" "with a control device capable of reducing NMOC [non-methane organic compounds] by 98 percent by weight" as the BSER for landfills.[17]

Under this BSER, EPA established thresholds for when Gas Collection and Control Systems (GCCS) are required. A GCCS is required if an active landfill meets the following criteria:

- a design capacity greater than or equal to 2.5 million megagrams (Mg) and 2.5 million cubic meters ($m^3$);
- an NMOC emission rate of 34 Mg/year or more;[18] and
- the operator does not demonstrate that surface methane emissions concentrations are below 500 parts per million (ppm).[19]

The owner or operator must install and start up a GCCS within 30 months of exceeding a certain emission rate.[20] Once subject to the standard, the rules require operators to meet certain methane emission rates and operating limits. To meet the landfill control requirements, the owner or operator "may control the gas by routing it to a non-enclosed flare, an enclosed combustion device, or a treatment system that processes the collected gas for subsequent sale or beneficial use."[21]

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13 Revisions and Confidentiality Determinations for Data Elements under the Greenhouse Gas Reporting Rule, 88 Fed. Reg. 32852, 32855 (May 22, 2023).

14 Id. at 32877.

15 See, e.g., Comment submitted by Clean Air Task Force (CATF), Environmental Defense Fund (EDF), and RMI, Docket EPA–HQ–OAR–2019–0424 (July 27, 2023); Comment submitted by Environmental Integrity Project (EIP), Docket EPA–HQ–OAR–2019–0424 (July 27, 2023).

16 42 U.S.C. § 7411(a)(1).

17 See, e.g., Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, Proposed Rule, 80 Fed. Reg. 52100 (Aug. 27, 2015); Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills, 61 Fed. Reg. 9905, 9914 (Mar. 12, 1996).

18 Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59342.

19 This exemption is available only for landfills with a NMOC emissions rate under 50 mg/yr. 40 C.F.R. §§ 60.35f(a)(6), 60.764(a)(6).

20 40 C.F.R. §60.762. A landfill must install and operate a GCCS within 30 months of: "(A) The first annual report in which the NMOC [Nonmethane organic compound] emission rate equals or exceeds 34 megagrams per year, unless Tier 2 or Tier 3 sampling demonstrates that the NMOC emission rate is less than 34 megagrams per year, as specified in § 60.767(c)(4); or (B) The most recent NMOC emission rate report in which the NMOC emission rate equals or exceeds 34 megagrams per year based on Tier 2, if the Tier 4 surface emissions monitoring shows a surface methane emission concentration of 500 parts per million methane or greater as specified in § 60.767(c)(4)(iii)."

21 Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59342.

EPA's rules also establish requirements for how surface methane monitoring must be conducted to assess how a GCCS is performing. Surface monitoring must be conducted on a quarterly basis[22] using Method 21[23] during "typical meteorological conditions."[24] For such inspections, 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 meter (98-foot) intervals.[25] Monitoring must also be conducted in locations "where visual observations indicate elevated concentrations of landfill gas, such as distressed vegetation and cracks or seeps in the cover and all cover penetrations" but can exclude dangerous areas, including steep slopes.[26] As the NGO petition notes, "[s]ince 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."[27] EPA requires a tiered corrective action structure if owners and operators detect exceedances.[28]

## EPA's Justification for BSER

When establishing or revising any BSER under section 111, EPA must consider whether the technology or operational requirements are adequately demonstrated, the associated costs, and any non-air quality health and environmental impacts, as well as any energy requirements.

### *Adequately Demonstrated*

For the 2016 rule, EPA's proposal considered several factors to select BSER including varying the design capacity threshold, NMOC emission rate threshold, and time allowed to install and then expand the GCCS.[29] To assess these options, EPA modeled and assessed various control options on its original dataset developed for the July 2014 NSPS proposal.[30] In this BSER assessment, EPA evaluated implementation considerations and "the incremental emission reductions, cost, and co-benefits that would be achieved beyond the baseline."[31]

Based on the modeling, EPA's 2016 rules reduced the NMOC threshold of 34 Mg/year and retained the design capacity of 2.5 million Mg and 2.5 $m^3$.[32] EPA has required the use of Method 21 since the 1996

22 40 C.F.R. § 60.36f(c)(1).

23 40 C.F.R. §§ 60.36f(c)(3), 60.765(c)(1).

24 40 C.F.R. §§ 60.36f(a)(c)(3), 60.765(a)(c)(3).

25 40 C.F.R. §§ 60.36f(c)(1), 60.763(d).

26 40 C.F.R. § 60.763(d).

27 NGO Petition at 32 (citing 40 C.F.R. § 60.34f(d)).

28 See 40 C.F.R. §§ 60.36f(c), 60.765(c).

29 Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, Proposed Rule, 80 Fed. Reg. 52100, 52119 (Aug. 27, 2015); Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59331 (Aug. 29, 2016); Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. 59276 (Aug. 29, 2016).

30 Id.

31 Id. at 52121.

32 81 Fed. Reg. at 59334

regulations,[33] and EPA did not consider alternative control options or work practice standards for BSER in the 2016 rules.[34]

### *Cost*

EPA projected that the incremental annual net cost for the final rule for new sources was $6 million, which includes $11.08 million to install and operate a GCCS and conduct testing and monitoring, offset by $5.1 million in revenue from electricity sales.[35] EPA found that this would not have an appreciable economic effect on landfill cost relative to the overall cost and revenue of the industry.[36]

For existing sources, EPA estimated annual net cost would be $54.1 million in 2025.[37] This estimate includes $92.6 million to install and operate a GCCS, as well as $0.76 million to complete the corresponding testing and monitoring.[38] EPA found that this cost would be offset by $39.3 million from electricity sales for certain landfills.[39]

### *Non-air Quality Health and Environmental Impact and Energy Requirements*

EPA stated that installation of a gas collection system will generate additional gas condensate, but it can be "routed to the same leachate treatment mechanisms in place for controlling precipitation-based leachate."[40] In addition, EPA noted that "[s]econdary air impacts may include grid emissions from purchasing electricity to operate the GCCS components, by-product emissions from combustion of [landfill gas (LFG)] in flares or energy recovery devices, and offsets to conventional grid emissions from new LFG energy supply."[41] EPA considered these in the net $CO_2e$ impacts and found net reductions and that the rule would have a "very minimal impact on energy supply and consumption."[42]

## EPA-Approved Alternative Test Method

On December 15, 2022, EPA approved an alternative test method to Method 21 for landfill surface monitoring.[43] The alternative test method allows use of Sniffer Robotics unmanned aerial system, compliant with Method 21, for surface emissions monitoring. The application provided justifications for the alternative test method including that the current procedures are "physically demanding and laborious," unsafe, and have a "high degree of subjectivity" and variability.

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33 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).

34 Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. 59331 (Aug. 29, 2016); Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. 59276 (Aug. 29, 2016).

35 Standards of Performance for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59363 (using a 7 percent discount rate (2012$).

36 Id. at 59362.

37 Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 81 Fed. Reg. at 59279 (using a 7 percent discount rate (2012$).

38 Id.

39 Id.

40 81 Fed. Reg at 59362.

41 Id. at 59362–63.

42 Id.

43 EPA Approval of Other Test Method 51 (Dec. 15, 2022).

## Comparison of BSER to State Policies

The NGO petition notes that three states—California, Oregon, and Maryland—have landfill methane standards that require more stringent pollution control systems and stronger monitoring requirements than EPA's, with Washington expected to finish a rule in early 2024.[44] California, in May 2023, started soliciting stakeholder input on additional improvements to its landfill methane rules.[45]

The NGO Petition included the following table that compares EPA's thresholds for requiring GCCS to states' thresholds, noting that "[w]hile 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."[46]

### NGO Table Comparison of Size and Emission Thresholds Requiring Installation of GCCS[47]

| EPA | California | Oregon | Washington | Maryland |
|---|---|---|---|---|
| Design capacity ≥2.5 million metric tons 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; $CH_4$ generation ≥664 metric tons; Surface methane ≥200 ppm<br>--------OR---------<br>Waste in place ≥200,000 tons; $CH_4$ 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 MMBtu/hr; Surface methane ≥200 ppm | Waste in place ≥450,000 tons; $CH_4$ generation ≥664 metric tons Surface methane ≥200 ppm |

In addition, the NGO Petition notes that state rules are stronger than EPA's. Specifically, the NGO petition states:

> 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. 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 conducting the monitoring.

44 California finalized their rules in 2010, Oregon in 2021, and Maryland in 2023. Washington passed a law in 2022 leaving some details to be finalized in regulations.

45 Landfill Methane Regulation Meetings and Workshops, California Air Resources Board.

46 NGO Petition at 17.

47 Id. with formatting edits.

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) in addition to showing that levels at individual locations do not exceed 500 ppm (instantaneous monitoring). 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.

Third, the states require better reporting of surface methane levels. Maryland and Oregon require submission of a report within 30 days following sampling. California and Oregon require reporting of all instantaneous measurements above 200 ppm, and Oregon requires reporting of instantaneous measurements over 100 ppm. Maryland requires reporting of "all results of surface emissions monitoring" with levels above 100 ppm clearly identified.

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.[48]

These states' regulatory frameworks can be used as examples for EPA's future regulations.

48 NGO Petition at 32–33 (internal citations omitted).

## About the Program

The Reducing Global Methane Emissions Research Cluster seeks meaningful and sustained progress in reducing global emissions of this very important greenhouse gas — through research and effective engagement with policymakers and key stakeholders. This Cluster is supported by the Salata Institute for Climate and Sustainability at Harvard University. The Institute funds interdisciplinary research focused on producing practical solutions to some of the toughest climate challenges. The five currently-supported Clusters comprise interdisciplinary teams of researchers from across Harvard's schools, whose varied expertise is required to address the complexity of the problems that they seek to solve. Robert N. Stavins, A.J. Meyer Professor of Energy and Economic Development at Harvard Kennedy School, directs the Methane Cluster. The findings, views, and conclusions in this publication are those of the authors alone.