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Hazardous waste management: A hidden input to US economic growth

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September 2026

EXECUTIVE SUMMARY

Waste is an inevitable byproduct of economic prosperity. As economies grow, industrial output expands and consumption increases, creating corresponding demand for waste management systems. Much of this material can be managed through conventional municipal waste channels; however, an important subset contains hazardous material that requires specialized handling, treatment, and technical expertise to ensure safe disposal. Improper management of these hazardous wastes can contaminate soil and drinking water resources, release toxic air pollutants, and create serious health risks for exposed communities. For this reason, the World Bank has described inadequate waste management as "one of the most underestimated threats to our shared future."[1]

The US generated more than 32 million tons of hazardous waste in 2023, equivalent to 200 pounds *per person* nationwide.

Despite the risks associated with hazardous waste, it is difficult to imagine a modern economy functioning without it. Virtually every good and service produced in the United States (US) either generates hazardous waste directly during production or relies on inputs that do. Fertilizers used in agriculture and food production, chemicals used to manufacture life-saving medicines and cancer therapies, steel production supporting automobiles and aircraft, and energy generation powering the nation's infrastructure all produce hazardous byproducts as part of their normal operations. These activities, which are often taken for granted in the modern economy, generate tens or even hundreds of thousands of tons of hazardous waste annually.

The importance of hazardous waste as a sector of the economy is evidenced by its growth in recent decades. Between 2003-2021, hazardous waste treatment and disposal industry revenues grew from $3.6 billion to nearly $9 billion annually. Owing in large part to its technical complexity, operating expenses for hazardous waste management have risen substantially faster than expenses in the broader waste management sector, as can be seen in Figure 1. This growth reflects a basic economic fact: As the US economy grows, so too do its needs for hazardous waste management.

Figure 1. Percentage growth in hazardous waste expenses compared to all waste and remediation services

Source: Federal Reserve Economic Data (FRED)

[1] Ed Cook, Kremena Ionkova, Perinaz Bhada-Tata, Sonakshi Yadav, and Frank Van Woerden, *What a Waste 3.0: Global Snapshot of Solid Waste Management Toward Circularity until 2050* (Washington, DC: World Bank, 2026).

In this report, we examine hazardous waste management and its importance to the US economy. Using the latest facility-level data from the US Environmental Protection Agency (EPA), we show that hazardous waste is generated by more than 18,000 facilities across a wide range of industries the US. These facilities range from large industrial manufacturers and pharmaceutical plants to retail distribution centers, commercial establishments, and even households. The most waste-intensive sectors of the economy – chemicals, petroleum and coal products, and metals – collectively generate over 75 thousand tons of hazardous waste per day while also contributing nearly $1 trillion to US GDP and supporting 2.7 million jobs.[2]

The US is poised to generate an additional *5 million tons* per year by 2033.

This role of hazardous waste management is likely to become increasingly important in the coming decade. Recent US industrial policy has aimed to reshore manufacturing of pharmaceuticals, semiconductors for computer chips, batteries for vehicles, and other forms of advanced manufacturing. These sectors are immensely valuable to the US economy but are also substantial generators of hazardous waste, responsible for hundreds of thousands of tons each year. Ensuring that the nation's hazardous waste management infrastructure can accommodate growth in these sectors is critical to sustaining future industrial expansion and economic growth.

However, the path forward to expanding management capacity is not without challenges. Facility closures, the COVID-19 pandemic, and extreme weather events have revealed vulnerabilities in the nation's hazardous waste management supply chain. These vulnerabilities, if left unmitigated, could expand and limit the potential for future economic growth for one simple reason: without the ability to safely manage hazardous waste, facilities can accumulate hazardous waste only for so long before production cannot legally continue. Analyzing three distinct capacity scenarios, we forecast that even modest shortfalls in management capacity can translate into significant economic losses over time. A capacity shortfall of just 1 to 3 percent reduces projected 2033 real gross output by $27.5 billion to $82.4 billion.

A capacity shortfall of just 1 to 3 percent threatens between *$27 to $82 billion* in US economic output over the next decade.

Over time, the nation's hazardous waste management infrastructure will inevitably be tested. Growth in waste-intensive industrial production, facility closures, extreme weather events, and large-scale remediations will place intermittent strain on available capacity. These pressures cannot be avoided. However, by identifying risk

[2] Federal Reserve Bank of St. Louis, *Federal Reserve Economic Data (FRED)*, series for Chemical Manufacturing (NAICS 325), Petroleum and Coal Products Manufacturing (NAICS 324), Primary Metal Manufacturing (NAICS 331), and Fabricated Metal Product Manufacturing (NAICS 332), accessed September 21, 2026, https://fred.stlouisfed.org.

factors to management capacity early and often, they can be mitigated before they translate into measurable economic consequences.

1. HAZARDOUS WASTE IS AN INESCAPABLE BYPRODUCT OF MODERN ECONOMIC ACTIVITY

Each year, millions of tons of hazardous waste is generated in the US through ordinary economic activity. Much of this hazardous waste comes from manufacturing industries that form the backbone of the overall economy, making essential inputs for fertilizers, industrial chemicals, medicine, fuel for cars and airplanes, and steel to build the nation's infrastructure. But hazardous waste is not limited to heavy manufacturing. It is also generated as a byproduct of construction, transportation, and even retail. Nearly every part of the economy either generates hazardous waste directly or depends on goods whose production does.

Let's take a closer look.

A. WHO GENERATES HAZARDOUS WASTE?

According to the latest EPA data on hazardous waste generation (the "Biennial Report"), hazardous waste was generated by more than 18 thousand facilities across 240 industries in the US, ranging from agriculture and food production to healthcare, education, and even retail. Nearly 60 percent of these facilities are classified as large quantity generators (LQGs), meaning they produced over 1 ton of non-acutely hazardous waste or at least 1 pound of acutely hazardous waste per month.[3] Overall, LQGs were responsible for 99 percent of all hazardous waste generated in the US, including 31 facilities that generated over 100 thousand tons of hazardous waste and 8 facilities (shown in Table 1 below) that generated over 1 million tons.

Table 1. LQGs that generated over 1 million tons of hazardous waste

Site ID	Facility Owner	City	State	2023 Volume (Tons)
TXD007330202	Eastman Chemical Company	Longview	TX	3,715,147
TXD001700806	Ascend Performance Materials	Alvin	TX	3,618,038
TXD059685339	Diamond Shamrock Refining Company	Sunray	TX	2,191,075
LAD008213191	Rubicon LLC	Geismar	LA	1,951,763
LAD008175390	Cornerstone Chemical Company LLC	Waggaman	LA	1,794,210
TXD008080533	Blanchard Refining Company	Texas City	TX	1,518,196
MSD096046792	The Chemours Company FC LLC	Pass Christian	MS	1,166,278
TXD000751172	INEOS Nitriles USA LLC	Port Lavaca	TX	1,003,444

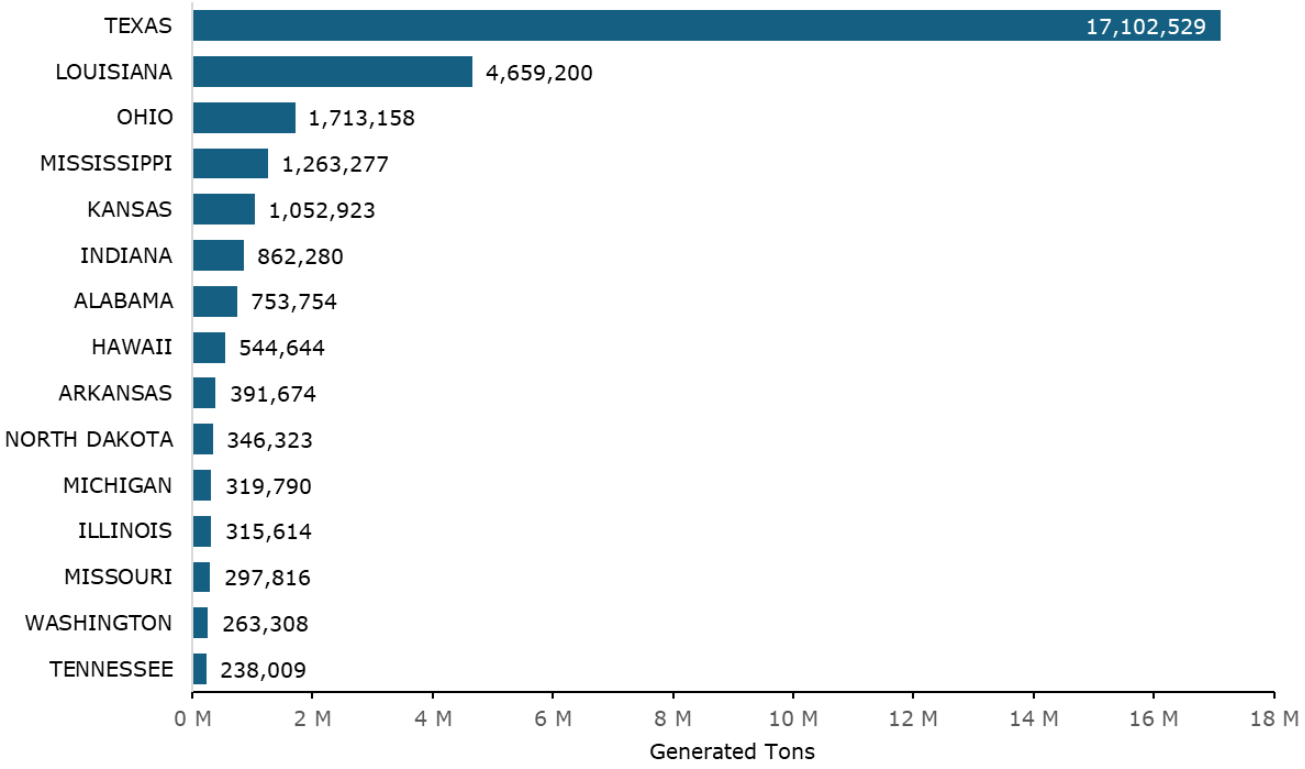
Source: EPA Biennial Report Data

[3] Acutely hazardous waste is highly toxic waste that can cause death, serious illness, or disabling injury in very small amounts, and is primarily composed of discarded, unused chemical products. Examples of acutely hazardous waste include cyanides (used in metal plating and mining), nicotine and salts (used in pharmaceutical manufacturing), arsenic compounds (generated in chemical manufacturing), and certain pesticides.

Hazardous waste generation by state

Although hazardous waste is generated in every state, it is most concentrated in states home to large chemical, refining, and metals industries. Texas was the largest generator of hazardous waste in 2023, accounting for more than 17 million tons, or 53 percent of the national total. Louisiana ranked second at 4.7 million tons, followed by Ohio at 1.7 million tons. Figure 2 below presents the top 15 states in terms of hazardous waste generation. A complete state-level breakdown is provided in the Appendix.

Figure 2. Top 15 states by hazardous waste generation / tons



Source: EPA Biennial Report Data

Hazardous waste generation by industry

In terms of economic sectors, manufacturing accounts for most hazardous waste generation in the US. The reason is straightforward. Manufacturing is not a one-to-one transformation of raw materials into finished products. It requires processing raw materials, separating out impurities, and discarding byproducts material from the production stream. Those steps generate residuals that must be managed as waste. Because the underlying materials are often toxic, corrosive, ignitable, or reactive, the residuals frequently qualify as hazardous waste. Recycling and waste minimization have reduced waste volumes in some settings, but they have not eliminated the basic link between manufacturing activity and hazardous waste generation.

In 2023, the manufacturing sector generated 29.1 million tons of hazardous waste (90 percent of the national total). Table 2 provides a breakdown of hazardous waste generation by manufacturing subsector. Although hazardous waste is generated across a range of manufacturing activities, it is most heavily concentrated in 1) chemical manufacturing; 2) petroleum and coal products; 3) metals manufacturing; and 4) semiconductors, computer and electronic equipment.

Table 2. Hazardous waste generation by manufacturing subsector, 2023

Manufacturing Subsector	Generated Tons	Percent of Total
Chemical Manufacturing	20,654,620	70.9%
Petroleum and Coal Products Manufacturing	4,799,016	16.5%
Primary Metal Manufacturing	2,627,381	9.0%
Plastics and Rubber Products Manufacturing	329,130	1.1%
Fabricated Metal Product Manufacturing	286,981	1.0%
Computer and Electronic Product Manufacturing	120,199	0.4%
Transportation Equipment Manufacturing	102,742	0.4%
Nonmetallic Mineral Product Manufacturing	56,826	0.2%
Miscellaneous Manufacturing	28,324	0.1%
Machinery Manufacturing	27,718	0.1%
Electrical Equipment, Appliance, and Component Manufacturing	17,572	0.1%
Wood Product Manufacturing	16,019	0.1%
Printing and Related Support Activities	15,127	0.1%
Furniture and Related Product Manufacturing	14,321	0.0%
Paper Manufacturing	9,451	0.0%
Food Manufacturing	6,426	0.0%
Textile Mills	4,402	0.0%
Beverage and Tobacco Product Manufacturing	1,803	0.0%
Textile Product Mills	1,295	0.0%
Apparel Manufacturing	330	0.0%
Leather and Allied Product Manufacturing	16	0.0%
Grand Total	**29,119,696**	**100.0%**

Source: EPA Biennial Report Data

#1 - Chemicals

Chemical manufacturing produces the basic inputs used in medicines, plastics, fertilizers, coatings, and many other consumer and industrial products. It is also a large part of the US economy. According to a study by the National Academy of Sciences, the US chemical industry supports approximately 25 percent of GDP and 4.1 million jobs through direct and indirect contributions.[4] The industry generates large volumes of hazardous waste because chemical reactions produce unwanted compounds alongside the intended product, and those materials must be separated and managed. For example, in the production of acrylonitrile (a common component in plastic, rubber, and synthetic fibers), the principal chemical reaction to make the compound also produces hydrogen cyanide, a lethal gas that must be removed and contained as hazardous waste. Similarly,

[4] National Academies of Sciences, Engineering, and Medicine, *The importance of chemical research to the US economy* (National Academies Press, 2022).

in the production of styrene (used to make polystyrene foam), small amounts of benzene, a well-known carcinogen, are generated as a byproduct and must be separated and managed as hazardous waste.

Pharmaceuticals

Pharmaceuticals are an important subsector of chemical manufacturing. In 2023, pharmaceutical manufacturing generated approximately 200 thousand tons of hazardous waste. The two largest generators were the Pharmacia & Upjohn Company, a subsidiary of Pfizer, and Evonik. Pharmacia & Upjohn generated 36 thousand tons at a single facility in Kalamazoo, Michigan. Evonik generated 26 thousand tons at its facility in Lafayette, Indiana, which was built with a $220 million investment to manufacture specialty lipids used in mRNA vaccines.[5]

Federal Reserve data show that pharmaceutical manufacturing output rose by roughly 12 percent between 2023 and 2025. Further growth is likely as major pharmaceutical companies have invested in reshoring US production capacity. Eli Lilly, for example, has announced capital commitments to US manufacturing in excess of $50 billion, including four new domestic manufacturing facilities.[6] Comparable commitments have been announced by Johnson & Johnson, Roche, Merck, and Amgen, which announced a $1 billion manufacturing expansion in North Carolina.[7] To the extent that more pharmaceutical production is located domestically, generation of hazardous pharmaceutical, or "P-list," waste is likely to increase.

#2 - Petroleum and coal

The petroleum and coal products sector refines crude oil into gasoline, diesel, and jet fuel and processes coal for power plants and coke used in steelmaking. It also produces asphalt, motor oil, charcoal, and a host of other petroleum and coal derivatives.

Hazardous waste is generated as a routine part of petroleum refining. Sulfur, for example, must be removed from fuels before they can meet environmental standards. Refineries do this with hydrotreating units that, over time, become saturated with hazardous contaminants and must be discarded. Likewise, when crude oil sits in storage tanks, heavier materials settle to the bottom and form hazardous sludge that must be removed.

Hazardous waste generated by petroleum and coal products manufacturing declined 18 percent between 2013-2023, from 5.8 million tons in 2013 to 4.8 million tons in 2023. Substantial improvements in waste minimization technology appear to be a driving force behind this decline: the amount of hazardous petroleum and coal products waste that underwent minimization increased from half a million tons in 2013 to more than 3.2 million tons in 2023. Even with these advances in waste minimization, however, petroleum and coal

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[5] Evonik, “Evonik breaks ground on $220 million Lipid Innovation Center in Lafayette, Indiana,” March 29, 2023, https://healthcare.evonik.com/en/evonik-breaks-ground-on-220-million-lipid-innovation-center-in-lafayette-indiana-197660.html.

[6] “Lilly Plans to More than Double US Manufacturing Investment Since 2020, Exceeding $50 Billion,” *Genetic Engineering & Biotechnology News*, February 27, 2025, https://www.genengnews.com/topics/bioprocessing/lilly-plans-to-more-than-double-u-s-manufacturing-investment-since-2020-exceeding-50-billion/.

[7] Patricia Van Arnum, “Big Pharma & US Manufacturing Investment,” *DCAT Value Chain Insights,* August 21, 2025, https://www.dcatvci.org/features/big-pharma-us-manufacturing-investment/.

products manufacturing remains one of the most waste-intensive subsectors of the economy and will likely remain so for as long as fossil fuels continue to supply a large share of US energy demand.

#3 - Metals

Primary and fabricated metals manufacturing creates finished or semi-finished metals for both consumer and industrial products. Hazardous waste is a routine byproduct of production. In steel manufacturing, for example, a layer of oxide scale forms on the metal surface when it is heated. Before the steel can be further processed, the scale must be removed. Producers do this by washing the steel in a strong acid solution. Over time, that acid becomes contaminated with dissolved metals and must be discarded as hazardous waste. Similar hazardous wastes are produced in downstream fabrication, where metal parts are cleaned, coated, or plated before use.

Hazardous waste generated by primary and fabricated metals manufacturing has decreased over the past decade, a change that is broadly consistent with trends in domestic production. According to Federal Reserve data, domestic production of primary metals declined by roughly 11 percent between 2013-2023, while fabricated metal products declined by 7.6 percent. This trend is likely to reverse in the coming years, however, as the Trump administration's steel tariffs have increased domestic steel production and, with it, the volume of hazardous byproducts requiring treatment and disposal.[8]

#4 - Semiconductors, computer and electronic equipment

Semiconductor manufacturing is another economically important source of hazardous waste. It is captured primarily within computer and electronic products manufacturing (NAICS 334) and parts of plastics and rubber products manufacturing (NAICS 326). Semiconductors are a major US export and have long generated a trade surplus. They have also been a clear focus of industrial policy in recent years. The CHIPS and Science Act provided substantial federal support for domestic production, and since its passage nearly $400 billion in private semiconductor investment has been announced in the US.[9]

Growth in hazardous waste associated with semiconductors can already be seen in data. Hazardous waste generated by plastics and rubber products manufacturing, for example, has increased nearly sixfold between 2013-2023. This increase was driven almost entirely by one company, ROHM America LLC, which manufactures resins and specialty polymer materials used in the electronics and semiconductor supply chain. As investment in domestic semiconductor production expands, hazardous waste generated in these manufacturing subsectors will likely increase as well.

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[8] Nathan Owens, "Steel Imports Down 30% in 2026 as Tariffs Bolster US Production," *Manufacturing Dive*, June 4, 2026, https://www.manufacturingdive.com/news/steel-imports-down-30-percent-ytd-tariffs-bolster-us-production/821998/.

[9] Diana Roy, "The CHIPS Act: How US Microchip Factories Could Reshape the Economy," Counsel on Foreign Relations, October 8, 2024, https://www.cfr.org/articles/chips-act-how-us-microchip-factories-could-reshape-economy.

Batteries

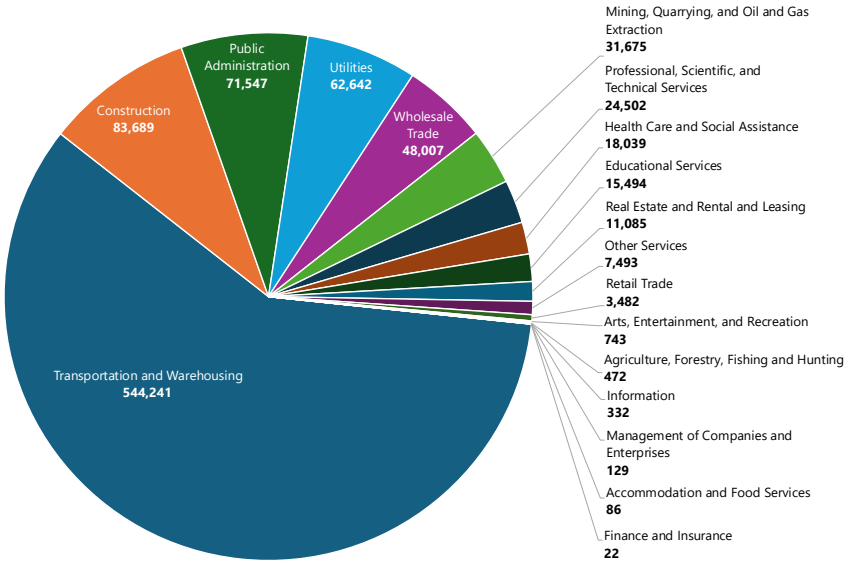
Battery manufacturing is smaller in terms of current waste volume, but it is positioned for rapid growth. It is generally captured within electrical equipment and component manufacturing (NAICS 335). The sector produces primary and rechargeable batteries used in consumer electronics, vehicles, and energy storage.

Demand for batteries rises as transportation and power systems become more electrified. US industrial policy has also emphasized domestic battery production. According to the Center for Strategic and International Studies, total demand for rechargeable batteries could more than quadruple from 2023 levels by 2030.[10] To the extent that this demand is met through domestic production, hazardous waste generation from battery manufacturing is likely to increase.

Other sectors of the economy

Hazardous waste generation is not only limited to industrial manufacturing in the waste management sector itself. Nearly 1 million tons of hazardous waste was generated by 150 different non-manufacturing industries across 18 distinct sectors of the economy, ranging from utilities and transportation to health care, education, retail trade, and food service. Figure 3 gives a breakdown of these additional hazardous waste-producing sectors of the economy.

Figure 3. Hazardous waste generated outside of manufacturing and waste management / tons generated



Source: EPA Biennial Report Data

Transportation was the largest non-manufacturing, non-waste management sector responsible for generating hazardous waste in 2023. This was driven by a 350-thousand-ton, $1 billion cleanup of hazardous waste following a major train derailment in East Palestine, OH where a Norfolk Southern train carrying over 30 cars of hazardous materials went off the tracks, contaminating over 150

[10] Ray Cai and Jane Nakano, "A New Phase for the US Battery Industry," Center for Strategic & International Studies, April 27, 2026, https://www.csis.org/analysis/new-phase-us-battery-industry.

thousand tons of soil and generating 350 thousand tons of hazardous cleanup waste.[11] As we discuss in Section 4, cleanup events such as this are a prominent risk factor to hazardous waste management capacity in the US.

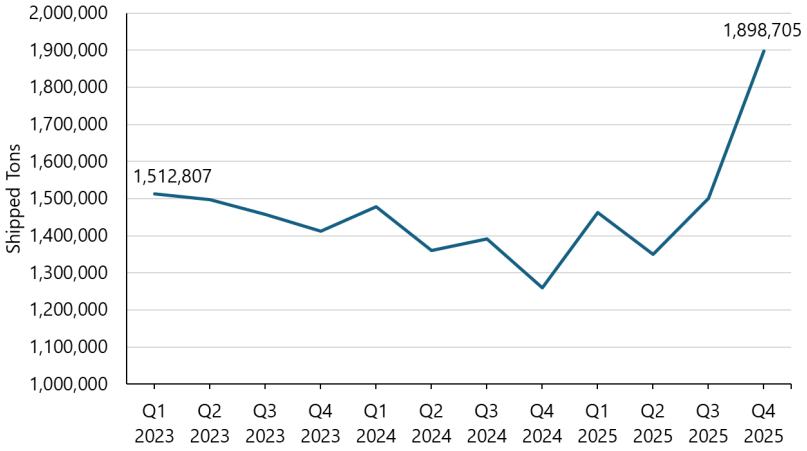
Figure 4. The Norfolk Southern train derailment in East Palestine, OH (February 3, 2023)

Source: National Transportation Safety Board (public domain)

B. ECONOMIC OUTLOOK: INDUSTRIAL GROWTH IS LIKELY TO INCREASE HAZARDOUS WASTE GENERATION

Hazardous waste management plays a role in supporting US industrial policy, as many industries targeted for expansion under recent legislation and trade policy are also among the most waste intensive. As domestic production in these sectors increases, their volumes of hazardous waste generated is likely to rise as well, placing additional demands on hazardous waste management infrastructure. The question is what increases in hazardous waste generation could we see if current production trends continue.

Figure 5. Quarterly hazardous waste shipments in the US, 2023-2025



Source: e-Manifest Data

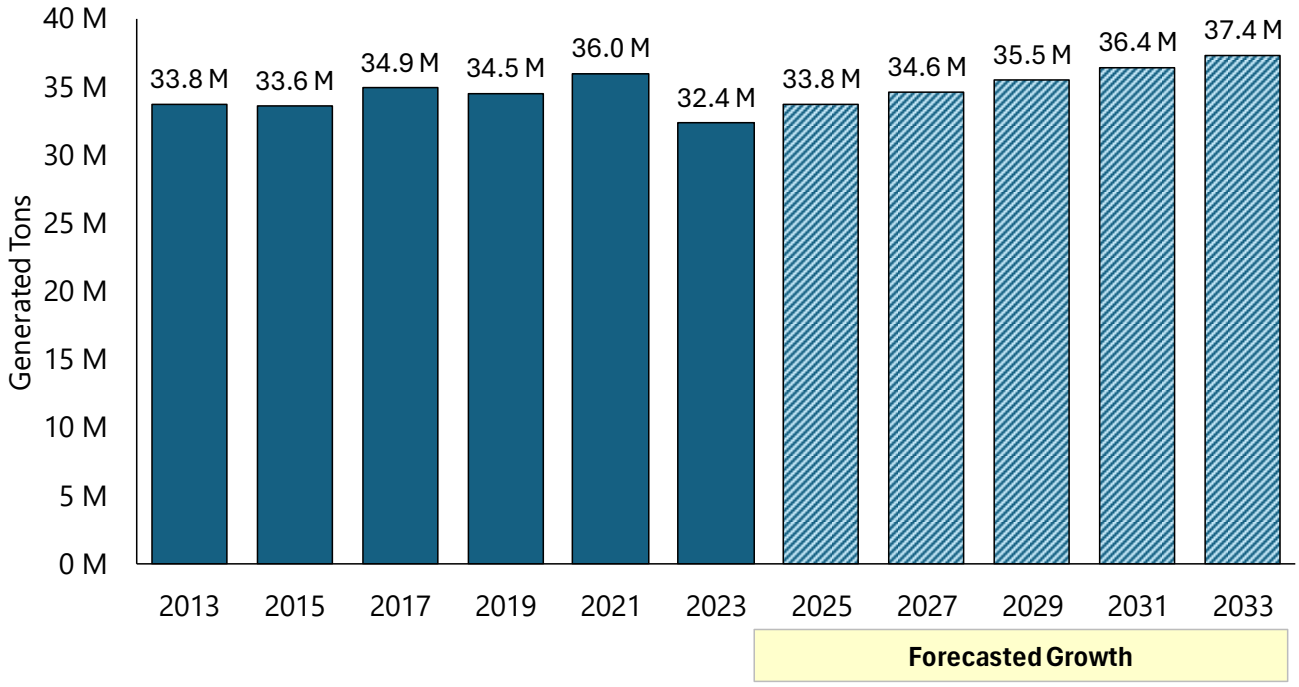
Recent data from the EPA's e-Manifest system indicates that generation is already on the rise. As of Q4 2025, hazardous waste shipments across the US are up 25 percent (+385 thousand tons) relative to Q1 2023.

To quantify the likely impact of future economic growth on demand for hazardous waste management, we forecast hazardous waste generation using industry-level economic growth projections from the US Bureau of Labor Statistics and data on observed hazardous waste generation across sectors. Figure 6 presents the results of our main specification. Total hazardous waste generation is projected to increase to 37.4 million tons

[11] Tom Perkins, "Ohio catastrophe is `wake-up call' to dangers of deadly train derailments," *The Guardian,* February 11, 2023, https://www.theguardian.com/us-news/2023/feb/11/ohio-train-derailment-wake-up-call. See also Josh Funk, "Soil removal from Ohio train derailment site is nearly done, but cleanup isn't over," *Associated Press*, October 26, 2023, https://apnews.com/article/east-palestine-derailment-norfolk-southern-cleanup-0eeb5c7c922c8affa1014732c799efc2.

annually by 2033 relative to 2013, nearly one and a half million tons higher than the level of hazardous waste generation immediately following the COVID-19 pandemic.

Figure 6. Forecasted growth in hazardous waste generation through 2033



Due to its high waste intensity, manufacturing is the driving force behind projected hazardous waste generation. In particular, increases in manufacturing output are projected to generate an additional 4 million tons of hazardous waste per year by 2033 relative to 2023 levels. Other increases of manufacturing include waste management and remediation sector itself (+1.2 million tons), wholesale trade (+17 thousand tons), and utilities (+9 thousand tons). For a complete table of sector-level projections, see the Appendix.

This forecast of hazardous waste generation is conservative in two ways. First, the forecast removes outlier remediation events, such as 1 million tons of mining remediation by Occidental Chemical Corporation in 2013 and 300 thousand tons associated with the Norfolk Southern train derailment in 2023. Including outlier events in the calculation of expected cleanup waste raises projected hazardous waste generation by approximately 64 thousand tons annually. Second, the forecast assumes the relative composition of manufacturing, transportation, and other sectors remains unchanged over time. This assumption is likely to underestimate the growth path of hazardous waste given current US domestic policy and industry trends. Steel tariffs have increased domestic steel production; advances in artificial intelligence have increased demand for semiconductors and related components; and systematic initiatives to reshore drug manufacturing have spurred domestic pharmaceutical production. To the extent that these waste-intensive industries grow faster than the rest of the manufacturing sector overall, future hazardous waste generation is likely to exceed the baseline forecast.

2. THE TECHNOLOGICAL SOPHISTICATION OF HAZARDOUS WASTE INFRASTRUCTURE

Modern hazardous waste management relies on a national network of treatment, recovery, and disposal facilities designed to safely manage the array of dangerous compounds found in hazardous waste. Operating these facilities requires substantial capital investment, specialized technical expertise, and extensive permitting.[12] Excluding intermediate transfers and storage, 809 hazardous waste facilities managed approximately 35.5 million tons of hazardous waste in 2023.

Depending on its properties and source, hazardous waste is managed in a variety of ways, referred to as "management methods." Here, we describe three management methods—incineration, landfilling, and recovery—that the EPA highlights in its assessments of national capacity "because such facilities are often costly, difficult to permit, and are essential for managing much of the nation's hazardous waste."[13]

1. **Incineration.** Incinerators are designed to destroy highly hazardous organic and inorganic matter. They will typically maintain on-site laboratories to characterize incoming waste and ensure it can be safely managed. Blending units combine wastes to create feed streams with consistent combustion characteristics while avoiding dangerous chemical reactions. In the incinerator itself, combustion chambers destroy hazardous organic compounds at temperatures exceeding 2,000 °F, while air pollution control systems capture contaminants generated during the combustion process before they can be released into the atmosphere. While the incinerator runs, detailed monitoring systems continuously track performance to ensure that the incinerator meets federal destruction and emissions standards.

2. **Landfill.** Hazardous waste landfills received 1.2 million tons of hazardous waste in 2023. As permanent disposal facilities, hazardous waste landfills are subject to stringent design and operating requirements. Disposal units must include double liners and have detection systems to monitor for potential soil and groundwater contamination. Landfill operators must possess sufficient technical expertise to characterize waste streams and ensure that reactive compounds do not come into contact, release toxic gases, or compromise the integrity of the disposal unit. In addition, once a landfill closes, it remains subject to closure and post-closure care requirements for an extended period of time, typically 30 years.

3. **Recovery.** As technology has advanced, the use of hazardous waste for energy recovery and the recycling of valuable metals has increased. Certain wastes, including concentrated organic liquids and spent petroleum byproducts, have high heat values and can be burned in industrial boilers, cement kilns, and other types of furnaces to generate electricity or steam, or to serve as fuel in industrial processes.

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[12] For information on hazardous waste facility requirements, *see* "Hazardous Waste Management Facilities and Units," US Environmental Protection Agency, accessed September 21, 2026, https://www.epa.gov/hwpermitting/hazardous-waste-management-facilities-and-units.

[13] "2024 National Capacity Assessment Report," US Environmental Protection Agency, January 24, 2025, pp. i-ii, https://www.epa.gov/hwpermitting/assessment-national-capacity-hazardous-waste-management.

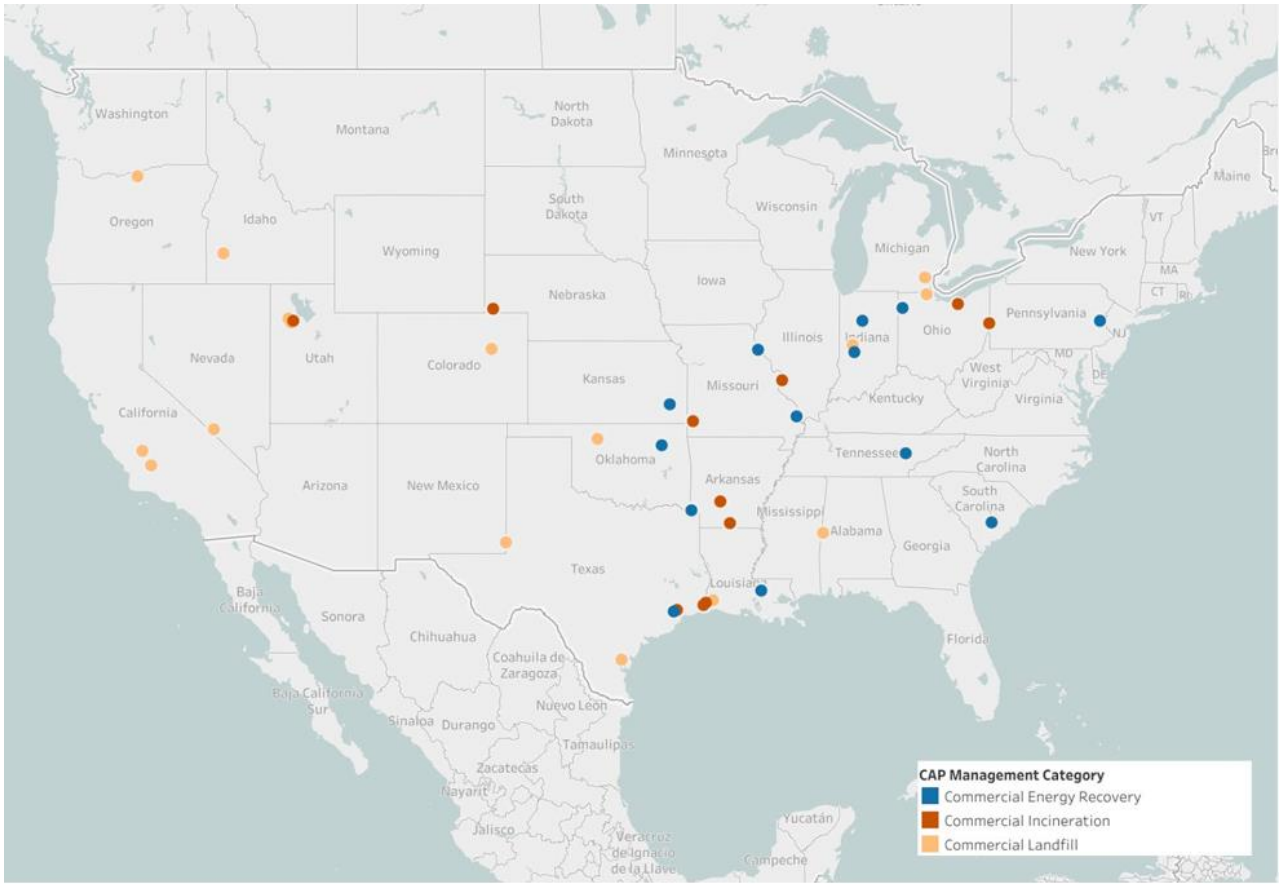
Hazardous waste can also be used as a source of recoverable materials. Industrial sludges and spent batteries may be treated using chemical, thermal, or electrolytic processes to extract valuable base and precious metals (e.g., lead, copper, and zinc). Similarly, solvents like acetone or toluene that have been contaminated during manufacturing or laboratory processes can be purified through fractional distillation and potentially reused.

The technical complexity and regulatory requirements associated with hazardous waste management, along with the fixed costs associated with opening new facilities, give rise to economies of scale.[14] Consequently, commercial management of hazardous waste in the US is organized around a handful of large-scale facilities. Unlike smaller onsite or captive facilities,[15] these commercial facilities are permitted to receive off-site waste from any third party and, therefore, must be capable of processing complex, difficult-to-manage hazardous mixed waste streams. Currently there are 17 commercial hazardous waste landfills, 12 energy recovery facilities, and 11 incinerators operating in the US. These facilities, shown in Figure 7, are distributed across the country but are more heavily concentrated in the Midwest and South. Despite their relatively small number, commercial facilities play an important role in the overall hazardous waste management system: commercial incinerators, landfills, and energy recovery facilities managed over 70 percent of all hazardous waste designated for those three management methods.

[14] Economies of scale occur when the average cost of providing a good or service declines as the volume of output increases. In hazardous waste management, the fixed costs associated with permitting, constructing, and operating specialized facilities can typically be spread across a larger volume of waste, reducing per-unit costs.

[15] Onsite management refers to hazardous waste managed at the same facility where it is generated. These units are used exclusively for the generator's own waste streams and are not permitted to accept offsite waste from third-party generators. Captive management refers to hazardous waste shipped offsite to a facility owned by the same company as the generator but located at a different site. These units may accept internally generated waste from across the firm's operations but do not manage waste generated by third parties.

Figure 7. Commercial hazardous waste incineration, landfill, and energy recovery facilities



Source: Exhibit 2 – EPA National Capacity Assessment (2024)

3. ECONOMIC IMPLICATIONS OF LIMITED HAZARDOUS WASTE MANAGEMENT CAPACITY

Given the connection between hazardous waste generation and industrial activity, the ability of the nation's infrastructure to manage hazardous waste is important not only for public health and the environment but also for the broader economy. Like shortages of other essential inputs to production, persistent shortages of hazardous waste management capacity can have far-reaching implications beyond the waste management sector itself. This section discusses two potential consequences of such shortages: slower economic growth and higher prices for goods and services.

A. REDUCED ECONOMIC GROWTH

First and foremost, inadequate capacity to manage hazardous waste limits firms' ability to expand and, in turn, slows down economic growth. This is because, unlike non-hazardous byproducts of production, a firm can accumulate hazardous waste only for so long before production cannot legally continue. In such cases, hazardous waste management capacity, not production capability, becomes an operational constraint. This has been observed in the US petrochemical industry, for example, where limitations in wastewater treatment capacity have resulted in facilities reducing processing rates to remain under federal discharge limits.[16]

Table 3. Hazardous waste intensity across major sectors of the US economy

Sector	NAICS Code	Hazardous Waste Intensity (Tons per Billion USD)
Agriculture, forestry, fishing, and hunting	11	0.8
Mining, quarrying, and oil and gas extraction	21	51.3
Utilities	22	92.5
Construction	23	16.2
Manufacturing	31, 32, 33	5,076.9
Wholesale trade	42	21.6
Retail trade	44, 45	1.4
Transportation and warehousing	48, 492, 493	108.8
Information	51	0.1
Finance and insurance	52	0.0
Real estate and rental and leasing	53	1.4
Professional, scientific, and technical services	54	7.7
Management of companies and enterprises	55	0.2
Administrative and support and waste management and remediation services	56	1,345.0
Educational services; private	61	35.1
Healthcare and social assistance; private	62	6.2
Arts, entertainment, and recreation	71	1.0
Accommodation and food services	72	0.0
Other services (except public administration)	81	7.4

Source: EPA Biennial Report Data; US Bureau of Economic Analysis

The extent to which constraints on management capacity affect firms' ability to produce efficiently depends on both the industry and the relationship between production and hazardous waste generation. Table 3 reports hazardous waste intensity, defined as the ratio of process waste to total output in billions of dollars, across major sectors of the US economy. The table shows that hazardous waste intensity varies substantially across industries. Manufacturing generates 5,077 tons (10 million pounds) of hazardous process waste per billion dollars of output, compared with 1,345 tons in the waste management sector itself and effectively zero in finance and insurance.

Growth consequences from limited capacity scenarios

Hazardous waste intensity provides a useful measure of an industry's potential exposure to management capacity shortages. Industries with a higher waste intensity generate more hazardous waste per dollar of output and, thus, are more likely to be affected by persistent shortages in management capacity. Importantly, it also allows us to translate capacity shortfall scenarios into estimated impacts on economic growth. Below we provide the results of three such scenarios:[17]

[16] See, for example, Shane Lund, "Overcoming Wastewater Challenges of Opportunity Crude Processing," *Digital Refining Petroleum Technology Quarterly*, February 2024, https://www.digitalrefining.com/article/1003053/overcoming-wastewater-challenges-of-opportunity-crude-processing. See also Rich Clasen, Stan Heimburger, Mike Fagan, and Mostafa Jahanian, "Treatment of Refinery Wastewater Containing High Concentrations of Chemical Oxygen Demand and Total Sulfides for Low Odor Processing through a Capacity-Challenged Bioreactor," USP Technologies, https://usptechnologies.com/whitepapers/treatment-refinery-wastewater-containing-high-concentrations-chemical-oxygen-demand-total-sulfides-low-odor-processing-capacity-challenged-bioreactor/.

[17] In each scenario, calculations assume that capacity shortfalls are "binding" in the sense that a firm, when faced with the constraint, must limit production to not exceed capacity limits. Sectors with a negligible waste intensity (10 or fewer tons per billion dollars of output) are assumed to not be impacted by capacity shortfalls. All other sectors face a 1, 2, or 3 percent reduction in achievable process waste growth, depending on the scenario. Finally, for simplicity, capacity shortfalls are assumed to impact only process waste.

- ***Scenario A: 1% capacity shortfall.*** Current capacity accommodates 99% of projected growth in hazardous waste generation by 2033.
- ***Scenario B: 2% capacity shortfall.*** Current capacity accommodates 98% of projected growth in hazardous waste generation by 2033.
- ***Scenario C: 3% capacity shortfall.*** Current capacity accommodates 97% of projected growth in hazardous waste generation by 2033.

Results for each capacity shortfall scenario are shown in Table 4. Relative to the baseline forecast, real US output growth from 2023 to 2033 declines between $27.5 billion and $82.4 billion depending on the capacity shortfall scenario. Waste intensive industries bear the brunt of these losses. Across the three scenarios, manufacturing loses between $8 billion and $23 billion in growth, transportation loses between $3 billion and $10 billion, and the waste management sector itself loses between $3 billion and $9 billion. Other sectors with lost growth between 2023-2033 due to the capacity shortfall include wholesale trade ($6.5 billion to $19.6 billion), construction ($1.5 billion to $4.5 billion), and utilities ($1 billion to $3 billion).

Table 4. Projected 2023-2033 economic growth under three capacity scenarios

Capacity Scenario	Projected Real Gross Output Growth (Billions)	Lost Growth (Billions)
Baseline Forecast	$8,554.9	
Scenario A (1% Shortfall)	$8,527.5	-$27.5
Scenario B (2% Shortfall)	$8,500.0	-$54.9
Scenario C (3% Shortfall)	$8,472.6	-$82.4

B. HIGHER PRICES FOR GOODS AND SERVICES

In addition to reduced economic growth, another potential consequence of persistent hazardous waste management capacity shortages is higher prices for certain goods and services. The mechanism is straightforward. For many production processes, hazardous waste generation increases alongside output. Hazardous waste management is therefore a variable cost of production, and sustained shortages of management capacity can, over time, increase the marginal cost of producing goods and services.[18]

[18] The extent to which shortages of management capacity translate into higher disposal costs depends on competitive market dynamics. Sustained increases in disposal costs create incentives for new providers to enter the market, existing providers to expand capacity, and for generators to seek alternative providers and invest in waste minimization. These market responses impose competitive discipline on providers and limit the extent to which disposal costs can increase following a capacity shortage.

Economic theory predicts that sustained increases in the marginal cost of goods and services can place upward pressure on prices. Firms facing higher costs may absorb some of this through reduced profitability; however, economics research generally finds that at least a portion of cost increases are passed through to consumers.[19] All else equal, the potential price effects of capacity shortages would be most pronounced in waste-intensive industries such as manufacturing, construction, and transportation. Any price effects experienced by these industries would likely propagate through the broader economy over time, as they supply inputs to a wide range of downstream industries.

4. RISK FACTORS AFFECTING HAZARDOUS WASTE MANAGEMENT CAPACITY

The EPA regularly monitors commercial hazardous waste management capacity in the US. In its most recent national capacity assessment, the EPA noted that closures of on-site and captive management facilities have shifted waste volumes toward commercial management and that this trend is expected to continue as facilities age and firms elect not to invest in replacement capacity. The agency also cautioned that both incinerators and landfills may have limited capacity going forward and encouraged state and regional authorities to seek ways to develop new capacity for the future, though it did not offer specific procedures or timeframes for this recommendation.[20]

Moreover, the COVID-19 pandemic and other major events revealed vulnerabilities in the nation's hazardous waste management system. Beginning in mid-2020, hazardous waste generators across the country reported difficulty securing access to commercial hazardous waste incineration. Generators were unable to offload hazardous waste, and some facilities were forced to accumulate waste on-site for longer than is allowed under RCRA regulations. In response, the EPA issued emergency guidance to states and regional EPA offices outlining options for providing temporary regulatory relief, including extensions to hazardous waste accumulation time limits for generators unable to secure incineration capacity.[21]

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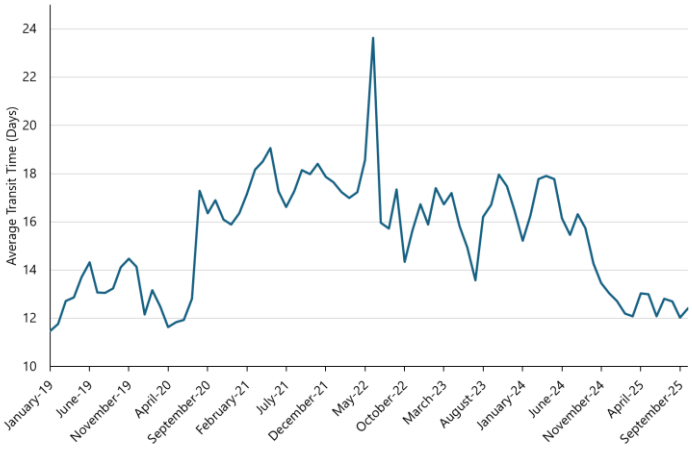
[19] A large economics literature examines the extent to which cost increases are passed through to prices. See, e.g., E. Glen Weyl and Michal Fabinger, "Pass-Through as an Economic Tool: Principles of Incidence under Imperfect Competition," *Journal of Political Economy* 121, no. 3 (2013): 528–583 (tax and cost pass-through); Mary Amiti, Oleg Itskhoki, and Jozef Konings, "International Shocks, Variable Markups, and Domestic Prices," *Review of Economic Studies* 86, no. 6 (2019): 2356–2402 (pass-through of international cost shocks).

[20] "2024 National Capacity Assessment Report," US Environmental Protection Agency, January 24, 2025, pp. i-ii, https://www.epa.gov/hwpermitting/assessment-national-capacity-hazardous-waste-management.

[21] "Regulatory Options for Addressing the Temporary Backlog of Containerized Hazardous Waste Needing Incineration," US Environmental Protection Agency Memorandum, RCRA Online Number 14939, August 10, 2021, https://rcrapublic.epa.gov/rcraonline/details.xhtml?rcra=14939.

Figure 8 illustrates the extent of the disruption to shipments of hazardous incineration waste across the US. Average transit times increased by approximately 35 percent beginning in July 2020 and remained elevated for nearly four years. At the peak of the backlog in 2022, average transit times for hazardous waste shipments destined for incineration were more than twice their 2019 levels.

Figure 8. Substantial delays in hazardous incineration waste shipments across the United States



Source: e-Manifest Shipment Data

The 2020–2024 incineration backlog exposed several vulnerabilities in the nation's hazardous waste management system. The remainder of this section examines the factors that contributed to the backlog and considers the extent to which similar conditions could give rise to capacity constraints in the future.

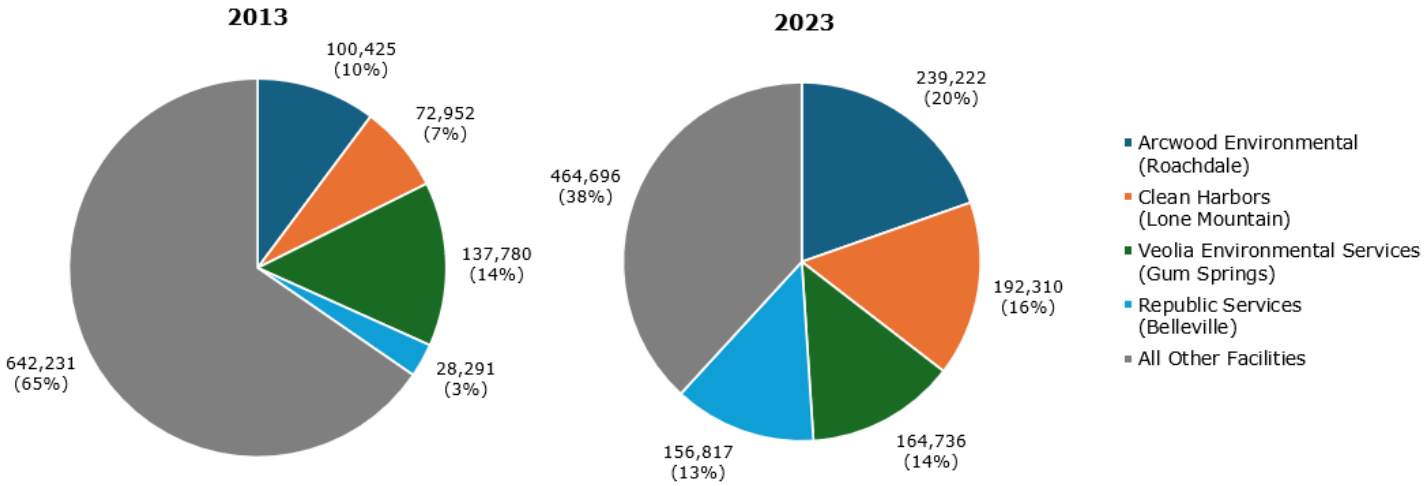
A. RISK FACTOR 1: FACILITY CLOSURES

Given the complexity of hazardous waste management facilities, the inherent safety risks associated with their operation, and the extensive environmental permits and regulations to navigate, some hazardous waste generators have chosen to close on-site management facilities and rely on commercial providers instead. As a result, hazardous waste management in the US has shifted toward large commercial facilities, a trend that has become more pronounced over the past decade.

Landfills

Between 2013 and 2023, the total number of facilities managing hazardous waste via landfill fell from 54 to 45, a 16.7 percent reduction. Of the 54 facilities active in 2013, 20 stopped managing landfill waste, and only 11 new facilities opened to take their place. At the same time, volumes handled by the largest operators grew substantially. The four largest hazardous waste landfills managed 397 thousand tons in 2013, roughly 40 percent of total landfill volumes. By 2023, the volume managed by the top four facilities nearly doubled to approximately 750 thousand tons. Figure 9 shows the current top four landfills and their growth since 2013.

Figure 9. Current top 4 landfill facilities / managed volumes (2013 vs. 2023)[22]



Source: EPA Biennial Report Data

Incinerators

Hazardous waste incineration has followed a similar pattern. Between 2013 and 2023, the total volume of incineration waste managed by incineration facilities receiving less than 15 thousand tons per year decreased by nearly 30 percent. Many of these smaller facilities are on-site or captive operations, permitted to handle only their own waste, and therefore do not impose constraints on commercial capacity. When on-site or captive facilities close, however, the waste they once managed does not disappear. It is diverted to commercial facilities, increasing overall demand for commercial capacity.

One significant captive facility closure in recent years was 3M's captive incineration facility in Cottage Grove, Minnesota, which burned around 20 thousand tons of hazardous waste each year from 3M factories and sites across the country. 3M's decision to shut down the incinerator and transition to commercial management was motivated by the company's desire to "focus on competencies that are core to [its] business."[23] The economic incentives facing 3M are not unique. Going forward, other firms may reach similar conclusions and choose to rely on commercial providers rather than continue operating captive facilities.

[22] Veolia acquired its Gum Springs facility in 2020 from the Alcoa Corporation. Landfill volumes in 2013 correspond to volumes managed at this facility under previous ownership.

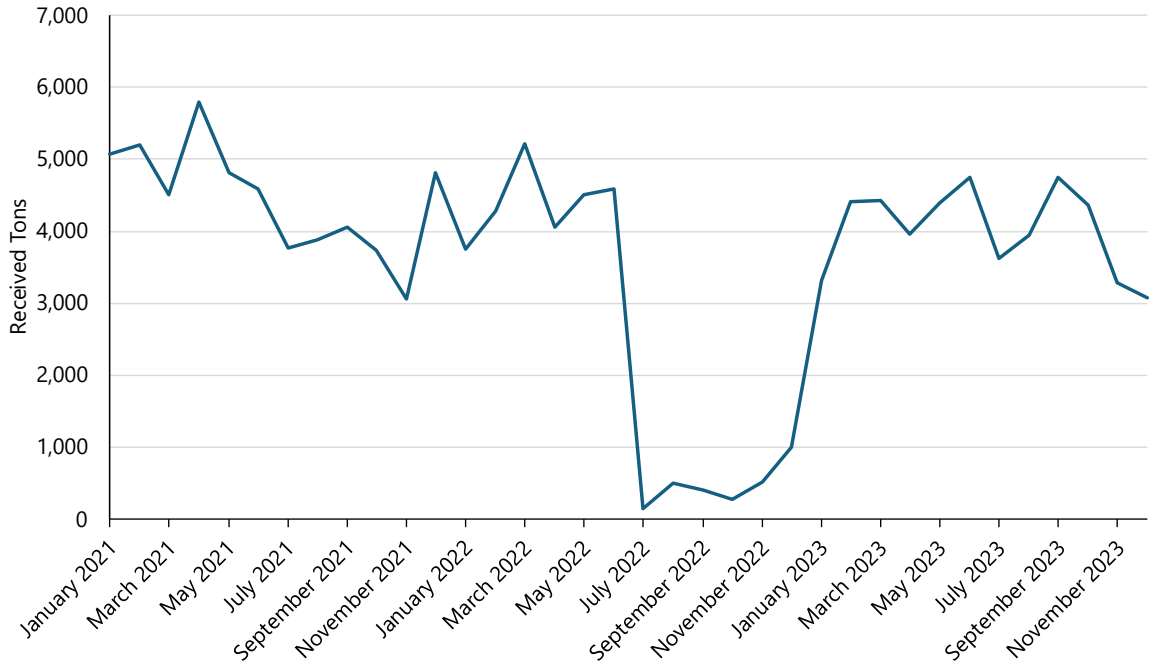
[23] Bob Shaw, "3M Will Turn Off Incinerator in Cottage Grove," *St. Paul Pioneer Press*, August 4, 2021, https://www.twincities.com/2021/08/04/3m-will-turn-off-incinerator-in-cottage-grove/.

B. RISK FACTOR 2: UNSCHEDULED MAINTENANCE AND TEMPORARY SHUTDOWNS

Reliance on large commercial facilities does not necessarily indicate a weakness in the hazardous waste management system. In many respects, large facilities are an efficient way to organize hazardous waste management. Their scale allows them to spread fixed costs over larger volumes and operate at high utilization rates which helps them achieve more efficient burn rates.[24] Greater reliance on a smaller number of facilities, however, does mean that disruptions at any single facility can have outsized effects on the entire network.

This is precisely what happened in June 2022 when Heritage Thermal Services (now Arcwood Environmental) shut down after a fire at its East Liverpool facility. Prior to the shutdown, the facility received an average of approximately 4,400 tons (8.8 million pounds) of hazardous incineration waste per month. Following the outage, volumes declined by more than 90 percent, forcing generators, transporters, and intermediaries to redirect large volumes of waste to other facilities.

Figure 10. Shutdown of the Heritage Thermal Services incinerator in East Liverpool, OH



Source: e-Manifest Data

The sudden loss of capacity and resulting diversion led to increased congestion at alternative facilities, which caused ripple effects across the country. According to e-Manifest shipping data, transit times for hazardous

[24] Commercial incinerators must generally operate at 85 to 95 percent capacity to burn at peak efficiency. And due to the energy requirements to restart an incinerator, they are rarely, if ever, taken completely offline.

incineration waste shipments across the entire country spiked nearly 30 percent following the incident. It took around seven months for the Heritage facility to receive volumes similar to pre-shutdown levels.

The Heritage facility outage demonstrates how the temporary loss of a single, large facility can significantly disrupt hazardous waste flows across the country. As the nation's hazardous waste infrastructure ages, additional mechanical failures and emergency shutdowns will inevitably occur; and commercial management will require sufficient capacity to absorb these disruptions when they do.

C. RISK FACTOR 3: EMERGENCY RESPONSE

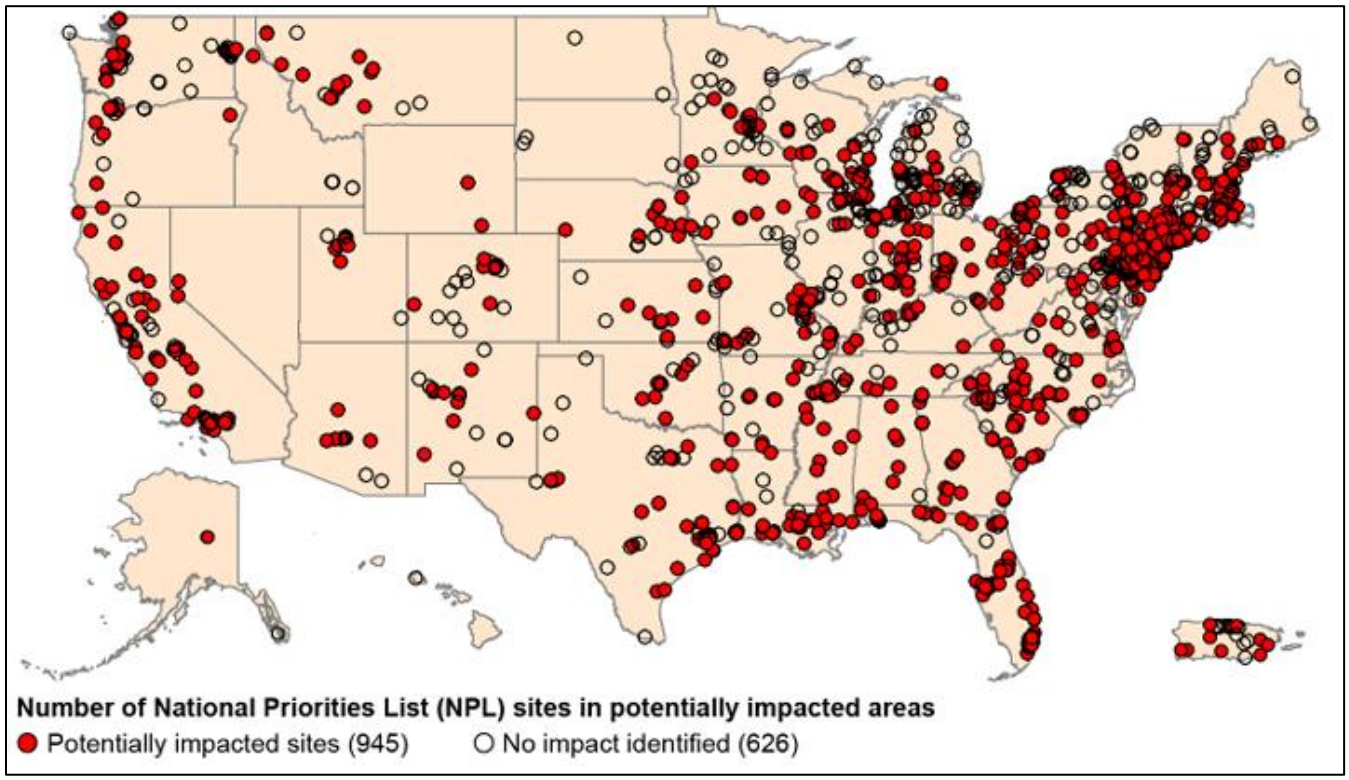
Climate risks

Commercial hazardous waste management facilities play an important role in the remediation of properties on the National Priorities List (NPL), heavily contaminated sites in the US that have been designated by the federal government for long-term cleanup due to the presence or threatened release of hazardous substances. If not properly contained or remediated, these materials can migrate into surrounding soil and groundwater and pose risks to human health and the environment.

Extreme weather events may increase the frequency or scale of some remediation activities. According to the US Government Accountability Office, approximately 60 percent of non-federal NPL sites are in areas potentially exposed to flooding, storm surge, wildfires, or sea level rise.[25] If an extreme weather event damages the containment systems at one of these sites, the uncontained hazardous materials must be removed to prevent further contamination. Such cleanup efforts can generate substantial volumes of hazardous waste and place sudden demands on commercial management capacity, especially landfills and incinerators.

[25] "SUPERFUND: EPA Should Take Additional Actions to Manage Risk from Climate Change Effects," US Government Accountability Office, GAO-21-555T, May 13, 2021, accessed September 21, 2026, https://www.gao.gov/products/gao-21-555t.

Figure 11. Nonfederal NPL sites located in areas that may be impacted by flooding, storm surge, wildfires, or sea level rise

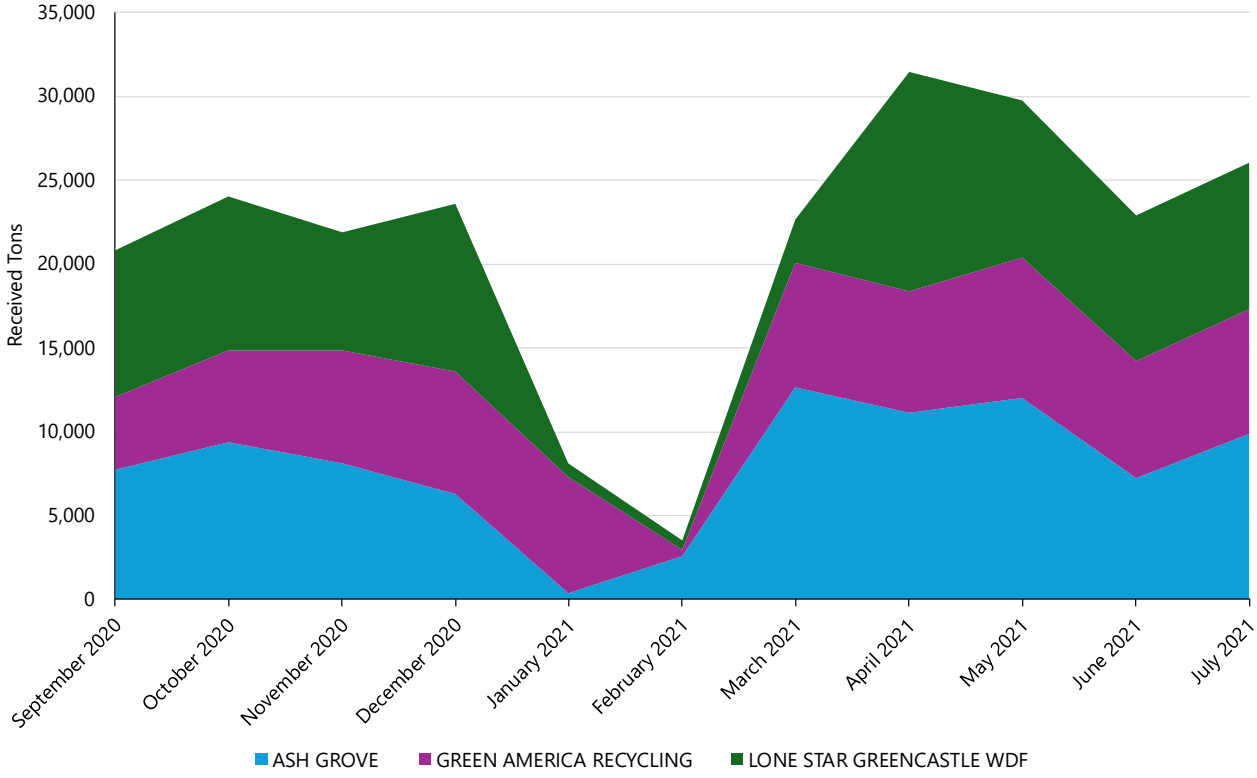


Source: "SUPERFUND: EPA Should Take Additional Actions to Manage Risk from Climate Change Effects," US Government Accountability Office, GAO-21-555T, May 2021

Extreme weather events may also affect the operation of hazardous waste management facilities themselves. In early 2021, a catastrophic series of winter storms caused widespread power outages, fuel supply disruptions, and transportation challenges across the South-Central US. Several hazardous waste management facilities, including energy recovery facilities and cement kilns, experienced temporary shutdowns or reduced operating rates during this period. These disruptions exacerbated the hazardous waste incineration backlog that began several months earlier.

The largest impacts were felt at three cement kilns in the Midwest (Ash Grove Cement Co. in Chanute, KS; Green America Recycling in Hannibal, MO; and Lone Star Industries in Greencastle, IN). These facilities collectively received over 20 thousand tons of hazardous waste per month prior to January 2021, as shown in Figure 12. When the winter storms hit, total waste receipts plummeted for approximately two months as operations at the facilities were disrupted.

Figure 12. Shutdown of major cement kilns caused by winter storms in 2021



Source: e-Manifest data

As climate change progresses, extreme weather events like the winter storms of 2021 are likely to become more frequent and severe. Climate change therefore remains a persistent and growing threat to hazardous waste management capacity in the US.

Cleanup wastes and remediation

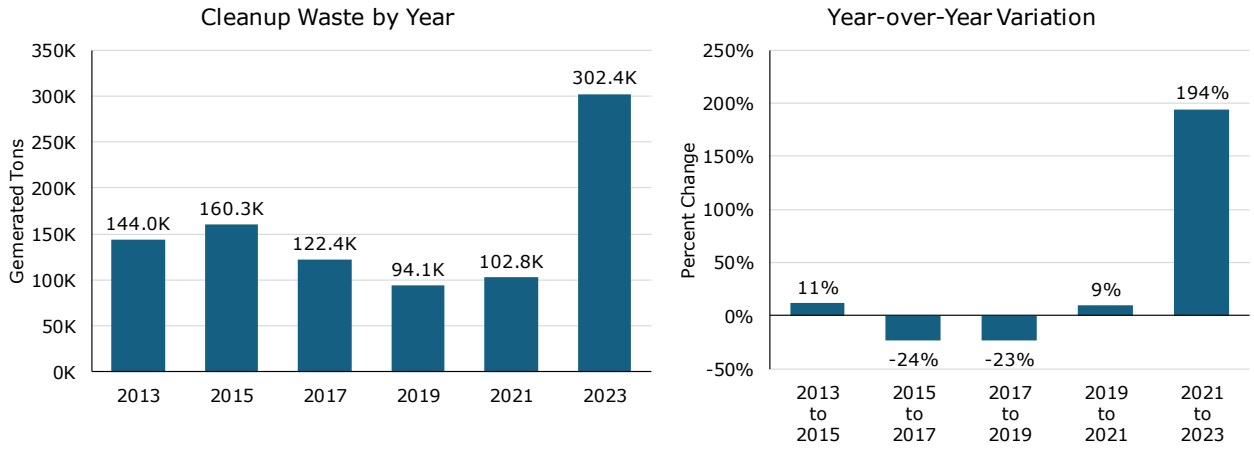
Cleanup waste (i.e., waste that generated from remediation rather than ongoing industrial production) also pose a persistent risk to hazardous waste management capacity. Because these wastes are not produced on a steady basis, they can enter the system in large quantities at irregular, often unpredictable intervals. Figure 13 below illustrates this volatility. Year-over-year changes in cleanup waste volumes managed by both landfills and incinerators fluctuate widely, with volumes fluctuating by tens of thousands of tons per year in some cases. The 194 percent spike in 2023 landfill volumes, for example, was driven largely by cleanup efforts following the February 2023 Norfolk Southern freight train derailment in East Palestine, Ohio. This accident generated more than 174 thousand tons of contaminated soil and over 39 million gallons of wastewater requiring disposal at permitted facilities.[26] When events of this magnitude coincide with ongoing remediation projects or periods of already

[26] "How Much Waste Was Removed as Part of the Cleanup Efforts?" US Environmental Protection Agency, accessed September 21, 2026, https://www.epa.gov/east-palestine-oh-train-derailment/how-much-waste-was-removed-part-cleanup-efforts.

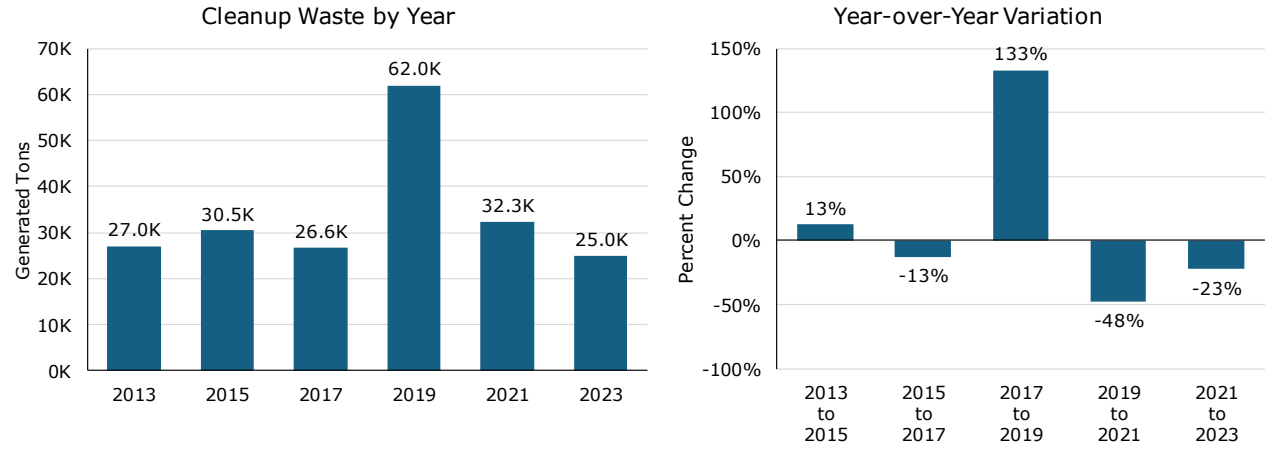
elevated demand, the resulting flows can overwhelm commercial treatment facilities—particularly incinerators—which typically reserve only a portion of operational capacity for cleanup activity at any given time.

Figure 13. Year-over-year variation in cleanup waste generation

Landfills



Incineration



Source: EPA Biennial Report Data

D. RISK FACTOR 4: HAZARDOUS WASTE REGULATION AND PERMITTING REQUIREMENTS

Regulation is a critical element of ensuring that hazardous waste management serves the public interest and protects public health and the environment. However, these same regulations can also impact the supply and demand in ways that limit hazardous waste management capacity. Strict handling requirements for hazardous waste incentivize generators to rely on commercial rather than on-site or captive management capabilities.

Expansive definitions for what constitutes hazardous material raises demand for hazardous waste management, as more volume requires treatment and disposal. And the permitting process, while essential for public safety and environmental protection, makes it difficult to quickly bring new management facilities online in response to capacity shortages.

Expanding definitions of hazardous waste. Changes in hazardous waste regulation affect demand for commercial hazardous waste management services by increasing the volume of materials subject to regulation. Over time, regulatory agencies have expanded the scope of certain hazardous waste requirements under RCRA and CERCLA. In April 2024, for example, the EPA designated two PFAS compounds as hazardous substances under CERCLA, subjecting releases of those compounds to reporting requirements and potential Superfund liability for the first time.[27] In the pharmaceutical sector, the EPA's 2019 Hazardous Waste Pharmaceuticals Rule (84 Fed. Reg. 5816) established new management requirements for hazardous waste pharmaceuticals.[28] Among other changes, the rule prohibits the disposal of hazardous pharmaceutical waste through sewer systems and instead requires that such wastes be managed through permitted hazardous waste facilities. The rule also expanded regulation to certain pharmaceutical waste streams that had previously been managed outside the RCRA. Regulatory changes of this type increase the volume of materials requiring specialized hazardous waste management and, all else equal, increase demand for commercial treatment and disposal capacity.

Permitting requirements and the speed of expansion. While hazardous waste regulations increase demand for management capacity, they can also affect the speed at which new capacity comes online. Hazardous waste facilities are subject to extensive permitting requirements that cover facility design and operations, waste analysis plans, ground water monitoring, closure and post-closure care, financial assurance, and emergency preparedness.[29] These requirements play an important role in protecting public health and the environment, but they also lengthen the time required to construct new facilities or expand existing ones. The addition of a third incineration unit at Clean Harbors' El Dorado, Arkansas facility, for example, took approximately 4 years to complete, 2 years of which were dedicated to permitting.[30] Similarly, Veolia's recent expansion of its Gum Springs, Arkansas complex to include a new thermal treatment facility required a multi-year planning, permitting, and construction process.[31] For the foreseeable future, permitting timelines and the pace at which

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[27] "Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances," US Environmental Protection Agency, accessed September 21, 2026, https://www.epa.gov/superfund/designation-perfluorooctanoic-acid-pfoa-and-perfluorooctanesulfonic-acid-pfos-cercla.

[28] "Final Rule: Management Standards for Hazardous Waste Pharmaceuticals and Amendment to the P075 Listing for Nicotine," US Environmental Protection Agency, accessed September 21, 2026, https://www.epa.gov/hwgenerators/final-rule-management-standards-hazardous-waste-pharmaceuticals-and-amendment-p075.

[29] See, for example, "Specific Areas Hazardous Waste Permits Must Address," US Environmental Protection Agency, accessed September 21, 2026, https://www.epa.gov/hwpermitting/specific-areas-hazardous-waste-permits-must-address.

[30] Clean Harbors, "Clean Harbors Unveils North America's Most Technologically Advanced Incinerator," December 6, 2016, https://www.cleanharbors.com/about-us/news/2016/clean-harbors-unveils-north-america-s-most-technologically-advanced-incinerator.

[31] This new thermal treatment facility, expected to have annual operating capacity of up to 100 thousand tons, will be the first H050-qualified thermal facility in the US. See "Veolia Gum Springs Complex," Veolia, accessed September 21, 2026, https://www.veolianorthamerica.com/gumsprings.

new facilities can be brought online are likely to remain an important constraint on the industry's ability to rapidly expand capacity.

5. CONCLUSION

Hazardous waste management is widely recognized as important for protecting public health and the environment, but it is often overlooked as an input to economic activity in the US. Unlike other byproducts of production that firms can store, reuse, or otherwise manage over time, hazardous waste is subject to strict accumulation limits that impose hard constraints on operations. Once those limits are reached, firms must secure treatment or disposal capacity or curtail production. For many generators, hazardous waste management is not simply another cost of doing business; it is an operational constraint on production.

A central question, therefore, is not whether demands on hazardous waste management capacity will increase as the economy grows, but how to make sure that capacity keeps up. Facility closures, extreme weather events, long permitting timelines, and the need for emergency response all impose constraints on the nation's hazardous waste management infrastructure. These constraints do not operate in isolation. They affect where firms choose to locate production, how supply chains are organized, and, ultimately, the cost of everyday goods and services.

Through advanced planning and strategic investment, vulnerabilities in the nation's hazardous waste management infrastructure can be addressed. Expanding treatment and disposal capacity, improving the speed and predictability of permitting, and supporting continued innovation will allow waste management capacity to keep pace with growth in hazardous waste generation across the economy. In doing so, hazardous waste management can continue to support industrial expansion and sustain economic growth.

APPENDIX

Hazardous waste generated by each US state, territory, and region (2023)

State	Generated Tons	Percent of Total
TEXAS	17,102,529	52.8%
LOUISIANA	4,659,200	14.4%
OHIO	1,713,158	5.3%
MISSISSIPPI	1,263,277	3.9%
KANSAS	1,052,923	3.3%
INDIANA	862,280	2.7%
ALABAMA	753,754	2.3%
HAWAII	544,644	1.7%
ARKANSAS	391,674	1.2%
NORTH DAKOTA	346,323	1.1%
MICHIGAN	319,790	1.0%
ILLINOIS	315,614	1.0%
MISSOURI	297,816	0.9%
WASHINGTON	263,308	0.8%
TENNESSEE	238,009	0.7%
CALIFORNIA	227,517	0.7%
PENNSYLVANIA	216,899	0.7%
NEW YORK	157,800	0.5%
NEW JERSEY	156,887	0.5%
KENTUCKY	152,231	0.5%
SOUTH CAROLINA	151,644	0.5%
MINNESOTA	143,217	0.4%
NORTH CAROLINA	114,012	0.4%
WISCONSIN	107,029	0.3%
OKLAHOMA	91,455	0.3%
ARIZONA	82,691	0.3%
VIRGINIA	70,268	0.2%
COLORADO	69,569	0.2%
GEORGIA	66,525	0.2%
FLORIDA	63,096	0.2%
OREGON	54,248	0.2%
IOWA	53,311	0.2%
MASSACHUSETTS	46,280	0.1%
WEST VIRGINIA	45,447	0.1%
CONNECTICUT	32,616	0.1%
MARYLAND	31,891	0.1%
UTAH	29,716	0.1%
NEBRASKA	23,603	0.1%
NEVADA	15,938	0.0%
MONTANA	12,503	0.0%
PUERTO RICO	6,919	0.0%
DELAWARE	6,416	0.0%
IDAHO	6,344	0.0%
NEW MEXICO	4,923	0.0%
RHODE ISLAND	4,766	0.0%
NEW HAMPSHIRE	3,990	0.0%
VIRGIN ISLANDS	3,338	0.0%
ALASKA	2,729	0.0%
WYOMING	2,718	0.0%
MAINE	2,545	0.0%
SOUTH DAKOTA	1,917	0.0%
DISTRICT OF COLUMBIA	1,799	0.0%
VERMONT	1,410	0.0%
REGION 06 PURVIEW	446	0.0%
GUAM	221	0.0%
REGION 10 PURVIEW	186	0.0%
REGION 09 PURVIEW	117	0.0%
TRUST TERRITORIES	13	0.0%
NAVAJO NATIONS	4	0.0%
Grand Total	**32,391,494**	**100.0%**

Projected hazardous waste generation (methodology and sector-level decomposition)

Hazardous waste generation forecasts are based on BLS industry output projections, BEA measures of real gross output, and both process and cleanup waste reported in the EPA Biennial Report. BLS industry output projections are obtained from *Table 2.2 (Output by Major Industry Sector)*, available at https://www.bls.gov/emp/data/industry-out-and-emp.htm. BEA estimates of real gross output are obtained from the table *U.Real Gross Output by Industry*, available at https://www.bea.gov/itable/. Process waste generation is calculated using 2023 EPA Biennial Report data and aggregated to major industry sectors using the first two digits of each facility's primary NAICS code. Cleanup waste and import waste are identified using EPA source codes. Cleanup waste is defined as waste associated with EPA source codes G41-G49, while import waste is defined as waste associated with source code G62. Import waste is excluded from the analysis.

Forecasted output by industry is obtained by applying BLS projected growth rates to BEA estimates of industry output. Forecasted process waste generation is then calculated by multiplying projected output by each industry's 2023 process waste intensity, defined as process waste generated per dollar of output. Expected cleanup waste is added to the forecast based on average cleanup waste generation between 2013-2023 after excluding three outlier sector-year observations: Mining, Quarrying, and Oil and Gas Extraction (NAICS 21) in 2013; Transportation and Warehousing (NAICS 48, 492, and 493) in 2023; and Agriculture, Forestry, Fishing and Hunting (NAICS 11) in 2021. These observations are excluded because they generated unusually large quantities of cleanup waste relative to other years.

Projected Hazardous Waste Generation by Sector, 2025-2033

Industry Sector	Actual Total Waste 2023 (Tons)	Projected Total Waste 2025 (Tons)	Projected Total Waste 2027 (Tons)	Projected Total Waste 2029 (Tons)	Projected Total Waste 2031 (Tons)	Projected Total Waste 2033 (Tons)	Change 2023-2033
Agriculture, forestry, fishing, and hunting	472.1	495.6	510.7	526.4	542.7	559.6	87.5
Mining, quarrying, and oil and gas extraction	31,675.5	31,602.0	32,338.2	33,091.8	33,863.1	34,652.7	2,977.2
Utilities	62,642.2	65,005.3	66,690.8	68,435.2	70,240.6	72,109.1	9,466.9
Construction	83,689.1	70,870.9	71,348.5	71,834.3	72,328.6	72,831.3	-10,857.8
Manufacturing	29,101,600.6	29,946,014.1	30,710,445.9	31,494,977.8	32,300,138.3	33,126,469.9	4,024,869.3
Wholesale trade	48,007.5	54,328.6	56,998.5	59,812.7	62,779.1	65,905.9	17,898.4
Retail trade	3,481.6	5,779.8	5,926.4	6,080.1	6,241.2	6,410.0	2,928.4
Transportation and warehousing	544,218.1	185,149.6	192,002.8	199,162.9	206,643.5	214,459.0	-329,759.2
Information	331.8	410.8	434.8	460.4	487.8	517.1	185.2
Finance and insurance	22.1	466.3	466.5	466.7	466.8	467.0	444.9
Real estate and rental and leasing	11,085.0	17,284.0	17,547.4	17,821.5	18,106.6	18,403.1	7,318.1
Professional, scientific, and technical services	24,502.0	27,338.5	28,473.5	29,661.0	30,903.6	32,203.8	7,701.8
Management of companies and enterprises	128.8	254.8	261.6	268.6	276.1	283.9	155.1
Administrative and support and waste management and remediation services	2,336,977.1	3,183,982.5	3,264,786.0	3,349,289.0	3,437,660.9	3,530,078.9	1,193,101.9
Educational services; private	15,493.8	17,469.7	17,865.3	18,272.2	18,690.9	19,121.6	3,627.8
Healthcare and social assistance; private	18,038.7	19,317.6	20,352.7	21,446.1	22,601.3	23,821.6	5,782.9
Arts, entertainment, and recreation	742.6	6,285.4	6,306.5	6,328.4	6,351.3	6,375.2	5,632.6
Accommodation and food services	85.6	184.6	187.4	190.4	193.5	196.7	111.1
Other services (except public administration)	7,492.8	17,726.3	17,976.5	18,237.1	18,508.4	18,790.9	11,298.2
Everything Else	71,562.3	114,312.1	115,071.8	115,842.3	116,623.9	117,416.7	45,854.4
Grand Total	**32,362,249.2**	**33,764,278.7**	**34,625,991.7**	**35,512,204.9**	**36,423,648.0**	**37,361,073.9**	**4,998,824.7**

Capacity scenarios (sector-level decomposition)

Projected Lost 2023-2033 Growth from Capacity Shortfall Scenarios

Industry Sector	Process Waste Intensity 2023 (Tons per Billion)	Projected Process Waste Growth 2033 (Baseline)	Achievable Process Waste Growth 2033 (Scenario 1)	Achievable Waste Growth Process 2033 (Scenario 2)	Achievable Process Waste Growth 2033 (Scenario 3)	Projected Output Growth 2033 (Baseline)	Acheivable Output Growth 2033 (Scenario 1)	Acheivable Output Growth 2033 (Scenario 2)	Acheivable Output Growth 2033 (Scenario 3)
Agriculture, forestry, fishing, and hunting	0.84	78.5	78.5	78.5	78.5	$94.0	$94.0	$94.0	$94.0
Mining, quarrying, and oil and gas extraction	51.28	3,769.8	3,732.1	3,694.4	3,656.8	$73.5	$72.8	$72.0	$71.3
Utilities	92.52	8,732.3	8,645.0	8,557.7	8,470.3	$94.4	$93.4	$92.5	$91.6
Construction	16.21	2,430.0	2,405.7	2,381.4	2,357.1	$149.9	$148.4	$146.9	$145.4
Manufacturing	5076.87	3,925,302.4	3,886,049.3	3,846,796.3	3,807,543.3	$773.2	$765.4	$757.7	$750.0
Wholesale trade	21.58	14,110.2	13,969.1	13,828.0	13,686.9	$653.7	$647.2	$640.7	$634.1
Retail trade	1.35	770.2	770.2	770.2	770.2	$569.7	$569.7	$569.7	$569.7
Transportation and warehousing	108.77	35,869.0	35,510.3	35,151.6	34,792.9	$329.8	$326.5	$323.2	$319.9
Information	0.13	128.7	128.7	128.7	128.7	$984.7	$984.7	$984.7	$984.7
Finance and insurance	0.00	0.8	0.8	0.8	0.8	$690.6	$690.6	$690.6	$690.6
Real estate and rental and leasing	1.39	1,372.4	1,372.4	1,372.4	1,372.4	$985.1	$985.1	$985.1	$985.1
Professional, scientific, and technical services	7.70	5,949.9	5,949.9	5,949.9	5,949.9	$772.6	$772.6	$772.6	$772.6
Management of companies and enterprises	0.17	35.5	35.5	35.5	35.5	$213.1	$213.1	$213.1	$213.1
Administrative and support and waste management and remediation services	1345.01	423,362.2	419,128.6	414,895.0	410,661.4	$314.8	$311.6	$308.5	$305.3
Educational services; private	35.10	2,036.4	2,016.0	1,995.6	1,975.3	$58.0	$57.4	$56.9	$56.3
Healthcare and social assistance; private	6.17	5,483.8	5,483.8	5,483.8	5,483.8	$888.9	$888.9	$888.9	$888.9
Arts, entertainment, and recreation	1.04	109.9	109.9	109.9	109.9	$105.3	$105.3	$105.3	$105.3
Accommodation and food services	0.04	14.7	14.7	14.7	14.7	$330.4	$330.4	$330.4	$330.4
Other services (except public administration)	7.44	1,304.9	1,304.9	1,304.9	1,304.9	$175.4	$175.4	$175.4	$175.4
Everything Else	12.9	3,853.5	3,814.9	3,776.4	3,737.8	$298.0	$295.0	$292.0	$289.0
Grand Total	770.6	**4,434,715.1**	**4,390,367.9**	**4,346,020.8**	**4,301,673.6**	**$8,554.9**	**$8,527.5**	**$8,500.0**	**$8,472.6**

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