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VIA ELECTRONIC MAIL

California Air Resources Board
Landfill Methane Regulation
LMR@arb.ca.gov

**RE: Recommendations for Revisions to the Landfill Methane Regulation:
Comments on Proposed Concepts from July 2025**

To Whom It May Concern,

The Environmental Integrity Project (“EIP”) respectfully submits the following comments to the California Air Resources Board (“CARB”) to facilitate and improve revisions to the Landfill Methane Regulation (“LMR”)¹. We continue to advocate for the improvements contained in our Comments submitted in January 2025, which are included as **Attachment A** to these comments. We also specifically address portions of CARB’s July 2025 proposed concepts in sections below.

I. Comments not directly responding to CARB proposed concepts that would reduce the risk of fire and/or subsurface elevated temperatures.

CARB should include revisions to the LMR that would better prevent subsurface elevated temperature (“SET”) events and/or landfill fires. Specific recommendations are included in sections below, along with recommended considerations for proposed concepts that may relate to the risk of a SET event and/or fire.

A. Background on landfill fires

First, the most common type of landfill fire occurs between the surface and two feet below the landfill soil cover, i.e., surface fires, where fuel and oxygen are abundant. The other type of landfill fire is a subsurface fire or smolder that varies with depth depending² on landfill operations, heat sources, available oxygen, and other factors. Subsurface smolder events (classified as SETs) can last multiple years to decades³ as the smolder thermally keeps breaking

¹ Cal. Code Regs. tit. 17§§ 95460-95476 (2010).

² *Landfill Fires Guidance Document*, CalRecycle, <https://calrecycle.ca.gov/swfacilities/lffiresguide/>

³ Alan McNarie, Old fire, new tricks, *The Hawaii Independent*, (Oct. 20, 2008).

down surrounding combustible MSW. If not properly addressed, the SET Event will become a smolder and may spread to the entire landfill facility if it is not isolated and contained. SET Events present a significant environmental threat by emitting pungent odors (reduced sulfur compounds and organic acids), Volatile Organic Compounds (“VOCs”), such as benzene, and particulate matter.⁴ In general, gas concentrations of non methane organic compounds (“NMOCs”) from MSW landfills double with every 18°F (7.7°C) increase in waste temperature.⁵

Next, SET events are mainly caused by oxygen intrusion, waste temperature increases and leachate recirculation. Oxygen intrusion can occur from overdrawing the gas collection and control system (“GCCS”). The typical vacuum applied to a gas extraction well is approximately 125–250 mm (5–10 inches) of water column.⁶ When landfill operators use a higher vacuum to enhance methane recovery for energy production or to control odors and emissions, i.e., overdraw the gas collection system, oxygen can enter the landfill through damaged gas wellhead seals and cracks, cracks in the soil cover, alternative daily cover (“ADC”), poorly compacted cover soils especially on side slopes, and unsaturated subsurface materials. The use of insufficient daily cover—like ADC and fine grained covers⁷—can contribute to oxygen intrusion and thus SET event risk.⁸

Additionally, the temperature of waste itself is relevant to the risk of a SET event and the degradation of control equipment (e.g. the GCCS, leachate system and liners). Smoldering of MSW can generate temperatures that can reach 1,225°F (665°C)^{9,10} and smoldering combustion has been documented to persist within an MSW landfill as low as 212 to 248°F (100 to 120°C)¹¹ and from 392 to 572°F (200 to 300°C) with measured temperatures as high as 1,292°F (700°C).¹² Deep subsurface fires have measured temperatures of 176 to 446°F (80 to 230°C).¹³ As a result

⁴ Nammari, “Emissions From a Controlled Fire in Municipal Solid Waste Bales,” 24 *Waste Management* 9-18 (2004).

⁵ LFG Energy Project Development Handbook, Chapter 2: Landfill Gas Modeling, (Sept. 13, 2016), https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/pdh_chapter2.pdf, at 8.

⁶ United States Army Corps of Engineering, Landfill Off-Gas Collection and Treatment Systems 3-17 (2008).

⁷ “For example, air intrusion was initially facilitated by using a thin sand cover (which has a higher air conductivity than a fine-grained soil cover) at the Sint Maarten Landfill. Stark et al, Managing Hurricane Debris and Elevated Temperatures, *Proceedings of Specialty Conf. GEO-EXTREME 2021*, ASCE, Savannah, GA, November, Geotechnical Special Publication 328, 1-10 (2021).

⁸ Aerobic decomposition can start from these and other actions that allow oxygen to enter the waste mass, such as, rapid settlement, poorly compacted or inadequate soil covers, especially on side slopes, abandoned gravel access roads, uncapped borings, leachate sumps, drainage systems, leaky penetrations and wells into the MSW, and passive venting systems. Changes in atmospheric pressure from cold fronts can also move landfill gas out or air into a landfill. Nastev et al, Gas Production and Migration in Landfills and Geological Materials, 52 *Journal of Contaminant Hydrology* 187-211 (2001).

⁹ Virginia Tech Expert Panel, *Bristol Landfill Expert Panel Report*, (April 25, 2022), available at <https://www.bristolva.org/649/Bristol-Landfill-Expert-Panel-Report>.

¹⁰ As measured in two MSWLFs undergoing smoldering combustion. *Id.*

¹¹ Ettala, Landfill Fires in Finland, 14 *Waste Management & Research* 61 (1996).

¹² Ettala, Emissions From Simulated Deep-Seated Fires in Domestic Waste, 14 *Chemosphere* 626-639 (2008).

¹³ Lönnermark, Emissions From Simulated Deep-Seated Fires in Domestic Waste, 70 *Chemosphere* 626-639 (2008).

of smoldering combustion, waste temperatures can rise to sufficient levels to thermally degrade, pyrolyze, or char MSW.

The damage to control equipment can be seen with sustained temperatures as low as 150°F (65.5°C)¹⁴ and high-density polyethylene (“HDPE”) can lose half its strength at every 60°F (33°C) rise in temperature, and at 140°F (60°C), HDPE will buckle at small loads.¹⁵ HDPE can occasionally withstand short-term exposure to temperatures up to 180°F (82°C), but prolonged exposure can compromise the integrity of the liner/pipe. According to one manufacturer, the tensile strength of HDPE may drop by approximately 15-25% at 180°F (82°C).¹⁶ At 266°F (130°C), HDPE melts.¹⁷ Various piping manufacturers report the maximum design temperature for HDPE geomembranes and polyvinyl chloride (“PVC”) piping is 140°F (60°C), while chlorinated polyvinyl chloride (“CPVC”) is 200°F (93°C). PVC begins to thermally break down and soften at 156 to 176°F¹⁸ and starts to melt at 180°F (82°C)¹⁹. As temperatures increase in a landfill, the concentration of some VOCs can increase by one to two orders of magnitude²⁰).

For the GCCS components and leachate control systems, when temperatures exceed 212°F (100°C), additional pressure is exerted on these systems. This pressure is directly related to water converting to steam and expanding 1,700 times in accordance with the ideal gas law ($PV=nRT$). The GCCS, landfill cover system, e.g., soil and/or geosynthetics, and leachate collect systems are not designed to resist this additional pressure and/or temperatures that exceed the allowable maximum temperatures.

Pollution impacts from fires and/or SET events, in general, are concentrations of some VOC emissions from municipal solid waste (“MSW”) landfills double with every 18°F (10°C) temperature increase.²¹ In general, gas concentrations of NMOCs from MSW landfills double

¹⁴ Over a year can impact geosynthetic bottom liner systems' service life and integrity. High-density polyethylene can lose half its strength at every 60°F (33°C) rise in temperature, and at 140°F (60°C), high-density polyethylene will buckle at small loads. Tetra Tech, *When Temperatures Rise—The Challenges of Hot Landfills*, Tetra Tech (May 18, 2018), <https://www.tetrattech.com/insights/when-temperatures-rise-the-challenges-of-hot-landfills/>.

¹⁵ Tetra Tech, *When Temperatures Rise—The Challenges of Hot Landfills*, Tetra Tech (May 18, 2018), <https://www.tetrattech.com/insights/when-temperatures-rise-the-challenges-of-hot-landfills/>.

¹⁶ Sino Pipe, *Understanding the Temperature Limits of HDPE Pipe: A Comprehensive Guide*, (Sept. 11, 2024), <https://sinopipefactory.com/blog/hdpe-pipe-temperature-rating-2/>.

¹⁷ Lyuba Rice, *The Temperature Limits of HDPE Material*, Legacy HDPE Boats (May 10, 2024), <https://legacyhdpe.com/the-temperature-limits-of-hdpe-material/>; Melting Point of Polymers and Plastics, Table <https://matmake.com/properties/melting-point-of-polymers-and-plastics.html>.

¹⁸ Georg Fischer, *Technical Manual: 80 PVC and CPVC, Schedule 40 PVC Piping Systems* (July 12, 2010), available at https://kebechem.com/fiches_techniques/Fiche_technique_pvc_cpvc.pdf.

¹⁹ Kabir Jindal, *PVC Melting Point, The Ultimate Guide* (Nov. 8, 2023), available at <https://plasticranger.com/pvc-melt-point-properties-applications-advantages-disadvantages/>.

²⁰ *Id.* at 1, 12.

²¹ Agency for Toxic Substances and Disease Registry (ATSDR). (2001), “Chapter 2: Landfill gas basics. Landfill gas primer—An overview for environmental health professionals,” “Chapter 3: Landfill Gas Safety and Health Issues.”

with every 18°F (7.7°C) increase in waste temperature.²² Some NMOCs are known or suspected carcinogens and are classified as hazardous air pollutants (“HAPs”). Benzene and methyl ethyl ketone are consistently found at elevated levels at the surface and in the collected landfill gas (“LFG”) during SET event investigations.²³ The VOCs produced from smoldering MSW typically include acetonitrile, acetone, benzene, 2-butanone (MEK), carbon disulfide, and tetrahydrofuran. Other VOCs detected in smoldering incidents include ethyl acetate, toluene, vinyl acetate, and xylene.²⁴

B. Recommendations to prevent the risk of SET events and/or fires not included in CARB’s proposed concepts

To better prevent SET events, CARB should consider specific revisions related to earlier installation of GCCS requirements; landfill cover; gas-to-energy system requirements; and wellhead monitoring requirements. We outline specific recommended revisions in sections below.

1. Earlier installation of GCCS

EIP reiterates our previous recommendations from comments we submitted to CARB on January 24, 2025 (“January 2025 LMR Comments”) that CARB require earlier installation of GCCS.²⁵ We incorporate by reference those same arguments herein.

Related to CARB’s proposed concept of requiring earlier installation of gas collectors in new waste areas at large landfills²⁶, we additionally recommend that CARB require the installation of wells in new cells. However, to guard against the risk of SET events and/or fire CARB should require that the operator first test the wells for a positive wellhead pressure reading. After that, the operator must sample again within 2 to 4 weeks to validate the result before connecting the wells to the GCCS. CARB should make clear that the wells installed in the new cells should be connected only when significant pressure is shown; allowing for as early as 12 months if the pressure requirement is met.

2. Landfill cover

We incorporate by reference in January 2025 LMR Comments our recommendations of landfill cover requirements that CARB should consider.²⁷ Related to the issue of SET events, we

²² LFG Energy Project Development Handbook, Chapter 2: Landfill Gas Modeling, (Sept. 13, 2016), https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/pdh_chapter2.pdf, at 8.

²³ Data Evaluation of the Subsurface Smoldering Event at the Bridgeton Landfill, (June 16, 2013), <https://semspub.epa.gov/work/07/30286004.pdf>, at 8.

²⁴ *Id.*

²⁵ January 2025 LMR Comments at 34-36. *See Attachment A.*

²⁶ California Air Resources Board, *Potential Updates to the Landfill Methane Regulation*, Public Workshop (July 18, 2025) at 17, available at 22 https://ww2.arb.ca.gov/sites/default/files/2025-07/Presentation-English_LMR%20Community_Meeting_07-18-2025.pdf [hereinafter “CARB 2025 LMR Workshop”].

²⁷ January 2025 LMR Comments at 36-40. *See Attachment A.*

re-iterate that alternative daily cover (“ADC”) should rarely, if ever be used.²⁸ Moreover, the use of ADC can also increase the risk of fires and SET events. For example, the material properties of auto shredder fluff, a typical ADC, can increase the fire spread rate because of its low density, porosity, and flammability.²⁹ Similarly, incinerator ash has been approved by state agencies as ADC at landfills, but scientific studies have shown that incinerator ash can generate significant heat at a landfill.³⁰ Because so many ADCs are not demonstrated to adequately control emissions, and may also increase the risk of dangerous SET events and fires, EPA should consider not allowing ADC.

3. Require landfill gas-to-energy facilities to be restricted to not more than 5% oxygen at the delivery point.

CARB should consider requiring that landfill-gas-to-energy (“LFGTE”) facilities be restricted to no more than 5% oxygen at the delivery point. This is important because LFGTE systems have been adopted to generate electricity or produce biomethane for pipeline injection or vehicle fuel. However, incomplete combustion or leaks in these systems can lead to persistent methane and hazardous air pollutants emissions, necessitating continuous monitoring and regulatory oversight.

4. Support for CARB proposed concepts related to wellhead monitoring

Commenters support the proposed concept of monthly measurements of pressure, temperature, gas flow rate and gas composition.³¹ While high oxygen concentrations greater than 5% may be acceptable for short periods if gas wellhead temperatures are below 131°F (55°C), the risk of a SET Event increases as the temperature exceeds 131°F (55°C) with oxygen of 5% or greater. Also, as the gas wellhead temperature exceeds 170°F (77°C), the potential for a SET Event becoming a smolder is higher if oxygen is at or above 5%. We additionally support more frequent wellhead monitoring to weekly or continuously for wells with persistent issues.³² The monitoring requirements described in the proposed concepts would be crucial to detecting risk factors for a SET event and being able to address problematic wells before a SET event and/or landfill fire becomes more likely. Commenters also support more frequent reporting of data (quarterly instead of annually).

²⁸ *Id.* at 38-39.

²⁹ Denbo, Don “Considerable Risk,” *Recycling Today* (June 26, 2019) <https://www.recyclingtoday.com/article/insurance-risks-for-recycling-companies/#:~:text=The%20production%20and%20storage%20of,older%20buildings%20can%20be%20shocking.>

³⁰ Jafari, N.H., Stark, T.D., and Rowe, K. (2014a). “Service life of HDPE geomembranes subjected to elevated temperatures.” *Journal of Hazardous, Toxic, and Radioactive Waste*, 18(1), 16.

³¹ CARB 2025 LMR Workshop at 15”].

³² *Id.*

Additionally, we support requiring operators to measure the liquid levels.³³ Liquid in wells can adversely impact collection wells³⁴, including increasing the risk of SET events and/or fire. Excessive liquid impacts well performance which can result in air intrusion. Accordingly, Commenters support this proposed concept, but also would urge CARB to consider more frequent monitoring of liquid levels, e.g. quarterly as opposed to twice per year.

5. Proposed concepts for temperature monitoring

First, we do not support a temperature standard over 131°F; this is the highest threshold that CARB should consider. As discussed in the Background section above, damage to GCCS components can be seen below 145°F³⁵. For these reasons, and because landfill fires can be so disastrous³⁶, CARB should not consider the additional 145°F standard.

We generally support the framework for correlating additional monitoring and corrective action requirements related to both a temperature and oxygen limit. However, first, we urge CARB to require that when a SET event is expected that levels of CO should be confirmed with qualitative laboratory analysis and not field equipment.³⁷ Additionally, CARB should define “extreme high temperature,” as anything over 140°F. We further urge CARB to consider any corrective action not completed at a wellhead with temperatures over 145°F a violation if not completed within 30 days.

³³ *Id.*

³⁴ “[l]iquid in the collection system (wells or piping) can impede gas flow, potentially leading to the buildup of heat and pressure. Therefore, it is crucial to address the management of both gas and liquids in landfills[...].” and EPA emphasizes the “importance of maintaining the leachate level below 30 percent of the total waste thickness to ensure high efficiency in LFG collection.” EPA, White Paper Series: Municipal Solid Waste Landfills-Advancements in Technology and Operating Practices, “Increasing Landfill Gas Collection Rates” (Oct. 2024), 10 [hereinafter “GCCS White Paper”]

³⁵ polyvinyl chloride piping *begins to fail at 145 °F* and fails at 165 °F, *temperatures above 140 °F could indicate aerobic conditions [meaning the presence of oxygen, posing a fire risk], and landfill gas temperature over 135 °F indicates a possible subsurface oxidation event (SOE)[rapid and self-sustaining combustion of organic waste that is exposed to oxygen (aerobic conditions)].* National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills Residual Risk and Technology Review, 84 Fed. Reg. at 36691 (*citing* SWANA/National Renewable Energy Laboratory (NREL), *Landfill Gas Operation and Maintenance Manual of Practice* 9-8 (1997), <https://www.nrel.gov/docs/legosti/fy97/23070.pdf>) (emphasis added).

³⁶ See EPA, *EPA Finds Chiquita Canyon Landfill Presents Imminent and Substantial Endangerment to Nearby Communities* (Feb. 22, 2024), available at <https://www.epa.gov/newsreleases/epa-finds-chiquita-canyon-landfill-presents-imminent-and-substantial-endangerment>.

³⁷ For example, CO levels above 1,500 ppm indicate an active smolder and/or pyrolysis. Jafari, N.H., Stark, T.D., and Thalhamer, T., “Spatial and Temporal Characteristics of Elevated Temperatures in MSW Landfills”. *Waste Management Journal*, Elsevier Science, Ltd., New York, NY, October, 2017, 59, 286–301, <http://dx.doi.org/10.1016/j.wasman.2016.10.052>. Levels between 1,000 and 1,500 ppm are considered suspicious and require further air and temperature monitoring. *Id.* Levels between 500 and 1,000 ppm may indicate pyrolysis, pre- or post-combustion conditions, but active combustion is typically absent. CO levels below 250 ppm with stable temperatures will confirm that smoldering and pyrolysis are not present or have been extinguished. *Id.*

6. Enhanced wellhead monitoring concepts

We strongly support the inclusion of monthly oxygen monitoring and corrective action requirements.³⁸ In its final LMR, CARB should be specific about the timing of initiating corrective action, and when failure to do so constitutes a violation. We generally support the enhanced monitoring concept as presented; increasing frequency to weekly and monitoring the temperature downwell and measuring CO (using lab analytical methods, not field measurements) would be important requirements to reduce the risk of SET events and/or fire.

We also support CARB's proposed concept for liquid level monitoring and the associated corrective action requirements.³⁹ However, we would encourage CARB to require liquid level monitoring more frequently than twice per year, e.g. quarterly. Again, CARB should be specific about the timing of initiating corrective action, and when failure to do so constitutes a violation.

II. Addressing CARB Proposed Concepts

EIP appreciates many of the new proposed concepts included in CARB's July presentation. Below we include more specific comments on those proposed concepts, and continue to reiterate recommendations from our January 2025 LMR Comments.

A. Satellite-detected emissions plumes concept

We support CARB's continued consideration of using advanced technologies for monitoring MSW landfills.⁴⁰ We also support CARB's proposed concepts to (1) require alternative technology in areas that cannot be safely accessed and (2) allow emerging alternative technologies to be evaluated and approved for use across the landfill. We incorporate by reference herein our suggested approach for the latter proposed concept as presented in comments our January 2025 Comments.⁴¹ Namely, CARB should include UAS OTM-51 as an allowed alternative to SEM requirements, subject to all appropriate limitations in EPA's ALT-150 Letter.⁴² CARB should also include in the LMR revisions a specific process for approval of alternative test methods.

³⁸ CARB 2025 LMR Workshop at 26.

³⁹ *Id.* at 27.

⁴⁰ CARB 2025 LMR Workshop at 15.

⁴¹ Env't Integrity Project et al., *Recommendations for Revisions to the Landfill Methane Regulation from Californians Against Waste, the Environmental Integrity Project, RMI and Industrious Labs* (January 24, 2025) at 25-27 [hereinafter "January 2025 Comments"]. See also **Attachment A**.

⁴² OTM-51 Approval Letter. ALT-150 is approved as an alternative to requirements in 40 C.F.R. §§ 60.34f(d) and 60.36(c)-(e), which include the SEM operational standards and compliance provisions for monitoring following Method 21 performance evaluation requirements (in 40 C.F.R. § 60.36f(d)(3)). ALT-150 was approved by EPA on January 19, 2023. Recent Postings of Broadly Applicable Alternative Test Methods 88 Fed. Reg. 3408 (Jan. 19, 2023).

B. Other SEM recommendations

We continue to urge CARB to reduce the surface methane concentration threshold from 500 pmv to 200 ppmv.⁴³ CARB should also explicitly require that SEM occurs only under normal atmospheric conditions, as we argued for extensively in our January 2025 LMR Comments.⁴⁴ We also support the other SEM concepts that focus on reducing the timelines for initiating repairs and completed new well installation; re-monitoring 1 month after repairs; monthly monitoring when exceedances are detected; improve cover thickness when exceedances are detected; and investigating the collection system and repair issues when exceedances are detected.⁴⁵

C. Support SERP

We support the proposed concept that CARB require operators to take action when notified by CARB of a satellite-detected methane plume. We continue to urge CARB to also consider data from third-parties in this requirement and incorporate herein arguments in support of a Super Emitter Response Program that we submitted in our January 2025 LMR Comments.⁴⁶

D. GCCS Downtime

We generally support CARB's proposed concepts for GCCS system downtime.⁴⁷ As described in the Landfill Fires Section above, we recommend additional requirements for earlier installation of gas collectors to guard against the risk of SET events and/or fires.

Additionally, given that CARB notes that research in Canada estimated working face emissions are 60% of the total emissions, CARB should also consider for measuring and controlling active face emissions. We incorporate by reference herein the same recommendations we made in our January 2025 LMR Comments.⁴⁸

We appreciate CARB considering these comments. Please do not hesitate to contact us if you have any questions or would like to further discuss.

Sincerely,

Leah Kelly, Senior Attorney, EIP
Haley Lewis, Attorney, EIP

⁴³ CARB 2025 LMR Workshop at 13.

⁴⁴ *Id.* at 14-15.

⁴⁵ CARB 2025 LMR Workshop at 16.

⁴⁶ *Id.* at 25-27.

⁴⁷ *Id.* at 17.

⁴⁸ January 2025 LMR Comments at 29-31. *See Attachment A.*