PFAS-CONTAMINATED SEWAGE SLUDGE

A REVIEW OF DISPOSAL OPTIONS, COSTS AND BENEFITS

Prepared for the Vermont House Committee on Agriculture, Food Resiliency, and Forestry

April 2025

The Issue

Per- and Polyfluoroalkyl Substances (PFAS) are a class of widely used chemicals that break down very slowly over time.

What we know

- PFAS break down very slowly
- PFAS are found in water, air, soil, animals, humans, food and more
- PFAS are found in wastewater and sewage sludge, and in biosolids applied to land
- PFAS pose risks to human and environmental health

What we need to know

- Long-term effects of PFAS from sewage sludge on human and environmental health
- Extent of bioaccumulation in crops, animals and food products
- Connections between levels and the longevity of exposure and impacts on human health

References:
National Institute of Environmental Health Sciences, 2023
Glüge et. al., 2023
CDC, 2024
De Silva et. Al., 2021
US EPA, 2025

PFAS in Vermont

2015 — Report on management of sludge and alternatives to land application

2017 — VT Dept of Environment Conservation (DEC) imposed some of the strictest groundwater standards for PFAS concentration

2018 — PFAS detected in all samples of biosolids from 25 WWTFs

2023 — VT DEC released the PFAS Roadmap to reduce PFAS in commercial products, identify sources of PFAS, and protect Vermonters from exposure to PFAS

2024 — VT DEC issued the Interim Strategy for Mitigating PFAS Risks Associated with Residuals Management (biosolids, septage, paper sludge)

2025 — Bill H. 292 was introduced to the House Committee on Environment

Bill H. 238 passed in the House, in the Senate Committee on Health and Welfare

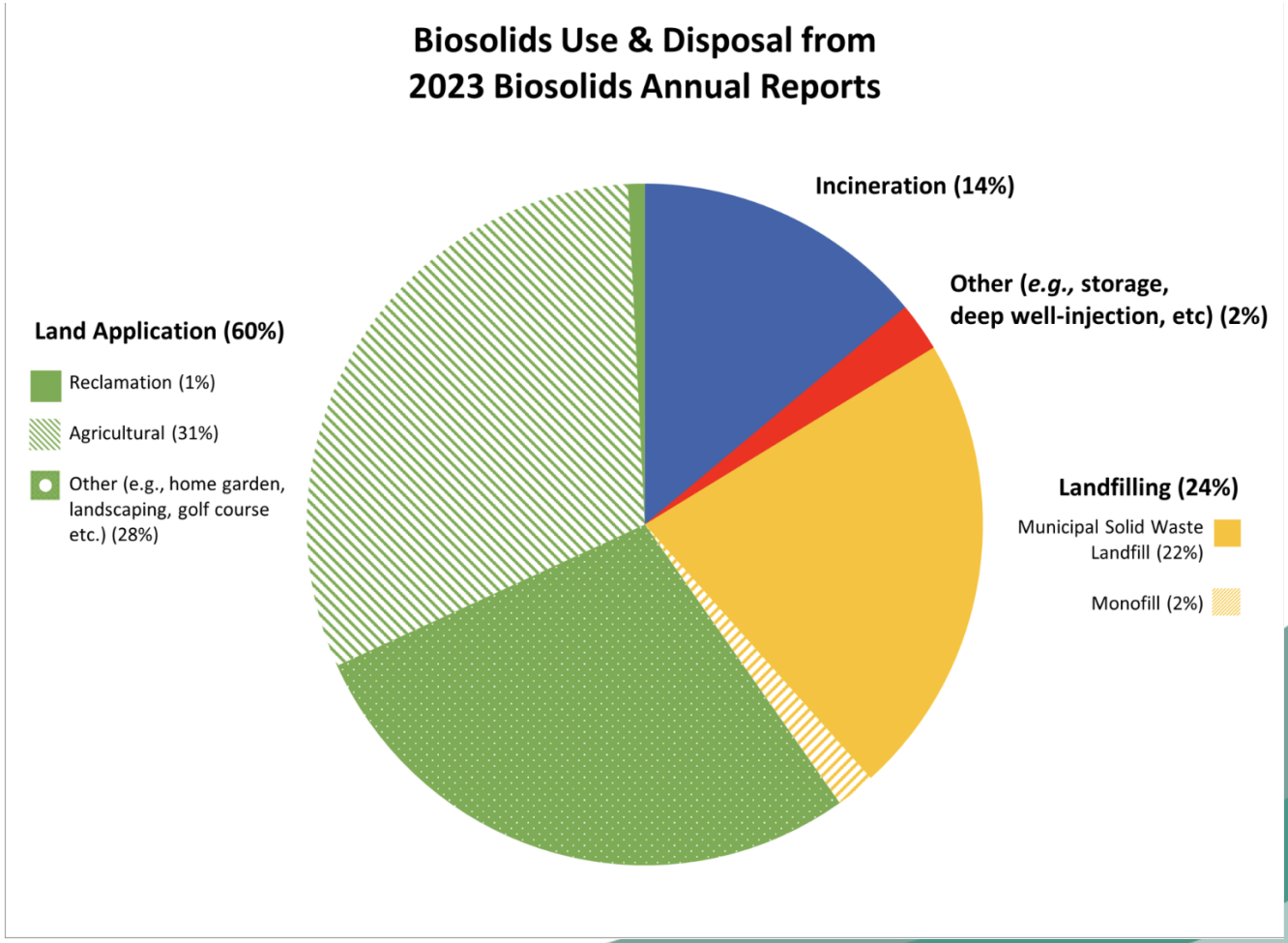
References:
VT DEC, 2022

Sewage Sludge Disposal Options

Established

- Land application
- Landfilling
- Incineration

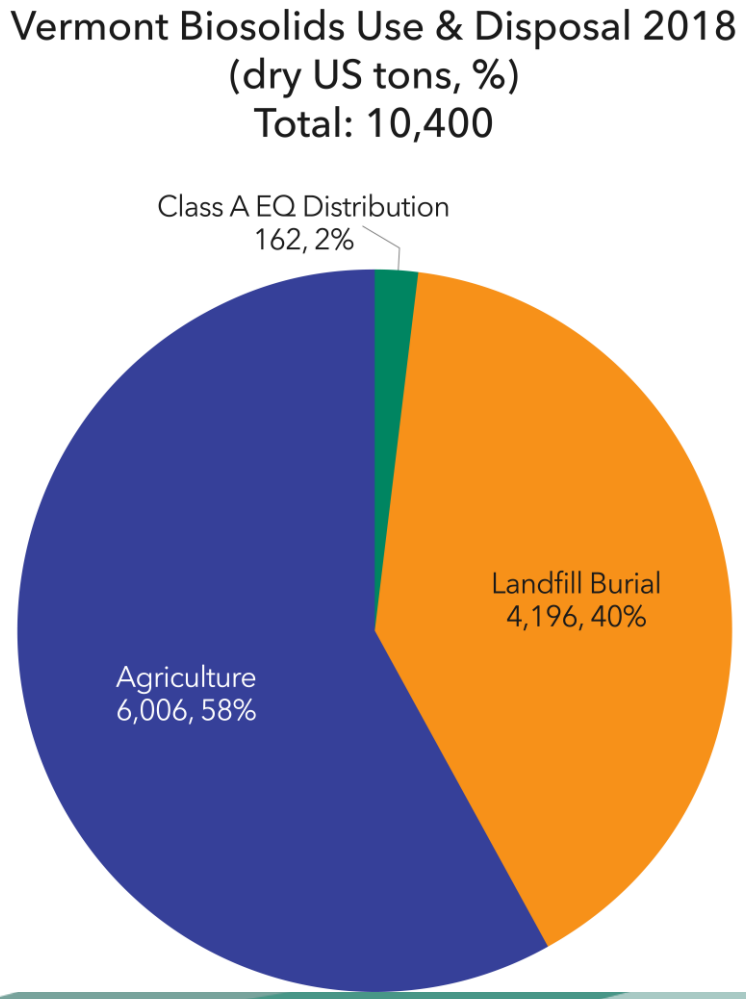
Other options are emerging but not yet widely used.



References:
US EPA, 2025

Sewage Sludge Disposal in Vermont

Management Option	Amount (dry tons) and Percent of Total		
	In-State	Out-of-State	Total
Class B Biosolids Land Application	194 (2%)	0	194 (2%)
EQ Biosolids Distribution	3,796 (31%)	4,965 (40%)	8,761 (71%)
Landfill Disposal	2,699 (22%)	609 (5%)	3,307 (27%)
Incineration	0	0	0
Total	**6,689 (55%)**	**5,573 (45%)**	**12,262 (100%)**



References:
(Table) VT DEC, 2024
(Graph) National Biosolids Data Project, 2018

Option 1: Land Application

Benefits:

- Cost efficient
- Improves soil health
- Reduces demand for chemical fertilizers
- Biosolid processing facilities already present in-state
- Risk reduction via regulation

Liquid Essex Junction biosolids being land applied on farmland that neighbors the WRRF. *Photo courtesy of NEBRA*.

References:
US EPA, 2019
US EPA, 2025
VT DEC, 2024

Option 1: Land Application

Challenges:

- PFAS contamination in water, soil, and food.
- Knowledge gaps increase uncertainty of risk
- Regulation may require rigorous monitoring and testing of biosolids, application sites, and surrounding areas

Fertilizer containing sludge being applied to farmland. (Courtesy North East Biosolids and Residuals Association)

References:
US EPA, 2019
US EPA, 2025

What are other states doing?

- Maine and Connecticut each have a ban on sale and use of biosolids from wastewater
- Oklahoma and Mississippi have introduced legislation to ban land application
- Texas has introduced legislation to limit PFAS in biosolids for agriculture.
- Other states, including Vermont, have tiered approaches to regulate land application based on PFAS concentrations.
- Colorado, Maryland, Michigan, Minnesota, New York, andWyoming have tiered approaches to regulate land applicationbased on PFAS concentrations.

References:
MOST Policy Initiative, 2025
Marten Law, 2025
VT DEC, 2024

What are other states doing?

- Colorado, Maryland, Michigan, Minnesota, New York, and Wyoming have tiered approaches to regulate land application based on PFAS concentrations.

State	PFAS Indicator	Tier 4 (µg/kg)	Tier 3 (µg/kg)	Tier 2 (µg/kg)	Tier 1 (µg/kg)
CO	PFOS	≥ 50	N/A	≤50	N/A
MD	PFOS/PFOA	≥ 100	50-99	20-49	≤20
MI	PFOS/PFOA	≥ 100	20-99	N/A	≤20
MN	PFOS/PFOA	≥ 125	50-24	20-49	≤20
NY	PFOS/PFOA	≥ 50	N/A	21-49	≤20
WI	PFOS/PFOA	≥ 150	50-149	21-49	≤20
VT	**PFOS** **PFOA**	**N/A**	**N/A**	**>3.41** **>1.61**	**<3.40** **<1.60**

References:
MOST Policy Initiative, 2025
Marten Law, 2025
VT DEC, 2024

Option 2: Landfilling

Benefits:

- Can contain PFAS contamination
- Common practice with already established regulations
- Higher cost than land application, but lower cost than incineration
- Capacity can be increased

The Coventry landfill, operated by Casella Waste Systems. Chittenden Solid Waste District photo

References:
EPA, 2025
CDM Smith, 2020

Option 2: Landfilling

Challenges:

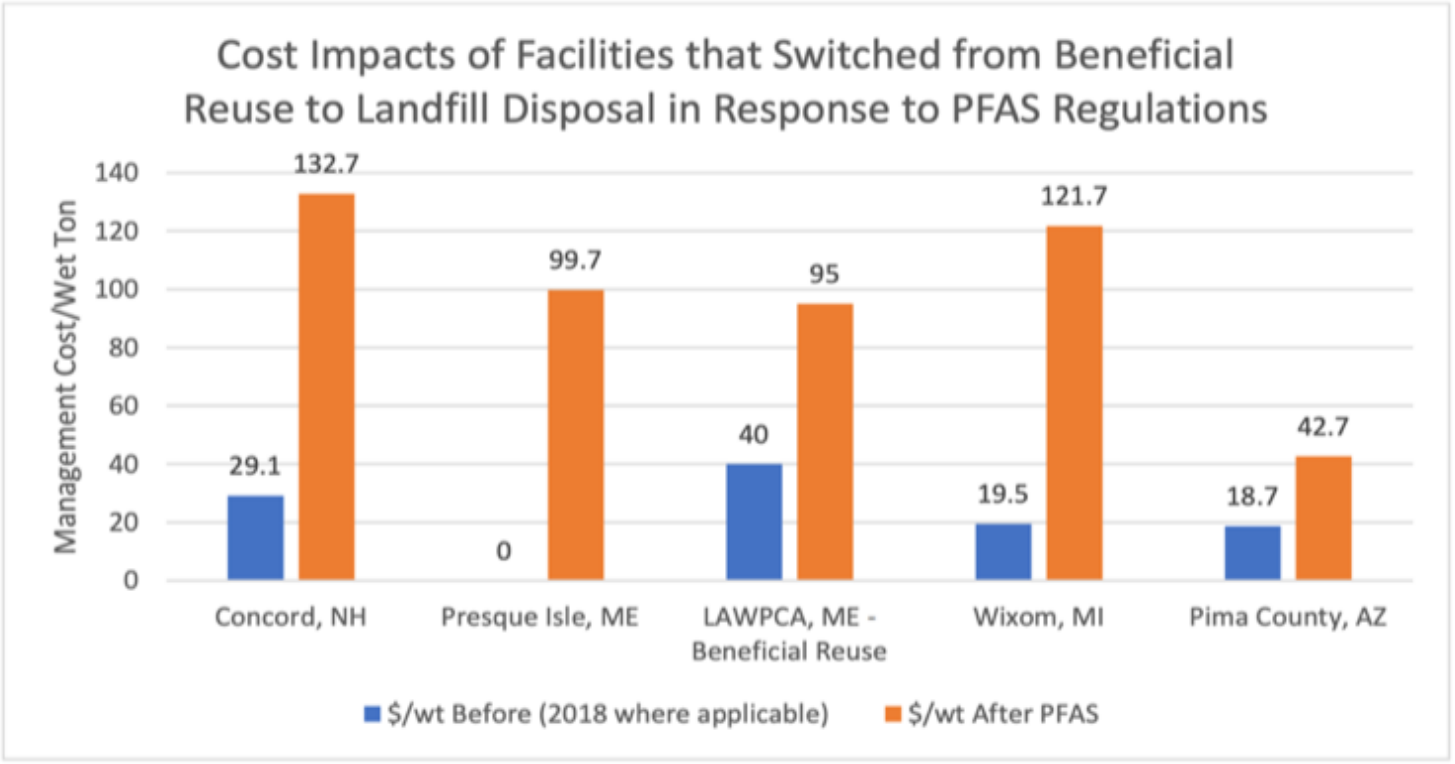
- Risk of contamination through spills, leachate
- Generates leachate
- Limited capacity
- Capital investment and maintenance costs
- Methane gas production

The Coventry landfill. Casella photo

References:
EPA, 2025
CDM Smith, 2020
Cotton, 2024
NEWMOA, 2021

What are other states doing?

- Many other states do rely on landfilling for biosolid disposal.
- Landfilling can increase costs over land application
- Cost is highly dependent on location
- Landfilling can be a temporary solution



References:
New England Interstate Water Pollution Control Commission., 2022
CDM Smith, 2020
NEWMOA, 2021

Option 3: Incineration

Benefits

- Breaks down PFAS, preventing direct source pollution
- Eases landfill pressure and minimizes storage needs.
- Available facilities and existing technologies

Credit: Center for Land Use Interpretation/Creative Commons
This hazardous waste incinerator in East Liverpool, Ohio, burned PFAS-containing firefighting foams under contract to the Defense Department.

References:
Meegoda, 2022
VT Materials Management Plan, 2024

Option 3: Incineration

Credit: Environmental Protection Agency Technical Brief PFAS Incineration IOAA PDF

Challenges

- High Costs
- Pollution Risks to air and water.
- Infrastructure Limitations

References:
Ling, 2024
NRDC, 2021
VT Materials Management Plan, 2024

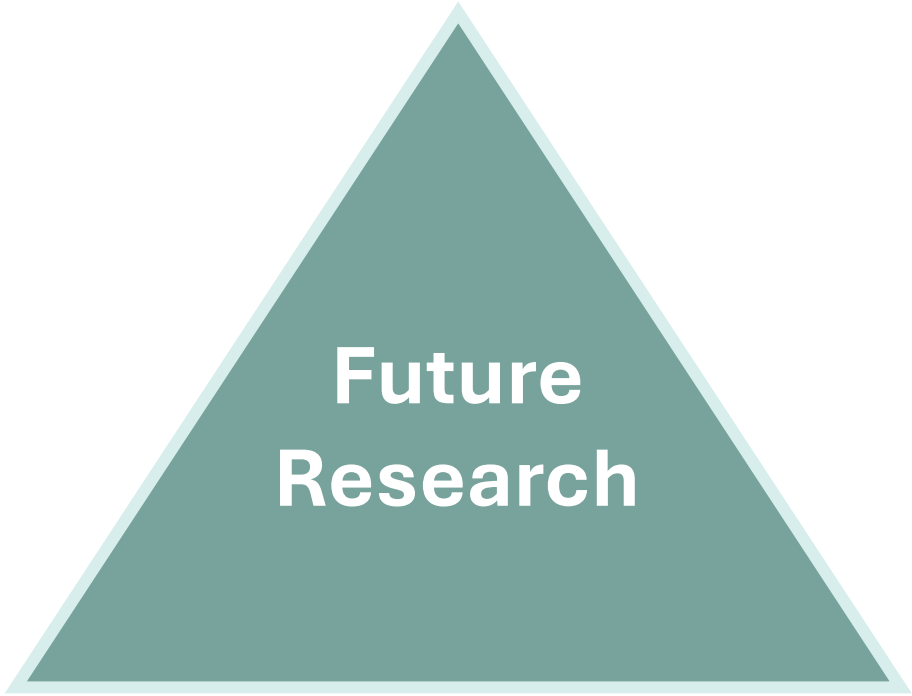
What are other states doing?

- Nationwide, only 14% of biosolids are incinerated
- Limited regional capacity for incineration
- Costs vary widely based on location
- In 2018, New England states incinerated up to 94% of their sewage sludge:

State	RI	CT	MA	ME	NH	NY	VT
% Incinerated	94%	88%	43%	21%	18%	15%	0%

References:
Kelley & Twohig, 2018

Cost/Benefit Analysis



Risk
Assessment

New
Technologies

Conclusion

- VT currently uses land application and landfilling as sludge management strategies
- Land application is cost effective and can be regulated, but still risks PFAS exposure
- Landfilling is the next most affordable option, but is limited by capacity
- Incineration is costly and can break down PFAS, but there is some risk of environmental contamination
- More research needed on treatment and disposal, as well as PFAS risk to human health, farm and food systems, and environment

Thank you!

References

Slide 2:

1. National Institute of Environmental Health Sciences. (2023, December 4). Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). National Institute of Environmental Health Sciences. https://www.niehs.nih.gov/health/topics/agents/pfc
2. Glüge, J., Scheringer, M., Cousins, I. T., DeWitt, J. C., Goldenman, G., Herzke, D., Lohmann, R., Ng, C. A., Trier, X., & Wang, Z. (2020). An overview of the uses of per- and polyfluoroalkyl substances (PFAS). Environmental Science: Processes & Impacts, 22(12). https://doi.org/10.1039/d0em00291g
3. CDC. (2024, November 7). Human Exposure: PFAS Information for Clinicians - 2024. Per- and Polyfluoroalkyl Substances (PFAS) and Your Health. https://www.atsdr.cdc.gov/pfas/hcp/clinical-overview/human-exposure.html
4. De Silva, A. O., Armitage, J. M., Bruton, T. A., Dassuncao, C., Heiger-Bernays, W., Hu, X. C., Kärrman, A., Kelly, B., Ng, C., Robuck, A., Sun, M., Webster, T. F., & Sunderland, E. M. (2021). PFAS Exposure Pathways for Humans and Wildlife: A Synthesis of Current Knowledge and Key Gaps in Understanding. Environmental Toxicology and Chemistry, 40(3). https://doi.org/10.1002/etc.4935
5. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) | US EPA. (2025, February 21). US EPA. https://www.epa.gov/biosolids/draft-sewage-sludge-risk-assessment-perfluorooctanoic-acid-pfoa-and-perfluorooctane

Slide 3:

1. VT DEC. (2022). Poly- and Perfluoroalkyl Substances Inputs to Wastewater Treatment Facilities. Wetson and Sampson. https://dec.vermont.gov/sites/dec/files/wmp/residual/2021%20VTDEC%20PFAS%20Inputs%20to%20WWTF%20Study.2022March29.pdf

Slide 4:

1. Basic Information about Sewage Sludge and Biosolids | US EPA. (2025, March 12). US EPA. https://www.epa.gov/biosolids/basic-information-about-sewage-sludge-and-biosolids

Slide 5:

1. Vermont Residuals Management Working Group. (2024). Interim Strategy for Mitigating PFAS Risks Associated with Residuals Management. Vermont Agency of Natural Resources, Department of Environmental Conservation.
2. Vermont. (2018). National Biosolids Data Project. National Biosolids Data Project. https://www.biosolidsdata.org/vermont

Slide 6:

1. US EPA. (2019). Land Application of Biosolids. Www.epa.gov. https://www.epa.gov/biosolids/land-application-biosolids
2. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) | US EPA. (2025, February 21). US EPA. https://www.epa.gov/biosolids/draft-sewage-sludge-risk-assessment-perfluorooctanoic-acid-pfoa-and-perfluorooctane
3. Vermont Residuals Management Working Group. (2024). Interim Strategy for Mitigating PFAS Risks Associated with Residuals Management. Vermont Agency of Natural Resources, Department of Environmental Conservation.

Slide 7:

1. US EPA. (2019). Land Application of Biosolids. Www.epa.gov. https://www.epa.gov/biosolids/land-application-biosolids
2. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) | US EPA. (2025, February 21). US EPA. https://www.epa.gov/biosolids/draft-sewage-sludge-risk-assessment-perfluorooctanoic-acid-pfoa-and-perfluorooctane

References

Slide 8 & 9:

1. PFAS Land Application Regulations - MOST Policy Initiative. (2025). Mostpolicyinitiative.org. https://mostpolicyinitiative.org/science-note/pfas-land-application-regulations/
2. EPA, States Signal Interest in Regulating PFAS in Biosolids - Marten Law. (2025). Marten Law. https://martenlaw.com/news/epa-states-signal-interest-in-regulating-pfas-in-biosolids
3. Vermont Residuals Management Working Group. (2024). Interim Strategy for Mitigating PFAS Risks Associated with Residuals Management. Vermont Agency of Natural Resources, Department of Environmental Conservation.

Slide 10:

1. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) | US EPA. (2025, February 21). US EPA. https://www.epa.gov/biosolids/draft-sewage-sludge-risk-assessment-perfluorooctanoic-acid-pfoa-and-perfluorooctane
2. CDM Smith. (2020). Cost analysis of the impacts on municipal utilities and biosolids management to address PFAS contamination. https://www.nacwa.org/docs/default-source/resources---public/cost-analysis-of-pfas-on-biosolids---final.pdf?sfvrsn=a4b3fe61_2

Slide 10:

1. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) | US EPA. (2025, February 21). US EPA.https://www.epa.gov/biosolids/draft-sewage-sludge-risk-assessment-perfluorooctanoic-acid-pfoa-and-perfluorooctane
2. CDM Smith. (2020). Cost analysis of the impacts on municipal utilities and biosolids management to address PFAS contamination. https://www.nacwa.org/docs/default-source/resources---public/cost-analysis-of-pfas-on-biosolids---final.pdf?sfvrsn=a4b3fe61_2

Slide 11:

1. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS) | US EPA. (2025, February 21). US EPA.https://www.epa.gov/biosolids/draft-sewage-sludge-risk-assessment-perfluorooctanoic-acid-pfoa-and-perfluorooctane
2. CDM Smith. (2020). Cost analysis of the impacts on municipal utilities and biosolids management to address PFAS contamination. https://www.nacwa.org/docs/default-source/resources---public/cost-analysis-of-pfas-on-biosolids---final.pdf?sfvrsn=a4b3fe61_2
3. Cotton, E. (2024, March 8). Casella halts pilot project after spilling thousands of gallons of leachate. VTDigger. https://vtdigger.org/2024/03/08/casella-halts-pilot-project-after-spilling-thousands-of-gallons-of-leachate/
4. Northeast Waste Management Officials' Association. (2021). Solid waste disposal capacity in the Northeast (NEWMOA) https://www.newmoa.com/solidwaste/projects/disposalcapacity/Solid_Waste_Disposal_Capacity21.pdf

Slide 12:

1. New England Interstate Water Pollution Control Commission. (2022). Northeast regional sludge end-use and disposal estimate. https://neiwpcc.org/wp-content/uploads/2022/10/NEIWPCC-Sludge-End-Use-Disposal-Estimate-Report_FINAL.pdf
2. CDM Smith. (2020). Cost analysis of the impacts on municipal utilities and biosolids management to address PFAS contamination. https://www.nacwa.org/docs/default-source/resources---public/cost-analysis-of-pfas-on-biosolids---final.pdf?sfvrsn=a4b3fe61_2

References

Slide 13-15:

1. Meegoda, J. N., Bezerra, B., Melissa Monteiro Casarini, & Kewalramani, J. A. (2022). A Review of PFAS Destruction Technologies. *International Journal of Environmental Research and Public Health*, *19*(24), 16397–16397. https://doi.org/10.3390/ijerph192416397
2. 2024 Vermont Materials Management Plan Effective Date: 2024 Vermont Materials Management Plan. (n.d.). Retrieved April 9, 2025, from https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/DRAFT-2024-MMP.pdf
3. Ling, A. L. (2024). Estimated scale of costs to remove PFAS from the environment at current emission rates. The Science of the Total Environment, 918, 170647. https://doi.org/10.1016/j.scitotenv.2024.170647
4. NRDC. (2021, July 19). Burned: Why waste incineration is harmful. www.nrdc.org. https://www.nrdc.org/bio/daniel-rosenberg/burned-why-waste-incineration-harmful
5. Kelley, E., & Twohig, E. (2018). WASTEWATER TREATMENT SLUDGE AND SEPTAGE MANAGEMENT IN VERMONT Vermont Department of Environmental Conservation Waste Management & Prevention Division Residual Waste & Emerging Contaminants Program. https://dec.vermont.gov/sites/dec/files/wmp/residual/RMSWhitePaper20180507.pdf