Advanced Monitoring to Improve Landfill Methane Detection and Capture

Landfills in Oregon are a major source of methane: a potent greenhouse gas with 80 times the near-term warming power of carbon dioxide. Fast action to cut methane is *essential* to address the climate crisis, improve local air quality, and protect public health – especially for communities living near landfills. Oregon adopted nation-leading landfill regulations in 2021, but in the years since, methane detection technologies have advanced significantly.[1] It is now clear that leveraging readily available, cost-effective monitoring technologies can more effectively identify and reduce climate pollution from Oregon's landfills, while keeping workers and nearby residents safe.

Manual monitoring methods are failing to adequately address methane pollution. Conventional surface emissions monitoring (SEM) requires a technician to walk across the landfill surface with a handheld detector once per quarter. This can involve more than 20 miles of walking across difficult terrain and weather conditions – with exposure to trip hazards, wild animals, and dangerous gases.[2] The walking SEM method fails to detect emissions that could be mitigated – due to its incomplete spatial coverage, infrequency, and susceptibility to human error or manipulation. In fact, many high-emitting areas of the landfill, such as the active working face, are excluded entirely from walking SEM. Surveys in the United States and Canada show active face emissions can represent 60-79% of total site emissions, meaning SEM effectiveness would top out at only 21-40% of emissions.[3] Furthermore, the U.S. Environmental Protection Agency issued a national enforcement alert in 2024, noting "recurring Clean Air Act compliance issues at MSW landfills leading to the significant release of methane, a climate super-pollutant, and other air pollutants" including "improper monitoring resulting in excess surface emissions of methane."[4]

Thankfully, advancements in methane monitoring technology — from satellites to aircraft to drones and fixed sensors — can fill major gaps in manual monitoring protocols and help operators capture more gas. Relative to manual methods, advanced technologies can cover more of the landfill surface area – capturing the active working face and other areas typically excluded from walking surveys. With remote sensing and fixed sensors, operators can access more frequent or even continuous data on their emissions profile, rather than a snapshot once per quarter. Further, surveys conducted with advanced methods are replicable, objective, and protect workers from hazardous, time-consuming, and physically demanding conditions.[5]

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[1] Environmental Defense Fund, *Methane Measurement Industry is Ready to Scale Up to Meet the Demand for Accurate, Real-World Data,* 2023, https://www.edf.org/media/report-methane-measurement-industry-ready-scale-meet-demand-accurate-real-world-data.
[2] U.S. Environmental Protection Agency*, Approval to Use Unmanned Aerial System Application as an Alternative to Method 21 for Surface Emission Monitoring of Landfills,* 2022, https://www.epa.gov/system/files/documents/2022-12/Barron%20Sniffer%20Alt%20with%20OTM%2051%20attached_signed.pdf.
[3] Dave Risk, *Advanced Leak Detection Technologies for Landfill Methane,* Flux Lab, 2024, https://ww2.arb.ca.gov/sites/default/files/2024-12/Session-2_FluxLab.pdf.
[4] U.S. Environmental Protection Agency, *Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements*, 2024, https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-andmaintenance.
[5] Ellie Garland, Ebun Ayandele, and Tom Frankiewicz, *Deploying Advanced Monitoring Technologies at US Landfills*, RMI, 2024, https://rmi.org/insight/waste-methane-assessment-platform/.

Figure 1: Advanced monitoring technologies deployed at landfills today

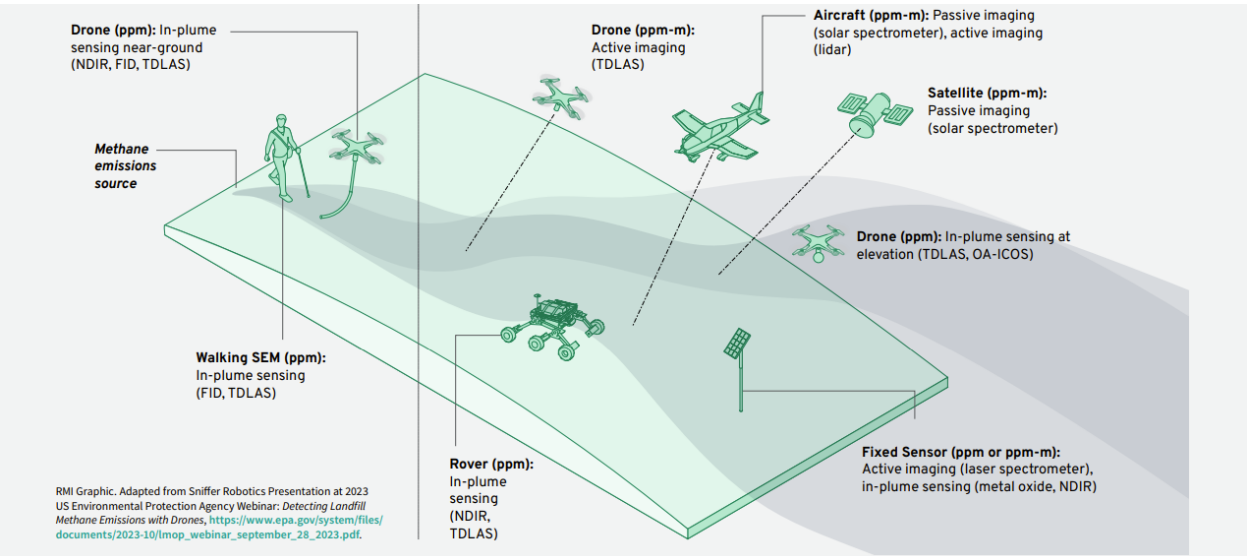

Figure 2: Advanced monitoring technologies have several advantages

Conducting landfill surveys with advanced methane detection technologies — such as satellites, aircraft, drones, rovers, and fixed sensors — can provide several benefits over conventional walking approaches. These advantages are summarized below, though they may vary by detection method (sensor) and deployment approach (platform).

Coverage: Advanced technologies can safely survey areas of the landfill excluded from current SEM, such as challenging walking terrain, steep slopes, construction areas, and the active working face. Aerial methods can efficiently scan the entire landfill surface area, enabling more extensive coverage of the landfill site.

Worker safety and efficiency: Advanced monitoring alternatives save workers from hazardous, physically demanding conditions. Walking a landfill can take multiple days, whereas an aerial survey can take less than an hour. Landfill technicians can instead focus on analyzing emissions data from advanced monitoring technologies and making the appropriate repairs, maintenance, or design improvements.

Frequency: Advanced monitoring methods can provide more frequent data than quarterly walking SEM. Fixed sensor networks can provide operators with continuous data on potential leaks across a wide variety of environmental and operating conditions. Current and planned satellite constellations also have the capability to scan large areas and identify high-emission events at frequent cadences, such as days to weeks. Drone-based surveys can be conducted more frequently, given the time savings and lower labor intensity.

Objectivity: Advanced monitoring technologies limit the risk of human error and minimize potential uncertainties around process and regulatory interpretation. Precise flight routes can also be more easily replicated.

Fast, actionable data: Advanced monitoring surveys can support and expedite the creation of more detailed monitoring reports that map measured methane concentration to specific GPS locations. Landfill operators can leverage these maps to inform quick repairs and guide operational decisions that maximize emissions reductions. This data can also support more robust recordkeeping in case of audits.

Transparency: Data collected by advanced methane detection technologies can easily be made available to the public to boost transparency, improve relations, and build trust with nearby communities or other stakeholders. For example, Carbon Mapper's detected plumes are visible to the public through their portal.

Advanced methane detection technologies can enhance operators' leak detection and repair programs, while also informing continuous improvements to landfill design and operations that can prevent fugitive emissions from occurring in the first place. With the assistance of advanced monitoring technologies, operators can improve their gas capture rates – in turn boosting energy project revenue. Operators can also save money over time by quickly remediating issues before

they develop into more costly problems. Importantly, the data collected by advanced methane detection technologies can easily and swiftly be made available to the public – improving emissions transparency and providing communities with vital information about potential exposure to health-harming pollution.[6]

Advanced monitoring technologies are cost-effective, widely available, and already being deployed by leading states and operators to identify and reduce emissions. Advanced technologies for detecting and quantifying methane are generally cheaper than walking SEM.[7] Specifically, satellite, aircraft, drone, and mobile truck methods can range from $3,000 to $14,000 per survey, and fixed sensors that take continuous measurements cost between $7,000-$30,000 per year.[8] There are dozens of companies that provide equipment and/or services for methane detection at landfills today.[9] Some remote sensing data is also publicly available free of cost.

Many landfill operators – both large private companies and municipalities – are already integrating aerial, near-ground, and continuous emissions monitoring into their operations to monitor for areas of elevated methane concentration and inform leak repairs and operational decisions. Sniffer Robotics, for example, has deployed its drone technology at more than 150 landfills, and the method has been approved by U.S. EPA as an alternative test method for SEM.[10] Imaging spectrometers on aircraft and satellites have surveyed hundreds of landfills across the United States, identifying and quantifying large emission events and prompting mitigation activities, with notable success through programs in California and Pennsylvania.[11]

In sum, these technologies are clearly beneficial for the climate, for landfill operators, and for community members – and we encourage the state to integrate these cost-effective technologies to better identify and reduce methane pollution from landfills.

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[6] In addition to methane, landfill gas contains volatile organic compounds (VOCs) and hazardous air pollutants (HAPs), as well as sulfur-based compounds – all of which can contribute to air quality issues and public health concerns.

[7] Oregon DEQ estimates that the annual cost for conducting quarterly walking SEM is roughly $60,000 per year per landfill. https://www.oregon.gov/deq/EQCdocs/100121_I_LandfillMethane.pdf

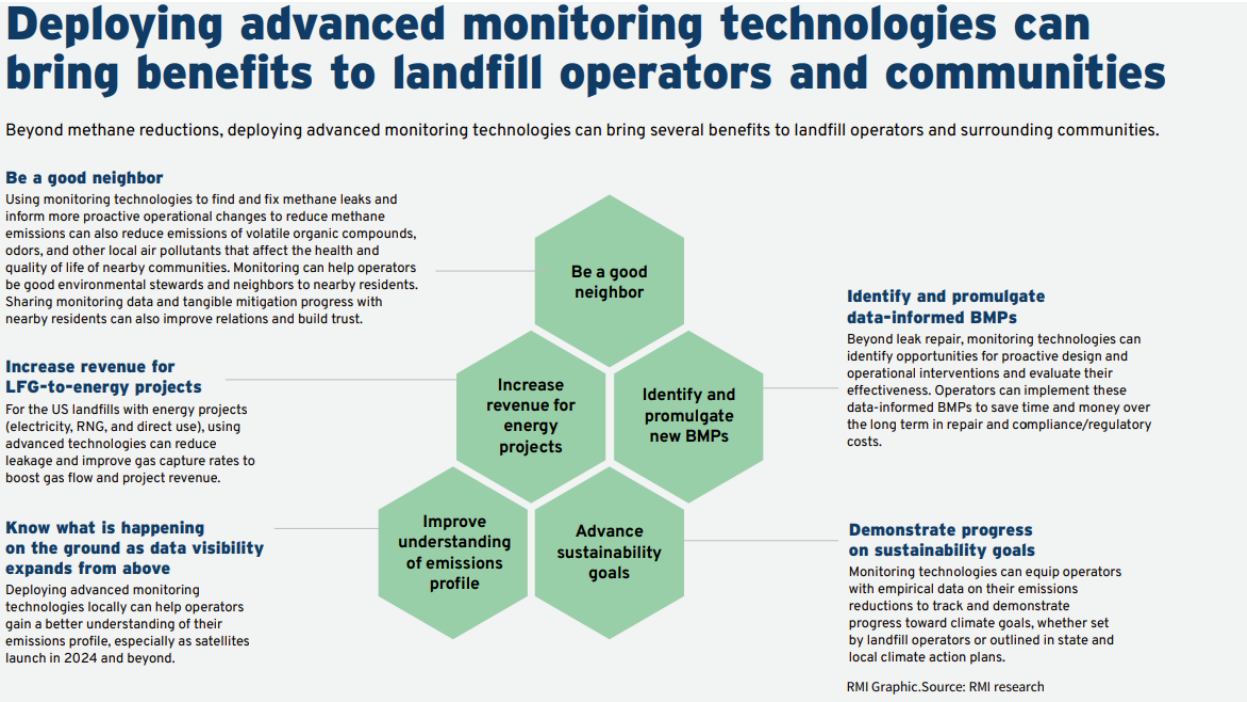
[8] Flux Lab, *A Controlled Release Experiment for Investigating Methane Measurement Performance at Landfills: Final Report*, 2024, https://erefdn.org/product/a-controlled-release-experiment-forinvestigating-methane-measurement-performance-at-landfills/

[9] The presentation notes that at least 98 advanced leak detection technologies and methodologies exist. Dave Risk, *Advanced Leak Detection Technologies for Landfill Methane,* Flux Lab, 2024, https://ww2.arb.ca.gov/sites/default/files/2024-12/Session-2_FluxLab.pdf.

[10] Sniffer Robotics, "US EPA Approves the SnifferDRONE™ for Monitoring Landfill Methane Emissions," Waste Dive, 2023, https://www.wastedive.com/press-release/20221230-us-epa-approves-the-snifferdronetm-for-monitoring-landfill-methane-emissions/; U.S. EPA, *LMOP Webinar: Detecting Landfill Methane Emissions with Drones*, 2023, https://www.epa.gov/system/files/documents/2023-10/lmop_webinar_september_28_2023.pdf

[11] Cusworth, D. et al., "Quantifying methane emissions from United States landfills," *Science*, 2024, https://www.science.org/doi/10.1126/science.adi7735; California Air Resources Board, *Summary Report of the 2020, 2021, and 2023 Airborne Methane Plume Mapping Studies,* 2024, https://ww2.arb.ca.gov/sites/default/files/2024-04/2020-2021-2023%20Airborne%20Summary%20Report_FINAL.pdf; Pennsylvania Department of Environmental Protection, *Pennsylvania Methane Overflight Study: Final Report,* 2022, https://greenport.pa.gov/elibrary/PDFProvider.ashx?action=PDFStream&docID=5424315&chksum=&revision=0&docName=PENNSYLVANIA+METHANE+OVERFLIGHT+STUDY+FINAL+REPORT&nativeExt=pdf&PromptToSave=False&Size=1376071&ViewerMode=2&overlay=0.

Figure 3: Benefits of deploying advanced monitoring technologies



Additional Resources on Advanced Monitoring at Landfills

- Ellie Garland, Ebun Ayandele, and Tom Frankiewicz, *Deploying Advanced Monitoring Technologies at US Landfills*, RMI, 2024, https://rmi.org/insight/waste-methane-assessment-platform/.
- U.S. Environmental Protection Agency, *White Paper Series: Municipal Solid Wate Landfills-Advancements in Technology and Operating Practices*, "Aerial Monitoring for Examining Landfill Methane Emissions" (October 2024), https://www.regulations.gov/document/EPA-HQ-OAR-2024-0453-0007.
- U.S. Environmental Protection Agency, *White Paper Series: Municipal Solid Wate Landfills-Advancements in Technology and Operating Practices*, "Unmanned Aircraft System (UAS) Technologies" (December 2024), https://www.regulations.gov/document/EPA-HQ-OAR-2024-0453-0034.
- U.S. Environmental Protection Agency, *White Paper Series: Municipal Solid Wate Landfills-Advancements in Technology and Operating Practices*, "Fenceline Monitoring" (December 2024), https://www.regulations.gov/document/EPA-HQ-OAR-2024-0453-0033.
- Dave Risk, *Advanced Leak Detection Technologies for Landfill Methane* (Dec. 18, 2024), https://ww2.arb.ca.gov/sites/default/files/2024-12/Session-2_FluxLab.pdf

- Flux Lab, *A Controlled Release Experiment for Investigating Methane Measurement Performance at Landfills Final Report* (July 9, 2024), https://erefdn.org/product/a-controlled-release-experiment-forinvestigating-methane-measurement-performance-at-landfills/
- California Air Resources Board, *Summary Report of the 2020, 2021, and 2023 Airborne Methane Plume Mapping Studies* (April 2024), available at https://ww2.arb.ca.gov/sites/default/files/2024-04/2020-2021-2023%20Airborne%20Summary%20Report_FINAL.pdf
- Pennsylvania Department of Environmental Protection, *Pennsylvania Methane Overflight Study Final Report*, December 2022, https://greenport.pa.gov/elibrary/PDFProvider.ashx?action=PDFStream&docID=5424315&chksum=&revision=0&docName=PENNSYLVANIA+METHANE+OVERFLIGHT+STUDY+FINAL+REPORT&nativeExt=pdf&PromptToSave=False&Size=1376071&ViewerMode=2&overlay=0