BEYOND TOXICS

OREGON'S SECRET CLIMATE KILLERS

PULLING BACK THE CURTAIN ON HIDDEN LANDFILL METHANE EMISSIONS

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BRIEF PURPOSE STATEMENT

In 2022, the Oregon Department of Environmental Quality implemented new rules which regulate landfill gas emissions. The rules require Oregon landfills with greater than 200,000 tons of waste-in-place to obtain an Air Contaminant Discharge Permit to submit data on the landfill characteristics and potentially monitor, collect and/or control landfill gas emissions. The DEQ's purpose was to reduce methane emissions to meet former Governor Kate Brown's directive provided in Executive Order No. 20-04 to give state agencies the authority to establish science-based greenhouse gas emissions reduction goals. Typically, landfill gas is made up of around 50% methane. Methane is a very strong greenhouse gas, more than 80 times as potent as carbon dioxide in the short-term.

In 2024, Beyond Toxics conducted an analysis of landfill operator compliance with Oregon's new landfill methane regulations which went into effect in October 2022. We examined 32 Surface Emissions Monitoring (SEM) reports submitted by eight Municipal Solid Waste (MSW) landfills out of a total of 11 MSW landfills that are required to follow the new rules. Our report is limited to eight landfills because three of the 11 large landfills received exemptions from the Department of Environmental Quality or did not comply with the new rules. Our investigation resulted in the following findings.

KEY FINDINGS

Three out of 11 of Oregon's large, currently operating landfills did not follow the state's surface emissions monitoring rules in 2023, one year after the rules went into effect in 2022. As a result, three of Oregon's largest landfills are completely unmonitored for potent methane emissions. This is important because 90% of the methane emissions produced by industries in Oregon come from its largest landfills.[1]

[1] Industrious Labs (2025). Don't Waste Our Future. Based on U.S. EPA Greenhouse Gas Reporting Program (GHGRP) 2022, U.S. EPA Landfill Methane Outreach Program (LMOP) (July 2023), and U.S. EPA GHG Equivalency calculator.

Our examination of maps submitted by the remaining eight largest MSW landfills reporting to regulators found that privately owned landfills (five out of eight)– all owned by large corporations– on average, excluded 48.6% of the landfill surface area from monitoring for methane emissions. While minor portions of these exemptions are legally justified, for example the open area of the landfill's working face where trash is being dumped, most of these exemptions are ambiguous. The high rate of exemptions calls into question how compliant landfill owner-operators are with Oregon's laws. Notably, it coincides with the U.S. EPA's recent nationwide enforcement alert noting "widespread" noncompliance with surface emissions monitoring rules including exempting substantial portions of landfills from SEM without sufficient justification.[2]

Compared to privately owned landfills, publicly owned landfills managed by local governments excluded, on average, just 10% of the surface area. The difference demonstrates significant disparities in methane emission data between privately owned landfills that are managed for profit, and publicly owned landfill operations that are managed for the benefit of local taxpayers and businesses.

There are key gaps regarding what surface emissions monitoring data is required to be reported to state regulators, which leaves the Oregon Department of Environmental Quality unable to review results. Most Oregon landfills required to conduct monitoring are not reporting their surface emissions monitoring locations using verifiable GPS tracking, making it impossible to verify that owner-operators are monitoring every 25 feet as required by law. As a result, there could be significant gaps in methane detection. There is also no way for state regulators to verify integrated monitoring results because landfills are not required to report basic information such as their 50,000 square foot grids and the average surface emission reading in each of those grids.[3]

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[2] Environmental Protection Agency. (2024, September 25). Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements. EPA Investigations Find Municipal Solid Waste Landfill Operators Are Failing to Properly Conduct Compliant Monitoring and Maintenance of Gas Collection and Control System. https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance

[3] Integrated monitoring results are derived from the averaging of all surface emissions monitoring measurements in a given 50,000 square foot grid.

RECOMMENDATIONS

The state of Oregon Department of Environmental Quality (DEQ) should immediately move to integrate the mandatory use of remote sensing technologies into Surface Emission Monitoring (SEM) rules to detect and pinpoint methane leaks at landfills.[4] One available technology is deploying methane detection equipment mounted on drones. The State can also require third party satellite methane detection systems, which provide comprehensive and more accurate measurements of the concentration of methane plumes, the direction of methane plumes moving off the landfill property, and the exact location of emission exceedances from landfills. DEQ can also require fixed monitors for real-time methane tracking. Gathering this comprehensive data set will lead to rapid mitigation of super-emitter leaks, improved methane capture for use in local energy generation or methane destruction through enclosed flaring.

DEQ should update their regulations to require SEM on all areas of landfills including steep slopes, closed cells, locations with covering vegetation and unspecified exemptions. Combining actionable emissions data from these areas along with mitigation strategies such as horizontal gas collection is critical for reducing greenhouse gas impacts and associated air toxics such as volatile organic compounds (VOCs), hydrogen sulfide, forever chemicals and fine particulate matter thereby improving air quality for local communities and climate mitigation to follow state climate action mandates.

Close reporting loopholes to ensure landfill owner-operators are adequately monitoring for methane. DEQ should immediately update its regulations to require that any owner or operator who conducts surface emissions monitoring must:

1. Report the areas exempted from monitoring and report the reasons for requesting those exemptions. This would address the current issue of exemptions being granted on a de facto basis.

[4] Throughout this report we emphasize Oregon because these are the arenas at which Beyond Toxics focuses its advocacy. Our findings could be replicable in other states or at the federal level.

2. Report measured concentration of methane in ppm for each SEM reading.

3. Report the SEM path walked by owner-operators.

4. All the above data should be in a spatial data format such as a shapefile, which makes for more efficient analysis of data gathered through surface emissions monitoring.

To prevent future potent methane emissions, governments at all scales can introduce mandatory organics diversion policies requiring consumers and haulers to separate and sort organic waste so that food and yard waste can be sent to facilities other than landfills to make compost and other products thereby preventing future generation of methane in landfills.

EXECUTIVE SUMMARY

Beyond Toxics conducted an analysis of 32 Surface Emissions Monitoring (SEM) reports submitted by eight MSW landfill operators to the Oregon Department of Environmental Quality for the year of 2023.[5] Per state rules, SEM is currently performed at landfills with over 200,000 tons of total lifetime waste and modeled methane emissions greater than 664 tons. We analyzed open landfills currently accepting municipal solid waste (variations of these rules apply to other landfills that are closed and/or accept only industrial waste). According to records from the DEQ, a total of 11 currently operating municipal solid waste landfills in Oregon meet the waste-in-place and methane emissions thresholds for the state's surface emissions monitoring rules. Three of those landfills were not following the new rules; two due to exemptions granted by the DEQ and one did not comply. SEM is performed quarterly by walking portions of the landfill surface with a handheld gas analyzer in a grid pattern to detect methane leaks. Individual leaks detected measuring over 500 parts per million (ppm) require remediation within 10 days. Operators are also required to divide their landfill into 50,000 square foot grids and average their SEM results within each grid, referred to as integrated monitoring. If a grid has an average of 25 ppm or higher, then the operator is required to conduct mitigation efforts to bring it below 25 ppm.

[5] (See OAR 340-239-0100).

These reports were qualitatively and spatially assessed to determine transparency, compliance, completeness and quality of submitted reports and gaps with landfill emissions regulations.

Across eight landfills, five are privately owned and three are publicly owned and managed by a local government. We found that an average of 33.1% of landfill surface area was excluded from surface emissions monitoring. These exemptions include permitted exemptions, such as the working face where garbage is actively being deposited, and exemptions that are more questionable such as final grading (the slopes of landfill sections that are closed and no longer having waste deposited into them).

Although on average 33.1% of landfill surface area was excluded from emissions monitoring, the data revealed that private landfill operators are excluding an average of 48.6% of landfill surface area from SEM. Methane leaks in those areas are going undetected. The result of data omission is accelerated climate damage, dangerous conditions for workers, and air pollution and odors burdening nearby residential neighbors who are exposed to hazardous byproducts escaping along with methane. While some of these areas are too dangerous to be monitored by workers, substantial portions of landfills could have been safely monitored, such as areas with some vegetation or moderately sloped sides. Instead, they were excluded and listed as exempted on the report to the DEQ. Additionally, all of these areas could have been safely monitored with unmanned aerial equipment or fixed sensor systems. For example, owner-operator Waste Connections in Medford argued 69% of Dry Creek Landfill was too steep to monitor despite there being readily available methane detection technology that could fly over these areas.

We observed that, in comparison, public operators excluded only an average of 10% of landfill surface areas from monitoring. The stark difference in the comprehensiveness of surface emissions monitoring calls for further investigation of how landfill operators request exemptions, how transparent they are about their operating procedures, and the frequency and duration of exemption approvals on the part of the DEQ.

Our findings come in tandem with the U.S. Environmental Protection Agency's recent public release of draft white papers that delineate how advanced methane detection technology such as fixed methane sensors and satellites could address serious deficiencies in finding and fixing methane leaks.[6] In fall of 2024, the EPA issued a nationwide enforcement alert, stating, in part, "While the regulations allow MSW landfills to exclude certain areas from the SEM (e.g., areas with steep slopes or other dangerous areas), the EPA observed during recent inspections that areas that are not dangerous are improperly excluded from monitoring. If a MSW landfill excludes areas from the SEM, the facility should document and explain the basis for excluding each area from monitoring in the surface emission design plan and SEM reports. The regular side slopes of the landfill may not be excluded from monitoring per the regulations."[7] Excluding the working face and a few other time-limited activities,[8] state and federal rules require that all areas of landfills should be monitored during SEM. In Oregon, DEQ air pollution permit writers approve or deny exemptions from SEM proposed by operators (referred to as "alternative monitoring plans").[9]

State regulatory agencies need to use their authority to ensure the exceptions they permit are ultimately demonstrated to be necessary. Additionally, requiring operators to use advanced monitoring systems for SEM in difficult to monitor areas could fill this regulatory gap.

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[6] USEPA, Office of Air and Radiation. (2024). White Paper Series: Municipal Solid Waste Landfills – Advancements in Technology and Operating Practices. USEPA, Office of Air and Radiation. https://www.epa.gov/stationary-sources-air-pollution/non-regulatory-public-docket-municipal-solid-waste-landfills

[7] Environmental Protection Agency. (2024, September 25). Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements. EPA Investigations Find Municipal Solid Waste Landfill Operators Are Failing to Properly Conduct Compliant Monitoring and Maintenance of Gas Collection and Control System. https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance

[8] Or. Admin. R. 340-239-0330, "The requirements of OAR 340-239-0200 do not apply to the working face of the landfill or to areas of the landfill surface where the landfill cover material has been removed and solid waste has been exposed for the purpose of installing, expanding, replacing, or repairing components of the landfill gas, leachate, or gas condensate collection and removal system, for conducting a remedial action, or for law enforcement activities requiring excavation; as long as these areas are kept to the minimum size and time duration as possible." [4] Throughout this report we emphasize Oregon because these are the arenas at which Beyond Toxics focuses its advocacy. Our findings could be replicable in other states or at the federal level.

[9] Or. Admin. R. 340-239-500(1)(c) "Alternative walking patterns to address potential safety and other issues, such as: steep or slippery slopes, monitoring instrument obstructions, and physical obstructions;"

We also found that landfill operators are omitting key pieces of data gathered from SEM, which, while legal, is an outcome of weak regulatory requirements and enforcement. For example, Oregon rules require that operators monitor every 25 feet of a landfill's surface area every year. This can be accomplished by monitoring every 25 feet every quarter or by monitoring every 100 feet each quarter but offsetting that path by 25 feet each quarter.[10] However, Oregon rules do not require operators to share their SEM path, so regulators are not able to verify the rule is being followed. Additionally, SEM data that is reported comes in print format, which requires regulatory staff hundreds of hours to translate to a spatial file storage format that provides comprehensive and more accurate data for analysis. This labor to convert the data, despite the existence of accessible Geographic Information Systems (GIS) technology for data analysis, is inefficient and a burden on regulatory agency resources.

Furthermore, landfill operators are only required to report methane leaks over 200 ppm or integrated monitoring exceedances 25 ppm and greater; they do not report all measured SEM values. This is particularly problematic for integrated monitoring results because those results are based on averaging all SEM measurements within a 50,000 square foot section, not just the values over 200 ppm. For example, there could be a series of SEM measurements between 100 ppm and 199 ppm in a concentrated area that would suggest a problem. However, if it were grouped in a 50,000 square foot cell where there were a substantial amount of measurements near 0 ppm, the problem area could be masked through the averaging process. Enhancing the specificity of data reporting and transparency would provide regulatory agencies with a stronger ability to identify problematic areas of methane escaping from landfills and require targeted remediation. Critical to this would be requiring landfill operators to report data in spatial data formats that are usable by widely available GIS software.

Policymakers can act to address data gaps and upgrade methane reporting standards to ensure a healthy climate, protect worker safety and public health and to reduce greenhouse gas emissions and related air pollutants.

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[10] Or. Admin. R. 340-239-0400(2)(a) "The walking grid in OAR 340-239-0800(3)(a)(B) may be reduced to 100-foot spacing so long as the walking grid is offset by 25-feet each quarter so that by the end of one year of monitoring, the entire surface area has been monitored every 25 feet"

BACKGROUND

Mitigating short-term methane emissions, a climate pollutant about 80 times more powerful than CO2,[11] is critical to preventing the world from reaching climate tipping points. Climate tipping points are thresholds at which the climate systems would irrevocably change and upend local weather systems, supply chains, and global food productions. Currently landfills are the third leading cause of methane emissions in Oregon and the United States, and the second leading globally.[12]

Methane emissions are a byproduct of disposing of organic waste into landfills. As organic waste (food scraps, wood, paper, textiles) decomposes in an oxygen deprived environment, methane gas is generated over the course of decades. Most landfills can be thought of as giant plastic bags containing waste (although some landfills have waste in direct contact with the ground). These cells are lined next to and on top of each other in a pyramid-like structure. Pipes line the bottom of cells in horizontal rows to extract liquid byproducts, referred to as leachate. Gas extraction wells are drilled vertically and sometimes horizontally into landfill cells to capture continually generated methane gas before it escapes to the atmosphere.

Currently, federal rules require certain landfills in the United States to implement gas collection and control systems (GCCS), which use gas wells to extract methane from about 600 U.S. landfills, excluding the working face (where waste is deposited on a daily basis).[13] While GCCS are intended to extract and capture methane, several challenges exist regarding their successful and efficient operation.

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[11] United Nations Environmental Programme. (2022, October 18). What's the deal with methane? Climate Action: Chemicals & Pollution Action. https://www.unep.org/news-and-stories/video/whats-deal-methane
[12] Saunois, M., Martinez, A., Poulter, B., Zhang, Z., Raymond, P., Regnier, P., Canadell, J. G., Jackson, R. B., Patra, P. K., Bousquet, P., Ciais, P., Dlugokencky, E. J., Lan, X., Allen, G. H., Bastviken, D., Beerling, D. J., Belikov, D. A., Blake, D. R., Castaldi, S., … Zhuang, Q. (2024). Global Methane Budget 2000–2020. Earth System Science Data Discussions, 2024, 1–147. https://doi.org/10.5194/essd-2024-115
[13] Rocky Mountain Institute, Ebun Ayandele, Tom Frankiewicz, & Ellie Garland. (2024). Deploying Advanced Monitoring Technologies at US Landfills.
https://rmi.org/wp-content/uploads/dlm_uploads/2024/03/wasteMAP_united_states_playbook.pdf

Primary failures include insufficient gas collection coverage, holes in the plastic-lined cells, poorly or non-operating pipe systems, badly calibrated extraction wells, and leachate liquids clogging gas extraction pipelines.[14] Notably, when methane is escaping landfills, other hazardous air pollutants are being released to the air as well. These include hydrogen sulfide, other volatile organic compounds, and airborne PFOAs (aka “forever chemicals”).[15] These chemicals harm quality of life and pose public health risks for nearby residents and landfill workers. It is critical to consider landfill air emissions as a public health threat and a significant environmental justice challenge.

SURFACE EMISSIONS MONITORING (SEM)

Certain landfill operators are required to implement and comply with Surface Emissions Monitoring (SEM) requirements. SEM requirements were first introduced by the federal government and administered by the EPA. Federal regulations require that these landfills perform SEM quarterly and follow the EPA’s Method 21 guidance,[16] to detect and mitigate emissions greater than 500 parts per million.[17] SEM involves technicians walking the surface of the landfill at regular intervals of 30 meters looking for distressed vegetation, holes in tarps, protruding equipment, and other signs of potential methane leaks. Technicians use hand-held methane gas monitoring equipment to measure methane concentrations in the air just above the surface of the landfill. If a leak above 500 ppm is detected, the operator is required to remediate the cause of the leak.[18]

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[14] Preet Brains, Haley Lewis, Keene Kelderman, & Leah Kelly. (2023). Trashing the Climate: Methane from Municipal Landfills. Environmental Integrity Project. https://environmentalintegrity.org/wp-content/uploads/2023/05/Trashing-the-Climate-report-5.18.23-updated.pdf
[15] Ashley M. Lin, Jake T. Thompson, Jeremy P. Koelmel, Yalan Liu, John A.. Bowden, & Timothy G. Townsend. (2024). Landfill Gas: A Major Pathway for Neutral Per- and Polyfluoroalkyl Substance (PFAS) Release. Environmental Science & Technology, 11(7), 730–737. https://doi.org/10.1021/acs.estlett.4c00364
[16]40 C.F.R. §§ 63.1958(d) and 63.1960(c)-(d)
[17] U.S. Environmental Protection Agency, https://www.govinfo.gov/content/pkg/FR-2021-05-21/html/2021-10109.htm
[18] U.S. Environmental Protection Agency, https://www.govinfo.gov/content/pkg/FR-2021-05-21/html/2021-10109.htm

States including California, Oregon, Maryland, and Washington have promulgated state regulations strengthening various aspects of SEM to detect and reduce methane emissions. However, they are still reliant on a quarterly walking survey grid pattern monitoring, which still allows areas of the landfill to be skipped altogether leading to insufficient detection of leaks (see more in our discussion).

Oregon updated its landfill emissions rules, finalized October 2021, as a result of Executive Order 20-04 initiated by Governor Kate Brown in 2020 to direct state agencies to reduce greenhouse gases to at least 80% below 1990 emissions levels by 2050. The state's 2022 rules differ from federal rules in significant ways. The new regulations require landfill operators to conduct SEM following a walking pattern with no more than 25-foot intervals annually across the landfill's surface area, as opposed to the federally mandated 100 foot intervals. It also requires integrated monitoring for landfills, which averages SEM measurements across 50,000 square foot gridded sections. If a section has an average of 25 ppm or higher, then the landfill operator is required to take action to bring methane levels down.[19] The working face of the landfill is excluded from surface emissions monitoring along with areas under construction for gas collection.[20] Regulations also reduced the size and emissions threshold at which landfills are required to install a GCCS and conduct SEM.[21] The DEQ also added additional requirements to boost methane capture, including stronger GCCS leak component monitoring and data reporting requirements for GCCS equipment indicators and down time, which we did not evaluate in this report.

Our research questions were as follows, for those MSW landfill operators that fall subject to Oregon's regulatory parameters:

1. Which currently operating Oregon landfills accepting municipal solid waste are subject to implementing the updated rules?

2. How much landfill surface area is being included and excluded from SEM?

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[19] Oregon Department of Environmental Quality, Heather Kuoppamaki. (2021, October 1). Landfill Gas Emissions Rulemaking DEQ Presentation. Landfill Gas Emissions Rules Advisory Committee. https://www.oregon.gov/deq/EQCdocs/100121_I_Slides.pdf
[20] https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=6533
[21] Ibid.

3. Are the MSW landfill operators monitoring in a walking 25-foot grid pattern over the course of a year, per state regulatory requirements?

4. Are the MSW landfill operators conducting and reporting integrated monitoring results per a 50,000 sq. ft. grid, per state regulatory requirements?

5. Are reports complete, accurate, easy to analyze and useful to ODEQ to help regulators determine compliance and effective methane mitigation?

METHODS

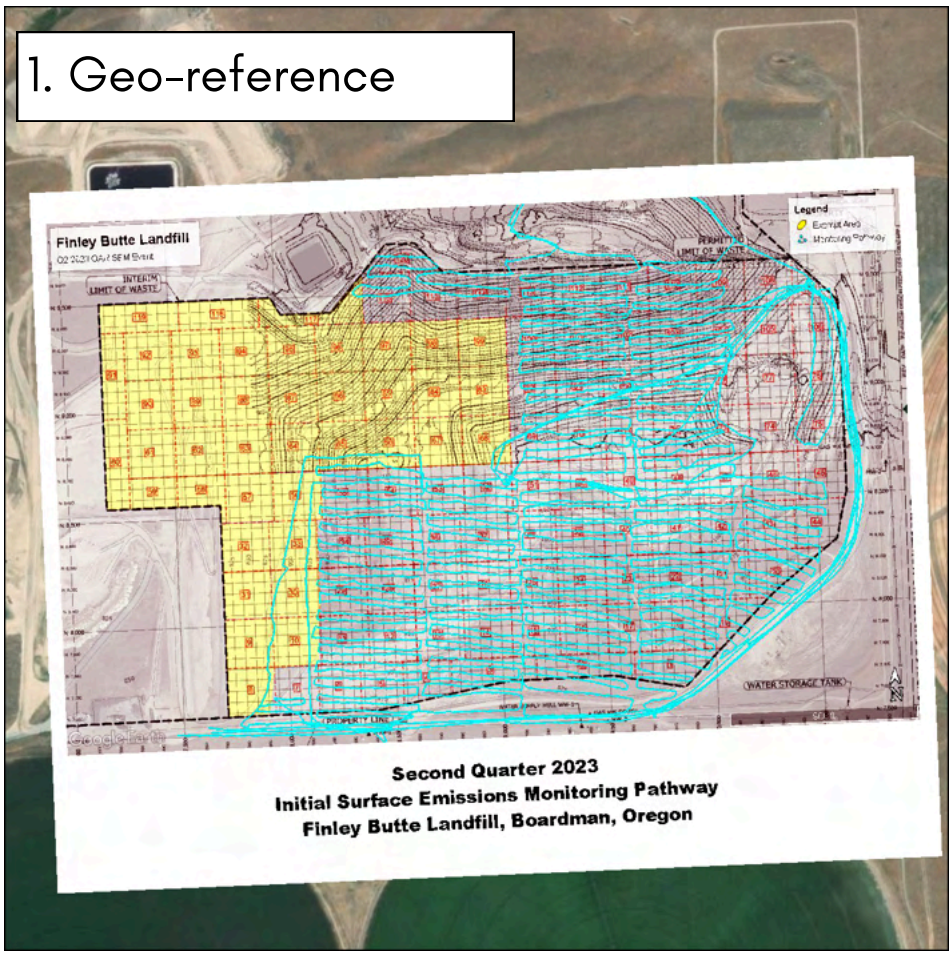
Beyond Toxics procured annual and semiannual reports, which certain landfills are required to file,[22] through a public records request to the Oregon DEQ filed in January 2024. We asked for reports filed by currently operating landfills accepting municipal solid waste that are known to exceed 200,000 tons of waste-in-place and 664 tons of methane a year since those are the thresholds at which Oregon's stricter SEM procedures go into effect.

Records were released in June 2024, and included SEM reports from eight of 11 qualifying Oregon landfills in 2022 and 2023. The other three landfills did not conduct SEM, which we inquired further about and will be discussed later. We analyzed solid waste landfills and we excluded landfills exclusively accepting construction and demolition waste, landfills that take only waste from industrial facilities, and all closed landfills. We performed a records analysis of SEM reports included in semiannual and annual reports to DEQ from 2023 for the eight of 11 currently operating municipal solid landfills required to adhere to stricter SEM requirements. In these reports, we analyzed the reporting of integrated monitoring results, 50,000 square foot grids, SEM exclusions, and SEM walking paths. We did not differentiate between SEM exclusions for the working face, asbestos pits, storage piles, steep slopes, overgrown vegetation, etc. because this information is not consistently available in reports compiled by operators. Operators often listed where they did not monitor without a specific justification.

[22] OAR 340-239-700(3)(c).

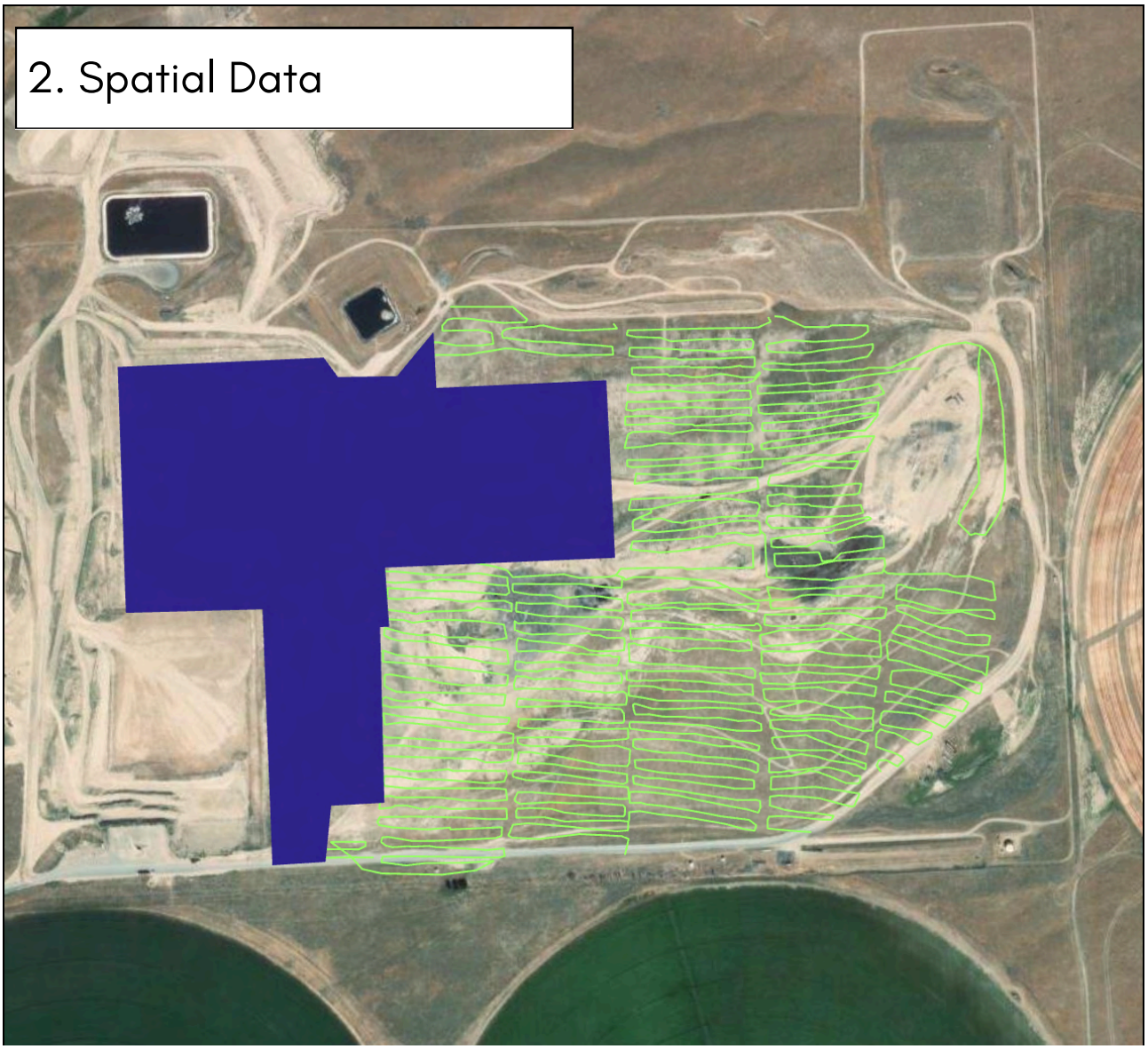
For research questions that required a spatial analysis, we georeferenced SEM report maps using ArcGIS Pro software. We then traced mapped features into vector data, which are GPS synchronized shapes that can be spatially analyzed. This allows us to do a few additional modes of analysis. For example, we can calculate the total area of a landfill and the SEM exempted areas. We can also create buffers around SEM paths to see if operators monitored every 25 feet. For the total area of landfill and areas of landfills excluded from SEM, we calculated their surface area in acres. For SEM paths, we created a 12.5 foot buffer around the walking path so we could visualize where gaps larger than 25 feet occurred between walking paths.

Figure 1: Frame 1, Frame 2, Frame 3, Frame 4

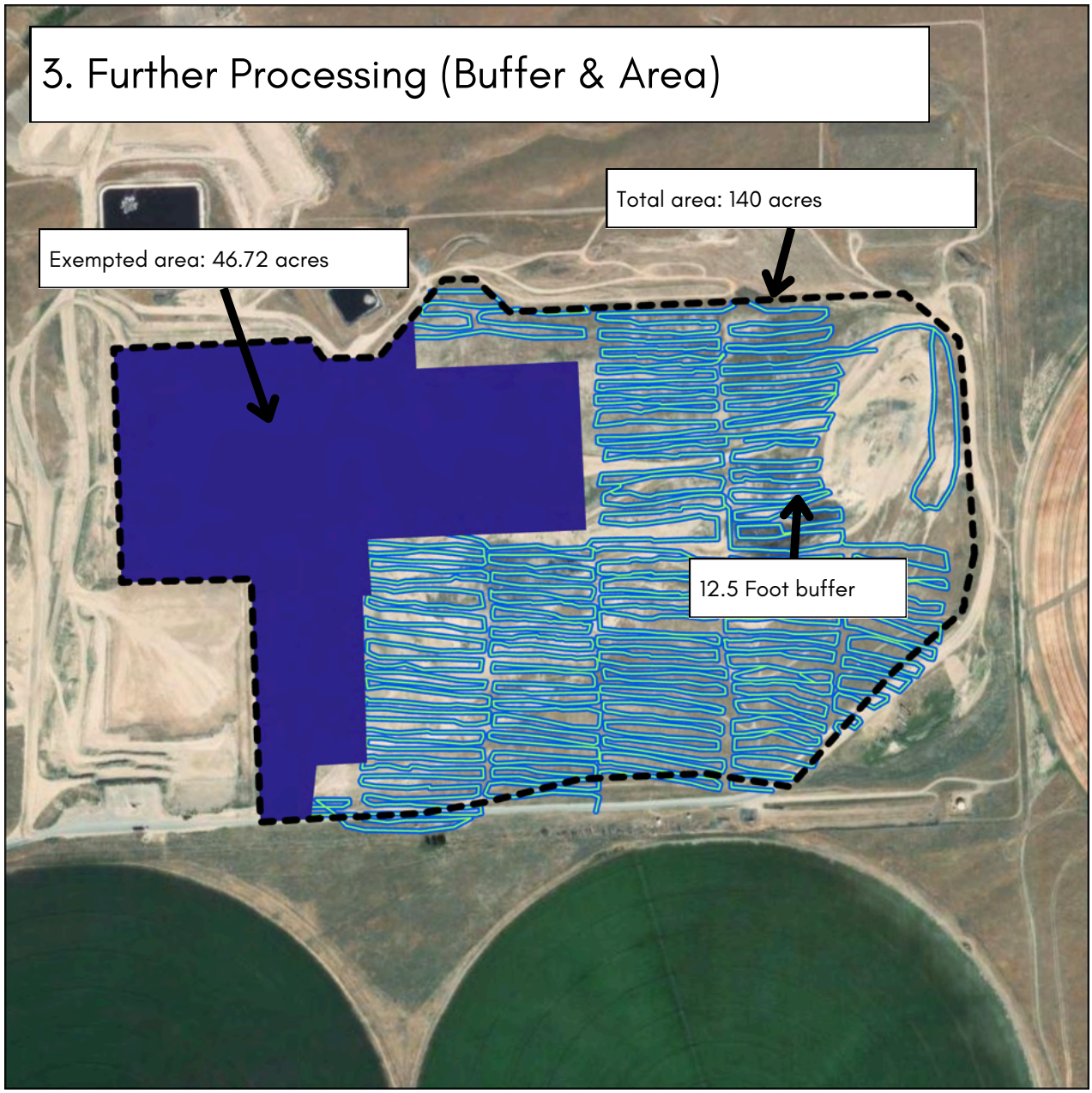


Frame 1: Overall, figure 1 shows our process of spatial data analysis for SEM reports using Finley Butte Landfill managed by Waste Connections in Boardman, Oregon as an example.

First we take the report graphic provided to the DEQ by the operator, which features a yellow polygon showing the area exempt from monitoring and a blue line showing where operators monitored. The first step is attaching the "paper" graphic to its GPS location. This is referred to as georeferencing. Now the graphic is overlaying its current satellite location.

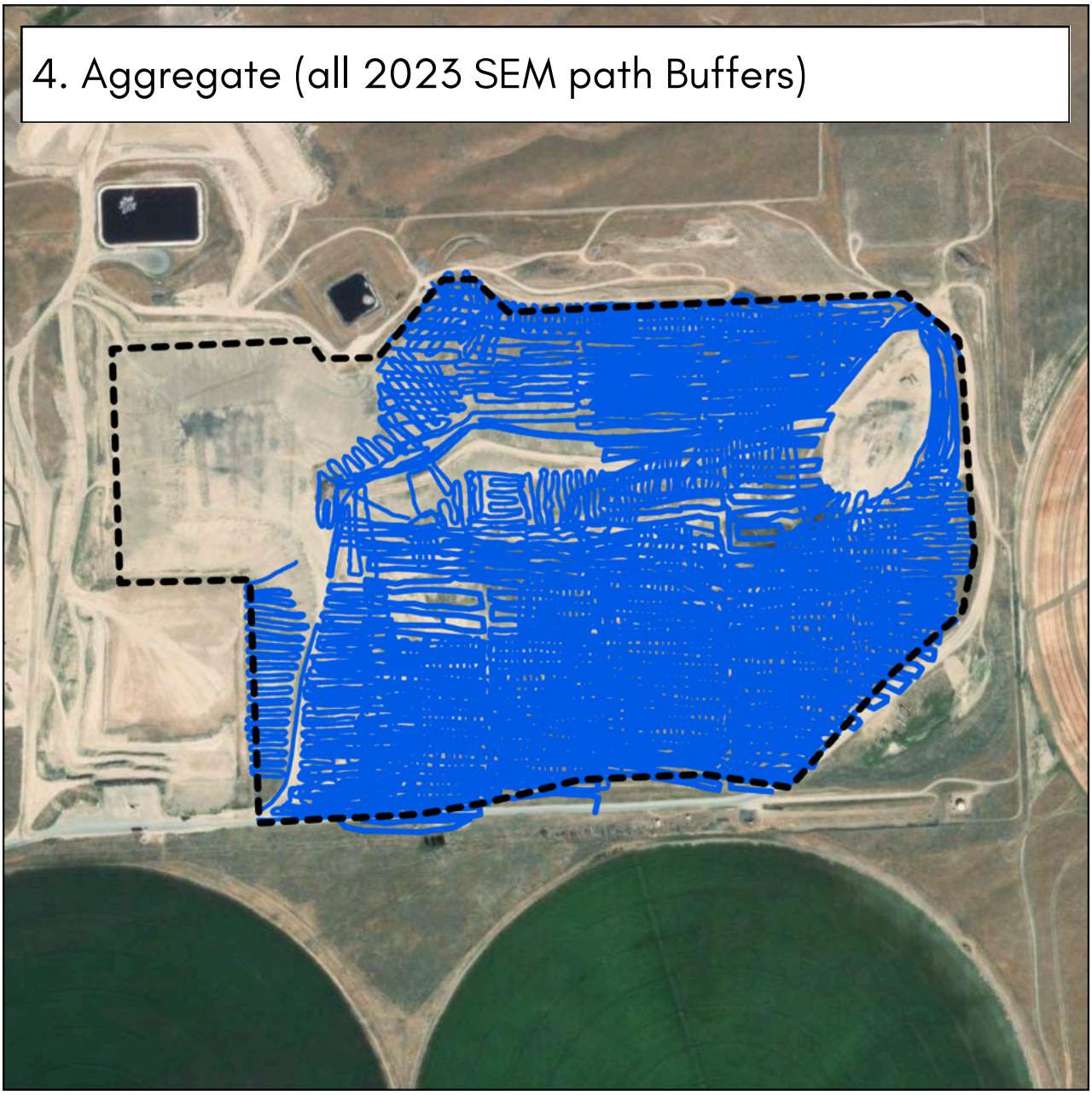


Frame 2: Next we build a shapefile, which is a file storage format used by GIS software. This is accomplished by tracing the exempt area into a polygon and the path into lines. Now, the area the operator exempted from SEM, formerly in yellow, is now in dark blue and the SEM monitoring path, formerly in blue and now depicted in green.



Frame 3: Now that we have a shapefile, we can do further forms of analysis. In this case, we want to know the area of the landfill, which we also traced into a shapefile, and the area of the exempt section. Since the data has been tied to GPS locations, we can calculate those features. The total area of the landfill is 140 acres and 46.72 acres were exempt. We can now calculate that for this quarter, Finley Butte excluded 33.4% of its surface area from monitoring.

We also need to know how well they followed the 25 foot rule. By calculating a 12.5 foot buffer on either side of the path, we can see where the buffers from all paths meet. 12.5 x 2 is 25 feet. We need to put all the paths from the year together to evaluate how well Finley Butte complied with this rule, which we will see in the next graphic.



Frame 4: In this graphic, we have compiled all of the SEM path buffers from each of the four quarters into one graphic. Areas that are in blue are where operators complied with Oregon's 25 foot rule. Areas where we can see the satellite imagery are where paths aren't offset by 25 feet, which means the operator failed to comply with the law. The only way we can evaluate this is through the ability to view all four paths/buffers around paths from each of the quarterly reports. This underscores how GIS analysis makes compliance monitoring more efficient.

WHY THIS METHODOLOGY?

By translating all of this data into a format that is usable in GIS software, we have the ability to look at data from across quarterly reports, or even years, in one environment. This allows us to see if areas have been repeatedly excluded from SEM each quarter, if the landfill operator has indeed monitored every 25 feet of the landfill over the course of a year, or if there are areas that repeatedly have high emissions for integrated monitoring.

Furthermore, we can plug in more spatial data for further exploration. Possibilities we didn't examine in this report, but are possible include: adding data on gas extraction wells, data on landfill cover infrastructure, or pulling in third party methane detection data such as Carbon Mapper, which detects methane plumes from space. The ability to see where landfills are experiencing methane exceedances from different sources of detection alongside their gas collection system infrastructure could generate effective insights on weaknesses in landfill gas systems, areas that need better or more frequent monitoring, or areas that DEQ needs to prioritize inspecting.

RESULTS AND DISCUSSION

Which Oregon landfills accepting municipal solid waste are complying with the DEQ rules adopted in 2021?

Oregon landfills are required to adhere to stricter DEQ requirements for methane management if they exceed 200,000 tons or more of lifetime waste-in-place and if their projected methane generation reaches 664 or more tons a year. Currently 11 Oregon landfills that are open and accepting municipal solid waste meet these metrics based on DEQ provided data (Table 1). Once a landfill reaches these thresholds, they are required to conduct surface emissions monitoring for four consecutive quarterly monitoring periods, with differing requirements thereafter if there is no measured concentration of methane of 200 ppm or greater are discovered during SEM.

Seven of the 11 MSW landfills are privately owned and operated while the other four are owned and operated by a county government. In total, all 11 landfills have a combined modeled methane generation of 169,943 tons in 2023, equivalent to the emissions of 1.6 billion gallons of gasoline burned.[23] The DEQ stated, "In 2017, six of the twenty-five largest stationary sources of GHG emissions in Oregon were landfills."[24] The seven private landfills were typically larger, occupying the top five ranked positions by total waste. On the other hand, the four public landfills held three of the bottom four slots by total waste. All 11 landfills are currently in operation and accepting municipal waste as of 2024.

Based on the numbers in Table 1 from Oregon DEQ, we would expect that all 11 Oregon MSW landfills would be subject to the stricter requirements of the state's current landfill emissions rules pertaining to conducting quarterly surface emissions monitoring. Through analyzing records and conversations with DEQ, we found that three landfills are not held to those higher standards. Each of these three landfills claimed unique circumstances specified below.

Examples of limited or non compliance:

1. Hillsboro Landfill, managed by Waste Management, Inc., was granted an exception to conducting surface emissions monitoring in its Title V operating permit by the DEQ, and does not have to comply with SEM requirements until April 2025. DEQ did not specify why.

2. Roseburg Landfill, managed by Douglas County, has not complied, and, as of May 2024, DEQ has stated they are looking into enforcement. We have not heard any developments since.

3. Baker Sanitary Landfill, managed by a local private company, claimed that its facility is two separate landfills, enabling it to divide its methane emissions between the two facilities and fall below the 664 tons threshold. DEQ has accepted this explanation although its own records present the landfill as one facility.

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[23] [22] OAR 340-239-700(3)(c). We first converted methane to a co2 equivalent of 84.
[24] [22] OAR 340-239-700(3)(c). , page 3

Table 1: Open Oregon MSW Landfills waste-in-place and Annual Methane Generation

Landfill, Owner-Operator	Owner-Operator Type	Total Lifetime Waste In Place (Tons)	Annual Methane Generation (Tons)
Columbia Ridge Landfill, WM	Private	64,358,280	43,497
Coffin Butte Landfill, Republic Services	Private	18,269,157	34,777
Hillsboro Landfill, Waste Management	Private	13,158,408	13,933
Finley Butte Landfill, Waste Connections	Private	13,158,408	13,933
Short Mountain Landfill, Lane County	County Government	11,750,975	13,042
Dry Creek Landfill, Waste Connections	Private	9,075,149	14,090
Wasco County Landfill, Waste Connections	Private	6,006,973	6,138
Knott Landfill, Deschutes County	County Government	4,642,663	3,826
Roseburg Landfill, Douglas County	County Government	3,696,825	35,058
Crook County Landfill, Crook County	County Government	1,116,102	739
Baker Landfill, Baker Sanitary Service	Private	766,113	778

Caption: The table features waste-in-place and methane generation rates for Oregon landfills accepting municipal solid waste while DEQ finalized rulemaking in 2021. Landfills highlighted in green were held to the updated SEM standards in 2023 and included in our analysis.

How much landfill surface area is being excluded from SEM?

We found that Oregon private landfill operators have excluded landfill areas from basic monitoring much more frequently than their publicly operated counterparts. During 2023 private landfills in Oregon exclude an average of 48.6% of landfill surface area from SEM each quarterly monitoring. On the other hand, county government operated landfills exclude an average of 10% surface area from SEM. We documented all exclusions, whether those exclusions have been shown to comply with Oregon rules or are more ambiguous.

Some landfills chose to give a reason for an exemption, and in other cases we were able to speculate a reason based on the design of the landfill. For example, we noticed Short Mountain, operated by Lane County, continuously did not monitor their asbestos pit, but did not specify that reason. In other cases, the landfill simply stated areas were exempt without providing a description and how a claimed exemption complies with the requirements, and we were unable to determine the criteria used to comply with exemption requests. Given this pattern, it was difficult to ascertain which exceptions were for working faces or other reasons consistently across all landfills. For this reason, we combined all exemptions to get a higher level view.

Table 2

Landfill, Operator	Private/Public	Quarter	Total Area (acres)	Exempted areas	% Excluded
Finley Butte, Waste Connections	Private	2023 - 1	140.08	37.52	26.78%
Finley Butte, Waste Connections	Private	2023 - 2	140.08	46.72	33.36%
Finley Butte, Waste Connections	Private	2023 - 3	140.08	80.92	57.77%

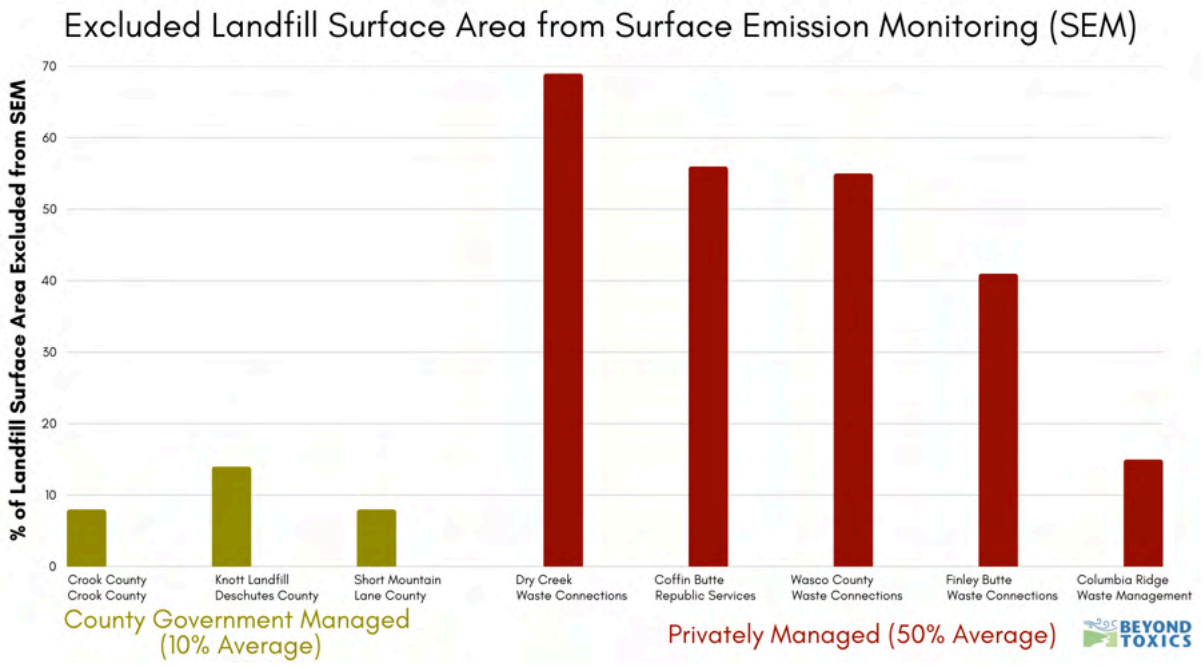
Finley Butte, Waste Connections	Private	2023 - 4	140.08	63.23	45.14%
Dry Creek, Waste Connections	Private	2023 - 1	85.86	59.62	69.45%
Dry Creek, Waste Connections	Private	2023 - 2	85.86	59.62	69.45%
Dry Creek, Waste Connections	Private	2023 - 3	85.86	59.62	69.45%
Dry Creek, Waste Connections	Private	2023 - 4	85.86	59.62	69.45%
Wasco County, Waste Connections	Private	2023 - 1	176.27	109.50	62.12%
Wasco County, Waste Connections	Private	2023 - 2	176.27	81.89	46.45%
Wasco County, Waste Connections	Private	2023 - 3	176.27	89.41	50.72%
Wasco County, Waste Connections	Private	2023 - 4	176.27	100.22	56.86%
Coffin Butte, Republic Services	Private	2023 - 1	136.34	84.21	61.77%
Coffin Butte, Republic Services	Private	2023 - 2	136.34	74.04	54.31%

Coffin Butte, Republic Services	Private	2023 - 3	136.34	74.04	54.31%
Coffin Butte, Republic Services	Private	2023 - 4	136.34	71.87	52.71%
Columbia Ridge, Waste Management	Private	2023 - 1	335.53	41.13	12.26%
Columbia Ridge, Waste Management	Private	2023 - 2	85.86	46.96	14.00%
Columbia Ridge, Waste Management	Private	2023 - 3	85.86	45.83	13.66%
Columbia Ridge, Waste Management	Private	2023 - 4	176.27	64.26	19.15%
Knott Landfill, Deschutes County	Public	2023 - 1	107.48	14.91	13.88%
Knott Landfill, Deschutes County	Public	2023 - 2	107.48	12.92	12.02%
Knott Landfill, Deschutes County	Public	2023 - 3	107.48	16.05	14.93%
Knott Landfill, Deschutes County	Public	2023 - 4	107.48	17.14	15.95%
Short Mountain, Lane County	Public	2023 - 1	111.34	9.30	8.35%
Short Mountain, Lane County	Public	2023 - 2	111.34	9.30	8.35%
Short Mountain, Lane County	Public	2023 - 3	111.34	9.30	8.35%

Short Mountain, Lane County	Public	2023 - 4	111.34	9.30	8.35%
Crook County. Crook County	Public	2023 - 1	84.52	5.82	6.88%
Crook County, Crook County	Public	2023 - 2	84.52	6.29	7.44%
Crook County, Crook County	Public	2023 - 3	84.52	6.96	8.23%
Crook County, Crook County	Public	2023 - 4	84.52	6.50	7.69%

The table above features the eight landfills following stricter SEM protocols and the data we were able to derive from their reports. Note that the working face is included in exemptions for SEM because most landfills did not specify the location and why an area of land was exempt. Total acres for landfills did not change over the course of a year because operators did not add any landfill surface area.

Figure 2.



Caption: The bar graph shows the average percentage of landfill surface area omitted from SEM by landfill site. Privately operated landfills for the most part excluded far more surface area than their government operated counterparts.

Our study found that the five private MSW landfills we analyzed on average omit nearly half (48.6%) of surface area from SEM every quarter (as opposed to the whole year together), leaving operators and regulatory agencies blind to vast portions of the landfill and the emissions emanating from them. While some of these exemptions might be intended to keep workers safe or are legally permissible, the large amount of surface area excluded raises questions as to whether private landfill operators are improperly excluding land from SEM. We found that 75% ofpublic landfills specified their exemptions for the working face, asbestos pits, or gravel and soil stockpiles, which totaled to an average of 10% of landfill surface areas. We were able to cross reference the fourth landfill based on other information they included in their report. On the other hand no private landfills specified the reason for exemptions in 2023 reports. The wide gap between private and public facilities may be an indication of non or limited compliance on the part of private waste corporations.

Examples of reasons given for not conducting surface emissions monitoring on certain areas

1. Waste Connections in Medford exempted 69% of its landfill, Dry Creek, from SEM monitoring without explanation. These areas all had final grade slopes, which could possibly be argued are too steep for monitoring. However, the EPA has stated that regular final grade side slopes of a landfill are not to be exempted.[25]

2. Owner-operator Waste Connections in Boardman, Oregon, chose not to monitor portions of the Finley Butte landfill that the U.S. EPA had monitored in June 2022. Waste Connections repeatedly denied the need to monitor anywhere they had placed waste in the last five years, even if that section of the landfill had waste older than five years. (Five years after waste is placed is the federal regulatory requirement to start SEM monitoring). Owner-operators then argued that the EPA should have never inspected that area due to safety concerns, even though they had never warned EPA of any safety concerns while accompanying them during their inspection. In 2023, Finley Butte Landfill continued to exclude those areas from monitoring.[26]

[25] Environmental Protection Agency. (2024, September 25). Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements. EPA Investigations Find Municipal Solid Waste Landfill Operators Are Failing to Properly Conduct Compliant Monitoring and Maintenance of Gas Collection and Control System. https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance

[26] Environmental Protection Agency & Daniel Heins. (2022). Clean Air Act Inspection Report Republic Services Waste Connections Finley Buttes Landfill, Boardman Oregon. EPA Region 10.

3 Republic Services, the owner-operator of Coffin Butte landfill near Corvallis, Oregon, argued 30-40 acres[27] of its landfill had too much vegetation to monitor. We would emphasize the owner-operators chose not to maintain the vegetation, which means this is a problem they created. Vegetation breaks through the upper cover material which would be highly prone to methane leakage (figure 3).

Caption: The EPA found multiple instances of vegetation growing through the tarp of the Coffin Butte landfill in both 2022 and 2024. The picture is one such example. The EPA measured methane at 1,000 ppm, twice the regulatory limit, near the base of the plant. Operators are supposed to constantly monitor the tarp integrity to ensure that there are no areas where methane could be leaking.

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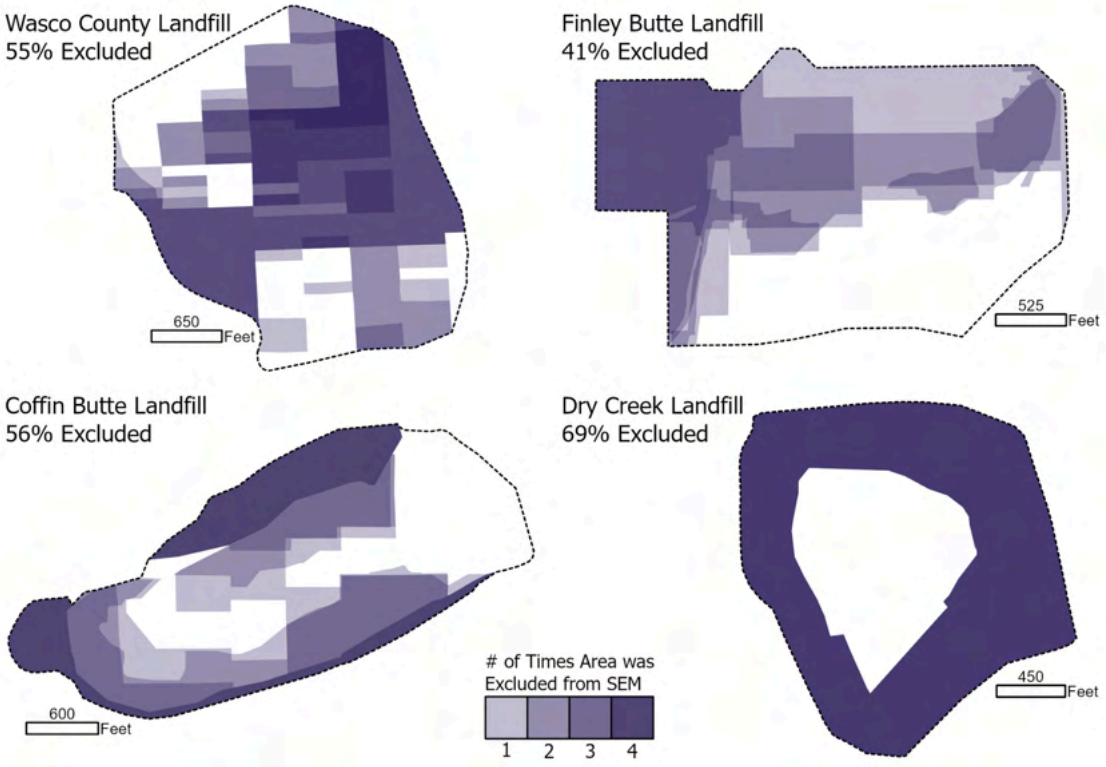
[27] Coffin Butte specifically exempted 40 acres in quarter 3 2022 and 30 acres in quarter 4 for high vegetation (both outside of our study). However, they continued to exempt the same areas in 2023, which spans the duration of our study, but they decline to specify the reason. We assume they are exempting those areas for the same reason based on satellite imagery from the times of inspection in 2023.

Figure 2



Caption: The maps feature four privately operated Oregon landfills with waste deposits outlined in black dotted lines. Each exempted area for the four quarterly reports in 2024 is layered and features where operators did not conduct SEM. The darker the shade of violet, the more frequently the area of the landfill went unmonitored. Oregon's private landfills excluded an average of 48.6% of landfill surface area from each quarterly monitoring.

Oregon rules exempt "the working face of the landfill to areas of the landfill surface where the landfill cover material has been removed and solid waste has been exposed for the purpose of installing, expanding, replacing, or repairing components of the landfill gas, leachate, or gas condensate collection and removal system, for conducting a remedial action, or for law enforcement activities requiring excavation. Rules specify this exclusion should be kept to the minimum size and time duration as possible."[28]

However, Oregon rules also allow for an alternative monitoring plan for "Alternative walking patterns to address potential safety and other issues, such as: steep or slippery slopes, monitoring instrument obstructions, and physical obstructions" approved by DEQ.

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[28] https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=6533

The reports we analyzed did not include information or details on alternative monitoring plans approved by DEQ, so it's difficult to evaluate exactly what agreements are made between private owner-operators and DEQ. Regardless, the large disparity between private and public owner-operators calls for further scrutiny by the DEQ for how and when they allow exceptions to SEM. As of now, the agency and public are completely blind to what is happening on 48.6% of private landfill surface areas. Large swaths of preventable methane leaks may be and likely are going undetected and unrepaired.

Further Limitations of SEM

Excluding large portions of landfills from any SEM is one demonstrated method of reducing the efficacy of methane monitoring. Not only can operators avoid conducting SEM over vast swaths of landfills, the EPA has repeatedly observed poor practices of operating SEM equipment. The EPA recently stated there is a massive gap in the monitoring methodology used by private operators and regulatory agency staff.[29] When conducting limited SEM, as part of inspections of several Oregon MSW landfills in 2022 and 2024, U.S. EPA inspectors found glaring issues with private operators including failing to use SEM equipment at a proper height leading to underrepresented emissions, ignoring protruding waste piercing through landfill cover, not monitoring leachate clean outs and gas wells, and more.[30] These led to landfills filing reports appearing to have fewer methane leaks of lesser severity. For example, at the Coffin Butte landfill owned and operated by Republic Services, a 2022 EPA inspection report stated that "despite Republic having seen no more than six exceedances in the recent SEM reports supplied ahead of the inspection that included penetration monitoring, including reports with zero exceedances, the EPA identified 61 points in exceedance of legal limit of 500 ppm, including 21 points above 10,000 ppm."[31]

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[29] Environmental Protection Agency. (2024, September 25). Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements. EPA Investigations Find Municipal Solid Waste Landfill Operators Are Failing to Properly Conduct Compliant Monitoring and Maintenance of Gas Collection and Control System. https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance

[30] Environmental Protection Agency & Daniel Heins. (2022). Clean Air Act Inspection Report Waste Connections Finley Butte Landfill, Boardman Oregon. EPA Region 10.

[31] Environmental Protection Agency & Daniel Heins. (2022). Clean Air Act Inspection Report Republic Services Coffin Butte Landfill, Corvallis Oregon. EPA Region 10.

Coffin Butte was not alone. The EPA also found glaring issues at Finley Butte landfill and Wasco County landfill both operated by Waste Connections. EPA inspectors found multiple large pieces of waste protruding through the cover, including wind turbine blade parts and tires, compromising the integrity of Finley Butte's landfill tarp cover.[32] At Wasco County, inspectors noted that the landfill operator had failed to keep adequate records of organic waste, which artificially reduced the projected methane emissions from LandGEM modeling.[33] These are three of the 100 landfills the EPA inspected across the nation before the agency put out an alert of widespread noncompliance with SEM rules.[34]

Recommendation: There are a variety of ready-to-go solutions that Oregon's regulatory agency can leverage to improve SEM and methane emissions prevention. For the immediate future, state regulators should immediately follow-up with MSW landfill operators, require explanations for areas excluded from monitoring and ensure that operators are following state regulations. Further, there are available advanced sensing technologies such as fixed methane sensors and drones that can comprehensively monitor large areas with greater frequency, including steep slopes and areas with vegetation, to provide Oregon operators and regulators with the missing information they need to find and mitigate methane leaks.

Are landfill operators monitoring in a walking 25-foot grid pattern, per state regulatory requirements?

Oregon requires that operators conduct SEM every 25 feet of a landfill over the course of a year. An operator can accomplish this by monitoring every 25 feet every quarter. Or, they can monitor every 100 feet every quarter, then offset that path by 25 feet for each consecutive quarter, so that by the end of the year every 25 feet has been covered. Notably, this rule was not followed in areas that were marked as exempt one or more times in a year.

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[32] Environmental Protection Agency & Daniel Heins. (2022). Clean Air Act Inspection Report Republic Services Waste Connections Finley Buttes Landfill, Boardman Oregon. EPA Region 10.
[32] Environmental Protection Agency & Daniel Heins. (2022). Clean Air Act Inspection Report Republic Services Waste Connections Wasco County Landfill, The Dalles Oregon. EPA Region 10.
[33]Environmental Protection Agency. (2024, September 25). Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements. EPA Investigations Find Municipal Solid Waste Landfill Operators Are Failing to Properly Conduct Compliant Monitoring and Maintenance of Gas Collection and Control System. https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance
[34] Environmental Protection Agency. (2024, September 25). Enforcement Alert: EPA Finds MSW Landfills are Violating Monitoring and Maintenance Requirements. EPA Investigations Find Municipal Solid Waste Landfill Operators Are Failing to Properly Conduct Compliant Monitoring and Maintenance of Gas Collection and Control System. https://www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance

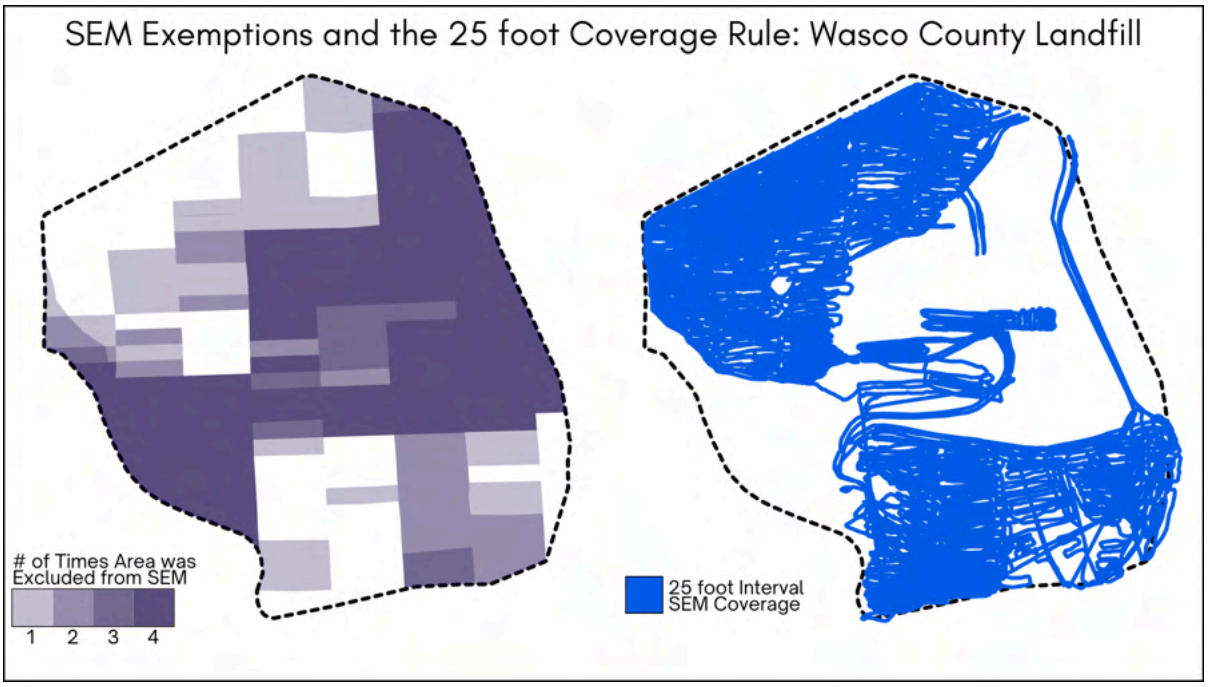
Five of the eight landfill operators did not report the GPS route they took to conduct SEM. Unfortunately, they are not required to report this information by Oregon rule. In our analysis of walking 25-foot grid patterns, we focused on landfill reports that provided actual monitoring paths because actual monitoring each quarter differs substantially from planned monitoring paths (see Figure 4).

Figure 4 - Planned SEM route Differs Greatly from Actual SEM route

Caption: The first frame of the figure features a planned SEM path that the Coffin Butte Landfill operator submitted to the DEQ. The second frame is a map of the actual GPS tracked SEM route. We can see far less of the landfill was actually monitored with the GPS path than the estimated route. These GPS referenced paths are much more accurate than planned routes when evaluating the comprehensiveness of SEM.

Only three out of eight MSW landfills (Coffin Butte, Finley Butte, and Wasco County) that conducted SEM voluntarily reported the GPS tracked SEM monitoring path. Our analysis found that, for the most part, those landfill operators that shared their SEM traversed path in reports appeared to have followed this rule with some room for improvement and one substantial failure. Given many of these operators excluded substantial surface area of their landfill from any SEM (see above section), the 25 foot rule was often not followed in areas that were excluded one or more times (Figure 5).

Figure 5



Caption: On the left is Waste Connections' exempted areas for Wasco County Landfill in 2023. The darker shade of violet, the more often that area was excluded from SEM over the course of the year. On the right, the graphic shows how the 25 foot rule was followed. If an area is completely blue, the 25 foot rule was followed. Gaps of white show where operators failed to monitor every 25 feet. By comparing the two graphics, we can see that operators most consistently met the 25 foot rule in areas that were monitored all four quarters. We can also observe the inverse relationship. The more often operators excluded an area from SEM, the more that area failed to follow the 25 foot rule.

Recommendation: This can easily be remedied by adding GPS tracked SEM paths to the recordkeeping and reporting requirements in OAR 340-239-0700, and a similar mechanism at the federal level. It would be beneficial to require that this data is not only reported in print form, but also in some spatial data format (shapefile, GeoJSON, etc.). The reason for this is Oregon does not require monitoring every 25 feet every quarter. Rather, they require that over the course of a calendar year, every 25 feet of a landfill is monitored. Having access to the spatial data will allow regulatory agencies to view all quarterly monitoring paths and results at once, and quickly verify the results.

Are landfill operators conducting integrated monitoring and reporting results?

Integrated monitoring is a key early identification monitoring strategy to identify where there are problematic methane emissions. It involves dividing the landfill into an integrated monitoring grid of 50,000 square foot cells, an area slightly smaller than a football field. After conducting SEM looking for individual, instantaneous exceedances of 500 ppm, the operators create an aggravate reading for each 50,000 square foot cell by averaging all individual SEM readings within each grid. If a grid has an aggregate SEM average above 25 ppm, then the landfill needs to perform remediation and do follow up SEM to ensure the average falls below 25 ppm.[35] State regulations require the landfill to report integrated monitoring exceedances over 25 ppm. State regulations do not specifically require the reporting of operators' integrated monitoring grids or non-exceedance integrated monitoring results. The requirements only stipulate that operators must tell DEQ if they have a 50,000 square foot cell exceeding 25 ppm.

Given that, we found that seven out of eight landfills reported at least some integrated monitoring result. Two of those landfills only reported their grid cells that exceeded 25 ppm as legally required. Five out of eight voluntarily shared all of their integrated monitoring results – the average SEM reading for each grid cell including their exceedances of 25 ppm.[36] The last landfill either did not have a 25 ppm integrated exceedance, or it simply did not report any data

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[35] https://www.oregon.gov/deq/EQCdocs/100121_I_Slides.pdf

[36] https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=6533 340-239-0700, 3(c) Semi-Annual Report. A landfill owner or operator subject to this rule, must prepare semi-annual reports for the periods of January 1 through June 30 of each year, unless otherwise approved in writing by DEQ. The Semi-Annual Report will be due on July 30, unless otherwise approved in writing by DEQ. The Semi-Annual Report must contain the following information:

Figure 6

Caption: The above graphic was submitted to DEQ by Waste Management at Columbia Ridge landfill showing how they divided the landfill into 50,000 square foot grids for their integrated monitoring results. In the full report, the operator submitted a table with each grid numbered and the associated average SEM reading result. Ideally, operators should be required to report this information to DEQ. Columbia Ridge is an example of data reporting that should be required by law.

Oregon Administrative Rules do not require operators to report the grid or integrated monitoring results unless a grid exceeds 25 ppm. We strongly recommend regulatory agencies require this basic information and they add a requirement for it to be in a spatial data format. We also recommend agencies require all SEM measurements and the coordinate it was recorded at (also in spatial data). Some landfills already report this information, but it's in a print table, which is too time intensive for a state agency to turn into spatial data.

Recommendation: Given the U.S. EPA's findings of widespread noncompliance, and as the climate crisis intensifies, Oregon DEQ needs to take a stronger stance in monitoring operators. DEQ should require operators to transfer the data they generate for annual and semiannual reports directly into spatial data formats.

We also recommend that regulators require spatial data on the location of gas extraction wells. Oregon DEQ could then visualize all of this data (integrated monitoring, instantaneous monitoring, SEM paths, Gas Collection and Control infrastructure, leaks detected by satellites, etc.) simultaneously using GIS software. This is important because it allows them to efficiently identify gaps in methane gas collection infrastructure and SEM results including exceedances and integrated monitoring measurements. Regulatory agencies need a complete picture of the puzzle, and allowing operators to spread those puzzle pieces across different reports and in unusable formats wastes public agencies' resources and hinders their ability to conduct oversight.

The Limits of SEM: Additional Solutions to Mitigating and Preventing Landfill Methane

SEM is a critical tool for identifying and mitigating methane leaks from landfills. However, there are more solutions already in use that operators and regulators can leverage to more effectively prevent harmful air emissions. Remote sensing, both passive (solar spectrometer) and active (Lidar), are promising avenues to enhance methane monitoring. Sensors are mounted on planes, satellites, and even drones, which then fly over landfills and detect methane plumes and concentrations at various scales depending on the air/spacecraft and instrument.

The White House National Strategy to Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System notes that remote sensing has found many preventable methane leaks that are currently going undetected by traditional SEM.[37] Recent findings from remote sensing technology have demonstrated that methane emissions are much higher than formula estimates by the EPA.[38] Remote sensing technology has been used to reduce methane emissions and associated environmental justice burdens posed by other air pollutants associated with methane leaks.[39]

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[37] Greenhouse Gas Monitoring and Measurement Interagency Working group. (2023). National Strategy To Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System. The White House. https://www.whitehouse.gov/wp-content/uploads/2023/11/NationalGHGMMISStrategy-2023.pdf
[38] Daniel H. Cusworth et al., Quantifying methane emissions from United States landfills.Science383,1499-1504(2024).DOI:10.1126/science.adi7735
[39] Daniel H Cusworth et al 2020 Environ. Res. Lett. 15 054012

There are readily available advanced methane detection technologies that can detect and pinpoint methane leaks at landfills, as illustrated in EPA's draft White Papers issued in Fall 2024, EPA's Landfill Methane Emissions Workshop in April 2021, EPA's Methane Detection Workshop in August 2021, CARB's Public Workshop on Landfill Methane Emissions in California in December 2022, and EPA's LMOP Webinar on Detecting Landfill Methane Emissions with Drones in September 2023.[40] Technology providers with drone surveying capabilities at landfills include ABB, Aerometrex, Bridger Photonics, Project Canary, Scientific Aviation, SeekOps, and SnifferDrone, among others. Airborne and satellite remote sensing are currently offered by Carbon Mapper and GHG Sat. Drones can survey a full landfill footprint with precision using point sensing or active imaging, measuring methane concentration in parts per million (ppm) or parts per million per meter (ppm-m). One drone provider has its technology deployed at over 150 landfills nationwide.[41] Stationary and land-based methane sensors can be placed strategically to support rapid and ongoing leak detection and repair on the active working face. These methods are the next wave in "smart" landfill design and can identify methane hot spots via always-on sensors on low towers or tripods on the landfill surface – meaning a methane spike can be found and dealt with quickly.

Recommendation: Oregon policymakers should ensure landfills move into the 21st century by requiring advanced methane sensing technology deployment that makes methane emissions visible, accurate and actionable. Both California and Colorado are building out programs that require owner-operators to respond to methane leaks detected by satellites orbiting the earth operated by third party institutions such as Carbon Mapper and GHG Sat.[42]

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[40]Greenhouse Gas Monitoring and Measurement Interagency Working group. (2023). National Strategy To Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System. The White House. https://www.whitehouse.gov/wp-content/uploads/2023/11/NationalGHGMMISStrategy-2023.pdf
[41]Greenhouse Gas Monitoring and Measurement Interagency Working group. (2023). National Strategy To Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System. The White House. https://www.whitehouse.gov/wp-content/uploads/2023/11/NationalGHGMMISStrategy-2023.pdf
[42] https://carbonmapper.org/ and https://www.ghgsat.com/en/

Diverting Organic Waste

Given that methane generation is the byproduct of placing organic waste in landfills, an obvious solution is to stop placing organic waste into landfills. Food rescue, food waste as an animal feedstock, composting food waste, placing synthetic organics (inorganic/organic hybrids for example carpet) in anaerobic digesters, and other forms of waste sorting are desirable alternatives to landfilling or incineration. These strategies preserve space in landfills for other uses, preventing or significantly delaying the need for landfill expansions and, depending on the policy, make progress towards zero-waste circular economies.

It's critical to note that methane is generated over the course of decades. Therefore, while organic diversion is an important solution to implement, we will need to monitor and mitigate methane from active and closed landfills decades into the future regardless.

CONCLUSION

In this report, we analyzed 36 Surface Emissions Monitoring (SEM) reports from eight currently operating municipal solid waste landfills in Oregon. We found that landfills in Oregon have varying levels of compliance with state regulations. Additionally, although legal, owner-operators under-report key pieces of information, which make it hard for regulators to ensure full compliance with the law. The Oregon DEQ needs to act quickly to remedy this situation by requiring owner-operators to monitor larger sections of their landfills and use other forms of monitoring when walking SEM is not possible or to support walking SEM with early identification of leaking emissions. Landfills are responsible for 90% of Oregon's industriously produced methane emissions ahead of both enteric fermentation (cattle) and the oil and gas sector. Curbing the pollutant is key to mitigating climate damage in the immediate future. The technology is available, and taking advantage of it is low hanging fruit for fighting the climate crisis.

Recommendations Review:

1. Use Advanced Methane Sensing Technology. Gathering this comprehensive data set will lead to rapid mitigation of super-emitter leaks, improved methane capture for use in local energy generation or methane destruction through enclosed flaring.

- The Oregon Department of Environmental Quality (DEQ)[43] should immediately move to require the use of advanced methane detection technology such as drones.

- Require landfill operators to respond to third party satellite methane detection systems, which provide comprehensive and more accurate measurements of the concentration of methane plumes, the direction of methane plumes off the landfill property, and the exact location of emission exceedances from landfills.

2. Update regulations to require Surface Emissions Monitoring (SEM) on all areas of landfills

    - Require fixed monitors for real time methane tracking in unsafe or other areas to ensure full coverage and to protect workers from hazards of conducting walking SEM. This requirement should also be instituted for landfills with high volumes of odor complaints from nearby communities.

    - Include steep slopes, closed cells, locations with covering vegetation and unspecified exemptions.

    - Actionable emissions data combined with mitigation strategies such as vertical and horizontal gas collection is critical for reducing greenhouse gas impacts and associated air toxics such as VOCs, hydrogen sulfide, forever chemicals and fine particulate matter thereby improving air quality and climate mitigation.

3. Oregon DEQ should immediately address reporting gaps by updating their regulations to require landfill owners and operators who are required to conduct surface emissions monitoring to:

    - Report all data in a spatial data format such as a shapefile, which makes for more efficient analysis of data gathered through surface emissions monitoring.

    - Report and identify the areas exempted from monitoring and report the reasons for those exemptions.

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[43] Throughout this report we emphasize Oregon because these are the arenas at which Beyond Toxics focuses their advocacy. Our findings could be replicable in other states. Thus regulatory recommendations are likely also applicable to other U.S. states.

- Report measured concentration of methane in ppm for each instantaneous SEM reading and integrated monitoring results.
- The SEM path walked by operators.
- Gas Control and Collection System Infrastructure– Gas extraction wells, piping, landfill cover.

4. To prevent future potent methane emissions, advance mandatory organic diversion policies requiring consumers and haulers to sort organic waste so that food waste can be used as a resource that is sent to facilities other than landfills to make compost and other products thereby preventing future generation of methane in landfills.

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