

epa.gov/research

When Does a Municipal Solid Waste Landfill Become an Elevated Temperature Landfill (ETLF)?

Innovative Science for a Sustainable Future

What is an Elevated Temperature Landfill?

The generation of heat in a municipal solid waste (MSW) landfill is normal as microorganisms break down waste^[1, 2]. Elevated temperature landfills (ETLFs) are MSW landfills that exhibit temperatures above regulatory thresholds (131 or 145 °F) due to abnormal chemical reactions within the waste mass^[3-6]. These reactions can cause changes in landfill gas composition, noxious odors, rapid and severe waste settlement, leachate seeps and outbreaks, and generate strong leachate, all of which add to operator costs for facility management.

ETLFs are NOT landfills that have experienced a fire. Landfill fires typically occur at or near the surface where oxygen is available, usually affect only a small area, and can be quickly managed.

ETLFs require different conditions and corrective actions than fires.

Common Indicators of an ETLF – Temperature and Gas Composition at the Well



Above 145 °F, methane generation slows. Above 162 °F, minimal landfill biological activity^(2, 3).

131-145 °F suggests heatgenerating chemical reactions may be occurring^[2, 3].

90-131 °F indicates normal operating landfills^[2, 3].

- Elevated gas temperatures (>131 °F)^[6-10]
- Decreased methane (CH₄ <40%) along with increased concentrations of CO₂ (> 50%)^[6-10]
- Increased carbon monoxide (CO), hydrogen (H₂), and ammonia (NH₃) gases^[6, 10, 11]

Contributing Factors

ETLFs likely result from a combination of reactive waste streams and landfill management practices. One common observation at ETLFs is that the affected area is wet, which suggests poor drainage through waste^[3]. Moisture management is always an important consideration for landfill designers and operators.

Accepted Waste Streams

Examples of waste streams that are known or suspected of causing elevated temperatures in landfills:

- Ashes and dusts (e.g., waste-toenergy ash, baghouse dust)^[12-15]
- Aluminum, iron, and steel production by-products and wastes (e.g., dross, slag)^[6, 7, 10, 11, 13, 16-18]

Heat and Odor Management Strategies

- Apply geomembrane cover
- Add additional gas extraction wells
- Excavate gaps in waste mass
- Install and operate closed-loop heat exchanger

A Combination of Factors Contribute to Elevated Temperatures

Management Practices

Internal moisture content can be affected by:

- Solidification, liquids addition, or leachate recirculation
- Type and hydraulic properties of cover or alternative cover materials
- Management of special wastes (i.e., codisposal or waste segregation)
- Removal of liquids from gas extraction wells

If you suspect an ETLF, determine the information that needs to be gathered to develop an appropriate management and mitigation strategy.

Connect with us Online











Bridgeton Landfill • Bridgeton, Missouri



Countywide Landfill • East Sparta, Ohio



Waimanalo Gulch Landfill • Oahu, Hawaii



Noble Road Landfill -Shiloh, Ohio



Middle Point Landfill • Middle Point, Tennessee



Rumpke Landfill • Cincinnati, Ohio



Site Description^[19]**:** Closed MSW landfill, operated 1976-2004, 52 acres, 320 ft deep, 8.7 million metric tons (MMT) waste in place

Dates of ETLF Status^[20, 21]: 2011-present

Indicators: >200 °F gas 2009-2020; noxious odors; sudden differential waste settlement; strong leachate; CO in gas

Site Description^[19]: Active MSW landfill, 175 acres, 184 ft deep, 22.0 MMT waste in place

Dates of ETLF Status^[22, 23]: 2006-present

Indicators: 230 °F gas 2009, >300 °F waste 2009; sudden waste settlement; noxious odors; strong leachate; NH_3 , H_2 , and CO in gas

Site Description^[19]**:** Active MSW landfill, 101 acres, 135 ft deep, 8.9 MMT waste in place

Dates of ETLF Status^[24]: 2005-2008

Indicators: 188 °F gas; H_2 and CO in gas

Site Description^[19]**:** Active MSW landfill, 91 acres, 213 ft deep, 6.6 MMT waste in place

Dates of ETLF Status^[25]: 2007-present

Indicators: >131 °F gas

Site Description^[19]: Active MSW landfill, 193 acres, 210 ft deep, 26.2 MMT waste in place

Dates of ETLF Status^[26]: 2011-present

Indicators: >131 °F gas; noxious odors

Potential Contributing Factors: Unknown industrial wastes

Management & Mitigation Strategy:

Exposed geomembrane cap installed, 2013-2014. Subsurface barrier with heat exchanger loop installed to limit reaction from spreading to a second section of the landfill, 2015-2016. Enhanced monitoring of gas wells and landfill elevations.

Potential Contributing Factors: Aluminum dross disposal and leachate recirculation over the co-disposal area

Management & Mitigation Strategy: Excavated a portion of the landfill to physically separate impacted and nonimpacted areas. Installed geomembrane cap. Enhanced monitoring of gas wells and landfill elevations.

Potential Contributing Factors: Codisposal of municipal waste incineration ash with municipal waste

Management & Mitigation Strategy: Installed gas collection system. Enhanced monitoring of gas extraction wells.

Potential Contributing Factors: Reaction of steel slag, which was accepted and used as daily cover

Management & Mitigation Strategy: Installed new gas extraction wells. Enhanced monitoring and reporting for wells of interest.

Potential Contributing Factors: Aluminum dross disposal

Impacts: Management & Mitigation Strategy: Installed geomembrane cap. Installed new gas extraction wells. Enhanced monitoring and reporting for wells of interest.

Site Description^[19]**:** Active MSW landfill, 315 acres, 197 ft deep, 55.3 MMT waste in place

Dates of ETLF Status^[27]: 2009-present

Indicators: >131 °F gas; sudden waste settlement; destroyed gas extraction wells, strong leachate; noxious odors Potential Contributing Factors: Unknown industrial waste

Management & Mitigation Strategy: Installed geomembrane cap. Installed steel gas extraction wells. Enhanced monitoring and reporting for wells of interest.

EPA/600/R-21/285





Connect with



us





References

- Yeşiller, N., J.L. Hanson, and E.H. Yee. Waste heat generation: A comprehensive review. Waste Management, 42, 166-179. 2015.
- 2. Schupp, S., et al. *Evaluation of the temperature range* for biological activity in landfills experiencing elevated temperatures. ACS ES&T Engineering, 1(2). 2021.
- 3. Yafrate, N. and S. Luettich. *Elevated temperature landfills (ETLFs)*. EM Magazine, A&WMA. 2017.
- US EPA. National Emission Standards for Hazardous Air Pollutants: Subpart AAAA Municipal Solid Waste Landfills. 40 CFR 63, Code of Federal Regulations. 2020.
- US EPA. New Source Performance Standards: Subpart Cf – Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills. 40 CFR 60, Code of Federal Regulations. 2020.
- 6. Jafari, N.H., T.D. Stark, and T. Thalhamer. *Progression of elevated temperatures in municipal solid waste landfills*. Journal of Geotechnical and Geoenvironmental Engineering, 143(8), 05017004. 2017.
- Jafari, N.H., T.D. Stark, and T. Thalhamer. Spatial and temporal characteristics of elevated temperatures in municipal solid waste landfills. Waste Management, 59, 286-301. 2017.
- 8. Stark, T.D. and N.H. Jafari. *Landfill operational techniques in the presence of elevated temperatures*. Geotechnical Frontiers, 289-297. 2017.
- 9. Benson, C.H. Characteristics of gas and leachate at an elevated temperature landfill. Geotechnical Frontiers, 313-322. 2017.
- Martin, J.W., et al. *Detection of aluminum waste reactions and waste fires.* Journal of Hazardous, Toxic, and Radioactive Waste, 17(3), 164-174. 2013.
- 11. Stark, T.D., et al. *Aluminum waste reaction indicators in a municipal solid waste landfill.* Journal of Geotechnical and Geoenvironmental Engineering, 138(3), 252-261. 2012.
- 12. Reinhart, D., R. Joslyn, and C.T. Emrich. *Characterization of Florida, US landfills with elevated temperatures.* Waste Management, 118, 55-61. 2020.
- Hao, Z., et al. *Heat generation and accumulation in municipal solid waste landfills*. Environmental Science & Technology, 51(21), 12434-12442. 2017.
- 14. Narode, A., et al. *Measurement of heat release during hydration and carbonation of ash disposed in landfills using an isothermal calorimeter.* Waste Management, 124, 348-355. 2021.
- Klein, R., et al. Temperature development in a modern municipal solid waste incineration (MSWI) bottom ash landfill with regard to sustainable waste management. Journal of Hazardous Materials, 83(3), 265-280. 2001.
- Huang, X.-L., et al. Characterization of salt cake from secondary aluminum production. Journal of Hazardous Materials, 273, 192-199. 2014.
- 17. Huang, X.-L. and T. Tolaymat. Gas quantity and composition from the hydrolysis of salt cake from second-

ary aluminum processing. International Journal of Environmental Science and Technology, 16(4), 1955-1966. 2019.

- Aghdam, E.F., C. Scheutz, and P. Kjeldsen. Assessment of methane production from shredder waste in landfills: The influence of temperature, moisture and metals. Waste Management, 63, 226-237. 2017.
- 19. US EPA. *Greenhouse Gas Customized Search* (09/28/2020-05/11/2021). Available from: <u>https://</u> <u>www.epa.gov/enviro/greenhouse-gas-customized-</u> <u>search</u>.
- Missouri DNR. Site Background Bridgeton Sanitary Landfill. June 29, 2018 (cited June 2, 2021). Available from: <u>https://dnr.mo.gov/waste-recycling/sitesregulated-facilities/closed-inactive-landfills/bridgetonsanitary-landfill
 </u>
- 21. Thalhamer, T. Data Evaluation of the Subsurface Smoldering Event at the Bridgeton Landfill. Missouri DNR. 2013.
- 22. Ohio EPA. *Countywide Director's Final Findings and Orders* (2007; accessed June 2, 2021). Available from: <u>http://edocpub.epa.ohio.gov/publicportal/edochome.aspx</u>.
- US EPA. Countywide Landfill (2018; accessed 05/22/2021). Available from: <u>https://</u> response.epa.gov/site/site_profile.aspx?site_id=3944.
- 24. US EPA. EPA reaches agreement over Waimanalo Gulch Landfill fire threat / \$1.1 million penalty for Clean Air Act violations. 2013. Available from: https:// archive.epa.gov/epapages/newsroom_archive/ newsreleases/78dd2c0dbd481e7685257b20006f9325.html.
- 25. Ohio EPA. *eDocument Search*. May 18, 2021. Available from: <u>http://edocpub.epa.ohio.gov/publicportal/edochome.aspx</u>.
- Tennessee DEC. Consent Order in Case No.SWM11-0008, In the matter of BFI Waste Systems of Tennessee, LLC. (2011; accessed June 2, 2021). Available from: <u>https://dataviewers.tdec.tn.gov/pls/enf_reports/f?</u> p=9001:720
- 27. Ohio EPA. *Rumpke Sanitary Landfill Inc. Director's Final Findings and Orders*. (2010; accessed June 2, 2021). Available from: <u>http://edocpub.epa.ohio.gov/</u> <u>publicportal/edochome.aspx</u>.

Contact: Max Krause, Engineer, US EPA Office of Research & Development, krause.max@epa.gov

Disclaimer: This document is for informational purposes only and is not intended as legal advice. The contents are for general informational purposes and should not be construed as legal advice concerning any specific circumstances. You are urged to consult legal counsel concerning any specific situation or legal issues. This document does not address all federal, state, and local regulations, and other rules may apply. This document does not substitute for any EPA regulation and is not an EPA rule. This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication.

> January 2022 EPA/600/R-21/285



