# Current and Near-Term Management of Massachusetts Wastewater Sludge

PREPARED FOR THE MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

PFAS and Residuals Technology and Management Study, Part 1

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# Technical Memorandum

Prepared for: Massachusetts Department of Environmental Protection (MassDEP)

Project Title: PFAS and Residuals Technology and Management Study, Part 1

**Technical Memorandum No. 1**

Subject: Current and Near-Term Management of Massachusetts Wastewater Sludge

Date: June 28, 2024


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# Abbreviation List

| | |
|---|---|
| AOS | Approval of Suitability |
| DTPD | dry U.S. tons per day |
| ECHO | Enforcement and Compliance History Online |
| EPA | Environmental Protection Agency |
| FCSWMD | Franklin County Solid Waste Management District |
| GHG | greenhouse gas |
| GLSD | Greater Lawrence Sanitary District |
| GNHWPCA | Greater New Haven Water Pollution Control Authority |
| IPP | Industrial Pretreatment Programs |
| MassDEP | Massachusetts Department of Environmental Protection |
| MAWEA | Massachusetts Water Environment Association |
| MDC | Metropolitan District |
| MGD | million gallons per day |
| MHI | multiple hearth incinerator |
| MWRA | Massachusetts Water Resources Authority |
| $MTCO_2e$ | metric tons of carbon dioxide equivalent |
| NEBRA | North East Biosolids and Residuals Association |
| NEIWPCC | New England Interstate Water Pollution Control Commission |
| NPDES | National Pollutant Discharge Elimination System |
| NYSDEC | New York Department of Environmental Conservation |
| PFAS | per- and polyfluoroalkyl substances |
| PFOA | perfluorooctanoic acid |
| PFOS | perfluorooctane sulfonic acid |
| POTW | publicly owned treatment works |
| ppb | parts per billion |
| UBCW | Upper Blackstone Clean Water |
| WPCF | water pollution control facility |
| WPCP | water pollution control plant |
| WQD | water quality district |
| WWTF | wastewater treatment facility |
| WWTP | wastewater treatment plant |

# Glossary

"Beneficial Purpose:" As defined by 310 CMR 32.05, "means to provide nutrients to growing vegetation or to improve the quality of soil for the purpose of growing vegetation."

"Biosolids:" Sewage sludge that has been processed for land application.

"Biosolids Processing Facility": Facilities where sewage sludge is processed for land application such as dryers, alkaline stabilization facilities, and composting facilities.

"Disposal:" As defined by 310 CMR 16.02, "means the final dumping, landfilling or placement of solid waste into or on any land or water or the combustion of solid waste." In this report, combustion is referred to as "incineration".

"Incineration:" The burning of waste materials as a method of waste volume reduction at facilities called incinerators.

"Land Application:" As defined by 310 CMR 32.05, "means fertilizing or amending soil by: (a) applying to the surface of soil by spreading, spraying, or other similar means, and/or (b) mixing or working into the soil or beneath the surface of the soil within the root zone of the crop by harrowing, plowing, rototilling, injecting, or other similar means."

"Management" or "End Use:" The final use or disposition of sludge or biosolids, typically through land application, disposal in a landfill, or incineration.

"Monofill:" A type of landfill or area of a landfill where only one type of waste is disposed.

"Municipal Solid Waste Landfill" or "Landfill": A designated site or excavation where household waste and other types of nonhazardous waste are disposed of.

"Residual:" For the purposes of this study, "residual" is used interchangeably with "sludge".

"Septage:" As defined by 310 CMR 32.05, "means the liquid, solid, and semi-solid contents of privies, chemical toilets, cesspools, holding tanks, or other sewage waste receptacles." Sludge pumped from private, non-POTW groundwater discharge facilities are also associated with septage.

"Sewage Sludge" or "Sludge:" "Sludge" is defined by 310 CMR 32.05 as "the solid, semi-solid and liquid residue that results from a process of wastewater treatment or drinking water treatment. This residue does not include grit, screening, or grease and oil which are removed at the headworks of the facility." In this document "sewage sludge" specifically refers to the residue that results from wastewater treatment at publicly owned treatment works.

# Executive Summary

This report, the first part of a two-part "PFAS and Residuals Technology and Management Study" produced for the Massachusetts Department of Environmental Protection (MassDEP), aims to establish the current landscape for managing wastewater sludge from publicly owned treatment works (POTWs) in the Commonwealth. Sludge is a necessary byproduct of wastewater treatment; all POTWs clean the liquid stream by removing organic matter, nutrients, and other compounds in the form of solids before releasing the liquid flow back into the environment. This report details where sludge is generated, how and where it is ultimately managed, and the challenges facing each of the outlets. Part 2, which will be completed in 2025, will focus on regulatory issues, source reduction strategies for per- and polyfluoroalkyl substances (PFAS), and technologies for material minimization and PFAS treatment for sludge. Ultimately, in the face of a very difficult regulatory environment and dwindling regional capacity for managing sludge, the overall goal of the two-part study is to provide short-term and long-term recommendations for sludge management in Massachusetts, tailored for utilities of varying sizes, based on a comprehensive understanding of sludge management capacity in the region and beyond, current and proposed regulations, and applicable technologies.

Based on work performed as part of this project, it is estimated that 165,683 dry U.S. tons of wastewater sludge were generated in 2023 (see Section 2 for more details on how this estimate was calculated and Section 3.2.1 for more details on sludge generation). Sludge production is expected to grow to 172,200 dry-tons in the next five years (Section 3.7). Very little additional capacity at existing facilities or capacity at new facilities of any type were identified that will be available in this timeframe, and some outlets will no longer be available. **It is therefore estimated that a minimum of 7% of the sludge generated in Massachusetts in 2028 (11,826 dry tons) will be unable to be accommodated by existing methods** (Section 7.1.2). This is a significant quantity, equivalent to nearly 2,500 tractor trailers full of sludge each year. The 7% does not include sludge management disruptions announced since May 2024, and will increase further if other potential disruptions become reality. Market risk (the likelihood and impact of disruption) was assessed for each current sludge management method (Section 7.2). **Sludge management methods with high market risks total an additional 45% of 2028 Massachusetts sludge.**

Identified alternatives include compost facilities in Canada (Section 5.5) or landfills in Ohio, Pennsylvania or elsewhere (Section 4.7); however, there are significant challenges with trucking or transporting sludge by rail over long distances, including the availability of equipment and personnel, rest requirements for drivers, potential to generate odors, and increased cost (Section 7.3). As sludge management becomes more restrictive throughout the region and beyond, Massachusetts POTWs will be competing for scarce capacity at available outlets with POTWs far beyond Massachusetts.

Of particular concern to current sludge management are the recent ban on sludge land application in Connecticut and proposed legislation in Massachusetts restricting land application. In 2023, a combined 21,800 dry U.S. tons of Massachusetts sludge (14%) was processed into biosolids compost or dried pellets and land applied in Connecticut and Massachusetts. **Proposed restrictions in Massachusetts, on top of the Connecticut ban, represent a looming massive disruption to the management of Massachusetts sludge and would lead to increased greenhouse gas (GHG) emissions from longer hauling and significant cost increases to POTWs—and ultimately ratepayers—across the state.**

The cost of sludge management has increased significantly in recent years. Based on available data, **sludge management costs have increased over 35% between 2018 and 2023** (Section 3.8), to an average of $156 per wet U.S. ton to manage dewatered cake and $0.16 per gallon to manage liquid sludge. While predicting future costs is difficult, it is estimated that by 2028 these costs will have risen to $190 to $250 per wet U.S. ton and $0.20 to $0.25 per gallon. Accounting for sludge production increases due to population growth and these cost increases, the annual cost for a typical small POTW (0.5 million gallons per day (MGD) permitted flow) is estimated to be nearly half a million dollars—a significant strain on the typical operating budget for a utility of this size. A typical large POTW (10 MGD) is projected to spend $1.5M-$2.0M annually for managing dewatered cake by 2028. Sludge management costs are increasing at a far greater rate than it is typically practical for a utility to raise user rates, challenging utility budgets.

Figure ES-1 shows the current management outlets for this sludge by state and management type. Typically, sludge is managed by one of three means. It is either: 1) burned in a furnace, reducing the material to ash ("incineration"; red bars in the figure); 2) applied to the land as a soil conditioner ("land application"; green bars); or 3) disposed of in a landfill or a sludge-only "monofill" ("landfilling"; orange bars).

The diversity of sludge management strategies utilized in Massachusetts is evident in Figure ES-1, with no single type of outlet in a given jurisdiction accounting for greater than 15% of the total for the state. (However, as discussed in the report, many individual utilities are wholly reliant on a single outlet.) Incineration is the most common outlet for sludge (when including the co-generation facility in Canada utilized by Erving POTW #2), totaling 75,000 dry U.S. tons in 2023 (46% of the total sludge produced), with the two incineration facilities in Rhode Island and the two in Massachusetts being the two largest categories in Figure ES-1.

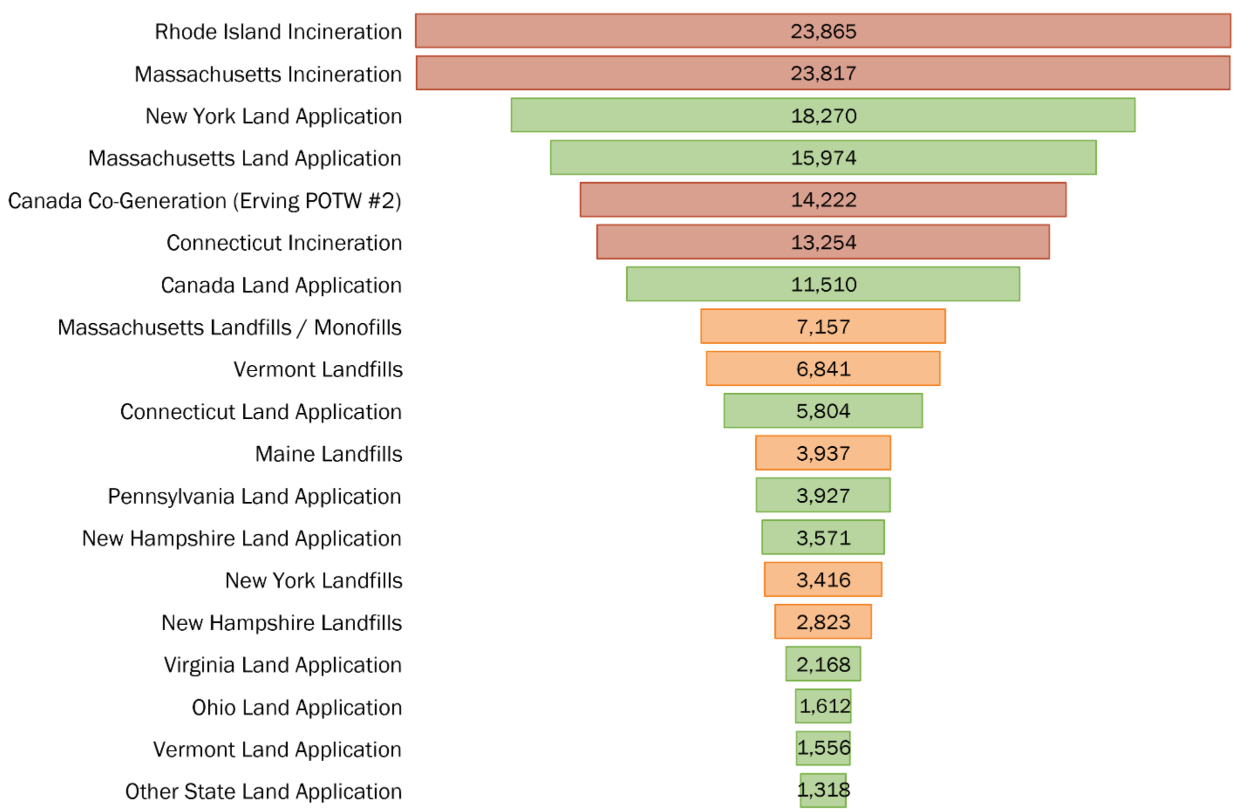


**Figure ES-1. Massachusetts sludge management by location and management type, 2023.**

*(Dry U.S. Tons. Red: incineration; green: land application; orange: landfills/monofills)*

Land application (shown in green)—primarily of dried pellets from two large POTWs with thermal dryers and of biosolids compost from small facilities at POTWs in Massachusetts and larger facilities in Maine and Canada—processes nearly the same amount of sludge—66,000 dry U.S. tons or 39% of the total. Note that the locations in Figure ES-1 for land application represent where the material was distributed to be used as a soil conditioner and not where the processing facility was.

Landfills and purpose-built sludge monofills in Massachusetts and surrounding states handle a relatively small proportion of sludge (around 14% of the total) compared with landfill rates in northern New England states and New York, likely due to the historical availability of the two other primary management options (land application and incineration).

Figure ES-2 gives a visual overview of the connections between where sludge is generated and where it is incinerated, landfilled or further processed for land application. POTWs in Massachusetts rely on numerous facilities of each type in the state and around the Northeastern United States and into Canada.

Each of the three types of outlets is facing challenges. Details on the specific challenges, as well as current and future capacity, costs and other relevant information, were obtained via surveys sent to all facilities currently managing Massachusetts sludge, and all 127 POTWs in the state.

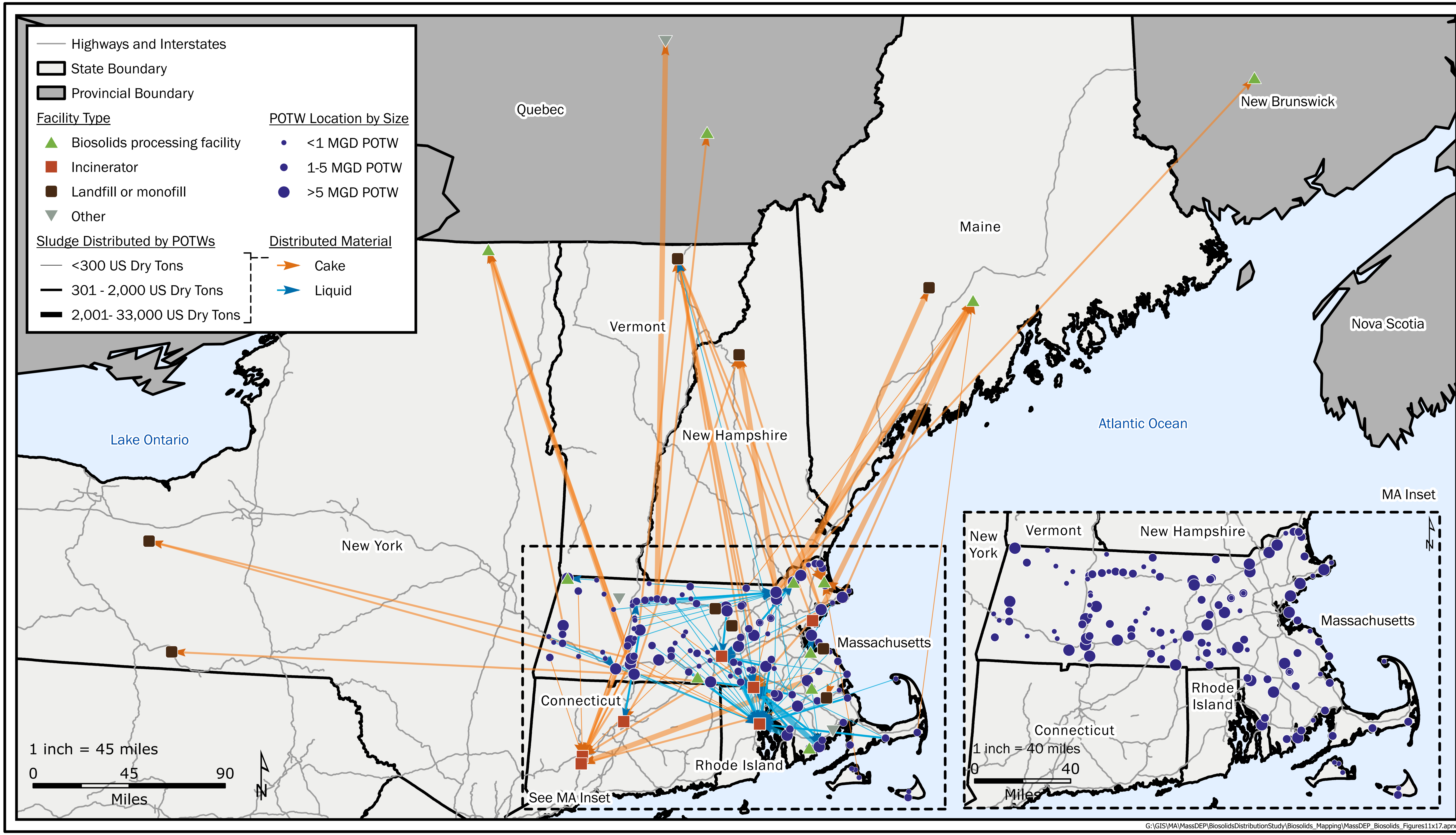


**Figure ES-2. Destinations for Wastewater Sludge Produced in Massachusetts**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

**Landfill capacity in the Northeast is dwindling (Section 4), particularly for "wet wastes" like dewatered sludge**, which can cause stability and other issues at landfills when accepted at high rates. Sludge disposal capacity within Massachusetts landfills is limited and inadequate to satisfy the amount of sludge produced within the state, especially as several landfills are slated to reach capacity within the next decades. While some facilities have a higher capacity for sludge disposal, concerns including odor, leachate quality, and the presence of PFAS appear to dissuade these facilities from accepting additional sludge beyond what is currently accepted. In the surrounding region, several states are experiencing landfill capacity concerns. Many of the landfills currently accepting Massachusetts sludge report plans for expansion, but this can often be a long and contentious process. The project team is not aware of any firm proposals for entirely new landfills in the region, with the exception of a proposed landfill in northern New Hampshire that is facing significant opposition from local residents and legislators.

Facilities that produce a material to be land applied (Section 5) face gradually tightening regulations on PFAS, with federal sludge limits expected from the Environmental Protection Agency (EPA) in 2025. While most of these facilities report planning to remain in operation for the foreseeable future, in Massachusetts only one small compost facility reports having available capacity to accept additional outside sludge from other POTWs. The other compost and drying facilities in the state are at capacity or are reserved primarily or entirely for the use of the host facility. **Outside of Canada and an alkaline stabilization facility in far northern New York, no facilities producing material for land application report having additional available capacity**.

Outside of Massachusetts, other New England states (Connecticut, New Hampshire, Rhode Island, and Vermont), New York, and Canada are the primary locations for land application of compost, dried biosolids and alkaline stabilized biosolids produced with sludge generated in Massachusetts. Several jurisdictions have passed regulations for PFAS levels for sludge that is land applied. New York has adopted an Interim Strategy for the Control of PFAS Compounds which sets limits on two of the most common PFAS compounds, PFOS and PFOA, of 20 parts per billion (ppb) for biosolids which can be land applied without further action needed until the EPA sets risk-based standards, in an effort to restrict land application to biosolids that are not significantly impacted by industrial inputs of PFAS. Vermont has also adopted an Interim Strategy for Mitigating PFAS Risks Associated with Residuals Management, which sets limits on five common PFAS compounds, PFOS (3.40 ppb), PFOA (1.60 ppb), PFHpA (0.84 ppb), PFNA (0.44 ppb), and PFHxS (0.38 ppb). Connecticut recently enacted a ban on the sale of "biosolids or wastewater sludge that contain PFAS," which will go into effect in 2026. The Canadian Food Inspection Agency has set an interim standard of 50 ppb for PFOS for sludge imported into the country.

Of the fourteen sewage sludge incineration facilities in New England and New York (Section 6), only two both accept sludge from other POTWs and report having additional capacity. The additional capacity of the two facilities (in Woonsocket, RI and Buffalo, NY) totals less than 10 dry U.S. tons per day (dtpd) —equivalent to around 2% of the daily sludge production in Massachusetts. And, of course, this capacity is not reserved for Massachusetts sludge. Nearly all of the facilities surveyed reported plans to stay operational for the foreseeable future; however, these facilities have all been in operation for multiple decades and short- and long-term outages due to planned and unplanned maintenance are not uncommon. West Haven, CT will be looking into rehabilitating their inactive incineration facility during an upcoming capital improvement project (previous capacity approximately 54 dry U.S. tons per day), which could moderately increase regional incineration capacity. **There are no other known potential increases in incineration capacity in the region and it is typically extremely difficult to obtain the necessary permits and public acceptance for new incinerators.**

**POTWs without dewatering equipment that produce liquid sludge (typically small facilities) are particularly at risk as there are far fewer options for managing liquid sludge.** Liquid sludge typically will not be accepted by landfills, compost facilities, and some incineration facilities. This vulnerability was highlighted while this report was being drafted when the Woonsocket, RI incineration facility contacted POTWs in Massachusetts (and elsewhere) informing them that the receipt of liquid sludge was ordered to be halted in the coming months by their city council. This has sent these POTWs scrambling for options. None of the other incineration facilities in the region that accept liquid sludge report having available capacity. When sludge management was facing severe challenges in Maine in the past few years, some POTWs producing liquid sludge in that state were forced to haul sludge to facilities as far away as New Jersey at great expense.

Massachusetts has set aggressive climate goals in the Clean Energy and Climate Plan for 2050. Different approaches to managing solids have different climate impacts. **Around 60% of Massachusetts sludge is landfilled or incinerated (on a dry weight basis), but these management approaches have disproportionate negative climate impacts, accounting for 87% of the net GHG emissions estimated to be associated with sludge management in the state** (Section 7.4). Composting and some other forms of land application actually have a net climate benefit. As climate regulations in Massachusetts, other states, and at the federal level become more stringent, processes that produce significant GHG emissions like landfilling and incineration will likely come under pressure.

Part 1 of this study also included an analysis of the septage generated in the state. In the resulting report, “Massachusetts Septage Management Study,” it is clear that the management of septage is also vulnerable to disruption. Since POTWs are primarily responsible for septage treatment, any pressures to POTWs in the region directly impact septage receiving at these facilities. If sludge management options continue to decrease due to new regulations, some POTWs may choose to limit or stop receiving septage as a way of reducing solids production and inputs of compounds of concern, such as PFAS. Therefore, disruption to sludge management in the region has an impact on all households and businesses in the state, including those not directly connected by sewer to a POTW.

# Section 1: Introduction

## 1.1 Project Objectives

The Massachusetts Department of Environmental Protection (MassDEP) commissioned this PFAS and Residuals Technology and Management Study to address the significant residuals management challenges faced by publicly owned treatment works (POTWs) in Massachusetts. Over the past several years, Massachusetts POTWs have experienced rapidly escalating management costs and, at times, temporary shutdowns of their off-site sludge management locations. The wastewater industry faces pressure on all fronts, including landfill capacity reductions, regional incinerator outages due to aging infrastructure, and biosolids land application site limitations due to concerns with per- and polyfluoroalkyl substances (PFAS).

Sludge management options in the Northeastern United States have been decreasing due to various factors, including legislative actions and limited in-state and regional landfill capacity. Reduced disposal options and solids carryover in treatment facilities pose a threat to water quality and permit compliance. Wastewater facilities have very limited capacity to store solids in the process. The ability to store solids is measured in days, not weeks. The inability to routinely dispose of biosolids can result in process control upsets (especially critical for facilities with tight nutrient limits), reduced hydraulic capacity, and the loss of biomass during high flow events that may result in permit violations. Public concern over the presence of PFAS in Massachusetts sludge, septage, and leachate, originating from various sources, necessitated a comprehensive study to establish a statewide residuals management strategy.

This report summarizes Part 1 of the PFAS and Residuals Technology and Management Study. Part 1 focuses on surveying POTWs and sludge management facilities to document and quantify current conditions, as well as to develop projections for management of Massachusetts sludge five years into the future. Part 2, which will be completed in 2025, focuses on sludge treatment technologies for PFAS reduction, PFAS source reduction strategies, and regulatory issues. The combined Part 1 and Part 2 PFAS and Residuals Technology and Management Study has the following principal objectives:

1. Conduct a detailed assessment of sludge and septage disposal practices in POTWs across Massachusetts.
2. Assess Sludge Management Alternatives
   - Landfill Disposal – Examine the capacity and long-term viability of in-state and out-of-state landfills for sludge and incineration ash disposal.
   - Incineration – Investigate the current capacity, reliability, and long-term use of in-state and out-of-state incinerators handling disposal of Massachusetts sludge.
   - Land Application – Investigate the current capacity, reliability, and long-term use of in-state and out-of-state facilities producing biosolids from Massachusetts sludge for land application.
3. Compile data on sludge and septage volumes and costs, and recommend adjustments to waste reporting for POTWs, addressing data gaps from previous studies.
4. Evaluate Technologies
   - Assess PFAS treatment methodologies for POTWs, including concentration, encapsulation, and destruction technologies for PFAS in leachate, sludge, and septage.
   - Evaluate sludge volume reduction technologies.

   – Examine PFAS reduction methodologies for POTWs and MassDEP within the legal, regulatory and policy framework.
5. Propose alternatives and recommendations for short-term and long-term sludge management in Massachusetts, tailored for utilities of varying sizes.
6. Provide insights to assist POTWs and MassDEP in advancing sludge capital projects, as necessary.

The PFAS and Residuals Technology and Management Study is crucial for establishing a sustainable path forward, ensuring compliance with regulations, protecting human health and the environment, and addressing the economic, technical, and logistical realities of waste management. The study will guide decision-making for utilities of different sizes and aid in the development of effective sludge management strategies in Massachusetts.

This project seeks to provide a holistic understanding of the current state of PFAS-contaminated residuals, proposing viable solutions that balance environmental protection, regulatory compliance, and practical considerations. The fundamental objective is to assist MassDEP in developing strategies for a more sustainable and resilient residuals management framework in Massachusetts.

## 1.2 Background

### 1.2.1 Review of Relevant Literature

The following sources were reviewed to provide technical background and historical context during this study. These sources also provided guidance during survey development for Massachusetts POTWs and for the various facilities processing Massachusetts sludge. These sources were specifically referenced in the Request for Quotes issued by MassDEP for this study. Brief descriptions of sources most relevant to Part 1 (this study) are provided below the reference list. Sources related to PFAS issues will be utilized in the next phase of this study, or Part 2.


- Environmental Council of States (2023). PFAS in Biosolids: A Review of State Efforts & Opportunities for Action.
- Michigan Department of Environment, Great Lakes, and Energy (EGLE) (2024). PFAS-related activities related to biosolids for land application, Industrial Pretreatment Programs (IPP), and drinking water and surface water quality standards. https://www.michigan.gov/egle.
- Minnesota Pollution Control Agency (2023). Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water.
- MSW Consultants (2019). Massachusetts Materials Management Capacity Study.
- New England Interstate Water Pollution Control Commission (NEIWPCC) (2022). Northeast Regional Sludge End-Use and Disposal Estimate.
- North East Biosolids and Residuals Association (NEBRA) (2019). The Mass Sludge Survey 2018, Wastewater Solids Generation and Management in Massachusetts, v.1.1, September 2019.
- United States Environmental Protection Agency (EPA), Environmental Council of States, and National Association of State Departments of Agriculture (2023). Joint Principals for Preventing and Managing PFAS in Biosolids.


The 2018 Mass Sludge Survey prepared by NEBRA for the Massachusetts Clean Energy Center included a comprehensive survey of sludge production from Massachusetts POTWs, and the present study utilized the 2018 Mass Sludge Survey as an important guide to understand recent trends in the Massachusetts sludge management market. The NEBRA study determined that Massachusetts produced 180,800 dry U.S. tons of sludge in 2018 and that sludge was managed as follows:

- 43% incinerated
- 38% land applied
- 18% sent to landfills or monofills
- 1% used or disposed in other unspecified ways

NEIWPCC's Northeast Regional Sludge End-Use and Disposal Estimate (September 2022) was another key document utilized to inform understanding of the Northeast sludge management market and to guide survey development. This study estimated that 794,563 dry U.S. tons of sewage sludge were disposed, or land applied in the Northeast region in 2018. Sludge was primarily landfilled and incinerated, with biosolids land application at a lower rate. POTWs located throughout Southern New England primarily relied upon incineration, and those in Northern New England relied on landfills and biosolids land application. Massachusetts, New Hampshire, and New York relied upon all three options.

The Massachusetts Materials Management Capacity Study was prepared by MSW Consultants for MassDEP. The goal of this 2019 solid waste report was to assess the overall capacities of possible material endpoints including facilities involved in disposal (landfill and combustion), transfer, recycling, composting, anaerobic digestion, animal feed operations, food rescue, and materials reuse operations. This source was a valuable reference when evaluating landfill disposal of Massachusetts sludge in Section 4 of this study. Further, because the 2019 report did not specifically reference landfill capacity for Massachusetts wastewater sludge, an addendum to the Massachusetts Materials Management Capacity Study regarding present and future landfill capacity of Massachusetts wastewater sludge is included in Appendix E.

### 1.2.2 Sludge Management Strategies

Three primary sludge management strategies are utilized for management of wastewater sludge produced in Massachusetts. These strategies include landfilling, land application, and incineration, and each strategy is briefly described below.

- **Landfilling**: Landfilling of sludge involves disposal of sludge cake at landfills or monofills in Massachusetts or elsewhere in the Northeast. Sludge cake refers to sludge that has been mechanically dewatered, typically to a solids concentration of 20% or more for landfill disposal, although individual landfills typically have specific sludge characteristic requirements. Refer to Section 4 for a detailed discussion on landfilling of Massachusetts sludge.
- **Land Application**: Land application involves stabilizing sludge via a process (where process requirements are dictated by both state and federal law) that produces a product suitable for beneficial use via land application called "biosolids." Land application is regulated by Federal regulation 40 CFR Part 503 (Standard for the Use or Disposal of Sewage Sludge) and by 310 CMR 32.00 (Land Application of Sludge and Septage) in Massachusetts. 310 CMR 32.02 indicates that this regulation is intended to allow land application of sludge for beneficial purposes in a manner that will protect public health and the environment from possible contamination which could occur from pathogens, metals, or toxic chemical compounds. Technologies presently utilized for processing of Massachusetts sludge include thermal drying, composting, and alkaline stabilization. Refer to Section 5 for a detailed discussion on land application of Massachusetts sludge.
- **Incineration**: Incineration is a sludge management process which combusts sludge, releasing heat from the volatile solids while the inert material becomes ash. There are two incineration

technologies used in this region, Fluidized Bed Incineration and Multiple Hearth Incineration (MHI). Refer to Section 6 for a detailed discussion on incineration of Massachusetts sludge.

## 1.3 Scope of Work

This section summarizes the scope of work included in Task 1 of Part 1 of the PFAS and Residuals Technology and Management Study. Task 1 includes data gathering from POTWs on their current sludge management practices. In addition, Task 1 includes data gathering on the three primary sludge management approaches utilized by Massachusetts POTWs: landfills, land application, and incineration. Task 2 of Part 1 is an analysis of septage management in Massachusetts, and Task 2 is summarized in a separate memorandum. Sub-tasks included in the Task 1 scope are briefly summarized below:

- Kick-off meeting.
- Review literature on Massachusetts residual management.
- Prepare draft survey templates for POTWs, landfills, biosolids processing facilities, and incinerators.
- Conduct workshop meeting to present draft surveys and solicit suggestions for enhancement.
- Send surveys to Massachusetts POTWs, landfills, biosolids processing facilities, and incinerators.
- Analyze data for Massachusetts landfills and for landfills outside of Massachusetts which currently accept Massachusetts sludge or may accept Massachusetts sludge in the future.
- Analyze data for Massachusetts biosolids processing facilities and for biosolids processing facilities outside of Massachusetts which currently accept Massachusetts sludge or may accept Massachusetts sludge in the future.
- Analyze data for Massachusetts incinerators and for incinerators outside of Massachusetts which currently accept Massachusetts sludge or may accept Massachusetts sludge in the future.
- Prepare draft report, including update of the Massachusetts Materials Management Capacity Study to include landfilling of Massachusetts sludge, identifying capacity gaps and needs, mass balance analysis of sludge production and management locations (present and five years into future), GHG emissions and energy cost analysis, energy recovery methods, and cost for management of Massachusetts sludge.
- Workshop meeting with MassDEP and other selected industry representatives to present the draft report and solicit comments.
- Issue final report.

# Section 2: Methods

## 2.1 Compilation of Existing Data

Prior to survey development, a comprehensive review of existing data was completed. This not only provided a baseline for the study, but it also helped guide survey development and distribution. Mickey Nowak, Government Affairs Chair of the Massachusetts Water Environment Association (MAWEA), provided a summary spreadsheet of sludge data collected from EPA's Enforcement and Compliance History Online (ECHO) database for 2022 and 2023. The EPA requires any POTW serving 10,000 people or more, has a design flow equal to or greater than one million gallons per day (MGD), or has an approved pretreatment program to submit an annual report. For 2023, eighty four POTWs in the Commonwealth fell into that reporting category. Of those 84 facilities, seventy-two have reported as of the writing of this report. Additionally, eleven facilities under 1 MGD design flow submitted annual reports. From the 2022 and 2023 annual reports, design flo4-w, sludge management practices and tonnages by outlet were obtained.

MassDEP provided the 2022 and 2023 annual reports for in-state and out-of-state facilities holding an Approval of Suitability (AOS). In accordance with 310 CMR 32.11, "No person shall use, sell, or distribute or offer for use, sale, or distribution in Massachusetts sludge or septage unless such sludge or septage is the subject of an AOS then in effect pursuant to 310 CMR 32.00." At the time of this study, there are seven in-state AOS holders. Additionally, there are five out-of-state facilities with an AOS, and while not all accept sludge from Massachusetts, they can land apply within the state. These AOS reports detail type of material distributed, delivery site, and total tons or yards. Additionally, MassDEP provided a compilation of in-state landfill annual reports with projected tons per year the landfill can accept, expected closure date, and leachate collection methods. In 2023, Brown and Caldwell (BC) conducted a study for Maine Department of Environmental Protection titled "Study for Sustainable Management of Wastewater Solids, Septage and Leachate in the State of Maine." This study was reviewed and referenced for insight on landfill capacity in Maine, as Maine landfills take some Massachusetts sludge.

Beyond providing a baseline of information, the review and compilation of existing data identified processing and management outlets for both in-state and out-of-state facilities currently accepting Massachusetts sludge. Facilities in Connecticut, Maine, New Hampshire, New York, Rhode Island, Vermont as well as multiple provinces of Canada were all identified as receiving Massachusetts sludge, and thus included in the study.

## 2.2 Future Sludge Generation Changes Based on Population Projections

This section describes the methodology utilized to project future state-wide sludge generation changes in Massachusetts based on population change projections. Note that this approach does not capture changes in sludge generation that would result from wastewater treatment process modifications that occur at individual POTWs, such as nutrient removal projects or anaerobic digestion projects, some of which would increase sludge generation and some of which would decrease sludge generation. In addition, this approach does not capture regional population trends in Massachusetts.

The UMass Donahue Institute utilizes census data and population projection methodologies to develop Massachusetts population projections. However, the UMass Donahue Institute has not yet posted their latest projections (anticipated in 2024). Therefore, historical population trends were utilized in this report to estimate future population growth. Massachusetts population increased from 6,566,307 in 2010 to 7,001,399 in 2023 based on data from the UMass Donahue Institute. This longer data set was utilized to minimize the impact of any anomalous population changes from the Corona Virus Disease (COVID-19) pandemic over the past several years. From 2010 to 2023, Massachusetts population increased by an average of 0.50% per year. This report assumes that population will continue to change at a similar rate over the next five years, and that sludge generation will similarly increase at a rate directly proportional to population growth. Therefore, for sludge generation estimates, a 2.5% total increase is projected in the next five years from 2024 to 2028.

## 2.3 Survey Development

In 2018, NEBRA, in collaboration with the Massachusetts Clean Energy Center, undertook a comprehensive Massachusetts Sludge Survey. The primary objective of this survey was to quantify the amount of sludge generated within the Commonwealth. Additionally, the study aimed to examine the management practices, locations, and associated costs related to sludge handling in the region. The data from the 2018 survey helped inform a 2022 New England Interstate Water Pollution Control Commission (NEIWPCC) study, which illuminated both an increase in sludge being managed in the Commonwealth, as well as a lack of secure sludge management outlets for facilities.

The 2018 survey shed light on the management of sludge generated in Massachusetts. However, given the evolving landscape, including declining sludge management capacity and the emergence of contaminants like PFAS, an updated and comprehensive data set is needed. To address this, four surveys were drafted to capture current information on sludge management practices and capacities.

The main goal of the surveys was to document how all POTWs in the Commonwealth are handling their sludge. To achieve this, a holistic strategy was adopted by designing surveys to gather data from POTWs as well as outlets for further processing and sludge management. The POTW survey focused on the quantity of sludge being produced, its destination, management costs, contingency plans, and any concerns such as sludge management outlet reliability or future PFAS regulations. The further processing and sludge management surveys provided another perspective by asking facilities about their current and long-term capacities to accept sludge. To get a more complete picture, sludge management outlets both within and outside of Massachusetts were identified to receive surveys using the annual report information compiled at the start of the study. Additionally, the surveys included questions to capture any future sludge management outlets on the horizon in the New England region, as well as contingency plans when primary disposal methods are not available.

Using Microsoft Forms, the following surveys were developed:

- POTW Sludge Management Survey: All POTWs in Massachusetts. (See Appendix G for a list of POTWs included in the survey.)
- Landfill Disposal Survey: Landfills currently accepting solids from Massachusetts POTWs or regional landfills that may have the capacity to accept Massachusetts solids in the future.
- Biosolids Processing Facility for Land Application Survey: Facilities with onsite composting, thermal drying, or alkaline stabilization in and out of the state that currently process Massachusetts solids or may have the capacity to process Massachusetts solids in the future.
- Incineration Survey: All sewage sludge incinerators in New England and New York.

Participants were asked to complete all surveys related to their facility, which sometimes involved taking multiple surveys. The lists of survey questions are included in Appendices A-D.

## 2.4 Draft Survey Review Meeting & Incorporating Feedback

Each of the draft surveys was presented in a meeting organized by MassDEP to refine the surveys before distribution. Stakeholders from NEBRA, NEIWPCC, POTWs, incineration facilities, biosolids processing facilities, septage hauling companies, and landfills were invited to the meeting. After the meeting, the draft survey templates were provided to attendees and MassDEP for review and comment. Each comment was reviewed and considered by the team. Stakeholders were contacted based on feedback as needed, and relevant feedback was incorporated into the final survey templates.

Final surveys were distributed via email. Contact information was provided by MassDEP, supplemented by the study team, MAWEA, NEBRA, and internet searches.

## 2.5 Information Gathering

Survey responses were compiled into spreadsheets and reviewed for accuracy. Existing data from annual reports were used to cross reference data received as well as fill in any gaps. Participants were contacted as needed to clarify responses, and several batches of reminder emails were sent, and calls made to those who had not completed the survey.

# Section 3: Massachusetts Wastewater Sludge Generation, Transport, and Management

## 3.1 Facilities Studied

Of 127 Massachusetts POTWs surveyed, 94 responded to the *POTW Sludge Management Survey* during the survey period (March 11 – May 14, 2024), representing 94.9% of the statewide wastewater permitted flow. The data set primarily includes POTWs with NPDES permits, although some POTWs with groundwater discharge permits are also included (refer to Appendix G for a list of all POTWs included in the study and their permit type). The Task 2 Technical Memorandum includes "sludge" generated from septic systems as well as groundwater discharge permittees that are not POTWs. Survey responses were supplemented by 2023 EPA Annual Biosolids Reports, sludge data provided by Franklin County Solid Waste Management District (FCSWMD), and direct consultation with POTW operators. The compiled data represent 88 percent of POTWs (Figure 3-1) and 98.9% of the statewide wastewater permitted flow (Figure 3-2). Information was not available for 14 POTWs (12% of POTWs and 1.1% of total permitted wastewater flow).

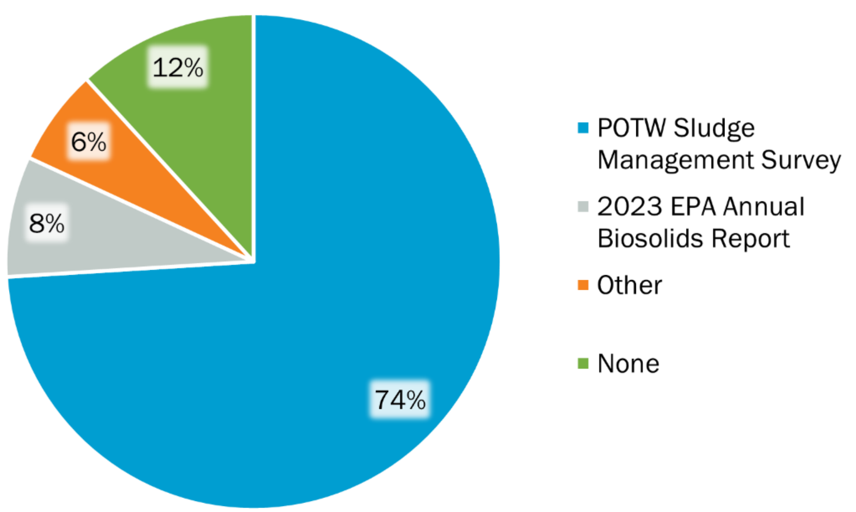


**Figure 3-1. Percent of POTWs represented by each primary data source.**

*'Other' (orange) includes sludge data provided by Franklin County Solid Waste Management District and direct consultation with POTWs.*

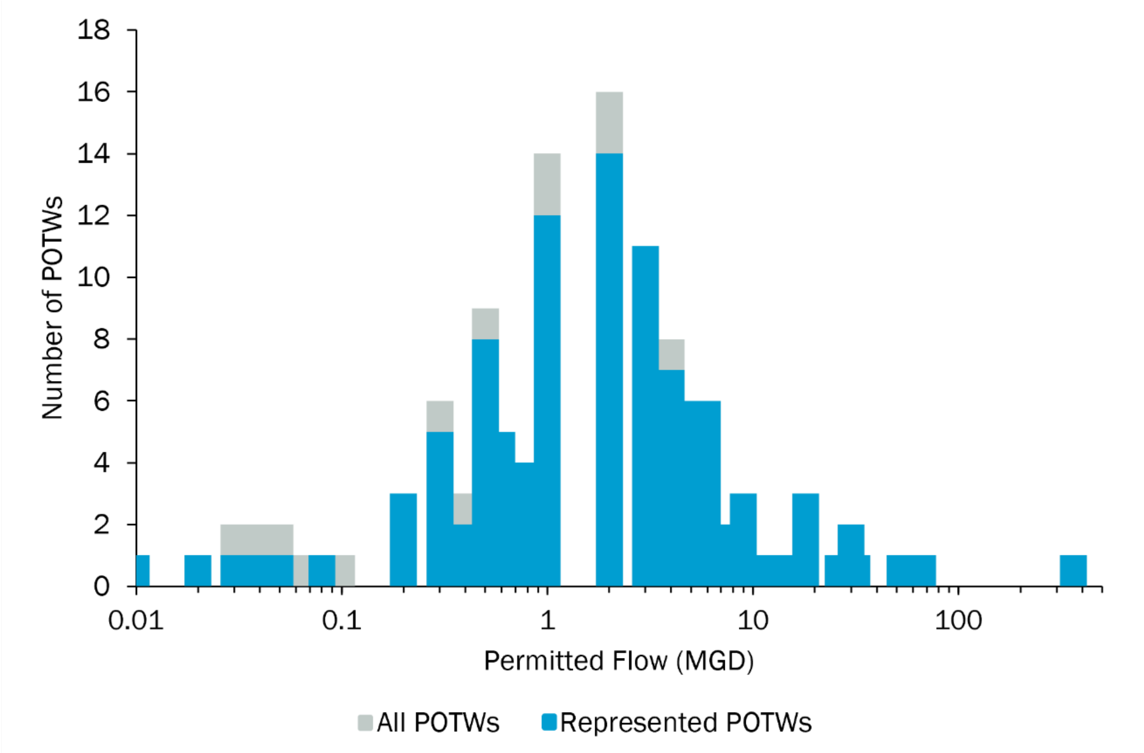


**Figure 3-2. Data included in the present study (blue) represent 98.9 percent of Massachusetts' statewide permitted wastewater flow.**

Thirty-five of 44 small POTWs (permitted flows <1 MGD) are represented in the present study, comprising 90.5% of permitted flow for small Massachusetts POTWs. Forty-nine of the 54 medium POTWs (1 to 5 MGD) contributed data, representing 92.7% of the statewide permitted flow for medium POTWs. Data are included from all 29 large POTWs (>5 MGD) in Massachusetts (Table 3-1).

**Table 3-1. Data Included in the Present Study are Summarized According to POTW Size.**
Small POTWs have permitted flows <1 MGD; medium POTWs have permitted flows between 1 and 5 MGD, and large POTWs have permitted flows >5 MGD

| | Total | Represented | Percent |
|---|---|---|---|
| Small POTWs (<1 MGD) | | | |
| Number of POTWs | 44 | 35 | 80 |
| Permitted flow (MGD) | 16.0 | 14.5 | 90.5 |
| Medium POTWs (1-5 MGD) | | | |
| Number of POTWs | 54 | 49 | 91 |
| Permitted flow (MGD) | 135.7 | 125.8 | 92.7 |
| Large POTWs (>5 MGD) | | | |
| Number of POTWs | 29 | 29 | 100 |
| Permitted flow (MGD) | 878.7 | 878.7 | 100.0 |

**Table 3-2. Summary of POTW Data by MassDEP Administrative Region**

| | Total | Represented | Percent |
|---|---|---|---|
| | Northeast | | |
| Number of POTWs | 18 | 16 | 88.9 |
| Permitted flow (MGD) | 541.8 | 540.4 | 99.7 |
| | Southeast | | |
| Number of POTWs | 31 | 26 | 83.9 |
| Permitted flow (MGD) | 149.1 | 142.1 | 95.3 |
| | Central | | |
| Number of POTWs | 35 | 32 | 91.4 |
| Permitted flow (MGD) | 149.7 | 148.6 | 99.3 |
| | Western | | |
| Number of POTWs | 43 | 38 | 88.4 |
| Permitted flow (MGD) | 189.8 | 187.8 | 99.0 |

Nitrogen and phosphorus treatment systems can impact both sludge quantity and sludge quality. For example, slow nitrification and denitrification during winter or excessive heterotrophic uptake can lead to sludge bulking, while chemical precipitation of phosphorus can produce excess sludge and result in sludge dewaterability challenges. These phenomena can increase the volume of sludge that requires management as well as impact potential outlets. As such, POTWs were asked to indicate their nutrient removal requirements and treatment practices. Forty-three survey respondents reported having both nitrogen and phosphorus effluent concentration permit limits, while 17 survey respondents reported having only nitrogen effluent concentration limits and 12 survey respondents reported having only phosphorus effluent concentration permit limits. However, of the 60 survey respondents who reported nitrogen effluent concentration permit limits, only 55 reported using nitrification unit processes and only 42 reported using denitrification unit processes. Although 55 survey respondents reported having phosphorus effluent concentration limits, only 35 reported using tertiary treatment unit processes for phosphorus removal. 84 of 94 survey respondents reported using aeration or another activated sludge process for liquid-stream treatment.

Approximately 61% of survey respondents reported receiving septage (Figure 3-3), and approximately 14% of survey respondents reported receiving hauled-in liquid waste other than septage or wastewater sludge (Figure 3-4). Interestingly, these proportions were consistent among geographical regions, although more than twice as many large and medium POTWs reported receiving septage or other hauled-in waste than small POTWs. For a more complete discussion of septage treatment in Massachusetts, see the Task 2 – Septage Management technical memorandum. Thirteen POTWs reported processing a total of 35,471,297 gallons of hauled-in waste other than septage or wastewater sludge in 2023 (Table 3-3). Greater Lawrence Sanitary District (GLSD) receives 67% of Massachusetts' hauled-in waste and is the only POTW that reported receiving hauled-in food waste. Recent construction of an organics-to-energy combined heat and power project increased GLSD's capacity for receiving hauled-in organic waste and energy production from their anaerobic digesters. Landfill leachate and commercial wastes were the most common hauled-in wastes treated by represented facilities of all sizes, drawing attention to the critical role of POTWs in managing liquid organic wastes.

Many commercial and industrial wastewaters discharged to POTWs receive at least minimal treatment onsite at the source facility. In fact, over 90% of 2023 sludge was generated at 45 POTWs that reported having active, EPA-approved IPPs. This is appropriately consistent with *The Mass Sludge Survey 2018*'s estimate that "93% of the solids produced in Massachusetts are from [POTWs] with active industrial pretreatment programs." While treatment of hauled-in commercial and industrial wastewater by POTWs may be an important community service, hauled-in wastes may also introduce chemical contaminants, including PFAS, which are not currently regulated under Massachusetts' IPP framework. The PFAS contribution of industrial indirect dischargers will be analyzed in Part 2 of the study, along with contributions from other sources such as residential wastewater.

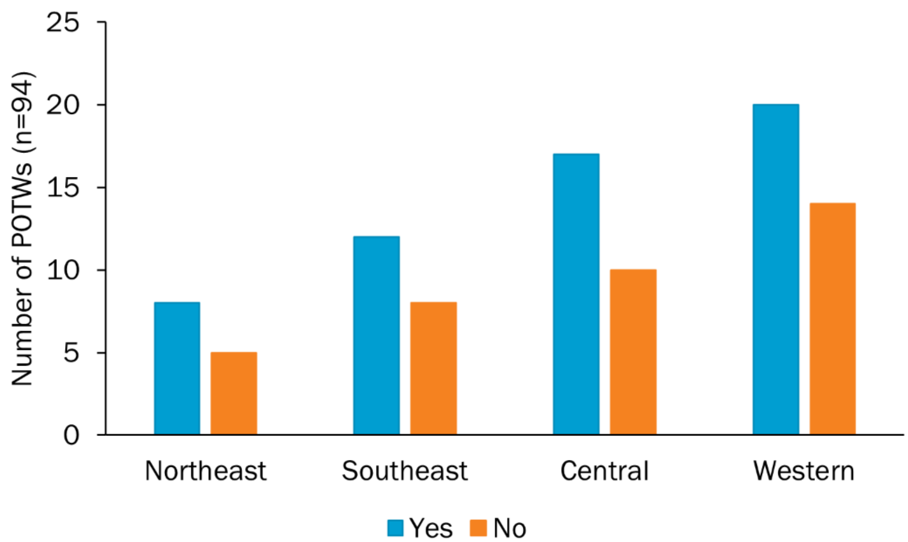


**Figure 3-3. POTWs receiving septage in 2023 by MassDEP administrative region.**

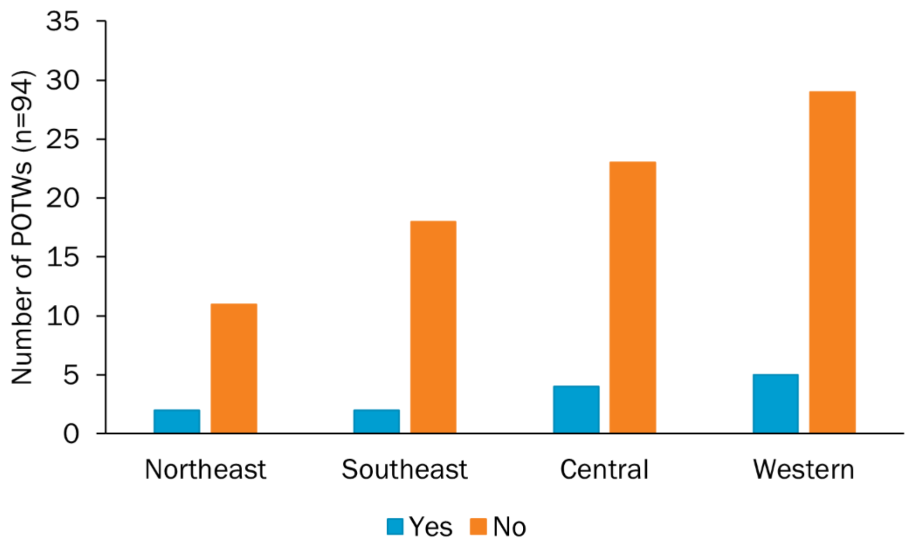


**Figure 3-4. POTWs receiving hauled-in waste other than septage and wastewater sludge by MassDEP administrative region in 2023.**

**Table 3-3. Hauled-in Waste Other than Wastewater Sludge or Septage Received by Massachusetts POTWs in 2023**

| POTWs | Gallons Received | Types of Waste Reported |
|---|---|---|
| Barnstable | 885,000 | FOG (i.e., fats, oils, and grease) |
| Belchertown | 1,000 | Local RVs |
| Devens | 8,200,000 | Commercial/industrial waste |
| GLSD | 20,261,000 | Food waste |
| Greenfield | 1,890,000 | |
| Hardwick-Gilbertville | 165,800 | Landfill leachate |
| Holyoke | 27,000 | Landfill leachate |
| Marshfield | 42,800 | FOG (i.e., fats, oils, and grease) |
| Palmer | 890,000 | Landfill leachate |
| Spencer | 110,000 | Commercial/industrial waste |
| Upper Blackstone | 2,835,597 | Landfill leachate, Commercial/industrial waste |
| Webster | 163,100 | Commercial/industrial waste |

# 3.2 Sludge Production and Processing

## 3.2.1 Sludge Production

An estimated 165,683 dry U.S. tons of wastewater sludge was generated in 2023 from Massachusetts POTWs. Comparison of the 2023 EPA Annual Biosolids Reports with the *POTW Sludge Management Survey* responses indicated likely reporting errors within the 2023 EPA Annual Biosolids Reports, with multiple instances of sludge quantities reported in units of dry U.S. tons rather than the dry metric tons required by EPA Annual Biosolids Reports. Therefore, 2023 EPA

Annual Biosolids Report data were corrected to account for these errors where apparent. Statewide sludge generation estimates were also corrected to account for known intra-state sludge processing to avoid double-counting this sludge, discussed further in Section 3.2.3. Compiled data and survey responses accounted for 163,625 dry U.S. tons generated in 2023.

Equation 3-1 was used to estimate sludge quantities from the 14 facilities without available information based on their permitted flow rates. These POTWs generated an estimated 2,058 dry U.S. tons sludge in 2023, bringing the estimated total sludge generated in 2023 to 165,683 dry U.S. tons, which shows good agreement with the 163,555 dry U.S. tons inferred from the corrected 2023 EPA Annual Biosolids Reports.

$$\text{Estimated sludge generated (dry U.S. tons)} = 180.16 \times \text{Permitted flow rate (MGD)} \qquad \text{Equation 3-1}$$

$$R^2 = 0.78$$

The present study's estimate is less than the estimated 180,800 dry U.S. tons reported in *The Mass Sludge Survey 2018.* Because *The Mass Sludge Survey 2018* incorporated data from EPA Annual Biosolids Reports, it is likely to have overestimated the sludge generated. It is assumed that some sludge quantities submitted in the EPA Annual Biosolids Reports were submitted in dry U.S. tons and not dry metric tons. The conversion factor from metric tons to U.S. tons is 1.102, so cases where dry U.S. tons were reported as dry metric tons resulted in a 10% over-estimate of sludge generation. In addition, some sludge appears to have been double-counted in *The Mass Sludge Survey 2018* when transported from the POTW of origin to another POTW for further processing or disposal. Therefore, a direct comparison between this analysis and *The Mass Sludge Survey 2018* is not feasible.

### 3.2.2 Onsite Sludge Processing Technologies

Of the estimated 165,683 dry U.S. tons of wastewater sludge generated from Massachusetts POTWs in 2023, about 39% (65,185 dry U.S. tons) was managed onsite at its POTW of origin. Onsite management refers to advanced sludge treatment or disposal at the POTW site, including incineration, landfilling or monofilling, and processing through thermal drying or composting. There are 11 POTWs with onsite sludge management (Table 3-4). Figure 3-5(a) shows that about 39% of sludge produced in Massachusetts is managed onsite, although only about 8% of Massachusetts POTWs have onsite management, as shown in Figure 3-5(b). This difference highlights that onsite processing tends to be most common at larger POTWs like MWRA Deer Island, GLSD, Upper Blackstone, and Lynn.

Upper Blackstone and Lynn incinerate sludge onsite as discussed further in Section 6, while Templeton disposes of sludge cake in an onsite monofill as discussed further in Section 4. MWRA, GLSD, Bridgewater, Dartmouth, Hoosac, and Southbridge utilize onsite thermal drying or composting to further process sludge into biosolids used for land application as discussed further in Section 5. MWRA is unique in that sludge is anaerobically digested at the Deer Island POTW in Winthrop, and then digested sludge is pumped under the Boston Harbor to the biosolids processing facility in Quincy for thermal drying. This report included MWRA in the onsite treatment category because sludge is not trucked to an off-site facility for advanced processing.

Shelburne Falls and Marion treat their sludge via long-term aerobic digestion in an onsite constructed wetland and lagoon, respectively. Shelburne Falls retains sludge in the constructed wetland, although they are considering removing some of this material soon, including producing a landfill cap soil amendment. Sludge is removed from the Marion lagoon on an infrequent as-needed basis.

Marion, Shelburne Falls, and Templeton are small POTWs and together account for just 0.2% of onsite sludge processing. The vast majority of onsite sludge processing (96.9%) can be attributed to five large POTWs (MWRA, GLSD, Upper Blackstone, Lynn and Hoosac) with an additional 2.9% accounted for by three medium POTWs (Bridgewater, Dartmouth, and Southbridge).

**Table 3-4. Massachusetts Wastewater Sludge Managed Onsite at its POTW of Origin in 2023**

| POTWs | Permitted Flow (MGD) | Avg. % Solids | Sludge Type | Management Type | Qty. Distributed (Dry US tons) |
|---|---|---|---|---|---|
| Bridgewater WWTP | 1.44 | 3.5 | Liquid | Composting | 343.9 |
| Dartmouth WPCF | 4.2 | 22 | Cake | Composting | 992.1 |
| Greater Lawrence Sanitary District | 52 | 95 | Cake | Thermal Drying | 6,215.0 |
| Hoosac WQD | 6.5 | 22 | Cake | Composting | 744.0 |
| Lynn Regional WF | 25.8 | 24.7 | Cake | Incinerator | 5,658.2 |
| Marion WWTP - Marion DPW | 0.588 | | Other | Lagoon | 86.6 |
| MWRA Deer Island WWTP | 361 | 2.2 | Liquid | Thermal Drying | 32,543.0 |
| Shelburne Falls WWTP | 0.25 | | Other | Constructed Wetland | 19.0 |
| Southbridge WWTP | 3.77 | 22.3 | Cake | Composting | 568.2 |
| Templeton WWTP | 0.6 | 16.9 | Cake | Monofill | 27.4 |
| Upper Blackstone Clean Water | 56 | 22.8 | Cake | Incinerator | 17,988.1 |
| | | | | **Total[1]** | **65,185.5** |

*1. Total sludge quantity calculated does not include sludge transferred from one POTW to another POTW for further sludge management to avoid double counting.*

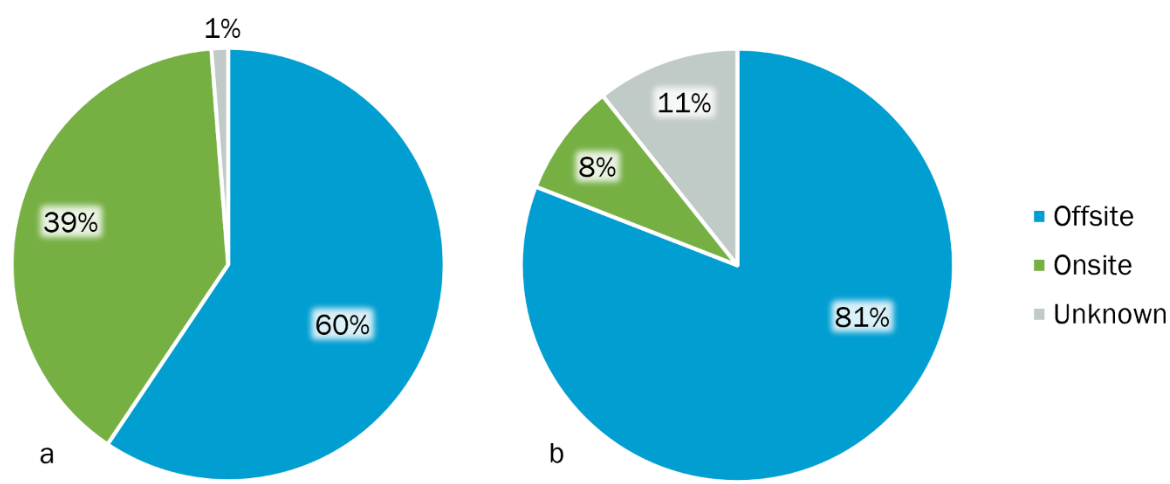


**Figure 3-5. a – Percent of sludge (by weight) managed by location; b – Proportion of POTWs that manage sludge by location.**

Although at least 103 of 127 Massachusetts POTWs (81%) haul a net 98,439 dry U.S. tons of sludge (60%) offsite for further processing or disposal (excluding sludge hauled from one POTW to another POTW), over half of survey respondents dewater sludge onsite (Figure 3-6). Dewatering is an effective method of reducing sludge volume prior to end use or disposal and is a common strategy for reducing hauling and/or overall management costs. Dewatering technologies use mechanical processes to increase sludge solids concentration and produce a sludge cake, with cake solids typically ranging from as low as 15% to 30% or greater. Note that dewatered cake with less than 20% solids is often less desirable for sludge management facilities, and sludge management facilities typically specify minimum acceptable cake solids and sometimes also specify maximum acceptable cake solids.

Alternatively, many POTWs utilize thickening technologies (gravity settling or mechanical processes) in lieu of dewatering to increase the solids concentration of their liquid sludge. Thickened liquid sludge will typically have concentrations of 8% solids or less, such that it is still flowable and pumpable. While assessment of sludge thickening technologies is beyond the scope of this study, thirty-two POTWs mentioned onsite thickening in their responses to the *POTW Sludge Management Survey*, 28 of which dispose of sludge offsite. Using gravity thickeners, gravity belt thickeners, rotary drum thickeners, and decanting strategies, POTWs transporting liquid sludge offsite achieved an average solids content of 4%, with a range of 1.2% to 6.7% solids. Interestingly, several POTWs have modified dewatering systems for operation as thickeners.

Facility size has a clear correlation to POTW use of dewatering technologies, with larger POTWs dewatering sludge more frequently than smaller POTW facilities (Figure 3-7). This likely reflects larger municipalities' ability to invest in dewatering capital projects and have the necessary trained operation and maintenance staff on hand. In addition, Figure 3-7 indicates that that larger facilities more often utilize centrifuge dewatering, while small and medium facilities tend to utilize belt filter presses or screw presses.

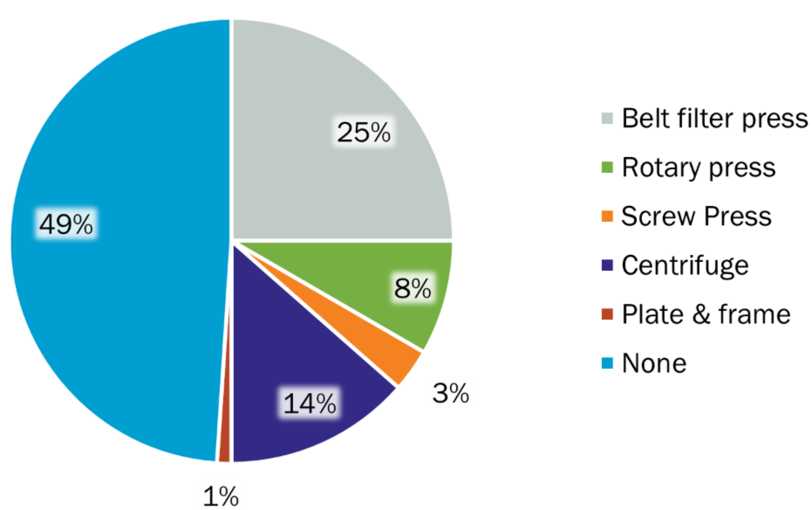


**Figure 3-6. Summary of POTWs' onsite dewatering technologies (n=96).**

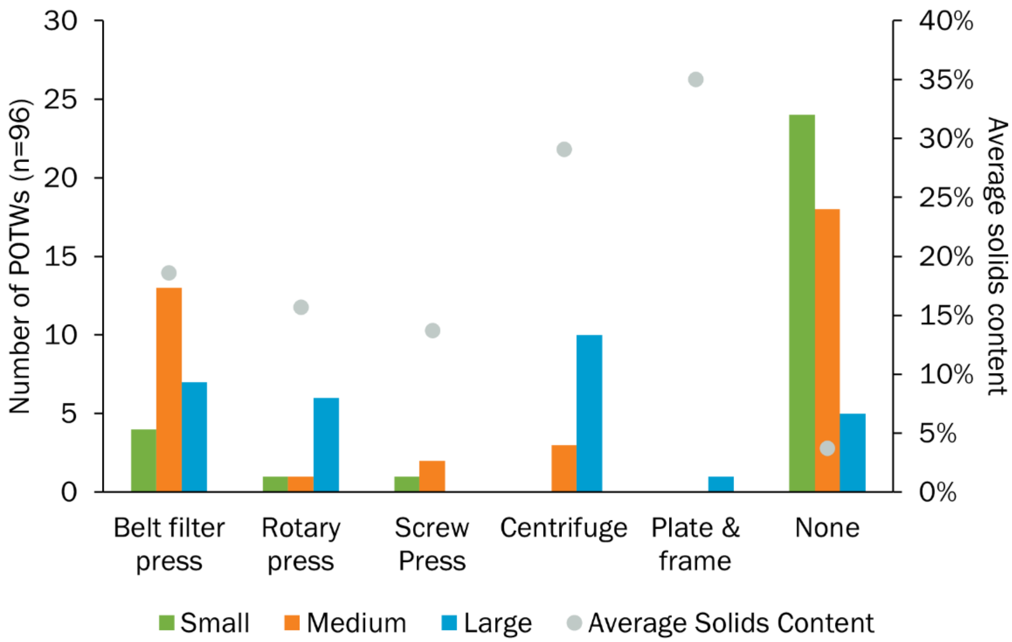


**Figure 3-7. Summary of onsite dewatering technologies by POTW size and the resulting average solids content for each technology.**

*Large POTWs have permitted flows >5 MGD; medium POTWs have permitted flows between 1 and 5 MGD; and small POTWs have permitted flows <1 MGD*.

This trend is further elucidated by examining the average percent solids reported by survey respondents according to facility size (Figure 3-8). The 14 POTWs using a centrifuge or plate & frame for dewatering achieve solids contents of 25 to 30%, which tends to be more effective than the belt filter presses, rotary presses, and screw presses more commonly used by smaller facilities.

Approximately 34% of POTWs are known to produce sludge cake and over 50% of POTWs are known to transport liquid sludge for further processing. For the remaining 16% of POTWs, it is unknown if they have dewatering or they are disposing of liquid sludge onsite in a constructed wetland or lagoon. The proportion of POTWs dewatering versus hauling liquid sludge is generally consistent in southeast, central, and western Massachusetts. The northeast region of the state is an apparent outlier, with 50% of POTWs known to dispose of sludge cake and 22% known to dispose of liquid sludge. This trend suggests that regional disposal options and markets for cake or liquid sludge may drive operational and investment decisions regarding onsite sludge processing. In fact, seventeen survey respondents explicitly mentioned dewatering capital projects in progress, planned, or possible within the next five years. Volume reduction can be associated with decreases in disposal costs, yet the limited market for dewatered sludge cake in Massachusetts and New England risks that cake disposal may require transporting sludge over longer distances for end use or disposal in some cases, increasing sludge hauling costs and GHG emissions associated with sludge management.

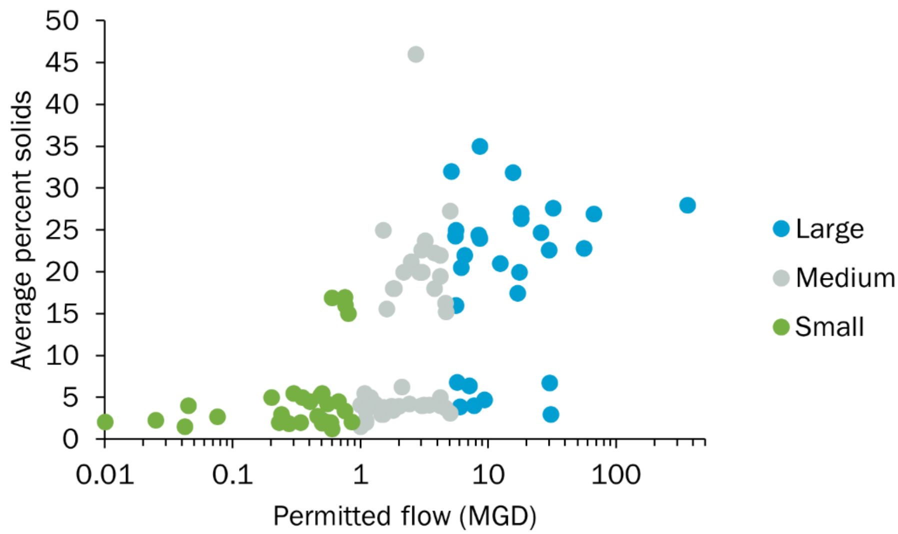


**Figure 3-8. Average solids content of sludge produced in 2023 as a function of permitted flow for large, medium, and small POTWs.**
*Data are shown for thickened and dewatered sludge only.*

Anaerobic digestion can also play an important role in volume reduction while also recovering renewable energy. *The Mass Sludge Survey 2018* identified 'significant interest' (70% affirmative survey responses) in development or future use of regional anaerobic digestion facilities. Currently, five POTWs have operational anaerobic digestions systems: MWRA Deer Island, MWRA Clinton, GLSD, Rockland, and Pittsfield. All five of these facilities report biogas capture and recovery. Approximately 24% (40,421 dry U.S. tons) of Massachusetts sludge is processed via anaerobic digestion, although this percentage is clearly skewed by the large MWRA Deer Island anaerobic digestion facility. MWRA Clinton and Rockland reported planning possible anaerobic digestion process upgrades, while the City of Fitchburg is "currently pursuing a vendor for possible anaerobic digestion with gasification for the West Fitchburg Wastewater Treatment Facility (WWTF) [that currently operates as a pump station]." However, twelve POTWs reported having onsite anaerobic digestion facilities that are no longer used because they have been abandoned or repurposed: Brockton, Easthampton, Fairhaven, Ipswich, Leominster, Northampton, Rockland, South Hadley, Springfield, Templeton, Ware, and Webster. Anaerobic digestion appears to be an underutilized sludge management technology for Massachusetts POTWs and represents a significant opportunity for future volume reduction and energy recovery.

### 3.2.3 POTW-to-POTW Sludge Management

The 2018 Mass Sludge Survey did not account for the "possible minimal double-counting of sludge from small facilities," assuming it "likely [did] not skew the totals significantly." However, POTW- to- POTW sludge management represents both an important management practice for 29 Massachusetts POTWs relying on this sludge outlet and a possible point of vulnerability to market disruption. The present study estimates that 7,901 dry U.S. tons sludge, nearly 5% of sludge generated in 2023, is known to have been transported from its POTW of origin to another Massachusetts POTW for further processing or disposal (Table 3-5).

| Table 3-5. POTWs that Managed Sludge Hauled from Other POTWs in 2023 | | | | |
|---|---|---|---|---|
| Destination POTW | Sludge Hauled to Destination POTW for Treatment (dry U.S. tons) | # POTWs Hauling Sludge to Destination POTW | Proportion of Sludge Hauled-in (% of Destination POTW's total) | Mean haul distance (miles) |
| Erving POTW #1 | 0.4 | 1 | 2.5 | 1.0 |
| Greater Lawrence Sanitary District* | 608.5 | 3 | 9.8 | 30.6 |
| Hoosac WQD* | 75.6 | 1 | 9.2 | 23.2 |
| Lowell Regional WW Utility | 948.9 | 12 | 12.7 | 77.5 |
| Montague WPCF | 37.1 | 2 | 18.4 | 13.7 |
| New Bedford WWTP | 145.8 | 2 | 2.0 | 45.4 |
| Upper Blackstone Clean Water* | 6,060.3 | 8 | 33.7 | 47.9 |
| Westfield WPCP | 23.8 | 2 | 2.3 | 13.6 |
| **TOTAL** | **7,900.5** | | | |

** POTWs that manage end use or disposal onsite*

GLSD and Upper Blackstone Clean Water (UBCW) clearly play an integral role in regional sludge management as large Massachusetts POTWs with onsite sludge management processes that receive sludge from other POTWs. Lowell, Montague, and Westfield provide a complementary service by dewatering liquid sludge hauled from 16 small and medium POTWs prior to offsite disposal of the resulting cake material. This practice is likely intended to keep hauling and disposal costs relatively low for smaller POTWs where it would be impractical to dewater sludge onsite. However, Figure 3-9 identifies several inefficiencies in POTW-to-POTW sludge management. *POTW Sludge Management Survey* responses indicated that POTWs negotiating hauling and disposal contracts typically select the lowest bidder, potentially bypassing more local management options with available capacity. Additionally, the same material may be transported to and from multiple facilities before its end use or disposal. For example, Erving POTW #3 liquid sludge is hauled to Erving POTW #1, and then might be hauled to Lowell, a total of about 74 miles. At Lowell, that sludge is dewatered prior to disposal at landfills in New Hampshire and Vermont, an incinerator in Rhode Island, and biosolids processing facilities in Maine or New Brunswick, an additional 58 to 424 miles. The same material may travel hundreds of miles, driving up statewide hauling costs and associated GHG emissions.

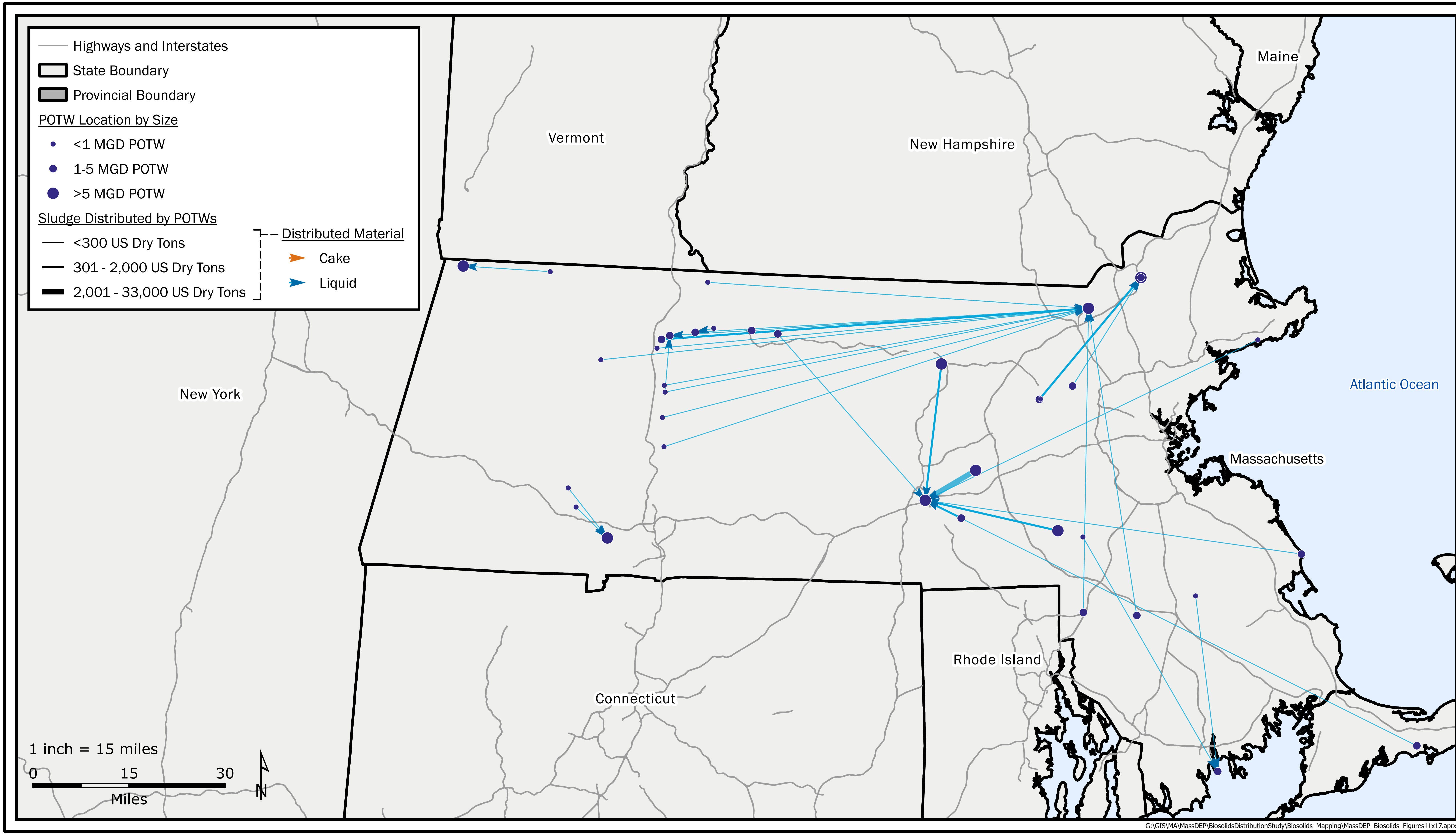


**Figure 3-9. Map of Massachusetts Sludge Hauled to Other Massachusetts POTWs**

## 3.3 Sludge Hauling

### 3.3.1 Sludge Hauling Volumes

In 2023, a total of 106,340 dry U.S. tons sludge was hauled offsite for further processing or disposal, including sludge hauled from one POTW to another POTW (Figure 3-10). Although the majority (71% on a dry-weight basis) of sludge disposed offsite was hauled as dewatered sludge cake, this comprises less than half of POTWs, emphasizing small POTWs' reliance on hauling liquid sludge. Specifically, 85 percent of small POTWs haul liquid sludge an average of 64 miles, while 80% of large POTWs haul cake an average of 163 miles. However, it is noteworthy that six large POTWs (three in central Massachusetts, two in the southeast region, and one in the western region) haul a total of 18,214 dry U.S. tons of liquid sludge, seventy-two% of which is hauled to incineration facilities and 28% of which is hauled to other POTWs.

This liquid-hauling phenomenon arises in part from reliance on incineration facilities in Rhode Island that accept large volumes of liquid sludge. Recently, the Woonsocket, RI City Council passed a resolution to eventually stop accepting hauled-in liquid sludge at their incineration facility but may still allow hauled-in sludge cake. While still in the preliminary stages, this transition would substantially impact the 31 Massachusetts POTWs that send sludge to the Woonsocket, RI incinerator, either directly or indirectly. Fifteen Massachusetts POTWs hauled 13,673 dry U.S. tons of liquid sludge to Woonsocket in 2023. Indirect impacts on sludge management options are likely to affect the additional 16 Massachusetts POTWs that rely on POTW-to-POTW sludge management in partnership with those 15 directly-impacted POTWs. Affected Massachusetts POTWs will be faced with a need either to identify alternative liquid sludge outlets or to prioritize dewatering capital projects – if the Woonsocket incinerator continues to accept hauled-in cake.

Note that some POTWs in southeastern Massachusetts that haul liquid sludge to the Woonsocket, RI incinerator have unused sludge dewatering equipment (e.g., New Bedford and North Attleborough). These facilities will need to evaluate the functionality and capability of this unused dewatering equipment if they intend to transition from liquid sludge hauling to sludge cake hauling, and others these POTWs may need to invest in new dewatering systems and potentially in odor control systems.

Sludge cake hauling is inherently more efficient than liquid sludge hauling, particularly when considered from a trucking perspective. Assuming 25% cake solids, 6.1 dry tons of sludge can be hauled in a 30-yard trailer. Assuming 4% solids in liquid sludge, 1.4 dry tons can be hauled in an 8,500-gallon tanker truck. In this example, liquid sludge hauling requires 4.4 times as many trucks as cake hauling for the same dry tonnage, resulting in corresponding increases in cost and greenhouse gas emissions.

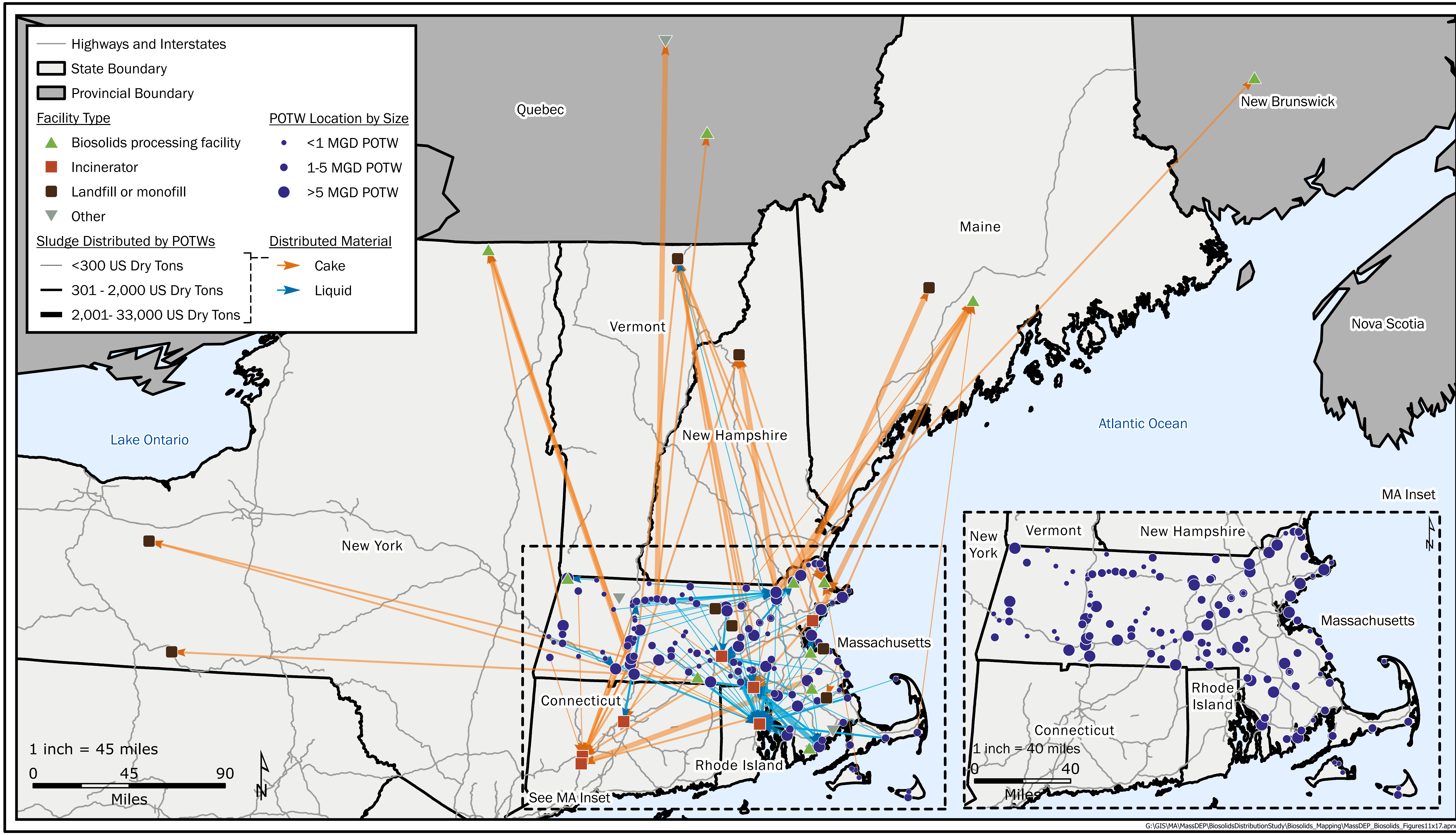


**Figure 3-10. Destinations for Wastewater Sludge Produced in Massachusetts**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

### 3.3.2 Hauling Distances

In 2023, sludge was hauled from 1 to 424 miles for further processing or disposal, with an average hauling distance of 96 miles. As expected, large POTWs tend to haul sludge farther than smaller facilities (Figure 3-11). This is a result of small and medium POTWs more frequently hauling to other POTWs for processing prior to end use or disposal as well as large POTWs' ability to produce dewatered sludge cake and haul it farther distances. When POTW-to-POTW sludge management is omitted, the overall average hauling distance increases by 14% to 110 miles. Interestingly, small POTWs haul sludge farther per dry U.S. ton of sludge hauled (Table 3-6), emphasizing the outsized role of hauling in small POTWs sludge management because small POTWs tend to haul sludge with a lower solids concentration than larger POTWs. It is therefore also likely that smaller POTWs incur disproportionately high sludge hauling costs. Just four small POTWs hauled cake offsite for disposal: Edgartown, Merrimac, and Rockport hauled 348 dry U.S. tons cake to a compost facility in the northeast region, while North Brookfield hauled 158 dry U.S. tons cake to a Connecticut incinerator.

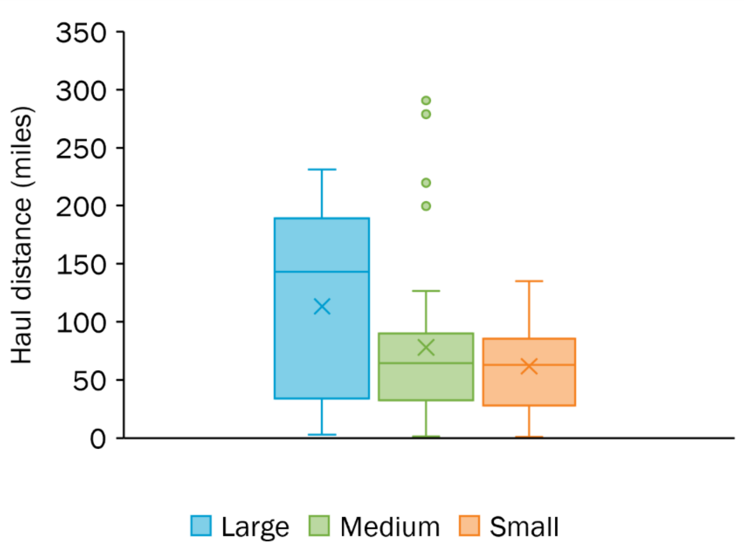


**Figure 3-11. Distance sludge was hauled for further processing or disposal in 2023 by POTW size.**

| Table 3-6. Distance Sludge was Hauled for Further Processing or Disposal Per Unit of Sludge Hauled In 2023 by POTW Size | | |
|---|---|---|
| | Miles Hauled per Dry U.S. Ton | |
| POTW Size | Range | Average |
| Large (>5 MGD) | 0.0 – 0.3 | 0.07 |
| Medium (1 to 5 MGD) | 0.0 – 4.5 | 0.47 |
| Small (<1 MGD) | 0.1 – 50.9 | 3.9 |

## 3.4 Overview of Sludge Management Methods

### 3.4.1 Sludge Volumes by Management Method

Of the estimated 165,683 dry U.S. tons of wastewater sludge generated from Massachusetts POTWs in 2023, the majority (76%) was further processed for land application (63,961 dry U.S. tons, 39%) or incineration (60,703 dry U.S. tons, 37%) (Figure 3-12a). About 25% of Massachusetts sludge was managed onsite at biosolids processing facilities for land application in 2023, as discussed further in Section 5, although only six POTWs have onsite biosolids processing facilities. GLSD and Hoosac Water Quality District (WQD) received sludge from an additional four POTWs in 2023, increasing the proportion of sludge further processed for land application within Massachusetts by 1% (Figure 3-12c). MWRA Deer Island is primarily responsible (79%) for the proportion of sludge managed at onsite biosolids processing facilities. Offsite incinerators were the next most prominent disposal site (about 22%), as discussed in Section 6 (Figure 3-12b). Sludge processed at UBCW comprises most of the onsite and in-state incineration, and UBCW received sludge from an additional eight POTWs. The role of out-of-state sludge management is further discussed in Section 3.4.2.

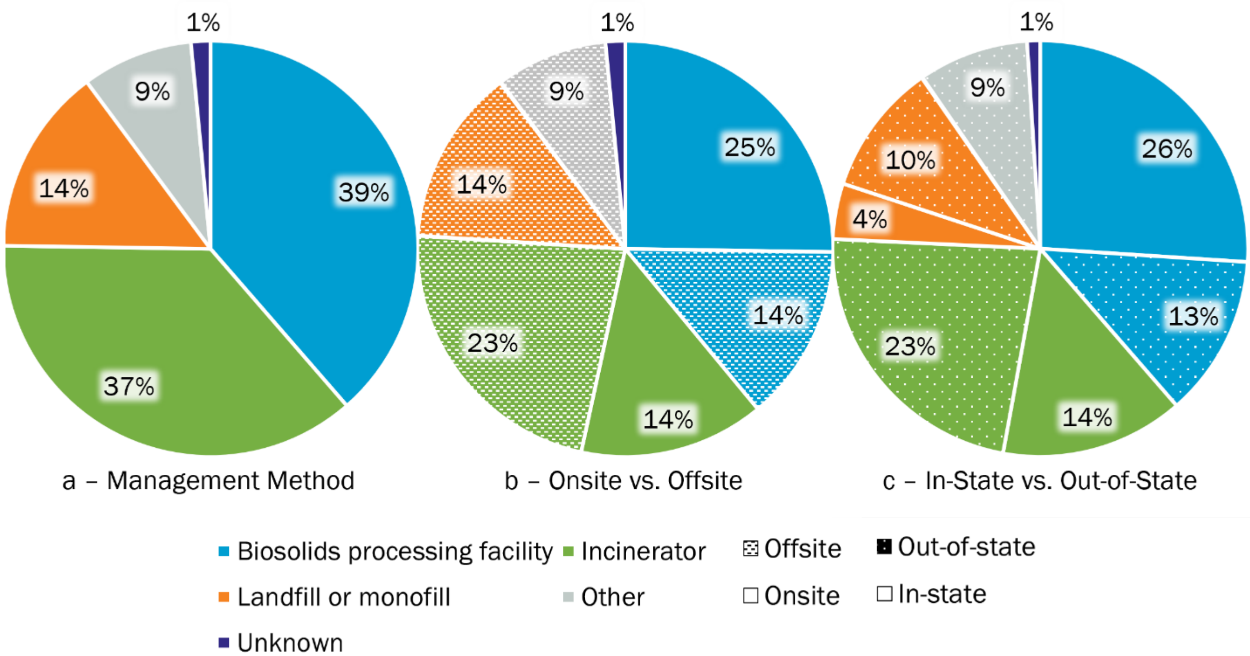


**Figure 3-12. a – Massachusetts sludge (dry U.S. tons) summarized by management method in 2023; b – Massachusetts sludge (dry U.S. tons) summarized by management method and site in 2023; c – Massachusetts sludge (dry U.S. tons) summarized by management method and state category.**
*Categories accounting for less than 1% of Massachusetts sludge generated in 2023 are not shown.*

In Figure 3-12, sludge from Erving POTW #2 was classified as an “Other” sludge management method. Erving POTW #2 (Erving Center WWTP) is highlighted because it is a significant producer of biosolids and because it is unique in many ways. The Erving POTW #2 facility is owned by the Town of Erving, but it is operated and maintained by the Erving Industries paper mill. POTW #2 consists of a conventional wastewater treatment process, including influent grinding, primary clarification, aeration lagoons, secondary clarification, and disinfection. POTW #2 receives a small amount of domestic sewage from the Town of Erving, but a majority of the flow and solids loading are received from the Erving Industries paper mill. A 2019 study determined that about 99.5% of the influent solids loading was from the paper mill. Onsite belt filter presses are utilized to dewater sludge to as high as 46% solids. Sludge from POTW #2 was hauled by Englobe in 2023 to two sites:

- 1,020 dry U.S. tons were used for mine reclamation at the Jeffrey Mine in Val des Sources, Quebec. The material was blended with other residual materials prior to being spread onsite. Note that this outlet is no longer available following the ban in Quebec on the import of sludge from the U.S. for land application.
- 14,222 dry US tons were shipped to a co-generation facility in Quebec.

Erving POTW #2 land applied biosolids as recently as 2021, but not in 2022 or 2023.

### 3.4.2 In-State vs. Out-of-State Management

A total of 74,195 dry U.S. tons of sludge were managed within Massachusetts in 2023, excluding sludge hauled from one POTW to another. Of the 74,195 dry U.S. tons of sludge managed within Massachusetts, approximately 58 percent was managed at biosolids processing facilities, approximately 32 percent was incinerated, approximately 10 percent was landfilled or monofilled, and less than one percent was managed by lagoon or constructed wetland or by an unknown method. As noted in Section 3.2.2, 65,185 dry U.S. tons of sludge were managed onsite in 2023. An additional 9,009 dry U.S. tons of sludge were managed off-site at Massachusetts biosolids processing facilities, incineration facilities, landfills or monofills, and lagoons or constructed wetlands (Figure 3-12c). Therefore, approximately 45% of Massachusetts sludge was managed at 23 Massachusetts facilities in 2023, while 55% of Massachusetts sludge was managed out of state (Figure 3-13).

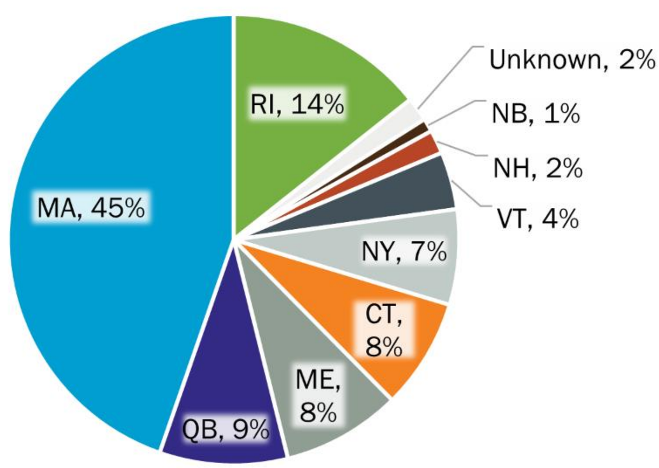


**Figure 3-13. 2023 Massachusetts sludge management summarized by disposal U.S. State or Canadian Province.**

### 3.4.3 Massachusetts Regional Trends

Figures 3-14 through 3-17 demonstrate strong regional trends within Massachusetts. The northeast region relies heavily on cake management via landfilling and via production of biosolids for land application (Figure 3-14). MWRA Deer Island's role in sludge management in the northeast region of Massachusetts is significant although not necessarily visible in Figure 3-14 because sludge is pumped, not hauled, to the Quincy drying facility. In addition to MWRA Deer Island, most material is hauled as cake north to landfills in Vermont, New Hampshire, and Maine, and the Casella Hawk Ridge Compost Facility in Maine.

The southeast region of the state heavily relies on incineration of liquid sludge in Rhode Island with the addition of some cake material hauled to an incinerator in Connecticut (Figure 3-15).

Central Massachusetts also heavily depends on liquid sludge disposal via incineration, especially at UBCW and two incinerators in Woonsocket and Cranston, Rhode Island (Figure 3-16). Several larger POTWs haul liquid to these incinerators, despite the relatively lower efficiency of hauling liquid rather than cake, because the incinerators are currently equipped to receive liquid sludge. A number of central region POTWs also haul cake to the Coventry landfill in Vermont.

Western Massachusetts has no significant processing facilities other than the small compost facility at the Hoosac WQD, and the region's dependence on hauling sludge is readily apparent (Figure 3-17). Among all four regions, Western Massachusetts POTWs haul sludge the greatest distance and to the most diverse number of outlets, including landfills in Vermont, New Hampshire, and western New York in addition to incinerators in Connecticut and Rhode Island. Several larger POTWs also haul sludge north to the Casella Grasslands Manufacturing Facility in upstate New York.

Despite nearly 40% of survey responses reflecting challenges with sludge management and an additional 12% expecting future challenges, 71% of survey respondents are not currently seeking new disposal providers. Many have had longstanding consistent contracts with the same disposal provider. The large and medium POTWs that report having issues identifying sludge outlets tend to be located in the central and western regions, while POTWs in the southeast report disposal challenges driven by availability of incinerators in Rhode Island and Connecticut. Nevertheless, 21% of survey respondents reported having no backup plan for sludge disposal. POTWs without backup sludge management plans are at greater risk of major operational impact if their primary sludge outlet is disrupted. This is particularly true in the current climate, where there is very limited available capacity in the region and finding alternative sludge outlets can be challenging.

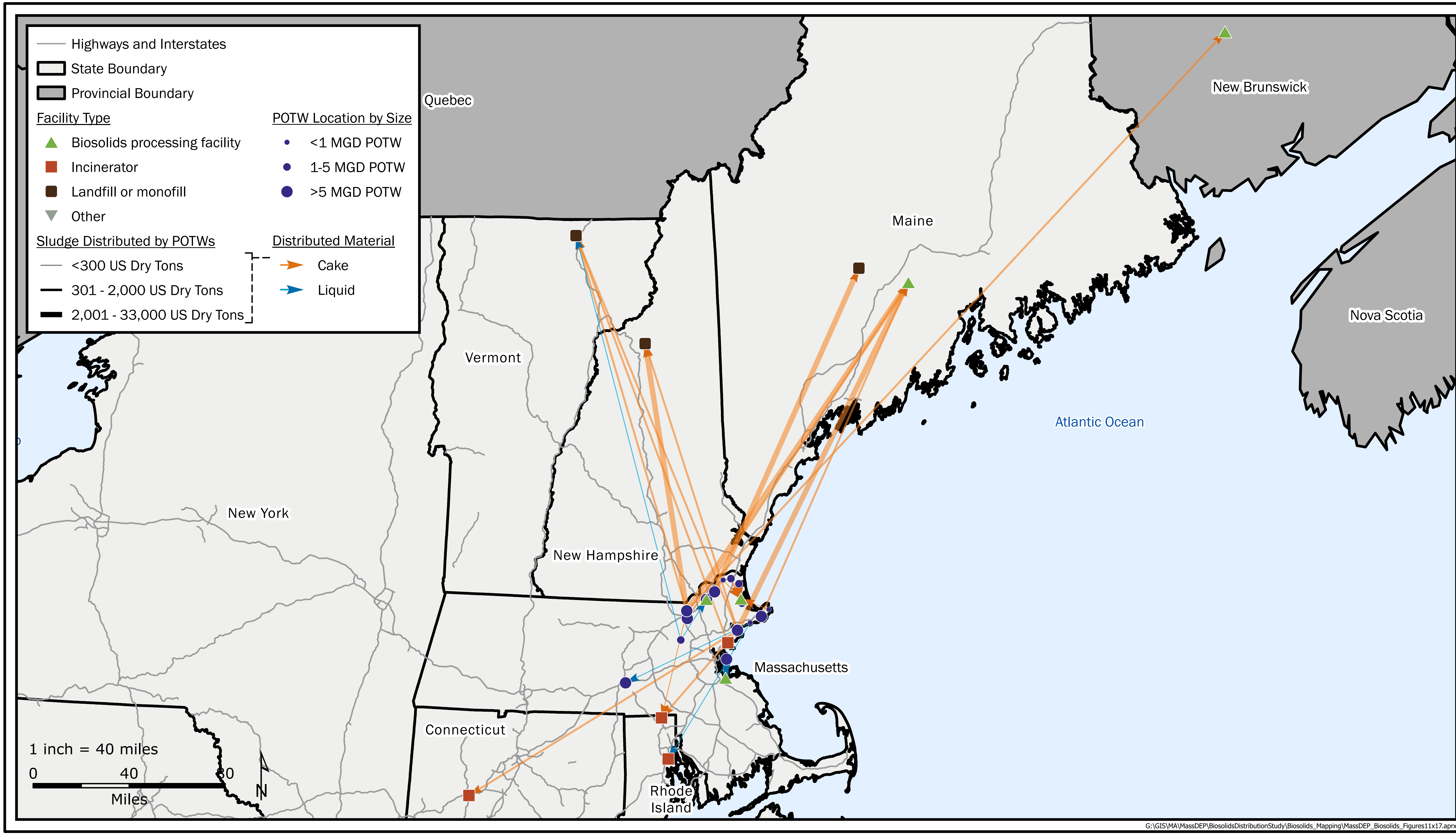


**Figure 3-14. Map of Northeastern Massachusetts Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

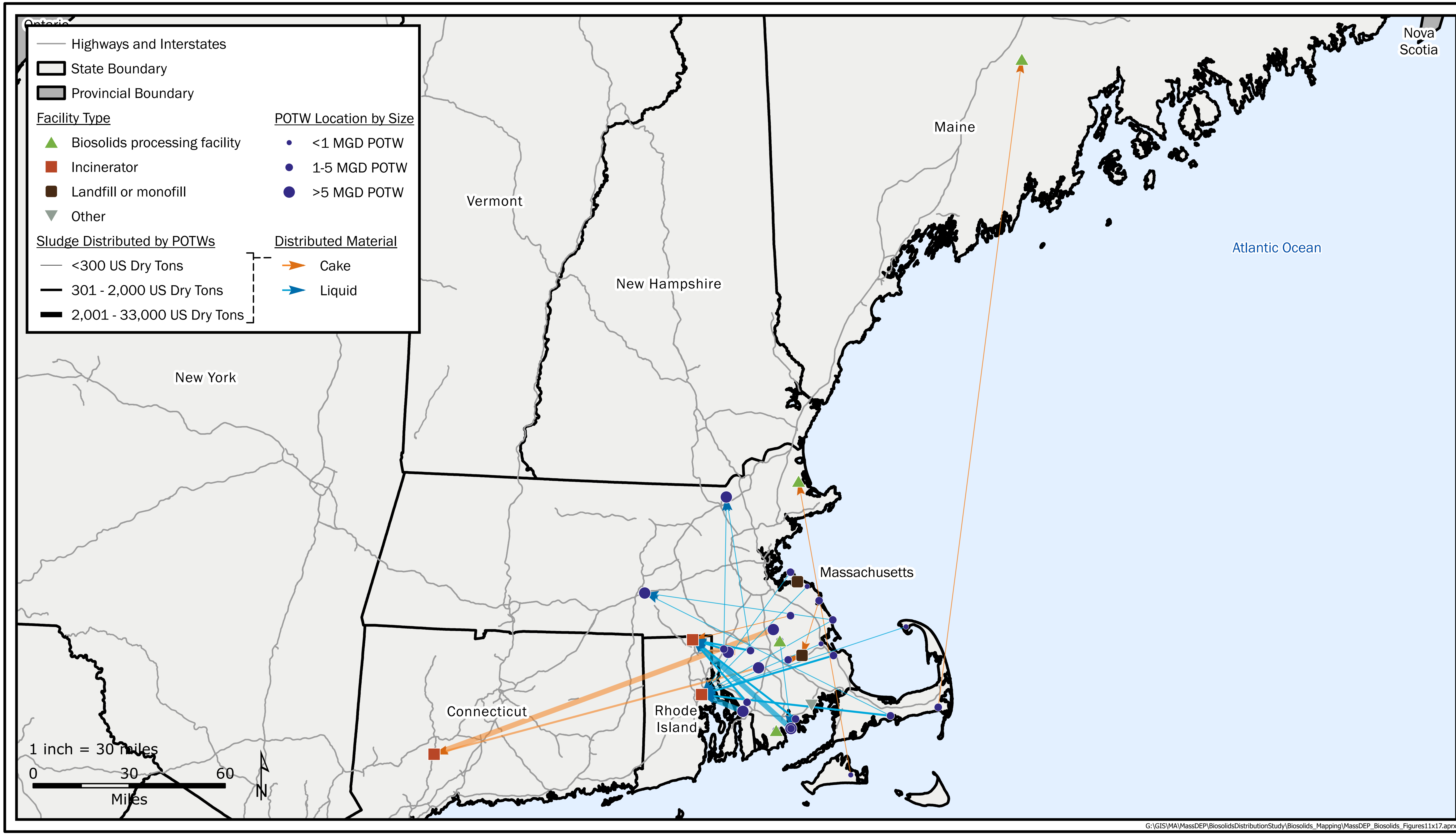


**Figure 3-15. Map of Southeastern Massachusetts Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

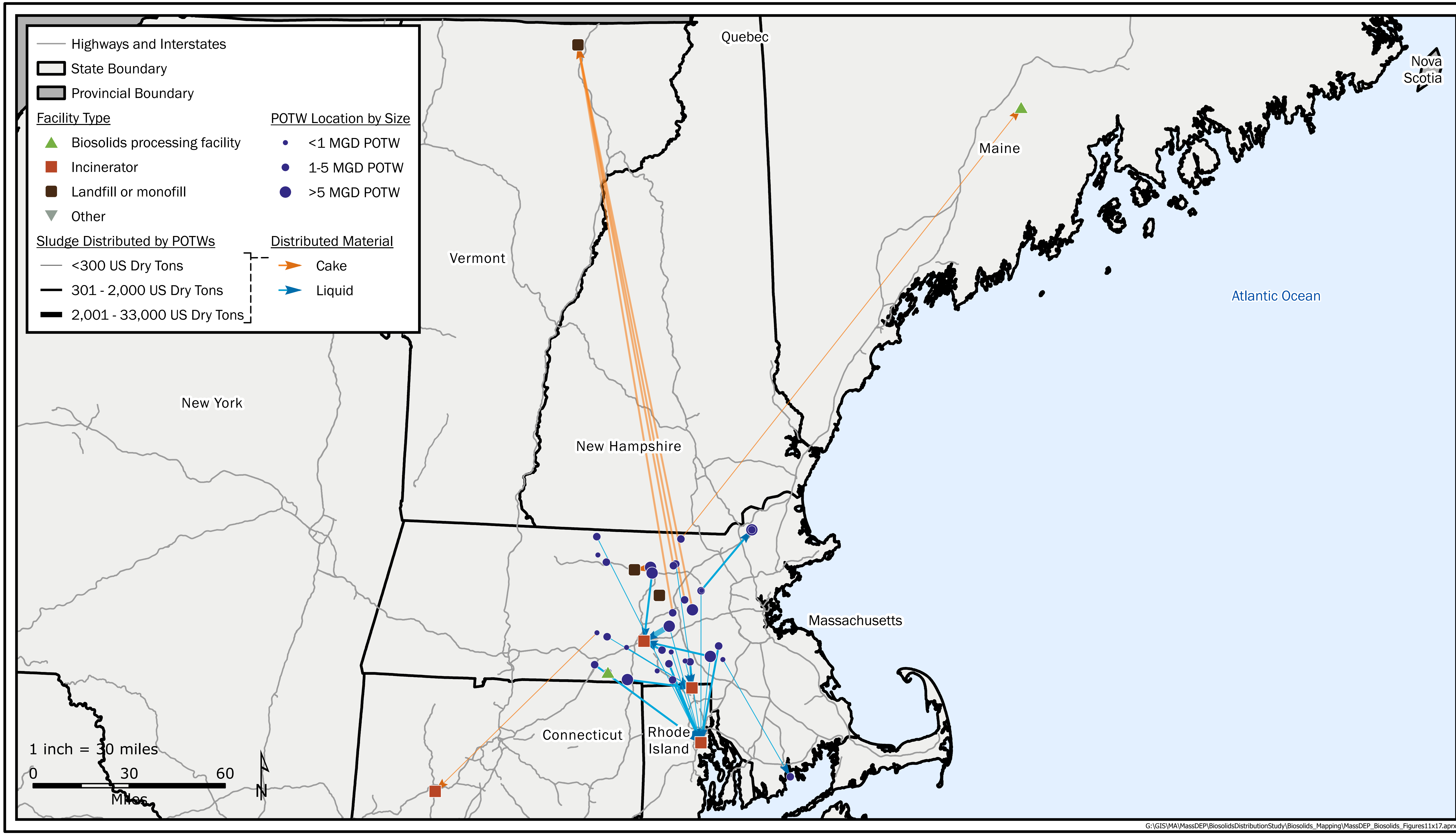


**Figure 3-16. Map of Central Massachusetts Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

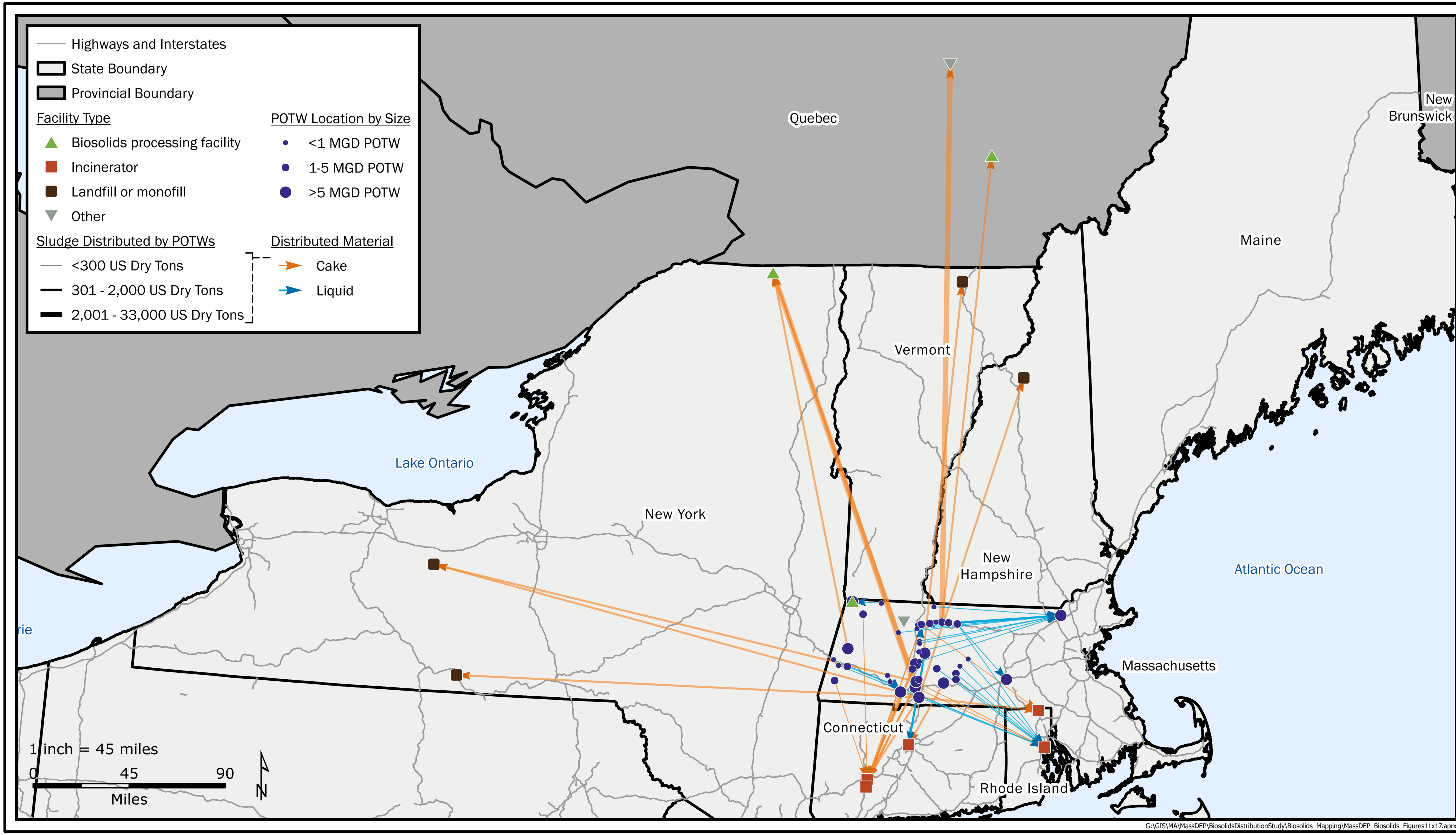


**Figure 3-17. Map of Western Massachusetts Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

### 3.4.4 Regional Sludge Processing Facility Potential

Interest in collaboration on regional sludge processing facilities appears to have increased since 2018. Eighty-one percent of *POTW Sludge Management Survey* respondents expressed interest in participating in a regional facility, although 41% of these explicitly noted that such a collaboration would have to be cost-effective for their facility to actually participate. While POTWs did not provide further detail on specific costs that would make participation in a regional sludge processing facility attractive, it is presumed that POTWs would consider both tipping cost and cost stability in that evaluation. In general, POTWs award sludge management contracts to the lowest bidder, although some POTWs may also value sludge management cost stability resulting from their participation in a regional sludge management facility. This is consistent with *The Mass Sludge Survey 2018*, which identified several opportunities for – and significant interest (70% affirmative survey responses) in – development or future use of regional sludge processing facilities. At the time of *The Mass Sludge Survey 2018*'s publication, strong potential for a regional facility in the Connecticut River Valley was identified. In fact, Springfield and Holyoke had already completed anaerobic digestion feasibility studies, while Greenfield had taken "local steps toward hosting a regional [anaerobic digestion] facility." There are no plans for these projects to move forward at this time. Nineteen additional facilities in the southeast and eight facilities in the northeast had also indicated interest in regional facilities. Nevertheless, at the time of the present study, Fitchburg is the only POTW that reports plans for a new anaerobic digestion facility that would accept sludge from other POTWs within the next five years, although MWRA Clinton and Rockland reported possible upgrades to their existing anaerobic digestion processes.

POTW-to-POTW hauling practices and conversations with industry professionals clearly indicate that some POTWs serve as de facto regional management facilities by managing liquid sludge from smaller facilities. Although *The Mass Sludge Survey 2018* discussed several potential projects for regional facilities and POTW operators and other industry professionals demonstrate clear interest in development of regional facilities, increased regionalization of sludge management within Massachusetts has not materialized. FCSWMD serves as an informative case study: As reported in *The Mass Sludge Survey 2018* and confirmed by ongoing conversations with industry professionals, Greenfield envisioned installing a municipally-owned anaerobic digester that would serve as a regional sludge outlet and began the project in earnest. Unfortunately, other nearby towns were not willing or able to contribute capital to the project, given that they would have no ownership of the completed facility. These municipalities also could or would not commit to long-term contracts with Greenfield's proposed anaerobic digestion facility given the volatile sludge management market and evolving regulatory environment. Without the financial and contractual support of would-be customer communities, Greenfield's anaerobic digestion project could not proceed. It is likely these small communities were simply unable to take on the financial or contractual risk that would be required to support the project. Interestingly, most Franklin County communities continued to demonstrate interest in a regional sludge management facility despite the lack of support for Greenfield's proposed facility. FCSWMD communities haul liquid sludge to Lowell for dewatering prior to end use or disposal, but Montague, a FCSWMD community, can occasionally dewater an extra load of liquid sludge if Lowell is inoperable. While FCSWMD functions as a loose negotiating bloc to meet the sludge management needs of the region's small communities, FCSWMD remains unable to establish a formal contract. FCSWMD, among other small communities, has relied on word-of-mouth connections and informal agreements for sludge management. With respect to identifying contingency plans, "the only way to do that is to build capacity."

Both UBCW and the Springfield Water & Sewer Commission reported collaborating with the Narragansett Bay Commission on a New England Regional Biosolids (NERB) project. If constructed, the NERB project has the potential to significantly improve regional sludge management capacity. Note that if UBCW discontinues incinerator operation once the NERB is constructed, residuals from the NERB facility will likely need offsite management.

## 3.5 Anticipated Changes at the POTW Level

In response to the evolving regulatory landscape, 70 percent of survey respondents reported planned or possible facility upgrades. These upgrades include both liquid treatment process and solids handling upgrades. In addition, respondents reported upgrades that are currently in design or construction, as well as upgrades that are still in preliminary planning stages. Only one POTW is expected to be decommissioned within the next five years: the MCI-Concord prison is expected to close later in 2024, and it is unclear if the facility will continue to operate in the future.

A continuing trend of more POTWs installing dewatering facilities is expected in the coming years to reduce sludge volume as well as disposal and trucking costs. Seventeen POTWs reported possible or planned dewatering capital projects: Bridgewater, Fall River, Provincetown, New Bedford, Oak Bluffs, and Winchendon indicated installation of new dewatering facilities, while Chicopee, Edgartown, Erving #2, Hoosac WQD, Lowell, Northampton, South Hadley, Rockport, Palmer, Scituate, and Westfield plan to upgrade existing dewatering facilities. Bridgewater is looking into sludge/cake removal and discontinuing their composting. It is expected that smaller POTWs will tend to install screw presses or rotary presses because their simplicity is more suitable for smaller POTWs. Larger POTWs are anticipated to more frequently install centrifuges to achieve higher cake solids. However, as discussed in Section 3.4.3, some disposal outlets are designed to receive dewatered sludge cake, while others are designed to receive only liquid sludge. Increasing the proportion of Massachusetts sludge that is dewatered may oversaturate the regional market for dewatered sludge cake, resulting in longer hauling distances for cake.

Fifty-seven percent of survey respondents mentioned the explicit goal of improving liquid-stream nutrient removal. However, the potential impact of nutrient removal process upgrades on sludge management is uncertain. For example, 13 POTWs expect to incorporate chemical addition for phosphorus removal, such as ferric chloride addition. While chemical precipitation can be an efficient method for phosphorus removal, it tends to increase sludge volume and decrease dewaterability.

PFAS concerns are rising among POTWs due to regulatory uncertainty and increasing costs. Sixty percent of survey respondents reported current concerns about PFAS. Pyrolysis and/or gasification is an emerging technology with potential for effectively treating PFAS chemicals. MWRA Deer Island, Attleboro, and Taunton have indicated interest in these technologies, and it is likely these and other PFAS removal technologies will be increasingly considered in the future.

Massachusetts' shifting sludge management landscape will have significant effects on POTWs within the next five years: 67 POTWs are currently undergoing sludge hauling or disposal contract negotiations or will be by 2028. Three additional POTWs report contract expirations within the next ten years.

## 3.6 Additional Survey Comments

*POTW Sludge Management Survey* responses indicated significant current and future challenges resulting from market volatility, regulatory uncertainties, and financial pressures. Survey respondents shared that they believe sludge management in Massachusetts has become "a statewide crisis" or will soon, with limited disposal options and rising costs. A few also mention concerns about current nutrient limits/regulations.

Sixty percent of survey respondents expressed concerns about PFAS, with more than half of those respondents (31%) reporting that they are nervous about uncertainty around changing regulations and costs for their facilities.

Noteworthy quotes from survey respondents are listed below. Minor revisions have been made for clarity and anonymity.

- “[The city] struggles with the rising costs and volatile nature of the sludge management industry. During times of emergency breakdown/liquid hauling, we especially struggle. The lack of a nearby disposal facility places a large financial burden on [a POTW] that already struggles to keep rates low.”
- “We have had one reliable outlet. This is a MAJOR concern. We have requested backup outlets; however, these are mostly [out of state], there are weight restrictions limiting hauling to 7,500 gallons, and it is a much longer haul. This would be an inefficient solution. We desperately need a reliable, local solution.”
- “As a result of efforts to optimize for nitrogen [removal], combined with a significant storm event, the facility had significant problems dewatering and solids built up throughout the system. Over the course of the next year the facility struggled with finding disposal for both solid and liquid material, and [we] had to deal with the resulting issues for over a year as well as accrue considerable expenses.”
- “Regional management should get better pricing and stability. Our facility is very tight on land, and we do not have an option here to expand like that. Other outlets can only help the situation in New England.”

## 3.7 Future Sludge Production Projections

Between 2023 and 2028, Massachusetts sludge generation is expected to increase at a rate equal to the projected population growth rate of 2.5%, as discussed in Section 2. Recent updates to Title 5 regulations, 310 CMR 15.000 have defined watersheds on Cape Cod with EPA-approved Total Maximum Daily Loads (TMDLs) as Natural Resource Area Nitrogen Sensitive Areas. To reduce nitrogen loading to these watersheds, many Cape Cod communities may or will shift their wastewater management from septic systems to centralized treatment. Development of sewerage and centralized treatment on Cape Cod is expected to add 15.57 MGD of wastewater treatment capacity by 2028. Based on the relationship between permitted flow rate and likely sludge production described in Section 3.2.1, Cape Cod is expected to produce an additional 2,805 dry U.S. tons of sludge in 2028. Therefore, Massachusetts sludge generation is expected to increase from 165,683 dry U.S. tons in 2023 to 172,249 dry U.S. tons in 2028. This estimate expects the quantity of paper mill sludge generated by Erving POTW #2 (15,241 dry U.S. tons in 2023) to remain approximately constant.

## 3.8 Sludge Management Cost Analysis

Sludge management costs reported in the *POTW Sludge Management Survey* yielded an average of $548 per dry U.S. ton in 2023, including both hauling and management or disposal fees (Table 3-7). Average cake and liquid management costs were $156 per wet U.S. ton and $0.16 per gallon, respectively. Note that many sludge hauling contracts include a fuel cost escalation clause, so fuel cost increases are passed on to the municipality.

**Table 3-7. Sludge Management Unit Costs Calculated from Available Data Overall and by Material Type**

| | 2023 Sludge Hauling & Management Costs | |
|---|---|---|
| | Cake ($/wet U.S. ton) | Liquid ($/gallon) |
| **Number of data points** | 13 | 17 |
| **Minimum** | 128.48 | 0.09 |
| **Mean** | 156.00 | 0.16 |
| **Maximum** | 190.00 | 0.29 |

The lack of data makes comparison of sludge management costs by region or type particularly challenging. Sludge management unit costs appear to be comparable among the northeast, southeast, central, and western regions regardless of whether the material is managed as cake or liquid (Figure 3-18). Western Massachusetts has the widest range of costs, which is expected based on the region's variety of management locations and types, as discussed in Section 3.4.3. No relationship between unit cost and POTW size was identified.

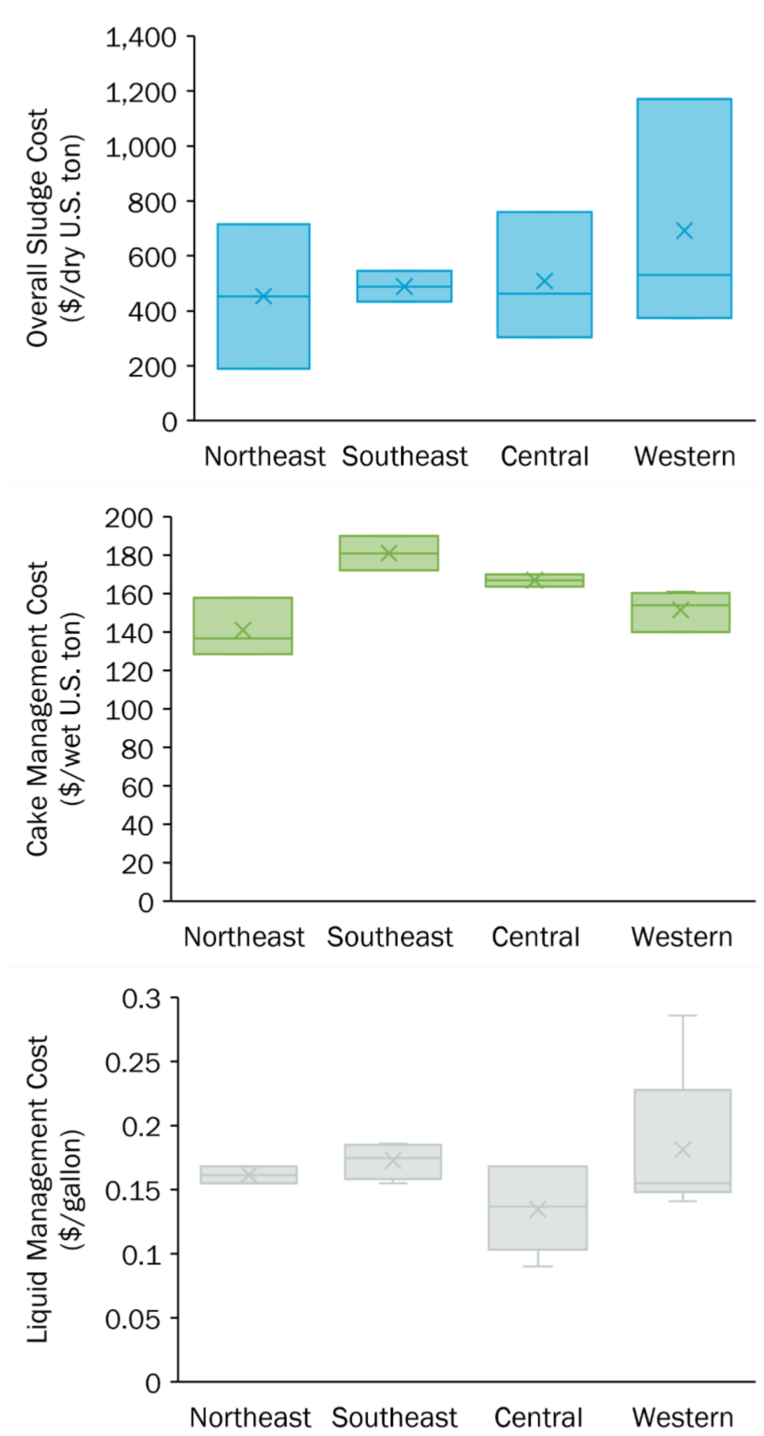


**Figure 3-18. Sludge management costs estimated overall (top), for cake material (middle), and for liquid material (bottom).**

Most respondents to *The Mass Sludge Survey 2018* (62%) accurately predicted a one to 30% overall increase in the cost of sludge management between 2018 and 2023. Since 2018, the average unit cost of sludge disposal has increased by an annual average of 7.1% based on data from 30 Massachusetts POTWs (Figure 3-19), with an average overall increase of 35.5% between 2018 and 2023. Figure 3-19 depicts typical annual changes in sludge management costs, as well as the high variability experienced by individual POTWs. This cost escalation may be partially attributed to the COVID-19 pandemic as well as a period of near record inflation, but it is assumed that sludge management cost increases also were significantly impacted by the increasingly tight sludge management market. The data exhibit substantial variability, yet it is common to see spikes much greater than 7.1% when new, often multi-year contracts are negotiated. This trend is expected to continue, if not accelerate, between 2024 and 2028 due to regulatory pressures and diminishing disposal capacities, as discussed in Section 7.

Projecting future sludge management costs is highly speculative and is influenced by many economic factors, including but not limited to, future inflation rates, fuel costs, and labor costs. Further, historic cost trends are not assured to continue. Finally, the regional sludge market is highly susceptible to disruption due to legislative or regulatory changes which could cause significant future increases. With these caveats, this report does make projections of future sludge costs assuming a 7.1% annual increase in sludge management costs over the next five years and based on average 2023 sludge management cost data. This approach yields 2028 average sludge management costs of approximately $190 to $250 per wet ton and $0.20 to $0.25 per gallon.

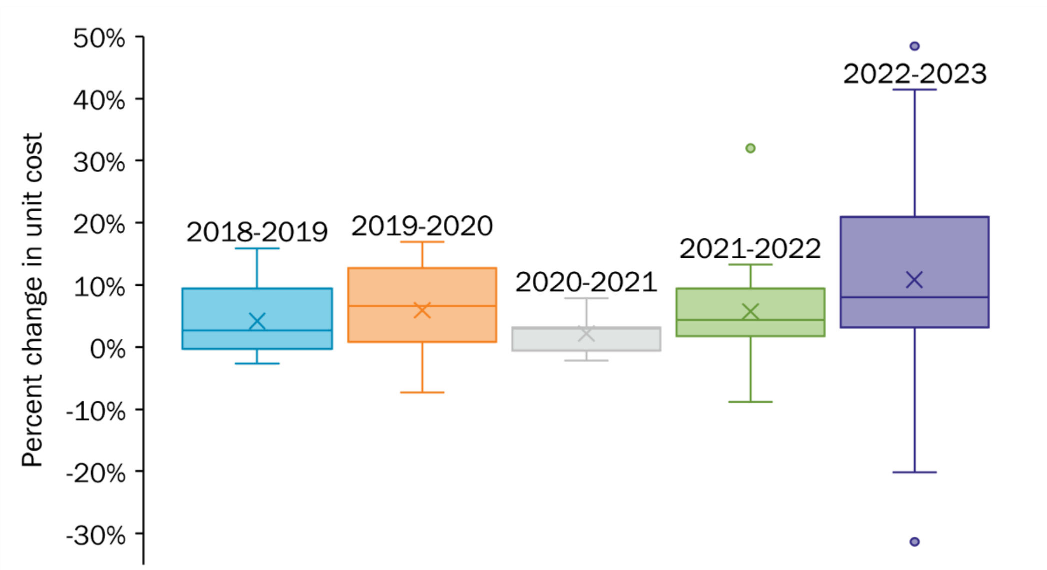


**Figure 3-19. Annual percent change in unit price of sludge management since 2018, including both hauling and management or disposal costs, based on data from 30 POTWs.**

Table 3-8 presents estimated sludge management costs in 2028 for POTWs with permitted flows of 0.5, 1.0, 5.0, 10.0, and 20.0 MGD. Typical sludge production was estimated for POTWs of different sizes utilizing Equation 3-1, adjusted by a factor of 2.5% to account for population growth as described in Section 2.

| Table 3-8. Estimated 2028 Annual Sludge Management Costs Calculated for POTWs of Different Sizes | | | |
|---|---|---|---|
| | Projected 2028 Sludge Management Costs | | |
| Permitted Flow (MGD) | Sludge Production (dry U.S. tons) | Annual Cake (22.5% solids) Sludge Management Cost | Annual Liquid (4% solids) Sludge Management Cost* |
| 0.5 | 92.3 | $80,000 - $110,000 | $110,000 - $140,000 |
| 1.0 | 184.7 | $160,000 - $210,000 | $230,000 - $280,000 |
| 5.0 | 923.3 | $780,000 - $1,030,000 | $1,100,000 - $1,400,000 |
| 10.0 | 1,847.0 | $1,550,000 - $2,050,000 | $2,300,000 - $2,800,000 |
| 20.0 | 3,693.0 | $3,100,000 - $4,100,000 | $4,400,000 - $5,600,000 |

# Section 4: Landfill Disposal

To better understand the current and future status of landfills receiving Massachusetts sludge as well as their capacity, a survey was sent in April 2024. The survey consisted of 47 questions, which were both qualitative and quantitative and focused on the owner, operator, landfill capacity, acceptance of sludge from non-local POTWs, future expansion or closure plans, and other concerns. A copy of this survey is included in Appendix B. Massachusetts landfill disposal data were also obtained through a combination of existing data from Massachusetts, New York, and Maine resources, where available. The capacity analysis provided includes data from landfill facilities located within Massachusetts, as well as out-of-state landfills currently accepting wastewater sludge from Massachusetts POTWs. The following data were acquired and analyzed:

- Facility name, type, location, and other identifying information.
- Permitted annual capacity and actual tonnage accepted (2023).
- Estimated remaining capacities and years of landfill life.
- Anticipated changes to waste acceptance rates.
- Challenges posed to facilities by wastewater sludge acceptance.

Data were evaluated to understand the current and projected future capacities for wastewater sludge disposal in landfill facilities in and around Massachusetts. Additionally, estimated costs for the landfill disposal of wastewater sludge from POTWs in Massachusetts was evaluated as an important consideration in the future of wastewater sludge management. Using the data collected, an addendum to the Massachusetts Materials Management Capacity Study was developed and is attached to this report as Appendix E. A summary of this addendum is included in this section.

Figure 4-1 is a map showing landfill management of Massachusetts sludge. As shown, there are seven landfills within Massachusetts that receive sludge from Massachusetts POTWs. However, Massachusetts sludge is also hauled considerable distances for disposal in Maine, New Hampshire, Vermont, and New York, where five landfills reported receiving wastewater sludge from Massachusetts POTWs. As outlined in Tables 4-3a and 4-3b in Section 4.3 below, the majority of wastewater sludge produced in Massachusetts and disposed in landfills is landfilled outside of the state. Based on the responses received from the survey, no Massachusetts sludge was reported to be landfilled outside of New England and New York.

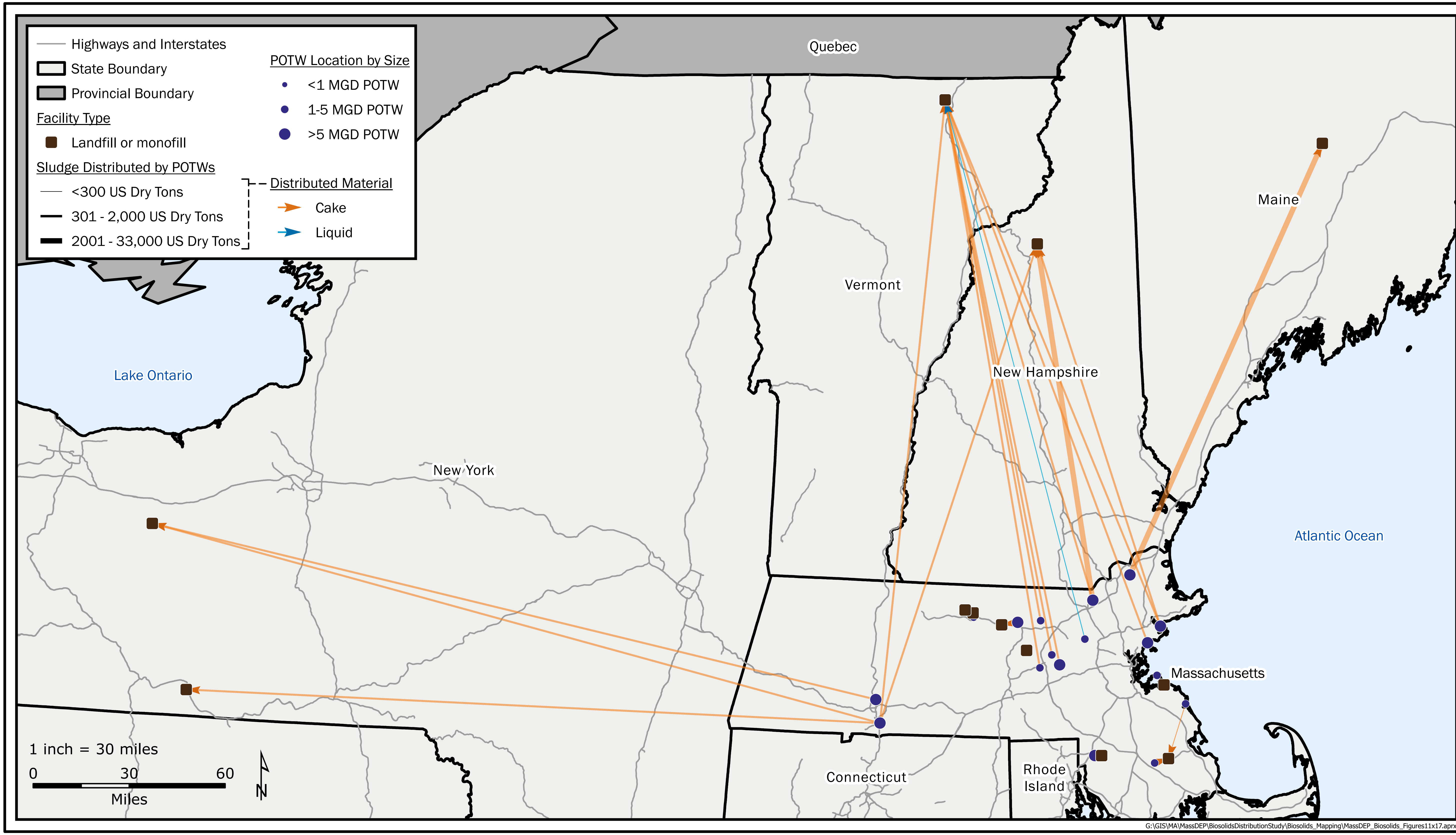


**Figure 4-1. Map of Landfill Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

## 4.1 Summary of Massachusetts Landfills

In an effort to obtain a comprehensive understanding of landfill disposal practices for wastewater sludge within Massachusetts, a number of landfill facilities were solicited for participation in the survey. A total of sixteen in-state facilities were included in the survey distribution list, from which fourteen responses were received—representing 87.5% of solicited facilities. MassDEP Annual Landfill Reports were also reviewed for relevant data pertaining to permitted waste acceptance rates at various facilities. Not all facilities are permitted to accept wastewater sludge, however, these facilities were solicited for participation in order to understand future potential for sludge disposal at each facility, as well as participants' willingness and concerns. Table 4-1 below summarizes the facilities contacted for participation in this study.

**Table 4-1. Massachusetts Landfill Facilities**

| Facility Name | Facility Address | Wastes Accepted | Response Received |
|---|---|---|---|
| Attleboro Monofill | 179 Peckham St, Attleboro, MA 02703 | Sludge/Ash | Yes |
| Resource Control, Inc. – RCI Fitchburg Landfill | 101 Fitchburg Rd RT 31, Westminster, MA | Municipal Solid Waste | Yes |
| Gardner WPCF | 808 West St, Gardner, MA | Sludge | Yes |
| Templeton WWTF | Templeton WWTF 33 Reservoir St, Baldwinville, MA | Sludge | Yes |
| Middleborough Sanitary Landfill | 207 Plympton St, Middleborough, MA | Municipal Solid Waste | Yes |
| Bondi's Island Landfill | 147 M St, Agawam, MA | Ash, limit other wastes | Yes |
| Upper Blackstone Clean Water | 50 Route 20, Millbury, MA | Ash | Yes |
| Specialty Minerals | 260 Columbia St, Adams, MA | Sludge | No |
| Bourne Landfill | 201 MacArthur Blvd, Bourne, MA | Municipal Solid Waste | Yes |
| Clinton Sludge Monofill (Clinton MWRA) | 677 High Street, Clinton, MA | Sludge | Yes |
| Crapo Hill Landfill | 300 Samuel Barnet Blvd, New Bedford, MA | Municipal Solid Waste | Yes |
| Hull Sanitary Landfill | 111 Rockaway Ave, Hull, MA | Municipal Solid Waste | Yes |
| Nantucket Landfill | 188 Madaket Rd, Nantucket, MA | Municipal Solid Waste | No |
| Peabody South Mound Swale | 40 Farm Ave, Peabody, MA | Municipal Solid Waste | Yes |
| Peabody Ash Monofill | 40 Farm Ave, Peabody, MA | Ash | Yes |
| Wheelabrator Millbury Inc. (Shrewsbury Monofill) | 620 Hartford Turnpike, Shrewsbury, MA | Ash | Yes |

## 4.2 Summary of Out-of-State Landfills

In an effort to obtain a comprehensive understanding of landfill disposal practices for wastewater sludge outside of Massachusetts, landfill facilities in and around New England were solicited for participation in the survey. Landfill facilities located outside of Massachusetts were solicited for participation if POTWs located within Massachusetts reported sending wastewater sludge to the out-of-state facility. A total of eight out-of-state facilities were included in the survey distribution list, from which five responses were received—representing 62.5% of solicited facilities. Table 4-2 below summarizes the facilities contacted for participation in this study.

**Table 4-2. Out-of-State Landfill Facilities**

| Facility Name | Facility Address | Response Received |
|---|---|---|
| Crossroads Landfill* | 357 Mercer Rd, Norridgewock, ME | No |
| Juniper Ridge Landfill* | 2828 Bennoch Rd, Alton, ME | No |
| Turnkey Landfill | 60 Steele Rd, Rochester, NH | No |
| New England Waste Services of VT Landfill (Waste USA Landfill) | 21 Landfill Lane, Coventry, VT | Yes |
| Ontario County Landfill | 1879 NY 5 & 20, Stanley, NY | Yes |
| Chemung County Landfill | 1488 County Rd 60, Elmira, NY | Yes |
| North Country Environmental Services Landfill (Bethlehem) | 581 Trudeau Rd, Bethlehem, NH | Yes |
| Clinton County Landfill | 286 Sand Rd, Morrisonville, NY | Yes |

**For facilities from which responses were not received, data are supplemented for analysis in this report by the 2023 Maine DEP Biosolids Management Report prepared by Brown and Caldwell.*

## 4.3 Current Landfill Capacity for Sludge Disposal

Participants of the survey were asked to report the permitted capacity at their facility, as well as the actual wastewater treatment sludge wet tons received. Table 4-3a below shows the data as reported for facilities accepting sludge from their individual municipality or treatment facility only, while Table 4-3b reports the same data for those landfill facilities which accept sludge from other sources. Only facilities from which responses were received or for which data are otherwise available are included.

**Table 4-3a. Landfill Acceptance Rates – Local Sludge Only**

| Facility Name | Landfill Type | Yearly Permitted Tonnage (Total) | Sludge Wet Tonnage Accepted in 2023 | % of Permitted Tonnage that was consumed by POTW sludge in 2023 |
|---|---|---|---|---|
| MA Facilities | | | | |
| Attleboro Monofill | Sludge/Ash Monofill from Attleboro only | No Limit* | 9,521 | - |
| Gardner WPCF | Sludge from Gardner only | No Limit* | 3,284 | - |
| Templeton WWTF (Winchendon/Templeton) | Sludge Monofill for Winchendon/Templeton only | No Limit* | 157 | - |

| Table 4-3a. Landfill Acceptance Rates – Local Sludge Only | | | | |
|---|---|---|---|---|
| **Facility Name** | **Landfill Type** | **Yearly Permitted Tonnage (Total)** | **Sludge Wet Tonnage Accepted in 2023** | **% of Permitted Tonnage that was consumed by POTW sludge in 2023** |
| Clinton Sludge Monofil (Clinton MWRA) | Sludge Monofill | No Response | No Response | - |
| Hull Sanitary Landfill | Municipal Solid Waste | 6,300 | No response | - |
| Peabody South Mound Swale | Municipal Solid Waste for City of Peabody and Town of Wilmington only | 152,500 | No response | - |
| Peabody Ash Monofill | Ash Monofill for Peabody Only | 547,500 | No response | - |
| Bondi's Island Landfill | Ash, Limited other wastes | 105,850 | No response | - |
| Crapo Hill Landfill | Municipal Solid Waste for member communities only | 115,000 | No response | - |
| Bourne Landfill | Municipal Solid Waste | 219,000 | 0 | 0% |
| Upper Blackstone Clean Water | Ash Monofill for Facility only | 10,000 | No response | - |
| Middleborough Sanitary Landfill | Municipal Solid Waste, Special wastes. Massachusetts only | 60,000 | 1,867 | 3.1% |
| **TOTALS** | | **1,216,150** | **14,829** | **-** |

**While the facility reported not being limited in their yearly tonnage acceptance, it should be noted that these facilities only accept wastewater sludge from local wastewater treatment facilities.*

| Table 4-3b. Landfill Acceptance Rates – Non-Local Sludge Accepted | | | | |
|---|---|---|---|---|
| **Facility Name** | **Landfill Type** | **Yearly Permitted Tonnage (Total)** | **Sludge Wet Tonnage Accepted in 2023** | **% of Permitted Tonnage that was consumed by POTW sludge in 2023** |
| MA Facilities | | | | |
| Resource Control, Inc. - RCI Fitchburg Landfill | Municipal Solid Waste | 538,000 | 9,294 | 1.7% |
| TOTALS | | 538,000 | 9,294 | - |
| Out-of-State Facilities | | | | |
| North Country Environmental Services Landfill (Bethleham) (NH) | Municipal Solid Waste | 190,000 | 14,708 | 7.7% |
| New England Waste Services of VT Landfill (WasteUSA Landfill) (VT) | Municipal Solid Waste | 600,000 | 52,612 | 8.8% |
| Ontario County Landfill (NY) | Municipal Solid Waste | 917,000 | 53,154 | 5.8% |
| Chemung County Landfill (NY) | Municipal Solid Waste | 250,000 | 33,702 | 13.4% |
| Juniper Ridge Landfill (ME)* | Municipal Solid Waste, Construction & Demolition, Special wastes | No Response | 57,090 | - |
| Turnkey Landfill (NH) | Municipal Solid Waste | No Response | No Response | - |

| Table 4-3b. Landfill Acceptance Rates – Non-Local Sludge Accepted | | | | |
|---|---|---|---|---|
| **Facility Name** | **Landfill Type** | **Yearly Permitted Tonnage (Total)** | **Sludge Wet Tonnage Accepted in 2023** | **% of Permitted Tonnage that was consumed by POTW sludge in 2023** |
| Crossroads Landfill (ME) | Municipal Solid Waste | No Response | No Response | - |
| **TOTALS** | | **1,957,000** | **211,266** | **-** |

**Facilities from which responses were not received but for which data are supplemented for analysis in this report by most recent individual DEP Annual Reports.*

While New York facilities appear to contain a higher capacity for wastewater sludge landfill disposal, it should be noted that disposal at these facilities presents high costs associated with transportation. Additionally, longer hauling distances present higher GHG emissions associated with transportation.

Many sludge disposal landfill and monofill facilities limit their acceptance of wastewater sludge as a percentage of the total volume of waste accepted. Participants were asked to describe any existing limits on the acceptance of "high-moisture content" or wet wastes. Responses are presented below.

- Sludge is limited to 8% of total waste acceptance rate (1)
- Sludge is limited to 10% of total waste acceptance rate (2)
- Sludge is limited to 15% of total waste acceptance rate (4)
- Sludge is limited to between 25-30% of total waste acceptance rate (1)

In addition to limiting sludge acceptance as a percentage of total waste accepted, many facilities regulate the sludge wastes they accept by mandating a minimum ratio of solids to liquid. This results in variable sludge densities when measuring quantities of sludge disposal on a wet-ton basis. In order to present a normalized value for Massachusetts sludge accepted by landfill facilities, distributed quantities of dry sludge are presented in Table 4-4 below. Only facilities from which responses were received or for which data are otherwise available are included.

| Table 4-4. Dry U.S. Tons of Massachusetts Sludge Accepted Based on Survey Response | |
|---|---|
| **Facility Name** | **Dry U.S. Tons of Sludge Accepted from MA POTWs** |
| Attleboro Monofill | 3,332 |
| New England Waste Services of VT Landfill (WasteUSA Landfill) | 6,841 |
| Resource Control, Inc. - RCI Fitchburg Landfill | 1,837 |
| Gardner WPCF | 894 |
| Crossroads Landfill | 3,938 |
| Ontario County Landfill | 1,696 |
| North Country Environmental Services Landfill (Bethleham) | 2,823 |
| Middleborough Sanitary Landfill | 735 |
| Clinton Sludge Monofil (Clinton MWRA) | 300 |
| Chemung County Landfill | 1,721 |
| Templeton WWTF (Winchendon/Templeton) | 27 |
| **TOTAL** | **24,175** |

Participants were also asked about the expected theoretical remaining available space for waste of the facility, as well as the anticipated number of years of remaining landfill life. Available remaining capacity includes currently permitted capacity, constructed or planned to be constructed. Potential landfill expansion includes capacity identified by the facility as potential expansion areas but not yet been permitted.

Approximately 16% of respondents (3) report a remaining permitted available landfill facility capacity between 500,001 and 1,000,000 cubic yards, while 26% of respondents (5) report greater than 2,000,000 cubic yards. The average reported remaining permitted available for landfill facilities was approximately 2,236,280 cubic yards including known expansion estimates.

Additionally, participants were asked whether or not expansion areas beyond that which are currently permitted have been identified at their facilities. forty-seven percent of respondents answered "yes" to this question, representing eight facilities, indicating that the remaining life of these landfill facilities may increase if those expansions are constructed. It should be noted that landfill expansion is a challenging process, and the feasibility of expansions are highly dependent on local support and opposition. A detailed table of the remaining permitted available capacity of landfill facilities, as well as potential expansions, is presented below as Table 4-5. Only facilities from which responses were received or for which data are otherwise available to determine remaining landfill capacity are included in Table 4-5.

**Table 4-5. Remaining Availability Capacities of Landfill Facilities Based on Survey Response**

| Facility Name | Facility State | Remaining Available Permitted Capacity at Facility (Cubic Yards) | Potential Landfill Expansion (Cubic Yards) |
|---|---|---|---|
| Gardner WPCF | MA | 32,313 | 276,500 |
| Hull Sanitary Landfill | MA | Minimal | - |
| Wheelabrator Millbury Inc. | MA | 2,000,000 | - |
| Upper Blackstone Clean Water | MA | 260,000 | |
| Resource Control, Inc. - RCI Fitchburg Landfill | MA | 4,590,680 | - |
| Middleborough Sanitary Landfill | MA | 531,060 | - |
| Crapo Hill Landfill | MA | 730,797 | 669,000 |
| Peabody South Mound Swale | MA | 8,000 | 660,000* |
| Bourne Landfill | MA | 1,197,000 | 3,978,000* |
| **MA TOTALS** | | **9,349,850** | **5,307,000** |
| North Country Environmental Services Landfill | NH | 715,000 | - |
| New England Waste Services of VT Landfill | VT | 1,200,000 | 1,250,000 |
| Ontario County Landfill | NY | 1,500,000 | TBD* |
| Chemung County Landfill | NY | 1,174,201 | 12,000,000* |
| Juniper Ridge Landfill | ME | 7,757,000 | - |
| **OUT-OF-STATE TOTALS** | | **12,346,201** | **13,250,000** |

**These landfill capacity expansions fall within the facility's plans but are not yet permitted for construction and should be considered tentative with regards to capacity projections.*

*Note: Not all out-of-state remaining capacity would be available for use by Massachusetts POTWs for sludge disposal. The remaining available capacity for Massachusetts sludge disposal is anticipated to be much less than overall remaining capacity values.*

The anticipated number of years of remaining landfill life is another important metric in determining remaining landfill capacity for sludge disposal. Figure 4-2 below outlines the estimated year of closure for responding facilities in and around Massachusetts accepting wastewater sludge produced within Massachusetts as of January 1, 2024.

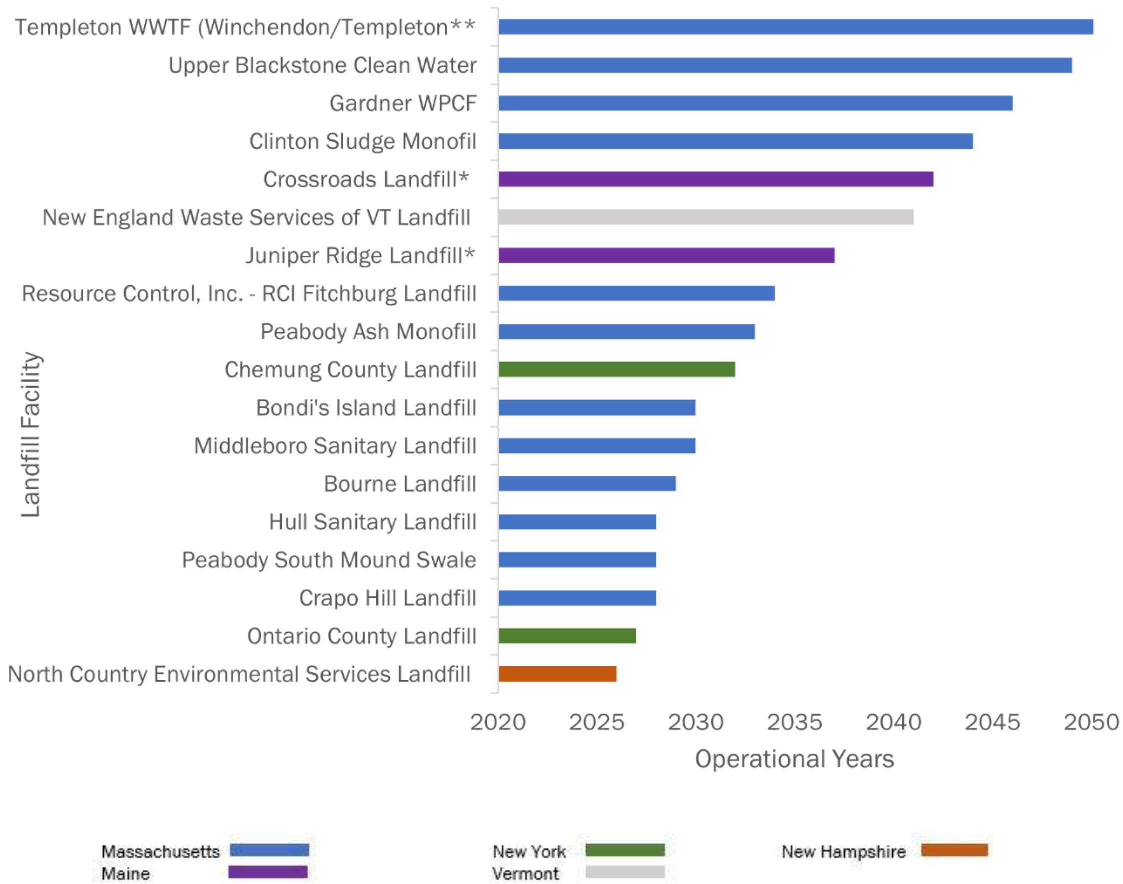


**Figure 4-2. Estimated year of landfill facility closure.**

**Facilities from which responses were not received but for which data is supplemented for analysis in this report by the 2023 MEDEP Biosolids Management Report.*

***Landfill closure year was reported between 2673-2723 – true value not shown to prevent large data spread.*

As illustrated by Figure 42, approximately 67% of responding facilities (12) reported less than or equal to ten (10) years of remaining landfill life, correlating with a closure year of 2034 (operation through the end of 2023). Twenty-eight percent of facilities (5) reported less than or equal to five years of remaining landfill life, correlating with a closure year of 2029 (operation through the end of 2028).

## 4.4 Future Landfill Capacity for Sludge Disposal

In order to understand how future landfill capacity for sludge disposal is expected to change, participants were asked to describe anticipated changes to sludge acceptance at their facilities. This metric was gauged by asking participants questions regarding the following topics:

- Anticipated increases or decreases in sludge acceptance rates over the next five years.
- Willingness to accept additional sludge.
- Challenges posed to the facility with an increase in sludge acceptance.

Twenty-nine percent (5) of respondents indicated an anticipated decrease in sludge acceptance rates over the next five years at their facilities. Twelve percent of facilities (2) indicated that they would consider accepting additional wastewater sludge, while 88% of facilities (15) indicated that they would not. Figure 43 below illustrates trends in landfill capacity in relation to wastewater sludge disposal over the next 10 years through 2034. The remaining capacity for wastewater sludge was extrapolated from the received data, where 2023 sludge acceptance rates were held constant for each facility unless an increase or decrease in rates was otherwise specified in survey responses.

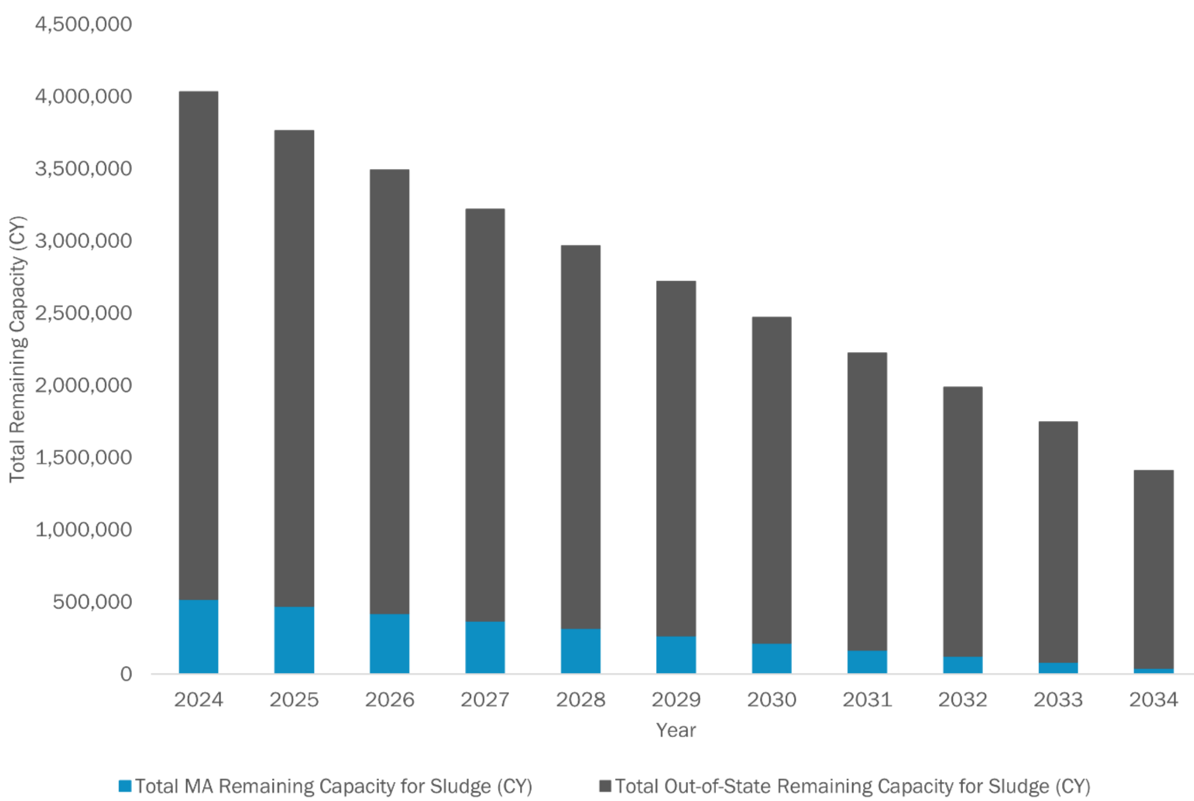


**Figure 4-3. Maximum remaining disposal capacity for sludge in New England and New York Landfills through 2034.**

As indicated by Figure 43, the total remaining available capacity for sludge disposal within New England and New York landfill facilities trends downward over the next 10 years. It should be noted that while landfill expansions are included in these capacity calculations, some survey participants indicated that while landfill expansions are anticipated for their facilities, the expansion values are not yet known. The available capacity in the region; however, it is not anticipated to significantly impact data trends. It should also be noted that out-of-state landfill capacities are not held exclusively for Massachusetts sludge disposal. The remaining capacities demonstrated in Figure 4-3 represent overall remaining capacities, while the capacity available for use by Massachusetts POTWs is likely much less.

Diminishing capacity in Massachusetts and surrounding states' landfills will result in more out-of-state disposal. This will likely result in increased disposal costs and additional GHG emissions due to farther hauling distances, assuming no other outlets become available--although remaining capacity in New York far exceeds that of Massachusetts and surrounding states' landfills.

It should also be noted that while remaining capacity for sludge exists in out-of-state landfills, this capacity is not reserved for wastewater sludge produced in Massachusetts. Demand for disposal in out-of-state facilities, particularly New York, is likely to increase both within New York state itself as well as in states throughout the Northeast region, which may impact the remaining available capacity for the disposal of sludge produced in Massachusetts. Not all available capacity identified within out-of-state landfills, including those located in New York, will be accessible for Massachusetts wastes.

The acceptance of wastewater sludge by landfill facilities is impacted by a variety of conditions. When asked about the challenges associated with the acceptance of additional wastewater sludge, participating facilities provided the following answers:

- Odor (10)
- Drainage/stormwater management (9)
- PFAS (8)
- Leachate quantity (8)
- Leachate quality (8)
- Global stability (8)
- Slope stability (8)
- Availability of bulking/drying agents (7)
- Increase in gas production (1)
- Facility accessibility (1)

Participants were asked to describe circumstances under which they would consider beginning, or increasing, acceptance of wastewater sludge at their facility. Facilities provided the following answers:

- Receiving MassDEP Special Waste Approvals
- Receiving an increase to the permitted accepted tonnage limit
- Facilitation of wastewater sludge delivery to the facility
- Urgent need from community members

Additional concerns and considerations provided by landfill facilities in relation to the acceptance of wastewater sludge are presented below:

- "With the unresolved state and federal regulatory framework surrounding PFAS (CERCLA, RCRA, NPDES, etc.), there is considerable uncertainty projecting the potential future costs and liabilities associated with managing sludge wastes that contain PFAS. Further, the ambiguity in the regulatory environment makes it challenging to predict the ability of the facility to accept sludge waste streams that contain PFAS."
- "Landfill capacity for sludge is not static, rather it is dynamic. The range in sludge percentages stem from operation constraints at the landfill. For example: when starting in a new cell, a base

layer of highly pervious municipal solid waste must be placed (the so called "fluff layer") to allow leachate to reach the leachate collection system. During the placement of this fluff layer, less sludge can be accepted at the landfill because there is less waste than can be mixed with the sludge. Additionally, there is seasonality in the flow of solid waste to the landfills. During the period where there is less solid waste, we must reduce how much sludge we accept. Looking at yearlong, or multiyear trends, does not tell the whole story of landfill operations and their ability to accept municipal sludge."

- "In 2018 odor issues at the [Landfill] caused significant public nuisance conditions. The County requested, and [the operator] obliged in reducing the volume of sludge being accepted. [The operator] will not exceed an 8% sludge to trash ratio at the [Landfill]."
- "[Our facility] has limited remaining capacity that is mostly being reserved for the future use of our member communities. We are limiting non-member wastes to the greatest extent possible."

## 4.5 Massachusetts Materials Management Capacity Study Update

As previously described, an addendum to the Massachusetts Materials Management Capacity Study was developed using the data collected through the survey in order to provide a more comprehensive understanding of waste management in Massachusetts as it pertains to wastewater sludge disposal at landfill facilities. The addendum is attached to this report as Appendix E providing the information outlined in this section.

## 4.6 Estimated Costs for Massachusetts POTWs for Landfill Disposal

Major costs associated with the landfill disposal of wastewater sludge from Massachusetts POTWs include tipping fees, hauling and transportation costs, and any additional disposal fees charged on a facility-by-facility basis. Hauling and disposal costs are highly dependent on sludge characteristics, hauling distance, and other contractual terms. In addition, some older sludge management contracts may not fully capture the current sludge market. Figure 4-4 below illustrates typical costs reported by POTW facilities associated with the hauling and disposal costs of wastewater sludge to final landfill disposal facilities. The limited number of facilities represented in Figure 4-4 is a representative example of costs and may not reflect disposal cost conditions on a state-wide basis.

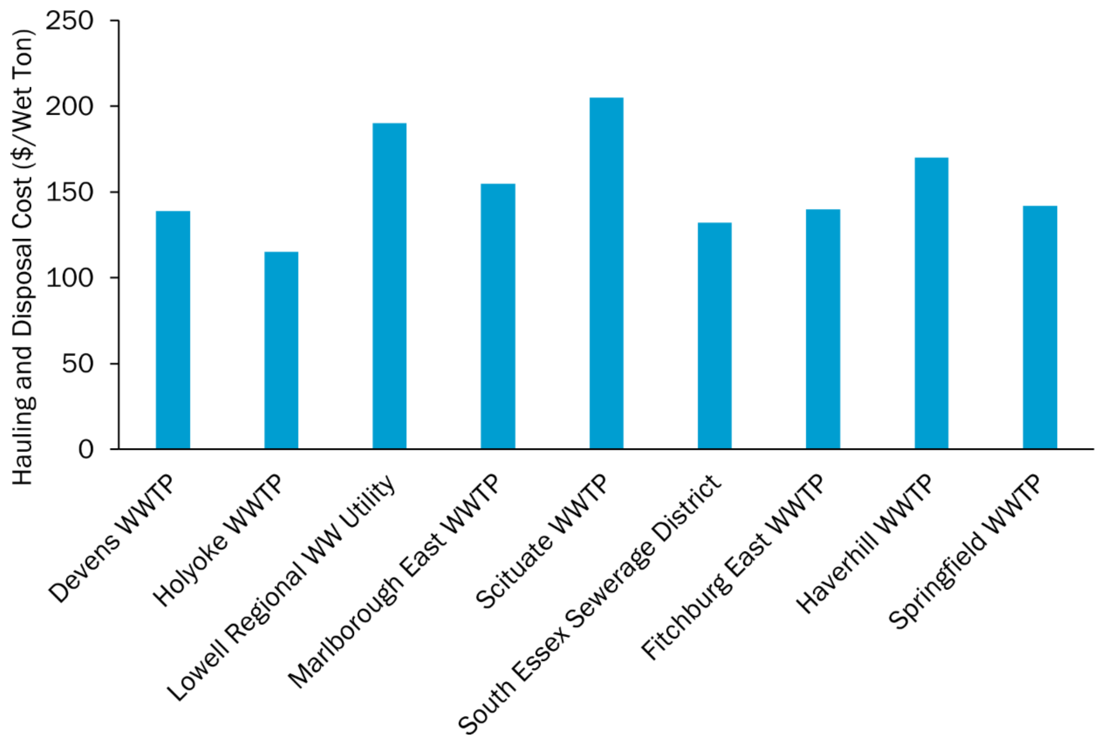


**Figure 4-4. Hauling and disposal costs for wastewater sludge from Massachusetts POTWs to landfills.**

For hauling and disposal contracts, costs to the Massachusetts POTWs reported in Figure 4-4 ranged from $115 per wet ton to $205 per wet ton. Note that these data do not include actual costs for processing sludge through processes such as dewatering, so the data set is limited to available information on hauling and disposal fees charged by commercially operated facilities.

Participants of the landfill disposal survey were asked to report tipping costs associated with waste disposal at their facilities. Participants reported tipping fees of between $115-$124 per wet ton, while several facilities indicated that tipping fees are not charged at their facility—generally, this applies to authorized facilities, those which serve specific towns or specific POTWs. Tipping fees associated with landfill disposal of wastewater sludge may result in increased values for hauling and disposal costs through landfill facilities.

As landfill capacities for wastewater sludge in Massachusetts continue to decline, hauling costs associated with sludge transportation are anticipated to increase for POTWs sending waste further away from the point of origin.

## 4.7 Potential Disposal Outside of Region

When considering the disposal of wastewater sludge at landfill facilities outside of the Northeast region evaluated by this study, the feasibility of and challenges associated with waste transport should be considered. As previously mentioned, increased hauling distances will result in increased disposal costs and GHG emission, including disposal at facilities within the mid-Atlantic and Midwest regions. Additionally, concerns regarding public opinion and local political climates may be considered, where additional transport of foreign sludge waste over state lines may be viewed unfavorably by local constituents.

With these factors considered, landfills outside of the New England region were reviewed to understand the magnitude of existing capacity, and the likelihood of their potential willingness to accept Massachusetts wastewater sludge. It is important to note that these landfills were not solicited for participation in the survey, and projected capacity data was not collected and analyzed as part of this evaluation. Operational municipal solid waste landfill facilities that were identified as potentially having capacity for out-of-state wastewater sludge disposal, and which may be considered as part of a wholistic approach to the future of Massachusetts sludge management, are listed below.

- Tunnel Hill Reclamation Landfill, New Lexington, OH
- Rumpke Sanitary Landfill, Cincinnati, OH
- Keystone Sanitary Landfill, Dunmore, PA
- Alliance Landfill, Taylor, PA
- Taylor County Landfill, Mauk, GA

## 4.8 Landfill Summary

As indicated by the data presented in preceding sections, sludge disposal capacity within both Massachusetts sludge monofills and municipal solid waste landfills is limited and inadequate to satisfy the volumes of sludge produced within the state requiring disposal, especially as several landfills are slated to reach capacity within the next 10 years. Four sludge monofills in Massachusetts have more than 10 years of remaining capacity but three of the four are known to only serve a local POTW. The fourth sludge monofill did not respond to the survey and is unlikely to accept sludge from other POTWs. While some facilities maintain a higher capacity for sludge disposal, concerns including odor, leachate quality, and the presence of PFAS appear to dissuade these facilities from accepting additional sludge beyond what is currently accepted.

Landfill capacity within New England and New York is slightly higher; however, competition for the disposal of wet wastes, including wastewater sludge, within the market is high, with several states in the area experiencing landfill capacity concerns, as noted in the 2023 Maine DEP Evaluation of Biosolids Management report. While capacity in New York is higher by comparison, transporting Massachusetts wastes to these areas presents additional concerns, including increased costs and GHG emissions. As landfill capacities within the state, New England and New York continue to decline, wastewater sludge produced in Massachusetts will increasingly require alternative management strategies, including, but not limited to, transportation to out-of-state management facilities such as other landfills, incinerators, and composting facilities.

# Section 5: Land Application

Land application of biosolids is the practice of treating sludge to produce biosolids and recycling the biosolids to land to support soil health and plant growth. This practice is regulated by federal law under Chapter 40 Part 503 of the Code of Federal Regulations (40 CFR 503) and under 310.CMR.32.00 in the Massachusetts state regulations. Biosolids land applied in other states may be subject to additional rules of those states. In Massachusetts, biosolids can be applied to land directly as Class A or Class B cake, categorized as Type 1, 2, or 3 sludge under state regulation depending on pollutant concentrations. Sludge processing for the production of biosolids occurs via two routes:

1. Solids are processed into biosolids in onsite, utility-owned facilities, such as thermally dried granules or compost. These facilities are typically purpose-built for the communities they serve,

with throughput matching POTW capacity. The products of these processing facilities are then land applied. Onsite facilities in Massachusetts include thermal drying systems at MWRA's Quincy facility and at GLSD, as well as a number of composting processes at POTWs.

2. Solids are sent off-site to processing facilities, which are typically, but not exclusively, privately owned and meant to process solids from multiple sources. These facilities represent regional biosolids management capacity for those utilities that do not have their own onsite processing. The products generated at these facilities are land applied. Off-site facilities that receive Massachusetts sludge include the Hawk Ridge Compost Facility in Maine, the Grasslands Manufacturing Facility in New York, and three composting facilities in Canada.

310 CMR 32.00 regulates the land application of sludge and septage in Massachusetts and is intended to allow land application of sludge for beneficial purposes in a manner that will protect public health and the environment from possible contamination which could occur from pathogens, metals, or toxic chemical compounds. Biosolids are classified as follows:

- **Type 1**: may be used, sold, or distributed or offered for use, sale, or distribution on any site without further approval of the Department, and which may be used for growing any vegetation.
- **Type 2**: may be used, sold, or distributed or offered for use, sale, or distribution on a site only with prior approval of the Department, and which may be used for growing any vegetation.
- **Type 3**: may be used, sold, or distributed or offered for use, sale, or distribution for land application on a site only with prior approval of the Department, which may be used for growing any vegetation not including direct food chain crops, and whose land application to a site must be recorded in the registry of deeds in the chain of title for such site.

An AOS from MassDEP is required prior to use, sale, or distribution in Massachusetts.

A large amount Massachusetts biosolids were land applied in New York, so it is important to understand New York land application and related PFAS regulations. New York NYCRR Part 361-3.9 establishes requirements that must be met in order to land apply biosolids in the state. When treating to Class A standards, New York Department of Environmental Control (NYSDEC) regulations underwent a revision in 2017 to remove restrictions on food and feed crops fertilized with Class A biosolids, in an effort to be more aligned with federal requirements. NYSDEC adopted the Division of Materials Management Program Policy 7- Biosolids Recycling in New York State - Interim Strategy for the Control of PFAS Compounds (DMM7) on September 20, 2023 with an effective date of October 20, 2023. While the term PFAS is commonly used when discussing the entire group of chemicals, NYSDEC is focused on the specific PFAS compounds perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) as they have been found to indicate the impact of industrial inputs on biosolids. As EPA standards are not expected until the end of 2024 or later, DMM7 is an effort to reduce environmental risk of PFAS compounds from recycled biosolids. The policy outlines sampling criteria and actions NYSDEC will take based on the results. The overall goal is to identify biosolids that are considered a high environmental risk as a result of industrial PFAS sources into wastewater treatment plants. Upon identifying these sources, the WWTP must address them to reduce PFOA and PFOS levels in order to continue recycling their biosolids. New York PFAS regulations will be further investigated in Part 2 of this study.

As detailed in Section 3, 64,837 dry tons of sludge were processed into biosolids for land application in 2023. In addition, 37 Massachusetts POTWs utilized biosolids processing facilities to manage at least a portion of their sludge in 2023. This section details current biosolids processing facilities within Massachusetts and in the region. In addition, future projections for land application of Massachusetts sludge are considered. To better understand the current and future status of these biosolids processing facilities as well as their capacity, a survey was sent in April 2024. The survey consisted of qualitative and quantitative questions and focused on the owner, operator, facility type, capacity, sludge acceptance from outside POTWs, future plans, and other concerns. A copy of this survey is included in Appendix C.

For the purposes of this report, a biosolids processing facility is defined as a facility that is designed to produce Class A or B sludge in compliance with US EPA's *Standards for the Use or Disposal of Sewage Sludge (40 CFR Part 503)*. Biosolids processing facilities that treat Massachusetts sludge to Class A or B standards utilize thermal drying, composting, or alkaline stabilization processes. It is our understanding that no Class B sludge from Massachusetts POTWs is currently being land applied.

Biosolids processing facilities currently processing Massachusetts sludge include a variety of facilities in Massachusetts, other states, and Canada. As shown in Figure 5-1, the Massachusetts Water Resources Authority (MWRA) Biosolids Processing Facility in Quincy, MA produces by far the most biosolids suitable for land application. This facility has been operational since the late-1980's and has one of the largest and most established anaerobic digestion, thermal drying and land application programs in the country. In Massachusetts, GLSD has a significant anaerobic digestion and thermal drying facility, and there are well established composting facilities in Ipswich, Dartmouth, Southbridge, Bridgewater, and at the Hoosac WQD. Facilities outside of Massachusetts that process significant volumes of Massachusetts sludge include the Hawk Ridge Compost Facility in Unity, Maine and the Grasslands Manufacturing Facility (alkaline stabilization) in Chateaugay, New York. While not land application, land reclamation is another management option utilized by Erving POTW #2. Land application focuses on enhancing soil quality and providing nutrients for plant growth, while land reclamation is dedicated to restoring damaged or degraded land to a useful condition. Reclamation often requires substantial nutrient input to revitalize the soil effectively, thus requiring higher application rates than land application. Note that Figure 5-1 presents the tonnage of Massachusetts sludge processed at each biosolids processing facility. It does not include sludge from other states that is processed by these facilities.

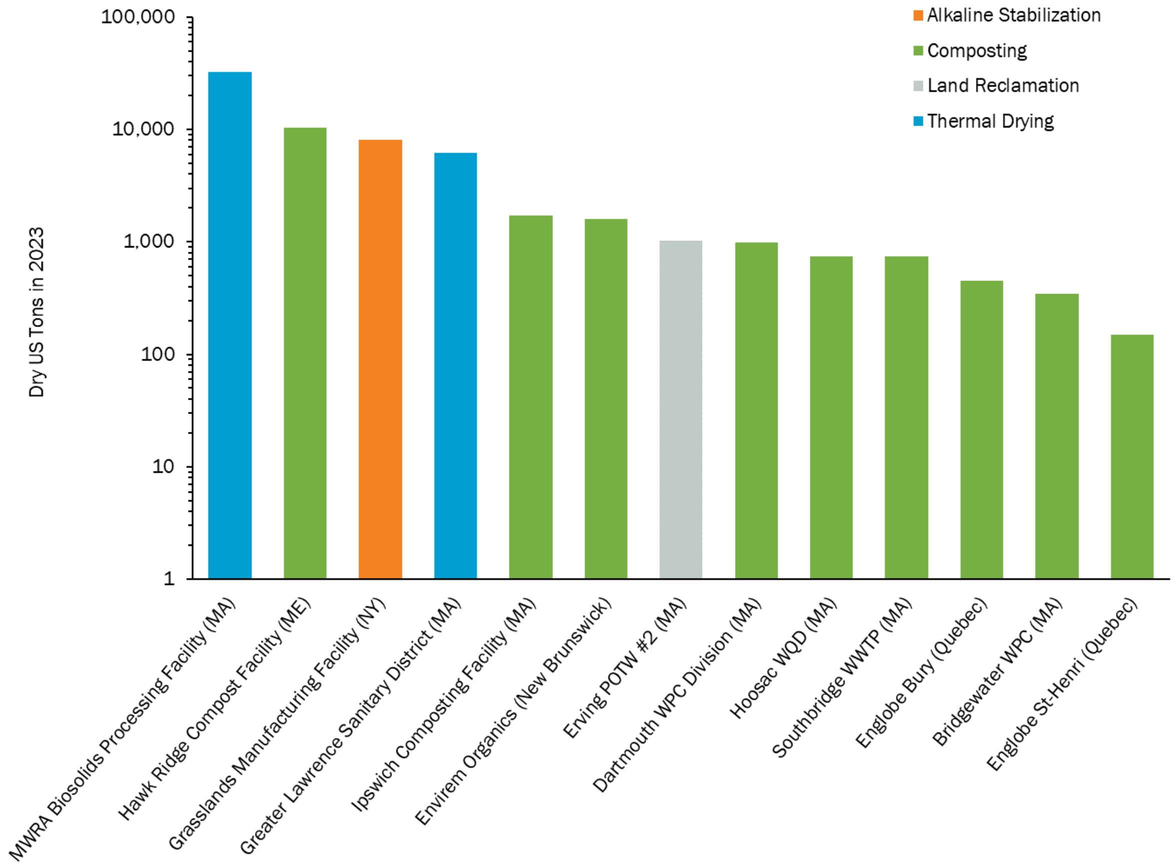


**Figure 5-1. Massachusetts sludge sent to biosolids processing facilities.**

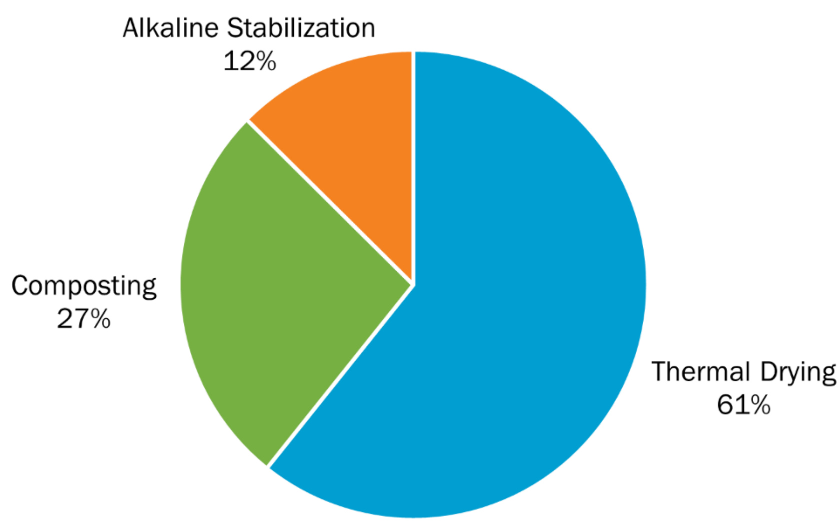


**Figure 5-2. Massachusetts sludge (dry U.S. tons) sent to biosolids processing facilities by technology.**

As shown in Figure 5-2, thermal drying is utilized for 61% of Massachusetts sludge processed for land application. The MWRA and GLSD drying facilities are dedicated to processing biosolids from those utilities and account for all of Massachusetts' thermal drying capacity. Composting accounts for 27% of Massachusetts sludge processed for land application. Composting facilities include the large Hawk Ridge Compost Facility in Maine, as well as a number of smaller composting facilities in Massachusetts. In addition, small volumes of Massachusetts sludge cake are trucked to Canadian composting facilities. Finally, the Grasslands Manufacturing Facility in New York utilizes an alkaline stabilization process on 12% of Massachusetts sludge processed for land application.

Figure 5-3 presents a map of sludge hauled from Massachusetts POTWs to biosolids processing facilities. This management strategy involves dewatered sludge cake hauling, often for long distances to central Maine, northern New York, and Canada. Note that Figure 5-3 only depicts hauling of cake to the processing facility and does not show hauling of the biosolids product to its final land application site. Therefore, biosolids hauled from MWRA, GLSD, and Massachusetts composting facilities are not shown on this map. From a regional perspective, several POTWs in northeastern Massachusetts utilize the Hawk Ridge Compost Facility in Central Maine and larger Western Massachusetts POTWs rely on the Grasslands Manufacturing Facility in northern New York.

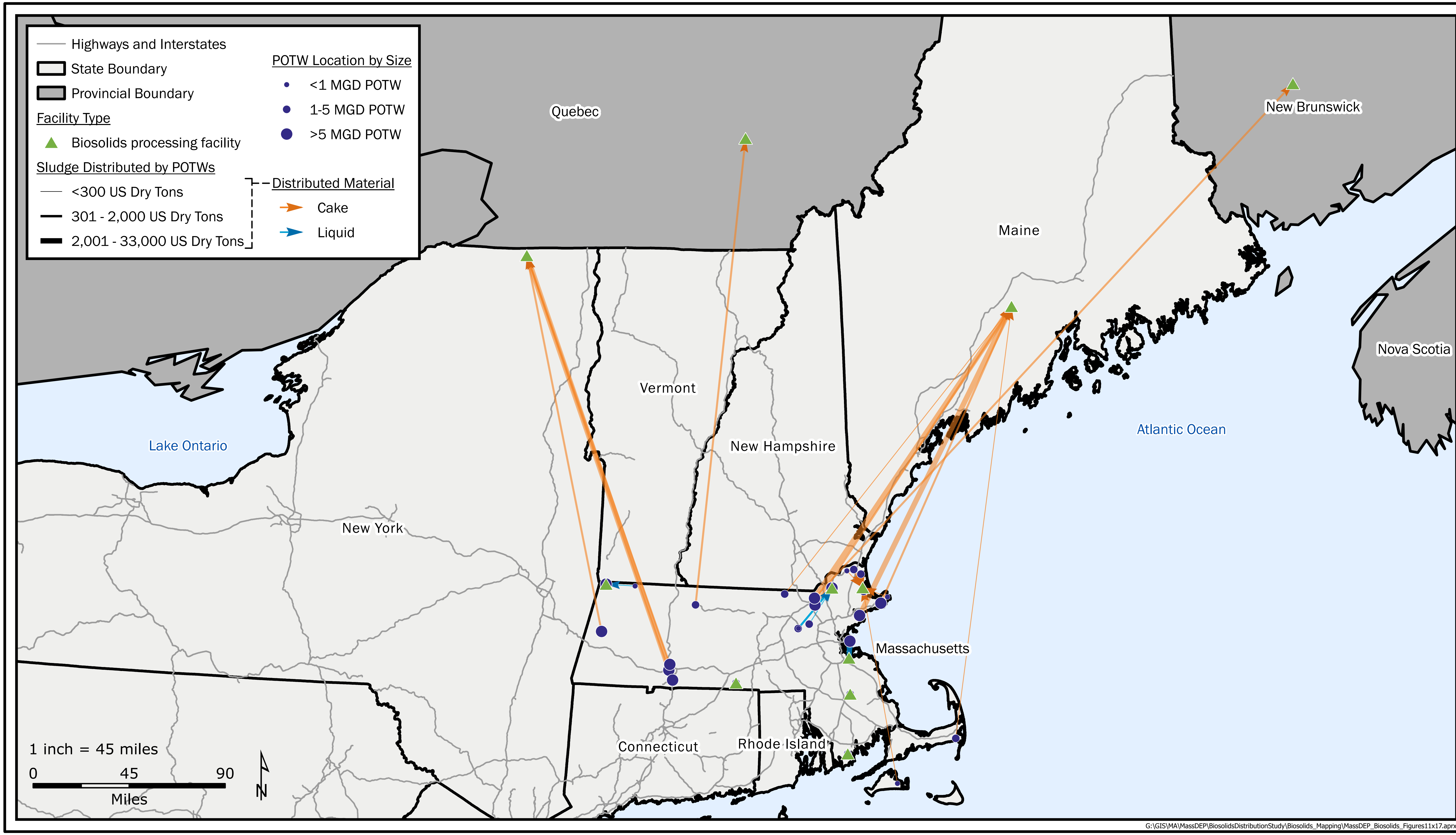


**Figure 5-3. Map of Biosolids Processing Facility Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

Land application of biosolids produced from Massachusetts sludge has potential to be a highly volatile management option in coming years. There is significant potential that legislation and/or regulations will be adopted at the state or Federal level that will limit land application of biosolids. A principal goal of this section is to define the current and near-future (5 year) use of land application processing technologies in Massachusetts, such that impacts and risks of future legislative, regulatory and technology shifts can be better understood.

## 5.1 Summary of Massachusetts Biosolids Processing Facilities

There are presently eight facilities in Massachusetts that provide advanced processing of biosolids suitable for land application, including two facilities which thermally dry biosolids: the MWRA facility in Quincy, MA and the GLSD facility in North Andover, MA. There are five facilities in Massachusetts which compost biosolids. Biosolids processing facilities located in Massachusetts are summarized in Table 5-1.

**Table 5-1. Massachusetts Biosolids Processing Facilities**

| Facility Name | Location | Processing Type | Massachusetts Sludge Processed in 2023 (Dry US Tons) | Accepts Sludge from Other POTWs | Survey Response Received |
|---|---|---|---|---|---|
| Massachusetts Water Resources Authority | Quincy, MA | Thermal Drying | 32,543 | No | Yes |
| Greater Lawrence Sanitary District | North Andover, MA | Thermal Drying | 6,215 | Yes | Yes |
| Ipswich Composting Facility (Agresource) | Ipswich, MA | Composting | 1,708 | Yes | Yes |
| Dartmouth Water Pollution Control | Dartmouth, MA | Composting | 992 | No | No |
| Hoosac Water Quality District | Williamstown, MA | Composting | 744 | Yes | Yes |
| Southbridge WWTP | Southbridge, MA | Composting | 737 | No | Yes |
| Bridgewater Water Pollution Control | Bridgewater, MA | Composting | 345 | No | Yes |

Due to the unique nature of each biosolids processing facility, brief descriptions of these facilities are included to add context and deeper understanding of processing Massachusetts biosolids for land application.

### 5.1.1 Massachusetts Thermal Drying Facilities

*MWRA Biosolids Processing Facility (Quincy, MA):* MWRA's Biosolids Processing Facility receives digested liquid sludge at 2.3% solids (average) via pipeline from MWRA's Deer Island WWTP, which treats wastewater from 43 greater Boston area communities. Liquid sludge is dewatered in Quincy to around 28% cake and then thermally dried with a natural gas-fired rotary drum dryer process to produce a pelletized product at greater than 90% solids. The facility includes six 6,500 dry pound/hour dryer trains, of which three trains are typically utilized during normal operating conditions and four trains during maximum conditions. The facility has a design capacity of 280 dry tons/day. Dried pellets are conveyed to 9 storage silos to await off-site distribution. The facility has approximately 5,500 tons of total storage capacity. At a nominal operating rate of 100 dry tons/day for a seven-day average, this equates to approximately 55 days of storage capacity. Note that the silos are rarely empty, so available storage capacity is typically less. The facility has three main outlets for pellets: direct land application in agriculture, land application through fertilizer blenders, and a very small amount used as alternative fuels. Usage varies by year, but a typical split is 65% land application, 32% blending, and 3% alternative fuels.

In 2023, the MWRA Biosolids Processing Facility received approximately 376,000,000 gallons of liquid sludge and processed 32,543 dry tons, making it the largest sludge processing facility in Massachusetts by a significant margin. The facility was purpose-built for MWRA's service area and does not have structures to receive sludge from non-MWRA communities. The facility typically operates for 5 days per week. If the drying process were out of service for any extended period, there are provisions to truck dewatered cake off-site. Based on the redundant drying capacity at the facility, off-site trucking of dewatered sludge cake is rarely needed, and off-site cake disposal sites would be determined by the drying facility operator at the time of need.

*Greater Lawrence Sanitary District (North Andover, MA):* GLSD's biosolids management process consists of anaerobic digestion and thermal drying. GLSD serves six member communities in the Greater Lawrence area (Lawrence, Methuen, North Andover, Andover, Dracut, and Salem, NH). Following anaerobic digestion, centrifuges produce dewatered cake prior to conveyance to the thermal drying process. GLSD produces enough electricity from biogas to run the entire treatment facility plus return some electricity to the grid. The drying facility includes two rotary drum dryer trains, of which one train is normally utilized. The drying process primarily utilizes biogas from the anaerobic digestion process, and biogas is also utilized in a combined heat and power (CHP) process to produce electricity. GLSD's drying process typically operates 365 days/year. The facility processed 6,215 dry tons in 2023, and the biosolids are either directly land applied or blended with soil and land applied.

GLSD has agreements with Acton, Maynard, and Concord to receive and process liquid sludge ranging from 2.0% to 4.5% solids. GLSD received 440 truckloads from these communities in 2023 and processed a combined total of 3,960,000 gallons of liquid sludge. GLSD does not anticipate expanding sludge receiving operations in the future to additional communities.

### 5.1.2 Massachusetts Composting Facilities

*Ipswich Composting Facility (Agresource):* Agresource operates an aerated static pile composting facility at the Ipswich Transfer Station. In 2023, the composting facility processed sludge cake from Ipswich as well as from Amesbury, Merrimac, Rockport, Newburyport, and Yarmouth, Maine. The facility is designed to receive up to 8,000 wet tons / year of sludge and received 7,987 wet tons in 2023. Preferred minimum cake dryness is 16% solids. The facility produced 4,200 dry tons of compost product at an average solids content of 55% in 2023. The facility normally operates for 6 days/week. In addition to wastewater sludge, the facility also composts leaf and yard waste, food waste, wood waste, food processing residuals, and water treatment residuals. Leaves, ground wood, and wood shavings are used as bulking agents.

*Dartmouth Water Pollution Control Division:* The Dartmouth Water Pollution Control Division utilizes an in-vessel composting process and composted 992 dry tons of sludge in 2023.

*Hoosac Water Quality District:* The Hoosac WQD utilizes aerated static piles and composted 744 dry tons in 2023. Belt filter press dewatering produces 22% cake prior to composting, and material is hauled by truck to the onsite composting facility. Agresource assists with marketing and selling compost.

*Southbridge WWTP:* Southbridge composted 737 dry tons in 2023 utilizing aerated static piles. Centrifuge dewatering produces 22.25% cake prior to composting. Wood chip amendment is mixed into the sludge, and then material is stacked into windrows with aeration for 30 days. The facility operates at approximately 75% of design capacity and typically operates for 5 days/week. The compost has an average solids content of 55%. The facility reports no available capacity to receive additional wastewater sludge based on product sales/distribution limitations. Agresource assists Southbridge in marketing their compost product, and 100% of Southbridge's product was land applied in Massachusetts in 2023.

*Bridgewater Water Pollution Control:* The Bridgewater Water Pollution Control Plant (WPCP) utilized aerated static piles and composted 345 dry tons of sludge in 2023. Belt filter presses are utilized for dewatering prior to composting.

## 5.2 Summary of Out-of-State Biosolids Processing Facilities

Based on available data from the survey and the 2023 EPA Annual Biosolids Reports, this study has evaluated eight out-of-state biosolids processing facilities, of which five received sludge from Massachusetts in 2023. Biosolids processing facilities located outside of Massachusetts are summarized in Table 5-2a and Table 5-2b. Table 5-2a lists municipal facilities and Table 5-2b lists commercial facilities. There are other land application processing facilities outside of Massachusetts that are not on this list, but this list documents facilities that currently receive Massachusetts sludge and facilities that have an AOS to land apply biosolids in Massachusetts.

**Table 5-2a. Out-of-State Biosolids Processing Facilities - Municipal**

| Facility Name | Location | Processing Type | Massachusetts Sludge Processed in 2023 (Dry US Tons) | Accepts Sludge from POTWs | Survey Response Received |
|---|---|---|---|---|---|
| Merrimack, NH WWTF | Merrimack, NH | Composting | 0 | Yes | Yes |

**Table 5-2b. Out-of-State Biosolids Processing Facilities - Commercial**

| Facility Name | Location | Processing Type | Massachusetts Sludge Processed in 2023 (Dry US Tons) | Accepts Sludge from POTWs | Additional Capacity for Massachusetts Sludge (Dry US Tons/Year) |
|---|---|---|---|---|---|
| Hawk Ridge Compost Facility | Unity, ME | Composting | 10,322 | Yes | Yes |
| Grasslands Manufacturing Facility | Chateaugay, NY | Alkaline Stabilization | 8,024 | Yes | Yes |
| Envirem Organics Inc. | New Brunswick, CA | Composting | 1,587 | Yes | No |
| Englobe Bury, Quebec | Bury, CA | Composting | 450 (Estimated) | Yes | Yes |
| Englobe St-Henri, Quebec | St-Henri, CA | Composting | 150 (Estimated) | Yes | Yes |
| Resource Management Inc. | Holderness, NH | Alkaline Stabilization | 0 | Yes | Yes |

**Hawk Ridge Composting Facility (Unity, Maine):** Casella Organics operates a significant composting facility in central Maine utilizing aerated static piles within closed vessels (GICOM Composting Technology) followed by aerated static pile composting to achieve a more mature product. The facility has a capacity of approximately 40,000 wet tons / year, but permitted monthly capacity is 4,800 cubic yards / month. Hawk Ridge received 41,907 wet tons of sludge in 2023 and has essentially operated at available capacity since opening in 1994 with a 99.5% uptime given their operating schedule The facility produced 53,570 cubic yards of compost in 2023 at an approximate solids content of 50%.

The Hawk Ridge Compost Facility has also processed source food waste and short paper fiber (paper mill sludge) in the past, although zero tons of these materials were received in 2023. Preferred solids content for incoming dewatered cake is around 25%, but cake as low as 14% can be accepted with charge for additional bulking agents. Bulking agents include wood chips, kiln dried and green wood shavings, and kiln dried and green sawdust. Beginning in 2023, Casella requires all sludge sources to have PFOA and PFOS concentrations of 20 parts per billion (ppb) or less. Approximately 60 POTWs are permitted and approved for processing at the Hawk Ridge facility, including 12 Massachusetts POTWs. Billerica, Chatham, Gloucester, Lowell, Pepperell, and South Essex Sewerage District sent material to Hawk Ridge in 2023. Hawk Ridge processed 39,791 wet tons (10,322 dry tons) of Massachusetts sludge in 2023. Approximately 95% of the sludge composted at Hawk Ridge in 2023 was from Massachusetts, with the remainder from two New Hampshire POTWs. For POTWs in northeastern Massachusetts, Hawk Ridge is a vital component of sludge management. Approximately 64.4% of the compost produced from Hawk Ridge was land applied in Massachusetts in 2023, with the remainder primarily land applied in New Hampshire. This material was utilized in a variety of outlets, including topsoil blending, golf courses, landscape mulch, etc., and was not utilized for agricultural purposes in Massachusetts. Casella noted that any land application bans in Massachusetts or requirements for a site-specific AOS would have significant negative impact on Hawk Ridge and its ability to accept sludge and distribute compost from Massachusetts sludge.

**Grasslands Manufacturing Facility (Chateaugay, New York):** Casella Organics operates a solid lime alkaline stabilization process in Chateaugay, New York which utilizes the Schwing Bioset process. The process blends sludge with lime and sulfamic acid to meet temperature and pH requirements of the USEPA Part 503 regulations to produce Class A biosolids. The Grasslands facility has a permitted capacity of 90,000 wet tons/year and produced 85,316 wet tons of biosolids product in 2023 at approximately 35% solids content. The facility normally operates for 250 days per year, including a 2-week planned maintenance shutdown each year. Beginning in 2023, Casella requires all sludge sources to have PFOA and PFOS concentrations of 20 ppb or less in line with the New York interim PFAS strategy. The preferred minimum sludge cake solids content is 22%. Grasslands is an important outlet for larger Western Massachusetts POTWs (Chicopee, Holyoke, Pittsfield, and Springfield), and processed 32,101 wet tons (8,024 dry tons) of Massachusetts sludge in 2023. All of the finished product from Grasslands was land applied in New York. The alkaline stabilized Class A biosolids are primarily utilized on large dairy/grain growing operations or in mine land reclamation. As such, there are limited markets for these biosolids in Massachusetts and New England.

**Envirem Organics (New Brunswick, CN):** Envirem Organics is a compost and environmental remediation company headquartered in Fredericton, New Brunswick, Canada. Envirem has received sludge from Massachusetts and other New England states for composting and processed a modest amount of Massachusetts sludge in 2023.

**Englobe Composting Facility (Bury, Quebec):** Englobe's Bury, Quebec composting facility utilizes static piles, which are manually turned with an excavator after mixing incoming sludge with wood bark. The facility can receive up to 60,000 tons of organic material per year, including biosolids, leaf, yard and food waste. Daily capacity for sludge is approximately 150-200 tons per day and is limited by mixing capacity. The facility received 30,000 tons of sludge in 2023 and has estimated capacity for up to an additional 15,000 tons of sludge per year. The facility typically operates for 6 days per week. Englobe-Bury received a small volume of Massachusetts sludge cake (2,150 wet tons) in 2023 through a third-party biosolids management company. The minimum solids content for sludge received at the facility is 18-20%, with 25-30% preferred. The full composting process can take up to a year to reach full maturity, and the finished product is screened and mixed with sand and peat for different blends of topsoils. All products are sold into the topsoil market. Note that the Quebec ban on the importation of U.S. sludge for land application does not impact the ability of composters in Quebec to accept U.S. sludge.

**Englobe Composting Facility (St-Henri, Quebec):** Englobe's St-Henri, Quebec composting facility utilizes static piles, which are manually turned with an excavator after mixing incoming sludge with wood bark. The facility can receive up to 80,000 tons of organic material per year, limited by the operations conditions at the facility. The facility receives approximately 60 tons/day of sludge, and daily capacity for sludge is approximately 150 tons/day. The facility received 35,000 tons of sludge in 2023 and has estimated capacity for up to an additional 10,000 tons of sludge per year. The facility typically operates for 5 days/week. Englobe-St-Henri received a small volume of Massachusetts sludge cake (686 wet tons) in 2023 through a third-party biosolids management company. The minimum solids content for incoming sludge received at the facility is 18-20%, with 25-30% preferred. The full composting process can take up to a year to reach full maturity, and the finished product is screened and mixed with sand and peat for different blends of topsoil. All products are sold into the topsoil market. Note that the 2023 Quebec ban on the importation of U.S. sludge for land application does not impact the ability of composters in Quebec to accept U.S. sludge.

**Resource Management Inc. Facility (Holderness, NH):** Resource Management Inc. (RMI) operates a wood ash alkaline stabilization facility in Holderness, NH. RMI did not receive any sludge from Massachusetts in 2023 (partly due to an increased demand from Maine for sludge processing), but RMI has processed Massachusetts sludge in the past and is open and interested in receiving Massachusetts sludge in the future. Dewatered sludge is delivered to the Residuals Management Facility where it is raised to a pH of 12 or higher using a blend of wood ash and wastewater solids at a ratio of 1:1 by volume. To meet regulatory requirements without the addition of more alkali, the biosolids remain at a pH of 12 or higher for two hours and then at a pH of 11.5 or higher for an additional 22 hours. To achieve a Class A product, pathogens are tested in compliance with 503.32(a)(6)1. Storage capacity is limited to 3,700 wet tons at any given time. Practical capacity is approximately 9,000 wet tons/year of wastewater solids processed into about 15,000 wet tons/year of Class A biosolids. Preferred solids content for sludge cake that is received is greater than 18%. The facility received 16,806 wet tons of sludge in 2023, with sludge volume beyond the 9,000 wet ton/year processing capacity transferred to a Canadian partner for composting. Approximately 90% of the product was Class A and 10% was Class B. The facility typically operates for 5 days/week and there were no unplanned shutdowns in 2023.

**Merrimack, NH WWTF Composting Facility (Merrimack, NH):** The Merrimack, NH WWTF has been operating a 15-bay in-vessel (IPS Agitated Bin) composting system since 1994 and has an AOS to land apply compost product in Massachusetts. The process utilizes a computerized temperature tracking system to monitor temperature and ensure compliance with temperature requirements. A biofilter is utilized for odor control of the enclosed composting building. The facility is separated into 5 bay sections, and there are two 50-HP agitators and transfer dolly to agitate each of the 15 bays. Each bay has five aeration zones, and each zone is a separate aeration section connected to a 3-HP blower. The aeration blowers are operated by a computerized control system based on temperature in each bay. Sawdust and finely ground wood are used as bulking agents. The facility produced 14,700 wet tons of compost at 66% solids in 2023. Sludge was received from eight New Hampshire POTWs (Bristol, Henniker, Sunapee, Winchester, Franklin, Jaffery, Hookset, and Milford), ranging from 200 to 2000 wet tons/year from each POTW. The facility reports that there is no capacity to receive additional sludge from other POTWs.

## 5.3 Land Application Data

This section summarizes data on where Massachusetts sludge is land applied for agricultural, horticultural or other beneficial reuse purposes after being processed at one of the facilities described in Sections 5.1 and 5.2. The goal is to illustrate potential market risks that future changes in land application legislation or regulation in Massachusetts or any other state would have on distribution of biosolids from Massachusetts. Recent changes, such as the Maine and Connecticut land application bans, are already impacting the distance that Massachusetts biosolids must travel to reach their final destination. Any future changes would further impact the land application market, as well as the broader Massachusetts sludge management market. For facilities which receive sludge from states other than Massachusetts (Hawk Ridge Compost Facility and Grasslands Manufacturing Facility), data for Massachusetts sludge were estimated based on the distribution percentages from these facilities.

The information presented in Figure 5-4 and Figure 5-5 was developed based on available land application data at the state level. Data were not available for specific land application locations in each state. Land application data for the MWRA and GLSD thermal drying facilities were obtained from Synagro. Land application data for the Hawk Ridge Composting Facility and the Grassland Manufacturing Facility were obtained via discussion with Casella Organics. Data for other facilities were obtained based on survey results and/or discussions with facility operators. Finally, for the Englobe and Envirem composting facilities in Canada, it was assumed that all compost products from those facilities remained in Canada.

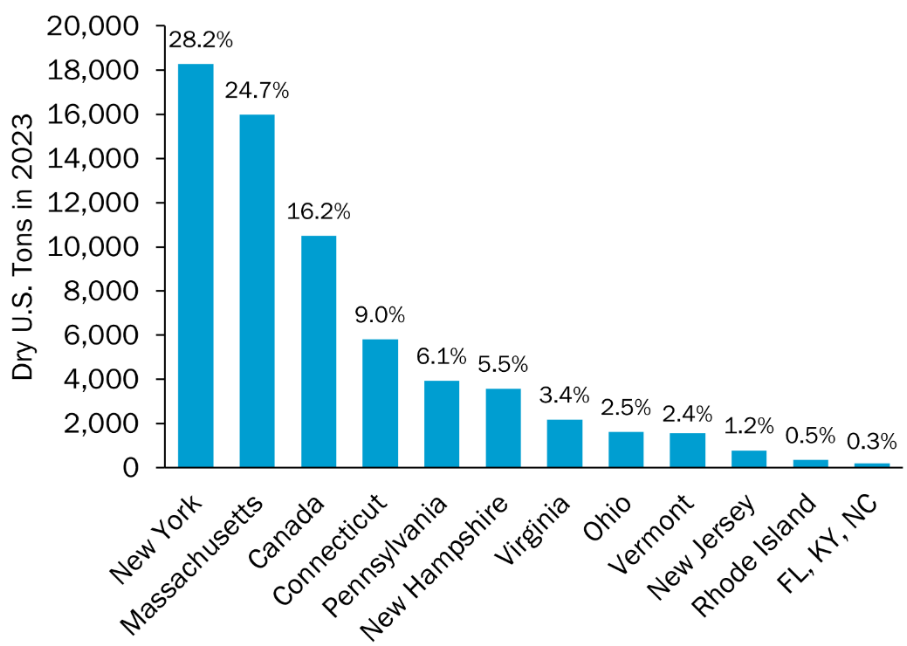


**Figure 5-4. Land application locations for Massachusetts sludge in 2023.**
*The approximate percent of Massachusetts sludge land applied is shown for each location.*

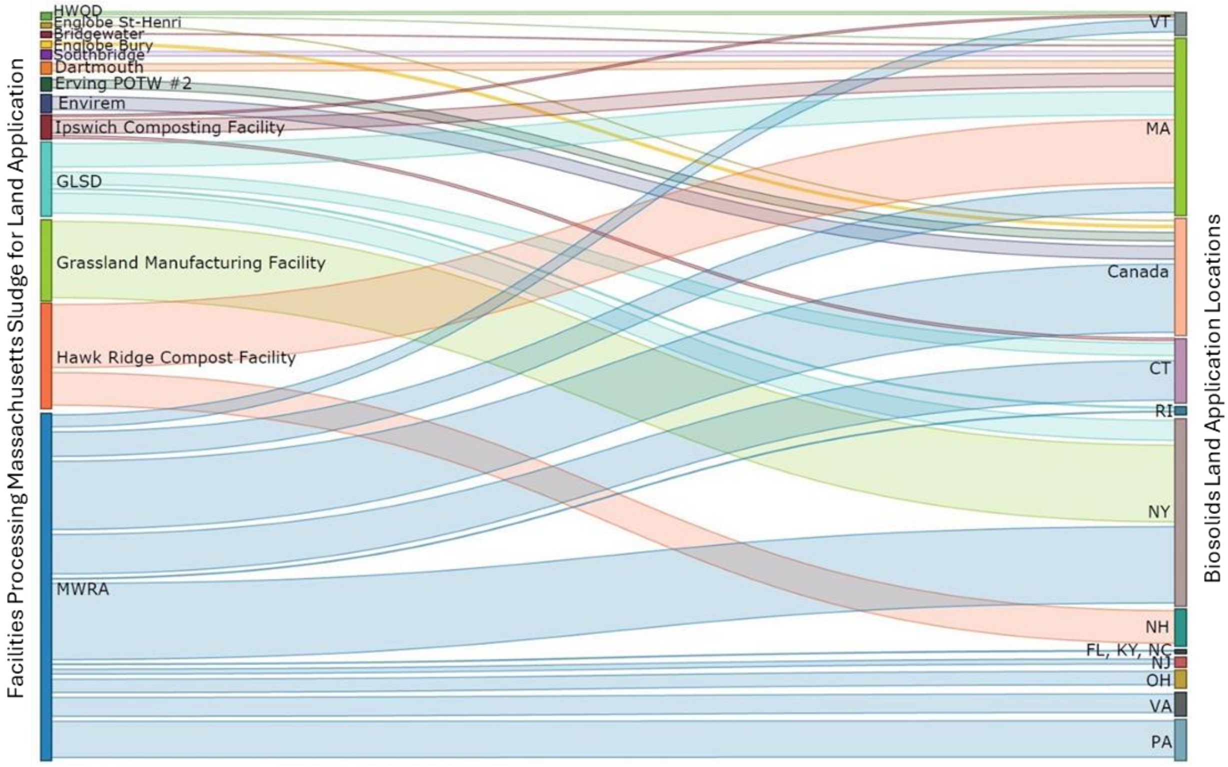


**Figure 5-5. Land application locations for Massachusetts sludge in 2023 (line thickness based on dry weight of Massachusetts sludge processed)**

As shown in Figure 5-4, Massachusetts biosolids were applied in thirteen states plus Canada in 2023. New York, Massachusetts and Canada received the most biosolids from Massachusetts, and all New England states except for Maine (which has a ban on land application of sludge) received Massachusetts biosolids. In June 2024, Connecticut passed the second sludge land application ban in the country, so compost and dried pellets produced with Massachusetts sludge will no longer be able to be distributed in Connecticut once the law goes into effect in October 2024.

Figure 5-5 depicts biosolids outlets for each biosolids processing facility processing Massachusetts sludge. A number of the larger facilities are utilizing multiple states as outlets for their biosolids product. Note that several of the biosolids processing facilities shown on Figure 5-5 also process sludge from other states, but the data presented is only for sludge generated in Massachusetts.

It is noteworthy that the Hawk Ridge facility in Unity, ME historically composted more sludge from Maine, and also land applied greater volumes of compost product in Maine. With the Maine land application ban, most Maine sludge is now landfilled, more Massachusetts sludge is composted at Hawk Ridge, and a majority of that Hawk Ridge compost is now land applied in Massachusetts. Table 5-3 provides a summary of land application data for Massachusetts biosolids from each biosolids processing facility.

| Table 5-3. Summary of Land Application Data for Sludge Produced in Massachusetts | | |
|---|---|---|
| Facility | Final Land Application Location | Dry U.S. Tons |
| Bridgewater | MA | 345 |
| Ipswich Composting Facility | MA | 1,623 |
| Ipswich Composting Facility | VT | 68 |
| Ipswich Composting Facility | CT | 17 |
| MWRA | CT | 4,267 |
| MWRA | MA | 2,739 |
| MWRA | RI | 194 |
| MWRA | VT | 1,474 |
| MWRA | Canada | 7,179 |
| MWRA | FL, KY, NC | 196 |
| MWRA | NJ | 782 |
| MWRA | NY | 7,986 |
| MWRA | OH | 1,612 |
| MWRA | PA | 3,927 |
| MWRA | VA | 2,168 |
| Hawk Ridge Compost Facility | MA | 6,647 |
| Hawk Ridge Compost Facility | NH | 3,571 |
| Grassland Manufacturing Facility | NY | 8,024 |
| GLSD | CT | 1,520 |
| GLSD | MA | 2,626 |
| GLSD | NY | 2,260 |
| GLSD | RI | 146 |
| Erving POTW #2 | Canada | 1,124 |
| Envirem | Canada | 1,587 |
| Dartmouth | MA | 992 |
| HWQD | MA | 265 |
| HWQD | VT | 14 |
| Southbridge | MA | 737 |
| Englobe Bury | Canada | 450 |
| Englobe St-Henri | Canada | 150 |

To further add historical context to changes in the land application market over recent years, the following two figures depict distribution data for dried pellet product from MWRA's Biosolids Processing Facility in Quincy, MA. Figure 5-6 shows the estimated average travel distance from Quincy, MA to land application locations. Detailed data on individual land application sites were not available, so these data were approximated based on central locations in land application states. The data indicate travel distances decreasing until 2018, and then climbing again over the past 5 years. These travel distance changes correspond to evolution in land application sites over the years, as depicted in Figure 5-7.

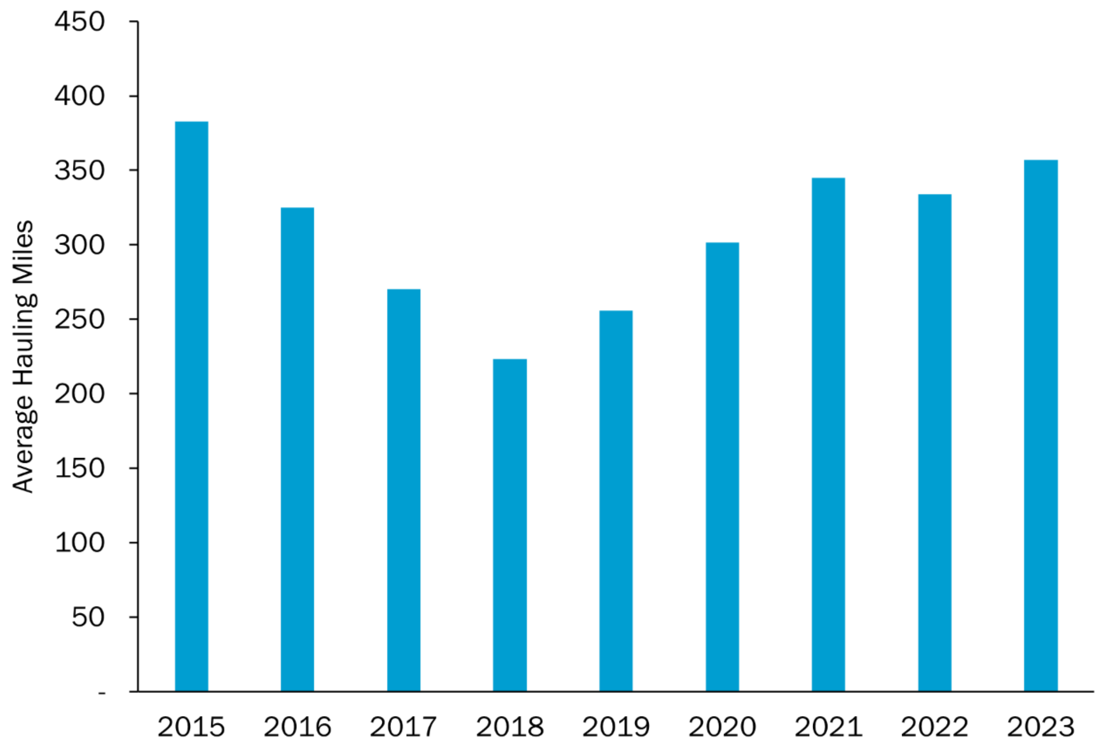


**Figure 5-6. Estimated average travel distance for MWRA dried pellets.**

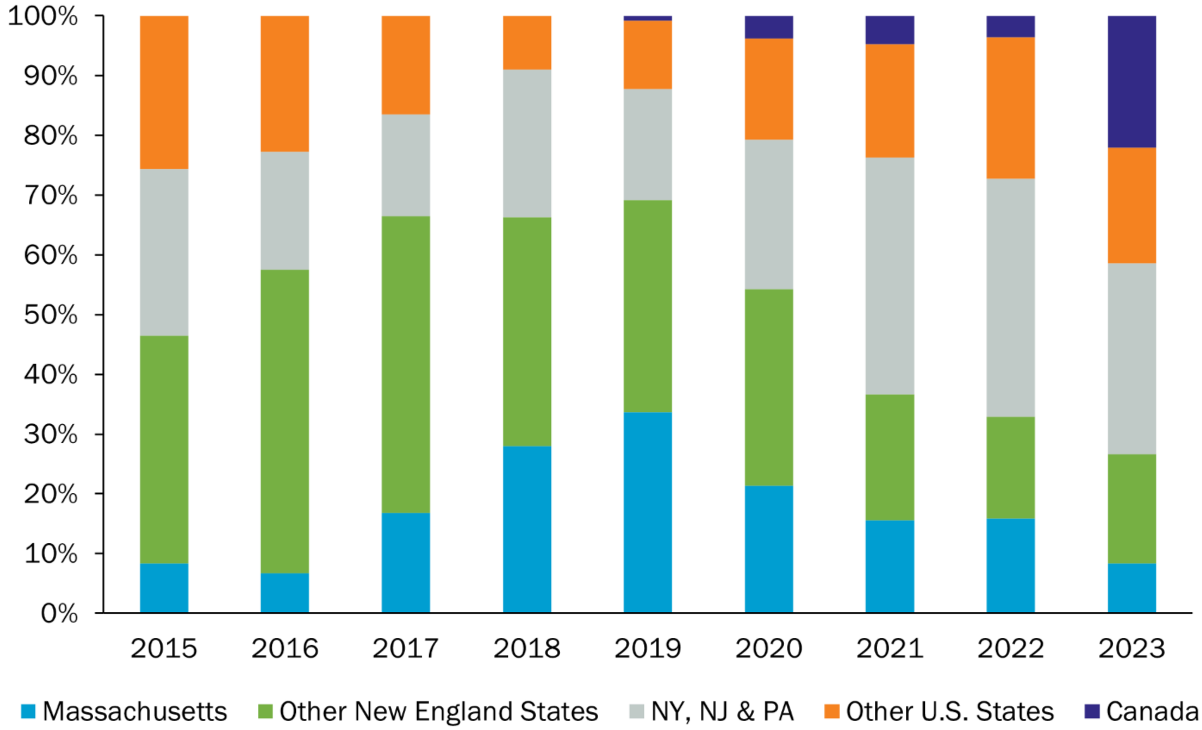


**Figure 5-7. Distribution locations for MWRA dried pellets.**

Land application of MWRA pellets in Massachusetts and New England peaked from 2017 – 2019. It is noteworthy that over 30% of MWRA pellets were land applied in Massachusetts in 2019, and almost 70% of the pellets were land applied in New England that year. By 2023, less than 30% of the pellets were land applied in New England and less than 10% were land applied in Massachusetts. The land application ban in Maine partly but not entirely accounts for this decrease. In addition, MWRA pellets were previously blended with paper mill sludge from Erving POTW #2 to produce a manufactured top soil for land application in Massachusetts, but that practice is no longer active, and Erving POTW #2 currently hauls their sludge to Canada.

Some MWRA pellets have been land applied in more distant states (Ohio, Indiana, Virginia, North Carolina, South Carolina, Georgia, and Florida) over the years, fluctuating between 10% to 25% of the total annual distribution. It is noteworthy that distribution to Canada increased to over 20% of the MWRA pellets in 2023, which appears to have offset the loss of the Maine land application market. Biosolids from the U.S. that are land applied in Canada must be registered fertilizers, Class A, and contain less than 50 ppb PFOS per the interim PFAS standard from the Canadian Food Inspection Agency.

## 5.4 Current Biosolids Processing Facility Capacity

As noted previously, 64,837 dry tons of sludge generated in Massachusetts were processed via biosolids processing facilities in 2023. For facilities located within Massachusetts, Table 5-4 summarizes current available biosolids processing facility capacity.

| Table 5-4. Current Massachusetts Biosolids Processing Facility Capacity | | | |
|---|---|---|---|
| | 2023 MA Sludge Throughput (Dry U.S. Tons/Year) | Estimated Facility Sludge Capacity (Dry U.S. Tons/Year) | Available Capacity for Additional Sludge from Other POTWs (Dry U.S. Tons/Year) |
| MWRA[1] | 32,543 | 102,492 | 0 |
| GLSD[2] | 6,215 | 8,049 | 0 |
| Ipswich Composting Facility[3] | 1,708 | 1,708 | 0 |
| Dartmouth WPC[3] | 992 | 992 | 0 |
| Hoosac WQD[4] | 744 | 1,544 | 800 |
| Southbridge WWTP[3] | 737 | 737 | 0 |
| Bridgewater WPC[3] | 345 | 345 | 0 |

*Notes:*

1. *MWRA capacity was estimated using the reported 6,500 dry pounds/train/hour design capacity, and assuming 4 operational trains and 90% uptime per train. This is consistent with the 280 dry ton per day design capacity. Available capacity at MWRA is reserved for future increases in MWRA sludge only and is not available for non-MWRA sludge.*
2. *GLSD capacity was estimated using the reported 6,000 pounds/hour evaporative design capacity per train and assuming 1 operational train and 90% uptime per train. GLSD reports there is no spare capacity for additional sludge beyond GLSD sludge and liquid sludge GLSD already receives from other POTWs.*
3. *Based on review of survey data, these Massachusetts composting facilities are assumed to be operating at capacity.*
4. *HWQD reports additional capacity for composting (up to 150 cubic yards per week). Up to 800 dry tons/year capacity is estimated to be available.*

As shown in Table 5-4, there is limited capacity for additional sludge to receive land application processing in Massachusetts. The MWRA and GLSD drying facilities have additional capacity, but that capacity is available only to MWRA communities, GLSD communities, and existing POTWs that are already hauling sludge to GLSD. MWRA and GLSD do not have available capacity for any other Massachusetts POTWs. Similarly, the Massachusetts composting facilities generally do not have available capacity to receive additional sludge cake from other Massachusetts POTWs. The one exception is the Hoosac WQD, which reports some available capacity to receive sludge from other POTWs (if between 22% and 28% solids).

For facilities located outside of Massachusetts, Table 5-5 summarizes current available biosolids processing facility capacity. Note that capacity is presented in wet tons for this table to be consistent with capacity data presented by facility operators listed below.

| Table 5-5. Current Out-of-State Biosolids Processing Facility Capacity | | | | |
|---|---|---|---|---|
| | 2023 MA Sludge Throughput (Wet Tons/Year) | Estimated Facility Capacity (Wet Tons/Year) | Estimated Available Capacity for Additional Sludge from Other POTWs (Wet Tons/Year) | Distance from Given MA Region (miles) |
| Hawk Ridge Compost Facility (Unity, ME) | 41,907 | 40,000 | 0 | 180 (northeast) |
| Grasslands Manufacturing Facility (Chateaugay, NY) | 85,316 | 90,000 | 4,684 | 270 (western) |

| Table 5-5. Current Out-of-State Biosolids Processing Facility Capacity | | | | |
|---|---|---|---|---|
| | 2023 MA Sludge Throughput (Wet Tons/Year) | Estimated Facility Capacity (Wet Tons/Year) | Estimated Available Capacity for Additional Sludge from Other POTWs (Wet Tons/Year) | Distance from Given MA Region (miles) |
| Envirem Organics Inc. (New Brunswick, Canada) | Unknown | Unknown | Unknown | 460 (central) |
| Englobe (Bury, Quebec) | 30,000 | 45,000 | 15,000 | 290 (central) |
| Englobe (St-Henri, Quebec) | 35,000 | 45,000 | 10,000 | 330 (central) |
| Resource Management Inc. (Holderness, NH) | 9,000 | 9,000 | 0[1] | 130 (central) |
| Merrimack, NH WWTF | 14,700 | 14,700 | 0 | 60 (central) |

Notes:

1. *While RMI is operating at design capacity, it operates with a blend of long-term and short-term sludge management contracts. RMI prefers long-term contracts, so there is opportunity for additional Massachusetts municipal sludge to be managed at RMI in the future.*

As shown in Table 5-5, there is some available capacity at land application biosolids processing facilities located outside of Massachusetts. Based on data received from the survey and follow-up discussions with these facilities, the estimated total available capacity is 29,684 wet tons / year (or approximately 6,500 dry tons / year assuming 22% cake solids). It is important to note that this capacity is not exclusively reserved for Massachusetts POTWs and is, in fact, likely to be desired by others in the region. In addition, there is substantial distance from Massachusetts to biosolids processing facilities that do have available capacity.

## 5.5 Future Biosolids Processing Facility Capacity Projections

Future plans reported by land application facilities processing Massachusetts sludge are summarized in Table 5-6.

| Table 5-6. Future Plans for Biosolids Processing Facilities | |
|---|---|
| Facility Name | Future Plans |
| Massachusetts | |
| Massachusetts Water Resources Authority | MWRA intends to continue thermal drying at their Quincy facility indefinitely. A major thermal drying facility upgrade is planned in the next five years. |
| Greater Lawerence Sanitation District | GLSD intends to continue thermal drying indefinitely. |
| Ipswich Composting Facility | Agresource intends to continue composting at their Ipswich location indefinitely, with plans to upgrade and/or expand operations in the future with new composting technology for more efficient operation. Expansion would require a permit modification to receive additional material. |
| Bridgewater Water Pollution Control | Bridgewater reports consideration of stopping composting operations in the next 5-10 years and transitioning to sludge cake management. |
| Dartmouth Water Pollution Control | Dartmouth reports a major compost facility upgrade is planned in the next 5-10 years. |

| Table 5-6. Future Plans for Biosolids Processing Facilities | |
|---|---|
| **Facility Name** | **Future Plans** |
| Hoosac Water Quality District | HWQD expressed concern that if MassDEP does not renew Approval of Suitability in 2026, sludge management costs would jump significantly. |
| Southbridge WWTP | Southbridge indicated they are unsure if composting will be able to continue due to marketing limitations and future PFAS regulations. |
| Erving POTW #2 | Erving Industries notes that they have considered alternative sludge management technologies such as dryers and PFAS elimination technologies for future upgrades. Concern was expressed that finding outlets for their sludge is challenging and that sludge management will become more expensive and difficult in the next 5-10 years, and that sludge management costs could impact the ability of the paper mill to stay in business. |
| Outside of Massachusetts | |
| Merrimack, NH WWRF Composting Facility | Merrimack, NH intends to continue composting indefinitely. |
| Hawk Ridge Composting Facility Unity, ME | Casella Organics intends to continue composting indefinitely. The facility is 30 years old and will soon require significant capital upgrades to continue to compost the current volume of sludge. The viability of markets for the finished compost will be critical to justify this expense. Approximately 75% of finished product is land applied in Massachusetts and any limitation in ability to sell finished product in Massachusetts will result in increased costs for Massachusetts POTWs or the inability to accept Massachusetts sludge. |
| Grasslands Manufacturing Facility Chateaugay, NY | Casella Organics intends to continue alkaline stabilization at this facility indefinitely. |
| Resource Management Inc. Facility Holderness, NH | RMI intends to continue with alkaline stabilization indefinitely, with a potential move to alternative biosolids processing technology and expansion in the future. Availability of high-quality wood ash is important, so legislation or regulation that impacts viability of wood-fired biomass facility is a concern. Facility permitting has gotten stricter over the years, and NHDES will be conducting a rule revision to sludge facility permit regulations in 2026. |
| Englobe Bury, Quebec Composting Facility | Englobe intends to operate composting operations at this facility indefinitely, with possible capacity increase in five years. |
| Englobe St-Henri, Quebec Composting Facility | Englobe intends to operate composting operations at this facility indefinitely, with possible capacity increase in five years. |

The largest biosolids processing facilities in the region (MWRA, GLSD, Hawk Ridge, Grasslands, RMI, Ipswich and Englobe) all report their intention to continue processing biosolids “indefinitely”, which is interpreted to imply into the foreseeable future. A number of these facilities also note potential for future upgrades and/or expansions. For the five-year time horizon used for future sludge projections in this study, expansions to these facilities were assumed unlikely to occur within the next five years, although they are possible in the future. Further, it is assumed that expansion of biosolids processing facilities may be contingent in some cases upon increased regulatory certainty in the coming years. Operators of larger processing facilities may be reluctant to spend significant capital on facility expansions with the current regulatory risks and unknowns. Moreover, as noted previously, these expansions largely impact the POTWs that own the processing facilities; in other words, an expansion of any of these facilities does not create new capacity for sludge from other POTWs in the region.

The smaller composting facilities located at Massachusetts POTWs (Bridgewater, Dartmouth, Ipswich, Hoosac and Southbridge) expressed greater uncertainty on future operations. As discussed in Section 5.3, these local composting facilities are generally more reliant on local markets around their POTW for distribution and are managing much of their compost product in Massachusetts, although the Hoosac WQD does have some additional distribution flexibility due to its proximity to

Vermont land application markets. As a result, these facilities are particularly susceptible to future legislative or regulatory changes, particularly any changes to land application of biosolids in Massachusetts. Further, these facilities tend to have more limited resources for biosolids marketing and distribution. When developing estimates for land application processing capacity in five years, it is prudent to assume that there will be some reduction in capacity from local POTW composters in Massachusetts.

The following list documents additional information that adds context and understanding to future biosolids processing facility capacity:

- MWRA is investigating pyrolysis for PFAS treatment.
- Springfield Water and Sewer Commission and UBCW are in the planning stages of a New England Regional Biosolids (NERB) project along with Narragansett Bay Commission (NBC) in Rhode Island. The goal of the project is to have a regional biosolids processing facility designed and possibly constructed within the next 10 years.
- The City of Fitchburg is currently pursuing a vendor for possible anaerobic digestion with gasification at the Fitchburg West WWTF, which currently functions as a pump station to direct sewage to the Fitchburg East WWTF.
- The Attleboro WWTF reported interest in a pyrolysis system in the next 5-10 years.
- The Montague water pollution control facility (WPCF), which accepts liquid sludge from a number of Franklin County POTWs for screw press dewatering at the Montague WPCF, indicated they hope to install a sludge dryer or composting system in the future with up to 8 dry ton per week capacity. Montague is currently evaluating the feasibility of these sludge management technologies.
- Westfield expressed interest in installing a thermal drying technology in the next 10 years.
- Scituate is considering sludge drying.
- A number of facilities expressed interest in new but unspecified sludge management technologies.
- Taunton has considered a drying / gasification facility, although this project is paused until permitting issues are resolved.
- Greenfield previously evaluated the feasibility of constructing a regional anaerobic digestion facility but is not currently pursuing that biosolids management approach.
- A large pyrolysis installation is in the process of obtaining permits in Moreau, NY. The facility has a reported capacity of 720 wet-tons per day of dewatered cake (equivalent to about 160 dry-tons per day at typical cake dryness) and will likely be built in phases. Since this facility has not yet obtained permits and therefore does not represent certain capacity it has not been included in future projections.

In summary, there is significant interest in advanced biosolids processing technologies, and there is reason to be optimistic that a number of projects will advance in Massachusetts and elsewhere in the 5- to 10-year window. For the purposes of this report, it is unlikely that any significant new advanced biosolids treatment processes will be constructed and fully operational in the next 5 years.

Based on 2023 data (64,837 dry tons to biosolids processing facilities) and a 2.5% increase in sludge generation from 2023 to 2028 as described in Section 2, the volume of sludge managed by biosolids processing facilities is projected to increase to 66,458 dry tons in 2028, or an additional 1,621 dry tons. Note that much of this increase is assumed to be absorbed by available capacity at the MWRA and GLSD thermal drying facilities.

For historical context in the region, it is noteworthy that three significant biosolids processing facilities in Maine are no longer operational for a variety of reasons. These facilities include the Lewiston-Auburn WPCA composting facility, the Plymouth alkaline stabilization facility, and the Brunswick Landing anaerobic digestion facility. Note that these three Maine facilities did not receive sludge from Massachusetts POTWs.

The following tables summarize projections for biosolids processing facility usage in 5 years (2028) for both municipal facilities (Table 5-7) as well as for commercially-operated facilities that accept sludge from POTWs (Table 5-8).

**Table 5-7. Future Biosolids Processing Facility Capacity Projections - Municipal Facilities**

| Biosolids Processing Facility | Estimated Massachusetts Sludge Processed in 2028 (Dry Tons/Year) |
|---|---|
| MWRA | 33,357 |
| GLSD | 6,370 |
| Massachusetts Composting Facilities[1] | 5,000 |

**Table 5-8. Future Biosolids Processing Facility Capacity Projections – Commercial Facilities**

| Biosolids Processing Facility | Estimated Massachusetts Sludge Processed in 2028 (Dry Tons/Year) |
|---|---|
| Hawk Ridge Compost Facility[2] | 10,322 |
| Grasslands Manufacturing Facility[2] | 8,024 |
| Other Biosolids Processing Facilities[3] | 3,385 |

Notes:

1. *In 2023, sludge sent to Massachusetts composting facilities totaled 5,546 dry tons. These composting facilities included Ipswich, Bridgewater, Southbridge, Dartmouth, and Hoosac Water Quality District. This study projects a slight decrease in sludge to Massachusetts composting facilities in 2027 to 5,000 dry tons. This projection is highly speculative but based on assumed challenges in finding outlets for composted product from Massachusetts composters and from potential regulatory risks. Legislation or regulations that limit land application could have significant impact on the smaller Massachusetts composting facilities and result in fewer than 5000 dry tons/year processed.*
2. *It is assumed that the Hawk Ridge and Grasslands facilities will continue to be important outlets for Massachusetts sludge in 2028 and will process the same sludge volumes as in 2023.*
3. *If 66,458 dry tons of Massachusetts sludge are sent to biosolids processing facilities in 2028, then it is projected that 3,385 dry tons must be sent to "other" biosolids processing facilities (or other management outlets). In 2023, these facilities included Canadian composting facilities managed by Envirem and Englobe.*

## 5.6 Estimated Costs for Massachusetts POTWs for Land Application

Figure 5-8 summarizes available cost data from POTWs that utilize biosolids processing facilities for sludge management. For tip fee only, costs ranged from $70 per wet ton to $100 per wet ton. For contracts covering hauling and tip fees, costs ranged from $135 per wet ton to $190 per wet ton. Hauling and processing costs are highly dependent on sludge characteristics, hauling distance, and other contractual terms. In addition, some older sludge management contracts may not fully capture the current sludge market.

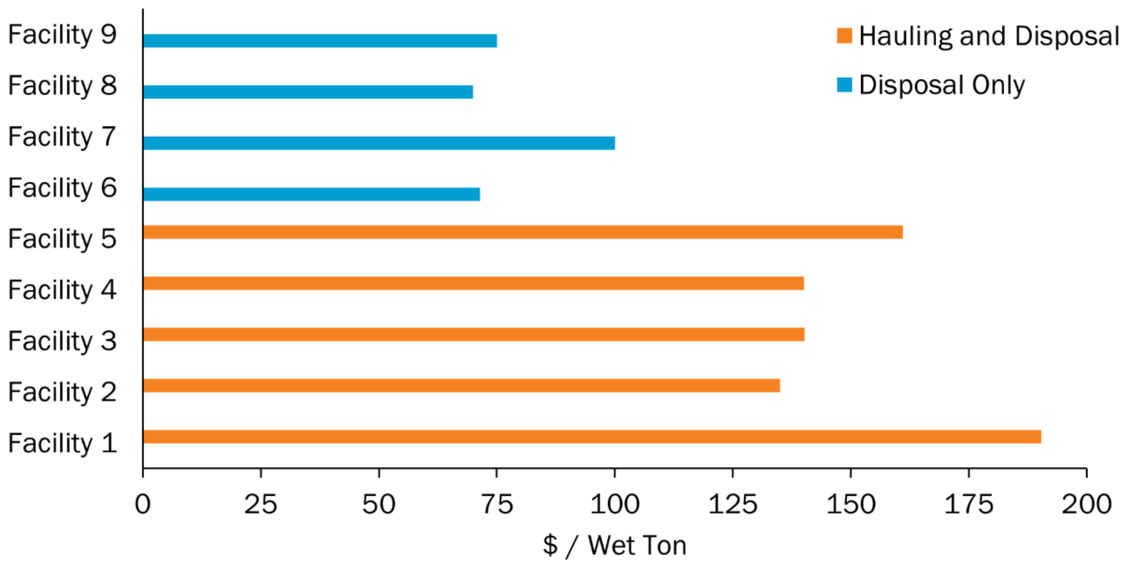


**Figure 5-8. Tip fee and hauling costs for POTWs bringing sludge to biosolids processing facilities.**

## 5.7 Other Comments and PFAS Concerns

The biosolids processing facility survey respondents expressed a variety of concerns with the current land application market, and particularly on potential impacts from regulatory or legislative changes due to PFAS in biosolids. These concerns are summarized below:

- Regulatory and Legislative Concerns
  - Multiple respondents expressed concern about ability to land apply biosolids in the future if new legislation or regulations limit land application.
  - One respondent noted that with the uncertainty of future regulations, they are hesitant to invest in larger scale upgrades.
  - One Canadian respondent noted that PFAS regulation remains a concern for both domestic biosolids and imported biosolids, and although there has not been disruption in their capacity to receive U.S. biosolids, there is an expected regulation in 2024 that will set new standards.
  - One respondent urged caution when developing standards for PFAS using compounding conservative assumptions, and that standards should be based on science and allow for sustainable biosolids recycling. Following Maine regulation of PFAS in biosolids, most other New England states are in the process of developing regulations related to PFAS. Inconsistent regulatory environments across New England creates several challenges when managing incoming biosolids from multiple states as well as maintaining permits for land application of Class A biosolids in multiple states.
- PFAS Concerns
  - Multiple respondents expressed concerns with PFAS and potential PFAS regulations.
  - Multiple respondents expressed that PFAS source elimination programs are necessary, and biosolids management facilities are passive receivers of PFAS.

  - One respondent noted that PFAS levels in their product have been declining, but that PFAS is still present.
  - One respondent noted that PFAS concerns have made it more difficult to market their biosolids product in recent years.
- Regional Biosolids Facility
  - One respondent noted that there is currently a need for a regional drying facility in New England, but it must have a municipal sponsor to go forward.
- Funding Concerns
  - One respondent noted that legislation and regulations to address PFAS that impact biosolids management facilities must address implementation costs and provide adequate funding.

## 5.8 Biosolids Processing Facilities Outside of New England

This section documents commercial biosolids processing facilities outside of New England that may have capacity to process Massachusetts sludge. Note that these facilities do not currently receive sludge from Massachusetts and a detailed evaluation of these facilities was not included in this study. The following facilities are provided to identify more distant sludge management options that may have the potential to serve Massachusetts POTWs.

**Table 5-9. Commercial Biosolids Processing Facilities Outside of New England**

| Biosolids Processing Facility | Facility Type |
|---|---|
| Denali – Rockland County, NY | Composting |
| Saratoga Biochar Solutions, Moreau, NY | Drying & Pyrolysis (In Permitting) |
| Denali – Burlington County, NJ | Composting |
| Synagro – Cumberland Co., NJ | Composting |
| McGill Fairless Hill, PA | Composting (Under Construction) |
| A&M Compost, Manheim, PA | Composting |

## 5.9 Land Application Summary

As indicated by the data presented in preceding sections, biosolids processing facilities are utilized to manage 39% of Massachusetts' total sludge volume. Management of the resulting products from these facilities is an important challenge given evolving PFAS regulations in New England states which could limit or eliminate land application as a viable outlet within the region. Thermal drying, composting, and alkaline stabilization processes at these facilities produce Class A / Type 1 product suitable for land application. The MWRA and GLSD thermal drying facilities account for the greatest volume of biosolids production within Massachusetts but are purpose-built for the communities they serve and have faced challenges in managing their products within New England. There are a number of smaller composting facilities within Massachusetts, and these facilities expressed increasing challenges in finding outlets for their compost product and are likely to be at the greatest risk for disruption from any future land application legislative or regulatory changes. The Hawk Ridge Composting Facility in Maine and the Grasslands Manufacturing Facility in New York are significant processors of Massachusetts sludge. Finally, three composting facilities in Canada were also utilized in 2023 to manage Massachusetts sludge; sludges entering these facilities will be subject to pending PFAS regulations in Canada. Note that the Quebec ban on the importation of U.S. sludge does not impact the ability of composters in Quebec to accept U.S. sludge.

Class A product produced from these facilities was widely distributed to thirteen states and Canada in 2023. The largest land application outlets for Massachusetts biosolids were New York, Massachusetts, and Canada, in that order. Class A biosolids generated by thermal drying, composting and alkaline stabilization facilities ultimately require a land application destination, and land application destinations will be highly contingent upon future PFAS regulations in the region. Increasingly stringent PFAS regulations have the potential to significantly reduce or eliminate outlets for these products, which could send them either further away or to landfill disposal, both of which have significant GHG impacts.

Biosolids processing facilities generally reported intentions to continue to operate for the foreseeable future, although some smaller composting facilities expressed concerns as noted above. Assuming the current regulatory framework remains in place, in 2028, it is projected that 66,458 dry tons will continue to be managed by land application processing technologies at MWRA, GLSD, Hawk Ridge Composting Facility, Grassland Manufacturing Facility, smaller Massachusetts composters, and Canadian composters.

# Section 6: Incineration

In the State of Massachusetts, several POTWs rely on incineration for final wastewater sludge treatment. The incineration process combusts sludge, releasing heat from the volatile solids while the inert material becomes ash. There are two incineration technologies used in this region, fluidized bed incinerator and MHI. A total of fourteen municipal wastewater facilities presently incinerate sludge in New England and New York, including two in-state and twelve out-of-state, specifically in New Hampshire, Rhode Island, Connecticut, and New York. To better understand the current and future status of these incinerators as well as their capacity, a survey was sent out in April of 2024 to all of these facilities. The survey consisted of 38 questions, which were both qualitative and quantitative and focused on the owner, operator, incinerator type, capacity, sludge acceptance from other POTWs, ash management, future incineration, and concerns of the utilities. The quantitative data received from these facilities included the practical design capacity of their incinerators, the estimated down time of each incinerator per year, the average amount of sludge incinerated annually and specifically in 2023 for each incinerator, the preferred total solids content of the sludge to be incinerated, the amount of ash produced annually, and remaining useful life expectancy of each unit. A copy of this survey is included in Appendix D.

The following assumptions were made when analyzing survey response data:

- To estimate ash production when values were not provided, it was assumed that ash produced was equal to the solids remaining after the volatile solids in the sludge were incinerated, and a volatile solids of 75% was assumed.
- If no information beyond maintenance down time and weekly down time was provided, 24/7 operation was assumed.
- Hartford, CT, a significant processor in the region, did not provide survey information so any values and information associated with their facility were taken from their website, past reports, and their Title V air permit.

Representatives for thirteen of the fourteen facilities completed the survey. A summary of the survey results is provided in Sections 6.1-6.6. The only facility listed and included in this study that did not complete the survey was the Hartford, CT facility, for which all information shown was based on publicly available information. A summary of the facilities surveyed is provided in Table 6-1.

**Table 6-1. Summary of Sludge Incinerators in New England and New York**

| Facility Name | City | State | Type of Incinerator | Capacity (dry tons sludge/day) | Accepts Outside Sludge | Reports Additional Sludge Capacity | Type of Sludge Accepted |
|---|---|---|---|---|---|---|---|
| Massachusetts | | | | | | | |
| Upper Blackstone Clean Water | Millbury | MA | Multiple Hearth | 72 | Yes | No | Liquid sludge |
| Lynn WWTP | Lynn | MA | Fluidized Bed | 26 | No | No | No outside sludge accepted |
| Other States | | | | | | | |
| New Haven WWTF* | New Haven | CT | Multiple Hearth | 43 | Yes | No | Liquid sludge |
| Naugatuck WWTF* | Naugatuck | CT | Fluidized Bed | 84 | Yes | No | Liquid sludge & dewatered cake |
| Waterbury WWTF* | Waterbury | CT | Fluidized Bed | 72 | Yes | No | Dewatered cake |
| The Mattabassett District | Cromwell | CT | Fluidized Bed | 36 | Yes | No | Liquid sludge |
| Hartford Metropolitan District | Hartford | CT | Multiple Hearth | 90 | Yes | Unknown | Unknown |
| Manchester WWTF | Manchester | NH | Fluidized Bed | 24 | No | No | No outside sludge accepted |
| Southtowns AWTF | Hamburg | NY | Fluidized Bed | 13 | No | Yes | No outside sludge accepted |
| Bird Island WWTF | Buffalo | NY | Multiple Hearth | 60 | Yes | Yes | Dewatered cake |
| Albany North | Menands | NY | Multiple Hearth | 53 | Yes | No | Liquid sludge |
| Albany South | Albany | NY | Multiple Hearth | 36 | Yes | No | Liquid sludge |
| Woonsocket WWTF* | Woonsocket | RI | Fluidized Bed | 105 | Yes | Yes | Dewatered cake |
| Cranston WWTF* | Cranston | RI | Multiple Hearth | 62 | Yes | No | Liquid sludge |
| **TOTAL** | | | | **776** | | | |

**The indicated incinerator facilities are owned by the utility and operated by either Synagro or Veolia*

Currently, there are seven incineration facilities processing wastewater sludge from Massachusetts communities, as shown in Table 6-2. The UBCW facility in Millbury, MA incinerates the most sludge in the state, the majority of which comes from central Massachusetts POTWs. The Woonsocket, RI WWTF incinerates sludge from POTWs in every region of Massachusetts, accounting for the second most sludge incinerated in the state. The Cranston, CT WWTF and the Naugatuck, RI WWTF are the third and fourth largest incinerators of Massachusetts sludge. These four facilities account for over half of the Massachusetts sludge currently being incinerated.

| Table 6-2. Massachusetts Sludge Hauled to Incineration Facilities by Region of the State Where Generated (dry US tons per year, 2023) | | | | | | |
|---|---|---|---|---|---|---|
| Incinerator | Central MA | Northeast MA | Southeast MA | Western MA | Total | % Solids Preference |
| Cranston WWTF | 2,283 | 21 | 7,065 | 823 | 10,192 | 3.5% |
| Lynn WWTP | | 5,658 | | | 5,658 | 23-28% |
| Hartford Metropolitan District | | | | 1,391 | 1,391 | Unknown |
| Woonsocket WWTF | 1,736 | 1,301 | 9,929 | 707 | 13,673 | 24-26% |
| Waterbury WWTF | 158 | 574 | | 3,316 | 4,047 | 20-25% |
| Upper Blackstone Clean Water | 17,988 | | 171 | | 18,159 | 4.2-7.0% |
| Naugatuck WWTF | | | 6,383 | 1,433 | 7,816 | *See Below |
| **TOTAL** | **22,165** | **7,554** | **23,547** | **7,671** | **60,936** | - |

**Naugatuck WWTF's preferred solids range for incineration is 3-7% for liquid sludge and 18-25% for cake.*

Figure 6-1 shows a map of incineration facilities processing Massachusetts sludge. Significant incineration facilities are located in Massachusetts, Rhode Island, and Connecticut, and incineration serves POTWs across the state. From a regional perspective, it is noteworthy that the Rhode Island incinerators are primarily receiving liquid sludge from Massachusetts POTWs, while Connecticut incinerators are primarily receiving dewatered cake.

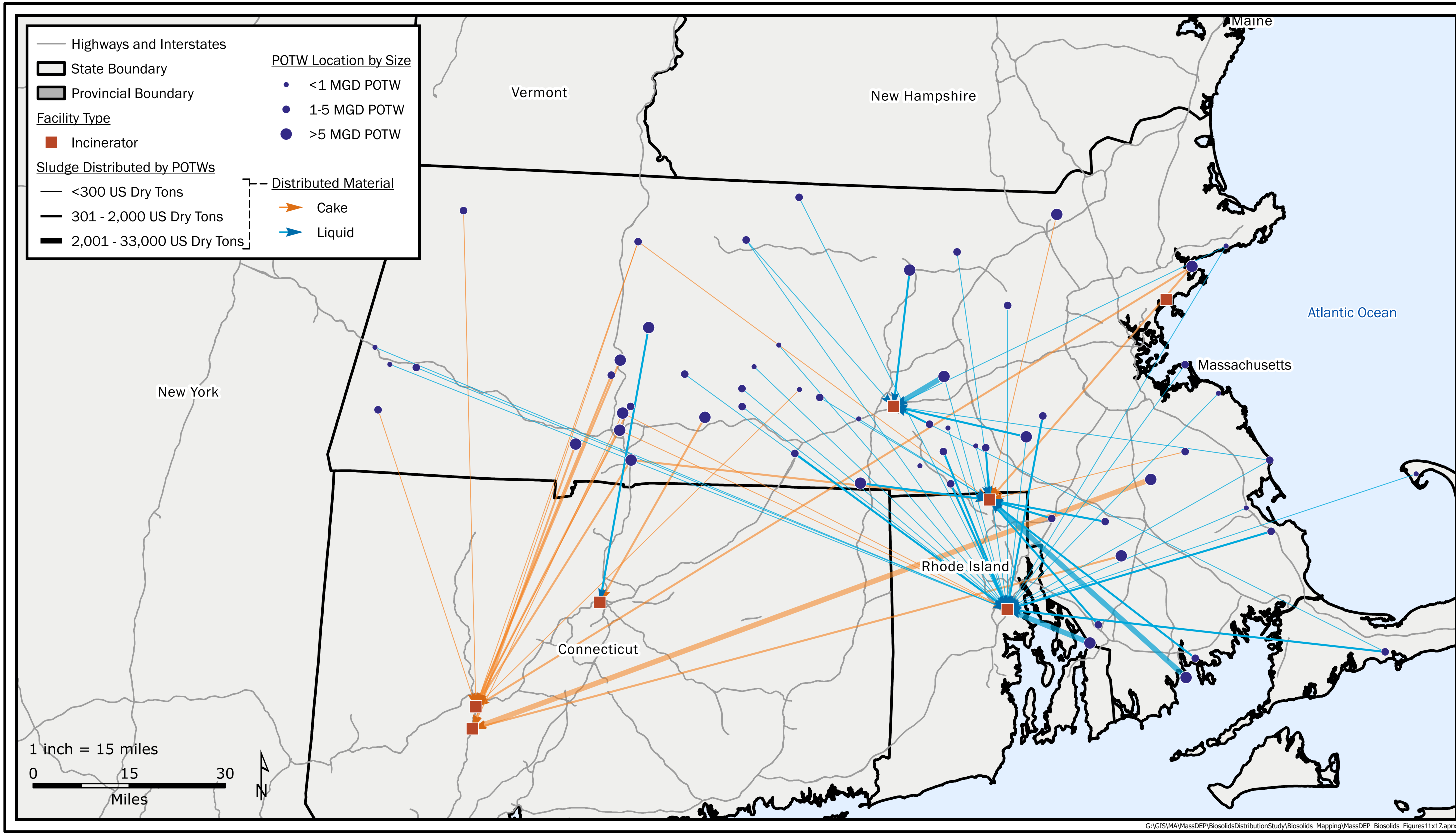


**Figure 6-1. Map of Incineration Sludge Management**

*Note: This map does not depict onsite sludge management. See Table 3-4 for Massachusetts wastewater sludge managed at its POTW of origin in 2023.*

## 6.1 Summary of Massachusetts Incineration Facilities

There are currently two sludge incineration facilities operating within the state of Massachusetts, one in Millbury, MA and one in Lynn, MA.

**Upper Blackstone Clean Water, Millbury, MA***:* The UBCW facility in Millbury, MA is operated by UBCW and is the larger of the two operating incineration facilities in Massachusetts with a treatment capacity of 72 dry U.S. tons per day. UBCW has two MHIs onsite, one of which is run continuously while the other remains as backup in case of performance issues. In 2023, UBCW incinerated 18,159 dry tons of Massachusetts sludge. The facility accepts sludge from other POTWs, but is currently operating at capacity, meaning they will not be able to accept additional sludge now or in the future unless additional capacity is added. Air permit limitations set a permitted capacity for Upper Blackstone of 115 dry tons of sludge incinerated per day, which is well above their treatment capacity. Facilities bringing sludge to UBCW must be permitted with the facility. All hauled-in, outside sludge is tested quarterly for metals. The solids content of their sludge is limited to a range of 4.2 to 7.0% total solids and every load is tested for total solids. The sludge feed to the incinerator (including UBCW and outside sludge) is tested quarterly for metals. UBCW rarely has a full facility outage, as they use their second incinerator as a backup, but when they have a planned outage, they notify participating wastewater facilities 1-2 weeks prior.

**Lynn, MA***:* The second in-state incineration facility is located at the Lynn WWTP and owned by the Town of Lynn's Water and Sewer Commission. Lynn WWTP operates a fluidized bed incinerator which runs 42 weeks per year with a treatment capacity of 26 dry U.S. tons per day. In 2023, the facility incinerated 5,658 dry tons of Massachusetts sludge. Lynn WWTP does not accept sludge from other POTWs and has no additional capacity available for incineration now or in the future.

**Brockton, MA***:* In addition to these two facilities, another incineration facility located in Brockton, MA was decommissioned in January of 2018. This facility had a treatment capacity of 55 dry U.S. tons per day.

## 6.2 Summary of Out-of-State Incineration Facilities

### 6.2.1 Connecticut

There are five incineration facilities in the state of Connecticut.

**Hartford Metropolitan District (MDC)**: The Hartford MDC operates the largest incineration facility in Connecticut. Hartford did not respond to the survey request for this study, but the facility has a maximum incineration limit of 21,060 dry tons of wastewater sludge per year as dictated by their Title V air permit. The facility consists of three MHIs. For the purposes of this study, the Project Team assumed two incinerators operate continuously at partial capacity, with the third as a backup. The Project Team also assumed that the incinerators are closed for upgrades/maintenance an average of 14 days per year; this value was not listed in the survey results, so it is based on the average downtime reported by MHI facilities. The facility accepts sludge from other POTWs, totaling 1,391 dry tons from Massachusetts in 2023, and it is unknown whether they have available capacity for additional sludge.

**Greater New Haven Water Pollution Control Authority (GNHWPCA)**: This POTW in New Haven, CT is owned by the Greater New Haven Water Pollution Control Authority and operated by Synagro. This facility has one MHI onsite, which has a treatment capacity of roughly 43 dry U.S. tons per day. The Project Team assumed that the facility operates this incinerator continuously, and the facility reported that they typically shut down the incinerator for 14 days per year. The GNHWPCA incinerator accepts sludge from other POTWs but does not currently have the ability to process additional wastewater sludge. They also noted that the facility rarely accepts out–of-state sludge. The facility requires that any sludge received has a total solids content ranging from 4 to 6%. When their incinerator is out of service, the facility sends sludge to an alternative incinerator or landfill. The facility plans to upgrade their incinerator in the next 5–10 years and continue incinerating indefinitely.

**Naugatuck, CT**: Veolia operates an incinerator at the Naugatuck WWTF in Naugatuck, CT. This incinerator has an operating capacity of 84 dry U.S. tons per day. The facility is owned by the utility and operates continuously with planned shut-downs for two weeks every three years, as well as eight hours per month for planned maintenance. On average, this facility incinerates 27,400 dry tons of sludge per year. In 2023, they incinerated 7,816 dry tons of Massachusetts sludge. The facility's permit limit requires that they do not incinerate more than 30,660 dry tons per year (DTPY). The facility also accepts sludge from a total of 46 different facilities but does not currently have capacity to accept additional wastewater sludge for incineration. By contract, the facility is required to reserve 60% of their incinerator capacity for Veolia's contracts with other POTWs.

**Waterbury, CT**: The City of Waterbury, CT owns a fluidized bed incinerator unit which is operated by Synagro. Their incineration unit was built in 1996 and has a treatment capacity of 72 dry U.S. tons per day, and the system is operated continuously and with ten days offline per year for system maintenance. The facility is limited to 72 dry U.S. tons per day or 3 dry tons per hour on a 12-month rolling average basis. In 2023, Waterbury's incinerator was responsible for the incineration of 4,047 dry tons of Massachusetts sludge. The Waterbury incinerator only processes dewatered sludge cake with percent solids ranging from 20 to 24%, but the facility will accept sludge so long as it is safe to transport or has greater than 14% solids. The system is currently operating at capacity and cannot accept additional sludge. The facility plans to upgrade their incinerator in the next 5 to 10 years and continue incinerating indefinitely.

**Mattabassett District, Cromwell, CT**: The Mattabassett District in Cromwell, CT owns and operates a fluidized bed incinerator, which was installed in 2015 and has a treatment capacity of 36 dry U.S. tons per day. They typically run the incinerator continuously, with a four-hour shut-down every two weeks and approximately four weeks per year. They are limited by permit to incinerating a maximum of 13,140 dry tons of sludge over any consecutive twelve-month period. The Mattabassett District incinerates sludge from twelve different POTWs across the state of Connecticut, and they place no contractual or practical limitations on the sludge coming from these POTWs. The system is currently operating at capacity and cannot accept additional sludge.

### 6.2.2 New Hampshire

**Manchester, NH:** The City of Manchester, NH owns and operates a fluidized bed incinerator, which has a treatment capacity of roughly 24 dry U.S. tons per day. Their incinerator runs seven days on, two days off, with roughly a month and a half of down time per year. The amount of sludge they are permitted to incinerate varies based on the throughput during stack testing. This facility does not accept sludge from other POTWs and does not currently have additional capacity for sludge incineration.

### 6.2.3 New York

**Southtowns Advanced Water Treatment Facility (Hamburg, NY)**: Southtowns Advanced Water Treatment Facility in Hamburg, NY owns and operates two fluidized bed incinerators, which have a treatment capacity of 10 dry U.S. tons per day each. The facility typically operates one incinerator 75% of the time and both incinerators 25% of the time. The incinerators operate continuously, with roughly 16 hours of down-time for maintenance each month and 3-4 weeks of down-time for maintenance in a typical year. Southtowns' Title V air permit limits incineration to a maximum of 10.33 dry U.S. tons per day. The Southtowns facility does not accept sludge from other POTWs, but reports having roughly 8 dry U.S. tons per day of treatment capacity available.

**Buffalo Sewer Authority (Buffalo, NY)**: The Buffalo Sewer Authority owns and operates two MHIs at their Bird Island treatment facility in Buffalo, NY. They typically run one incinerator at a time, which has a treatment capacity of 60 dry U.S. tons per day. The incinerators run continuously, and in a typical year, have a down-time of one and a half months. The air permit limits processing capacity based on stack testing, which has allowed them to process anywhere from 45 to 60 dry U.S. tons per day. The Bird Island facility accepts sludge from other POTWs, but capacity varies based on stack testing limits.

**Albany County Water Purification District (Albany, NY)**: The Albany County Water Purification District currently owns and operates two facilities with incinerators, one in Menands, NY which they refer to as the "North Plant" and a second in Albany, NY, which they refer to as the "South Plant". Both facilities have two MHIs, of which they operate one at a time. The North Plant incinerators have a treatment capacity of 53 dry U.S. tons per day, and one is typically operated 24 hours per day, five days per week. The South Plant incinerators have a treatment capacity of 36 dry U.S. tons per day, with a typical operational time of three days per week. Albany County has plans to decommission the South Plant incinerators, as they will be consolidating incineration at the North Plant. The facilities can currently accept sludge from other POTWs, but report having no additional capacity for sludge incineration at this time.

### 6.2.4 Rhode Island

**Woonsocket, RI**: The City of Woonsocket, RI owns a facility with two MHIs, which are operated by Synagro. The incinerators each have a treatment capacity of 105 dry U.S. tons per day. It was assumed for the purposes of this study that the facility runs one incinerator continuously. The facility reported a total down-time of two weeks per year for maintenance. The facility is limited to incinerating 105 dry U.S. tons per day based on their air permit, and they accept sludge from other POTWs for incineration. In 2023, the Woonsocket incinerator was responsible for the incineration of 13,673 dry tons of Massachusetts sludge, the second largest portion of incineration for the state. In their service response, they reported having minimal additional capacity for incineration, but due to ongoing odor complaints, traffic, and handling issues, a resolution was approved by Woonsocket City Council on May 4, 2024, which declared the city will stop accepting liquid sludge in the future. Currently, roughly 31 dry U.S. tons per day of the sludge incinerated at this facility is liquid sludge. The other incineration facilities currently accepting liquid sludge do not report having additional capacity, meaning 31 dry U.S. tons per day of liquid sludge will need a new management method in the future. However, this may open up 31 dry U.S. tons per day of additional capacity for dewatered sludge incineration at this facility, depending on if they are able to continue incinerating at their current volume.

**Cranston, RI**: The City of Cranston, RI owns a facility with two MHIs, which are operated by Veolia. The first MHI has a treatment capacity of 18 dry U.S. tons per day and the second has a treatment capacity of 44 dry U.S. tons per day. The first incinerator has roughly 100 days of down-time annually, and the second has roughly 40 days of down-time annually. In 2024 Cranston's incinerator was responsible for the incineration of 10,192 dry tons of Massachusetts sludge. Cranston's permit limits are set based on their stack testing, which change periodically. The Cranston facility currently incinerates sludge from POTWs in Massachusetts, Connecticut, and Rhode Island, however they do not have any additional capacity for sludge incineration at this time.

## 6.3 Current and Future Incineration Capacity

The total installed capacity in the New England and New York states surveyed was roughly 775 dry U.S. tons per day at the time of the survey. In 2023, these facilities incinerated a total of 416 dry U.S. tons per day of sludge. The total installed capacity of the facilities which accept sludge from other POTWs is 710 dry U.S. tons per day. In 2023, the facilities accepting sludge from other POTWs incinerated a total of 432 dry U.S. tons per day of sludge. Note that the maintenance and annual run-time varies for each of these facilities, and some facilities reported permitting requirements that can limit their throughput. For these reasons, the amount of sludge that these facilities are able to incinerate may be less than their total installed capacity. These facilities have all reported that they are operating at or just below their incineration capabilities. **Overall, there is very little additional capacity for incineration in these facilities**.

There are two facilities which accept sludge from other POTWs that reported having additional capacity—the Woonsocket, RI WWTF and the Bird Island WWTF in Buffalo, NY. The Bird Island facility has a capacity of roughly 60 dry U.S. tons per day of treatment and the Woonsocket facility has a capacity of 105 dry U.S. tons per day of treatment. Both facilities were not able to estimate their available capacity at the time of this survey but reported it as minimal. The Bird Island facility can accept more sludge based on its stack testing limits, and the Woonsocket facility has minimal capacity available. To include these facilities in the future regional capacity analysis, the additional capacity for each of these facilities was assumed to be 2 dry U.S. tons per day. Figure 6-2 provides a summary of the capacities of the incinerators that treat Massachusetts sludge and how they compare to other facilities. Note that this figure shows the capacity with an assumed 24 hour per day operation unless otherwise specified by the facility. The Southtowns AWTF in Hamburg, NY estimated having approximately 8 dry U.S. tons per day of additional capacity for sludge incineration but does not accept outside sludge. Eleven of these facilities reported having no additional capacity for sludge incineration, with the other three reporting only minimal capacity.

As noted in the sections above, a sludge increase of 2.5% is expected over the next five years due to population growth in Massachusetts. Assuming this value is similar for the surrounding states, incinerators that accept sludge from external POTWs would have to process roughly 146,600 dry tons of sludge in the year 2028, or an additional 9.8 dry U.S. tons per day to meet the same sludge processing proportion for the region that they did in 2023. Given the total estimated additional incineration capacity for external sludge for the region as a whole is currently 4 dry U.S. tons per day, the growth in Massachusetts sludge will not be able to be handled by incineration facilities at current levels.

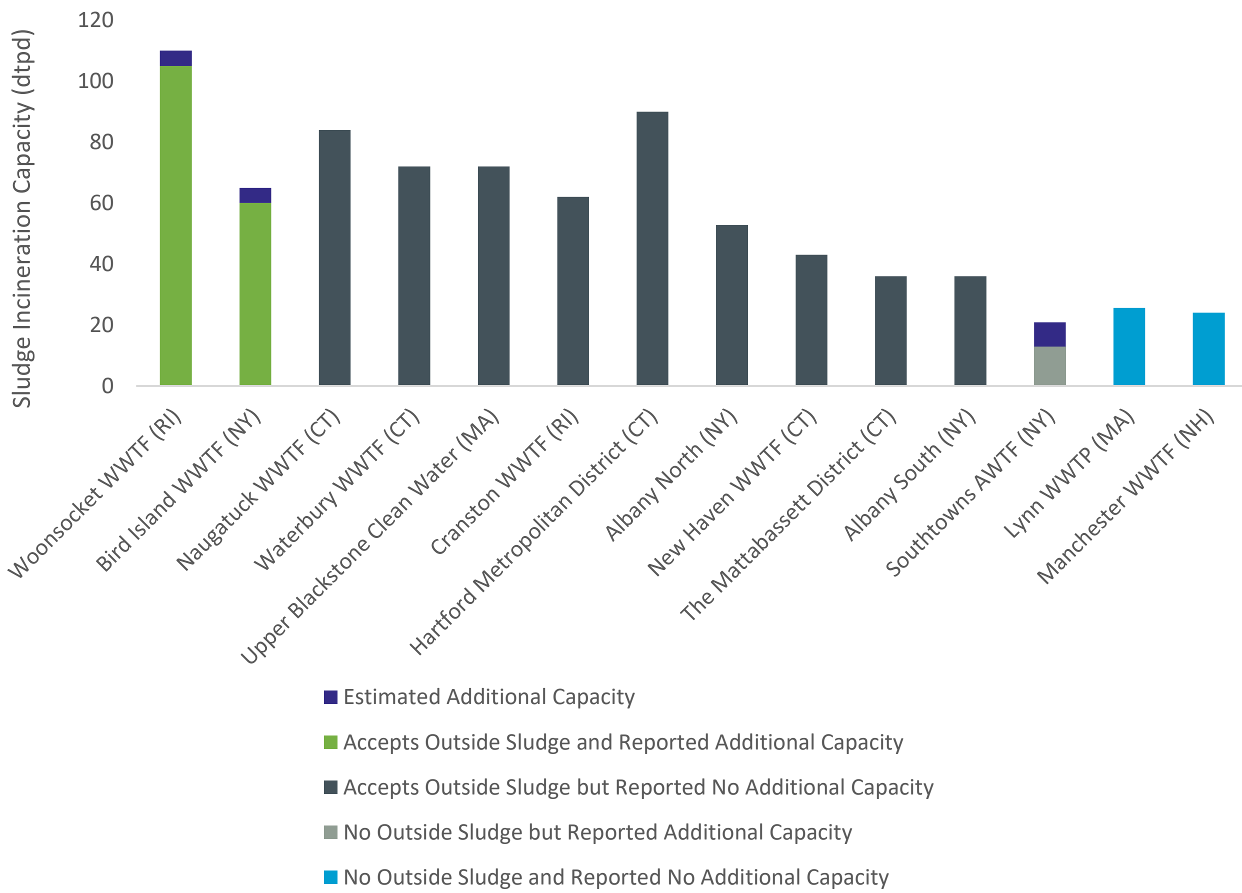


**Figure 6-2. Total capacity of sewage sludge incinerators in New England and New York and ability to accept outside sludge.**

Most of the facilities currently operating in New England and New York reported having no additional capacity for incineration. The incineration survey requested an estimate of the remaining useful life of these incinerators from each facility contacted. The remaining useful life of the incinerators in their current condition, as well as their estimated remaining useful life after upcoming upgrades is shown in Table 6-3. The Waterbury WWTF and New Haven WWTF incinerators as well as Lynn WWTF's incinerator will undergo upgrades within the next 5-10 years which will increase the remaining life of their incinerators by an estimate of 20 years each. Note that these upgrades will not increase the capacity of the incineration units. The Southtowns AWTF's incinerators are estimated to have at least 10 years of remaining useful life, based on data from ongoing projects BC have with this facility. The Cranston WWTF could not provide a definite estimate of the remaining useful life of their incinerators, and Hartford, CT did not provide an estimate for this report. UBCW is evaluating long-term biosolids management options, potentially collaborating with Springfield Water and Sewer Commission and the Narragansett Bay Commission on construction of a regional biosolids management facility within 10 years. It is presumed that Upper Blackstone's incineration facility will be decommissioned if/when they construct an alternative biosolids management facility.

| Table 6-3. Remaining Useful Life of Incinerators | | |
|---|---|---|
| Facility Name | Remaining Useful Life at Current Conditions (Years) | Remaining Useful Life with Future Upgrades (Years) |
| New Haven WWTF | Unknown | N/A |
| Naugatuck WWTF | 20 | N/A |
| Waterbury WWTF | 6 | 25 |
| The Mattabassett District | 23 | N/A |
| Upper Blackstone Clean Water | 15 | N/A |
| Lynn WWTP | 1 | 21 |
| Manchester WWTF | 5 | N/A |
| Southtowns AWTF | BC estimate >10 years | |
| Bird Island WWTF | 25 | N/A |
| Albany North | 30 | N/A |
| Albany South | 30 (scheduled to be decommissioned) | 30 (scheduled to be decommissioned) |
| Woonsocket WWTF | 28 | N/A |
| Cranston WWTF | Indefinite | |
| Hartford Metropolitan District | Unknown | |

The facilities surveyed provided a list of several major drivers affecting the continuation or discontinuation of their incineration systems. The most common of these included regulatory requirements, costs of maintaining the incinerators, costs of hauling to landfills, and limited disposal options. Current regulatory requirements which are influencing the continuation of incineration at these facilities include PFAS and GHG emission legislation, as well as general air permitting legislation including Title V permits. Additionally, future changes from EPA or state legislators could prove challenging for these facilities. The biggest concern these facilities have with current and future incineration is capacity. New England has limited disposal options, which puts a lot of pressure on incinerators and makes any potential downtime of large incinerators risky, as there will be limited places to take the sludge. The Massachusetts sludge sector has experienced significant disturbances in recent years due to unplanned outages at regional incineration facilities, which highlights the critical importance of these incineration facilities to the overall sludge market.

Almost all of these facilities plan to continue incineration indefinitely and will upgrade as necessary to continue operating. Albany, NY will be decreasing their incineration capacity when they shut down their South Plant incinerators. Another facility in West Haven, CT will be looking into rehabilitating their incinerator during an upcoming capital improvement project. Their fluidized bed incinerator was decommissioned in 2017 and had a capacity of roughly 54 dry U.S. tons per day. It is assumed that if this incinerator is rehabilitated, it will have the same treatment capacity as before. Overall, there is very little capacity for sludge incineration available, and while the West Haven facility could potentially accept more in the future, this would not be enough to account for Massachusetts solids projections.

## 6.4 Ash Management

The solid byproduct of incineration is ash, which generally consists of the solids remaining after the volatile solids have burned away. For the purposes of this study, when ash production was not reported by those surveyed, an estimate of their ash production was calculated using the annual average sludge incinerated with an estimated volatile solids content of 75%. In total, the incinerators in this region produce roughly 40,000 tons of ash per year. Of this number, 32,000 tons of ash are landfilled, and 8,000 tons are beneficially reused as landfill daily cover. See Table 6-4 below for a detailed summary of the ash produced by each facility in DTPY. Note that these ash volumes were not accounted for in the landfill sludge analysis because ash is treated as different from sludge by landfills as it is not classified as a "wet waste" and has fewer stability, odor and handling issues.

**Table 6-4. Annual Incinerator Ash Production Per Facility**

| Facility Name | Annual Ash Production (DTPY) | Beneficial Ash Reuse | Ash Use in Landfill |
|---|---|---|---|
| New Haven WWTF | 1,125 | No | Disposal |
| Naugatuck WWTF | 6,159 | No | Disposal |
| Waterbury WWTF | 5,000 | Yes | Daily Cover |
| The Mattabassett District | 3,000 | No | Disposal |
| Upper Blackstone Clean Water | 5,660 | No | Disposal |
| Lynn WWTP | 735 | No | Disposal |
| Manchester WWTF | 650 | Yes | Daily Cover |
| Southtowns AWTF | 1,000 | No | Disposal |
| Bird Island WWTF | 2,464 | No | Disposal |
| Albany North | 1,676 | Yes | Daily Cover |
| Albany South | 761 | Yes | Daily Cover |
| Woonsocket WWTF | 2,084 | No | Disposal |
| Cranston WWTF | 4,055 | No | Disposal |
| Hartford Metropolitan District | 5,265 | Unknown | Unknown |

## 6.5 Estimated Costs for Massachusetts POTWs to Incinerate

POTWs pay a tip fee to incineration facilities that process their sludge, which is typically used to pay for the cost of running and maintaining the incinerator as well as to generate revenue for the facility. As demand for incineration and operating costs have increased, tip fees have also increased. Most incineration facilities noted that tip fees are continuously changing according to operations costs, so it is difficult to define a specific cost associated with incineration. An incineration facility in Massachusetts reported that for sludge which contains over 4.2% solids, they charge $386 per dry ton for the first 50 dry tons each month, then $323 per dry ton for additional sludge. For sludge with solids content below 4.2% solids, they bill it as septage at $0.12 per gallon.

In the *POTW Sludge Management Survey*, 26 Massachusetts POTWs reported spending between $0.09 and $0.34 per gallon for hauling and tip fees to send liquid sludge to incineration facilities in 2023 (average: $0.19 per gallon). For cake, the hauling and tip fee cost reported by 24 POTWs in the survey was $118-$203/wet-ton (average: $153/wet-ton). These values are similar to the cost of landfilling cake, which ranges from $115-$205/wet ton (see Section 4.6).

## 6.6 Incineration Summary

Sludge incineration is responsible for processing roughly 37% of sludge from Massachusetts POTWs. In 2023, this value was equal to roughly 60,000 dry U.S. tons of sludge. Incineration capacity is nearly at its limit in the region, with only three facilities reporting additional capacity for an estimated total of 10 dry U.S. tons per day of additional capacity. Note that this additional capacity is a regional estimate and would not be available solely to Massachusetts POTWs. The Woonsocket, RI and Naugatuck, CT facilities treat the highest volume of wastewater sludge in the region. The Naugatuck facility is operating at capacity, and the Woonsocket facility has minimal capacity for additional sludge acceptance. Only two facilities accept sludge from other POTWs and report having a small amount of additional capacity, including the Woonsocket, RI facility and the Buffalo Bird Island, NY facility. When these facilities are out of service due to unpredictable system failures, they either send their additional sludge to other incinerators in the area, or directly to landfills due to capacity limitations.

In total, the incinerators in this region produce roughly 40,000 tons of ash per year. Of this number, 32,000 tons of ash are landfilled, and 8,000 tons are beneficially reused as landfill daily cover.

Incineration facilities generally reported that they intend to continue incineration indefinitely, however most had concerns about future regulatory and permitting requirements, particularly regarding air quality and PFAS. The facilities with incinerators that are nearing the end of their remaining useful life, including the Waterbury, New Haven, and Lynn incinerators, plan to upgrade their systems in the next 5-10 years to extend the life of the incinerators by roughly 20 years each. Note that these upgrades will not increase the capacity of these incinerators. The only potential for an increase in incineration capacity planned for this region in the near future is West Haven WWTP's incinerator rehabilitation, which is still being studied for its feasibility, and would increase the total incineration capacity in the region by 54 dry U.S. tons per day. That said, the South Plant in Albany, NY will be closed in the coming years and consolidated into the North Plant. This consolidation will not include incineration, meaning the region will experience a loss of roughly 36 dry U.S. tons per day of sludge incineration capacity. Overall, there is very little additional capacity for incineration in the region, and incinerators are struggling to meet the demands of the current sludge production volumes.

# Section 7: Analyses

## 7.1 Mass Balance Analysis of Sludge Production and Management Locations

### 7.1.1 Current Conditions

Figure 7-1 summarizes sludge management in Massachusetts in 2023. Refer to Appendix G for a complete mass balance summary of all sludge produced in Massachusetts and the sludge management location utilized. In Figure 7-1, the referenced land application locations refer to the final locations where biosolids are land applied, not locations of the biosolids processing facilities.

Key takeaways from Figure 7-1 include the following:

- The diversity of sludge management strategies utilized in Massachusetts is a relative strength as there is not an over-reliance on any single technology or outlet location.
- Incineration is a critical strategy for sludge management in Massachusetts, with large volumes of sludge incinerated in Rhode Island, Massachusetts and Connecticut.
- Massachusetts biosolids are land applied in a wide range of locations, led by New York, Massachusetts and Canada. While the diversity of land application sites is a benefit, land application is at risk from future legislative or regulatory changes. Reduction or loss of any land application location would require hauling of biosolids to more distant sites, increasing costs and GHG emissions.
- Landfilling is not a dominant sludge management strategy for Massachusetts, but it is not insignificant. Landfills in Massachusetts and Vermont each account for more than 10% of Massachusetts sludge management in 2023.

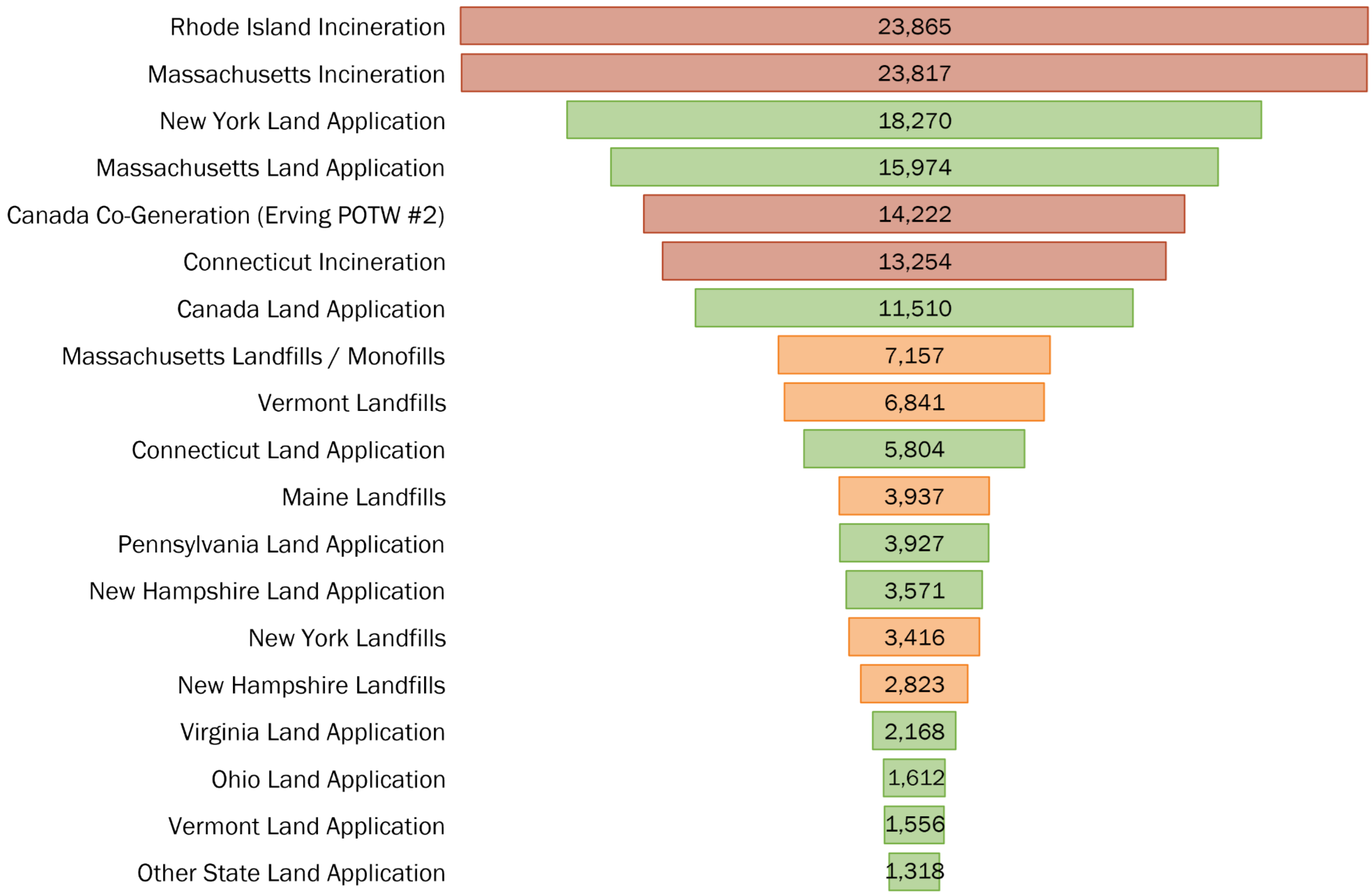


**Figure 7-1. Summary of Massachusetts Sludge Management by Location and Management Type (2023)**

*(Dry U.S. Tons. Red: incineration; green: land application; orange: landfills/monofils)*

### 7.1.2 Anticipated Future Conditions

Figure 7-2 summarizes projected future sludge management conditions in 2028 as compared to 2023 data. As noted in earlier sections of this report, the following assumptions were made in developing these projections:

- Sludge production in Massachusetts is projected to increase by approximately 2.5% from 2023 to 2028, consistent with anticipated population growth based on historical trends.
- Incineration capacity is assumed to remain unchanged from 2023 to 2028. This report assumes that no new incineration capacity will be constructed in the next five years, but that existing incinerators will continue to process Massachusetts sludge at approximately existing capacities.
- Landfill capacity for Massachusetts sludge will decrease from 2023 to 2028, as summarized in Section 4.
- MWRA and GLSD will process slightly more sludge than in 2023 from their member communities, consistent with the 2.5% sludge production increase noted above.
- Sludge production from Erving POTW #2 will remain unchanged from 2023 to 2028, as the majority of solids generated by this facility are associated with the adjacent paper mill. In 2028, it was assumed that all Erving POTW #2 sludge will be sent to the Quebec co-generation facility that processed the majority of their sludge in 2023. Further, it was assumed that the land reclamation site in Quebec that received some Erving POTW #2 sludge in 2023 will not be used in 2028 due to the Quebec land application restrictions.
- The overall throughput of smaller Massachusetts composters is projected to decrease from 5,546 dry tons processed in 2023 to 5,000 dry tons processed in 2028. This projected decrease is based on consistent challenges expressed by smaller Massachusetts composting facilities in finding outlets for their compost product in 2023. In addition, some small composters expressed concerns on potential legislative or regulatory change impacts on their ability to find compost outlets. Therefore, this report has assumed a slight decrease in composting usage from smaller Massachusetts facilities. However, this assumption is speculative and highly reliant on any actual legislative or regulatory changes implemented in the next five years.

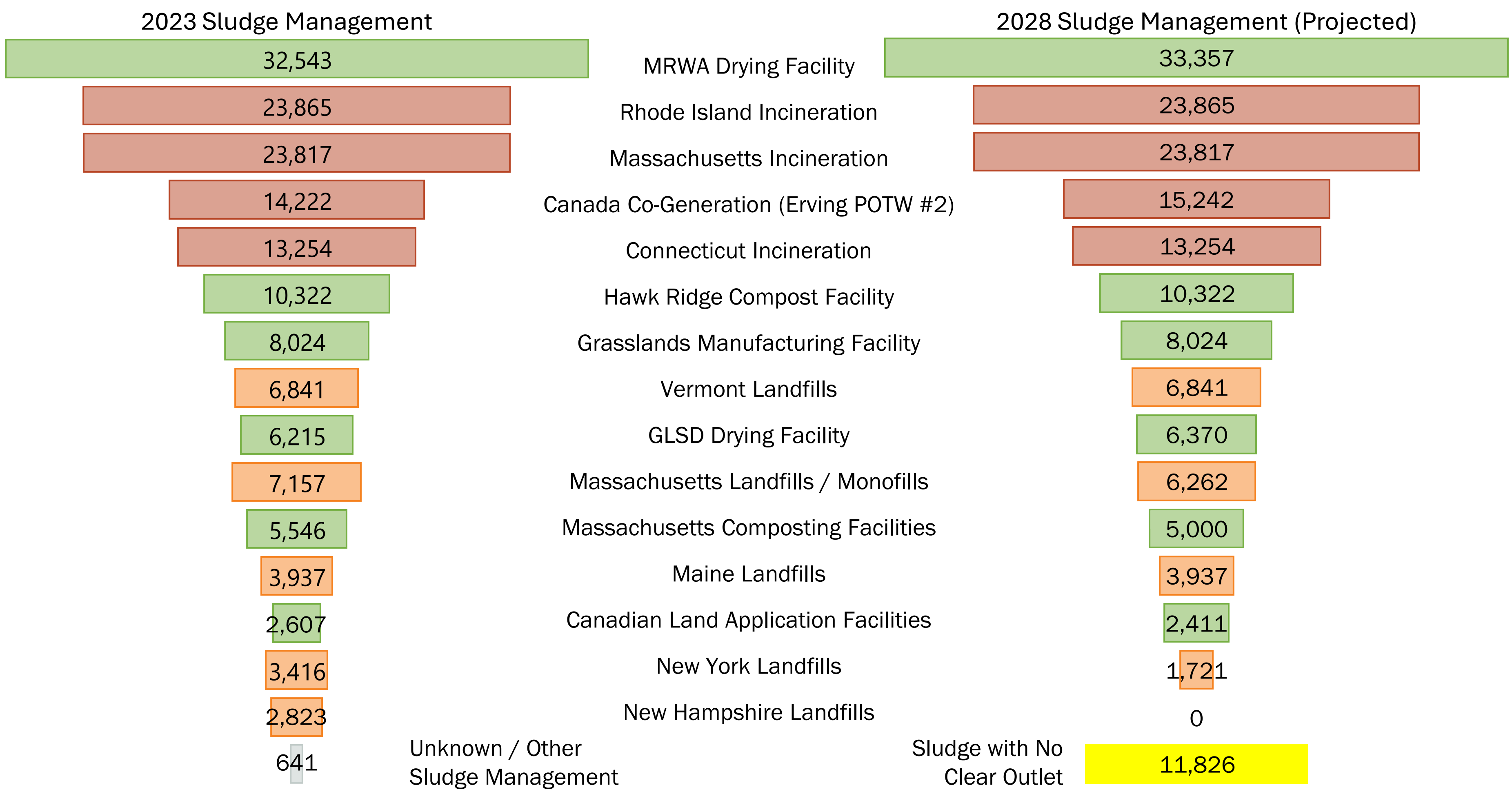


**Figure 7-2. Massachusetts Sludge Management in 2023 and 2028 (Projected) by Processing or Disposal Facility Location**

*(Dry U.S. Tons. Red: incineration; green: land application; orange: landfills/monofills; gray: other)*

Due to future uncertainty in the land application of biosolids, this report does not attempt to project volumes of Massachusetts sludge that will be land applied in specific states in 2028. Rather, Figure 7-2 shows projected usage of individual biosolids processing facilities in 2028 and assumes that these facilities will be able to develop sufficient land application outlets for their biosolids product. Note that this is a significant and uncertain assumption, and planned and future potential regulatory drivers in Massachusetts and other states that impact this assumption will be further considered in Part 2 of this study. Further, one goal of this future anticipated conditions analysis is to apply market risk assessments to these baseline projections in the following Risk Analysis section to develop understanding of future risks to the Massachusetts sludge management market.

Key takeaways from Figure 7-2 include the following:

- Diversity of Massachusetts sludge management strategies remains a relative strength in 2028.
- Incineration remains a critical strategy for sludge management in Massachusetts, with large volumes of sludge incinerated in Rhode Island, Massachusetts and Connecticut.
- Biosolids processing facilities are projected to continue to be critical for Massachusetts, with the MWRA, GLSD, Hawk Ridge, and Grasslands facilities all major biosolids producers.
- Landfilling of Massachusetts sludge is projected to remain an important but diminishing strategy for Massachusetts sludge.

The yellow box in Figure 7-2 identifies that 11,826 dry tons of sludge does not have an identified sludge management strategy in 2028. This represents approximately 7% of the total 172,249 dry tons of sludge projected to be produced in Massachusetts in 2028. In a tight sludge management market, this is not an insignificant volume of additional sludge that requires management. As there is very limited spare capacity identified in New England, it is assumed that much of this sludge will likely need to be hauled to more distant sludge management destinations. It is possible that some additional sludge can be hauled to Canadian facilities in the future, with the remainder needing to find other U.S. sludge management facilities located outside of New England.

Further tightening of the Massachusetts sludge management market will likely be exacerbated by a number of important factors in the next five years.

- Most Massachusetts POTWs have limited onsite sludge storage capacity, so upsets to their sludge management strategy quickly cause impacts at the POTW. Typical sludge storage capacity ranges from 2-14 days at most POTWs, as documented by the following examples: Montague (2.3 days), Springfield (3.2 days), Lowell (3.6 days), Billerica (4.4 days), GLSD (8.7 days), and MWRA (13.6 days). As a result, even temporary disruptions in sludge management outlets can result in a problem for many POTWs. This issue has already been observed when regional incineration facilities have been offline for maintenance in recent years, and POTWs they serve have struggled to find temporary outlets for their sludge. This will likely continue to be an issue in the coming years.
- Many Massachusetts POTWs do not have adequate back-up sludge management plans. When combined with limited sludge storage capacity noted above, POTWs are further stressed by upsets in the tight sludge management market.
- New sludge management solutions are in the planning stage and will likely be constructed in the future, but significant new capacity is not likely to be developed in the region in the next five years.

The future conditions analysis presented in this section in many ways represents a best-case scenario. It is likely that some sludge management strategies presented above will not be available at the listed capacity due to regulatory, commercial or mechanical issues, and the actual volume of sludge without an identified sludge management strategy will be greater than 11,826 dry tons by 2028. Of particular concern are the Connecticut land application ban and the pending Massachusetts land application restriction legislation. In 2023, a combined 27,484 dry tons of Massachusetts sludge was processed into biosolids, and land applied in Connecticut and Massachusetts. When combined with the 11,826 dry tons of unaccounted sludge from the above analysis, this results in a total of 39,310 dry tons of sludge that is potentially unaccounted for in 2028, or 21.2% of the total sludge produced by Massachusetts. This equates to an additional 140 trucks per week that would potentially need to travel to long distance sludge management sites outside of New England. This condition represents a massive disruption to the Massachusetts sludge management market, and has the potential for environmental impacts, GHG emissions, and cost increases far beyond those discussed in this report.

## 7.2 Market Risk Analysis

This section summarizes technical and regulatory risks that have the potential to impact future sludge management in Massachusetts. Risk analysis typically considers both consequence and probability to develop a semi-quantitative understanding of risk for various scenarios, as shown with the following generic equation:

Risk = Consequence x Probability

Table 7-1 summarizes a market risk analysis of current sludge management strategies. In this analysis, consequences are quantified in two ways: (1) consequence rating based on sludge volume processed by each sludge management strategy and (2) consequence rating based on number of POTWs served by each sludge management strategy. The goal of this approach is to recognize that strategies which manage large volumes of Massachusetts sludge are important, but so are strategies which benefit large numbers of Massachusetts POTWs. Probability ratings are assigned to each sludge management strategy based on projected likelihood of disruption in the next five years, with a 5 assigned to strategies with a high risk of disruption and a 1 assigned to strategies with a low risk of disruption. A total risk score for each sludge management strategy was calculated based on the following formula:

Total Risk Score = Consequence Rating Based on Volume Processed x

Consequence Rating Based on Number of POTWs Served x Probability of Disruption

The Total Risk Scores show the relative market risks for each sludge management strategy, with higher risk scores indicating higher market risk.

Rhode Island incineration was identified as having the highest market risk score (100). The market risk associated with Rhode Island incineration is noteworthy for a number of reasons: (1) Rhode Island incinerators process the highest volume of Massachusetts sludge of any sludge management strategy; (2) Rhode Island Incineration serves 60 Massachusetts POTWs; (3) Rhode Island incinerators are aging infrastructure in need of ongoing maintenance; (4) there is industry concern with any future air permit regulatory changes (including PFAS) that could impact incineration; and (5) the City of Woonsocket has announced its intention to cease liquid sludge acceptance at its incineration facility in the future, which would have broad impact on Massachusetts POTWs, especially small facilities.

| Table 7-1. Market Risk Analysis of Massachusetts Sludge Management | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sludge Management Strategy | 2023 Sludge Processed (Dry U.S. Tons) | Number of MA POTWs Served | Consequence Rating – Volume Processed | Consequence Rating – Number of POTWs Served | Disruption Probability Rating | Probability Rating Explanation | Total Risk Score |
| Rhode Island Incineration | 23,865 | 60 | 5 | 5 | 4 | Maintenance needs for aging infrastructure; Risk of liquid sludge no longer accepted at Woonsocket | 100 |
| Massachusetts Land Application | 15,974 | 21 | 4 | 5 | 4 | Risk of land application reduction due to proposed legislation | 80 |
| Massachusetts Incineration | 23,817 | 10 | 5 | 4 | 3 | Maintenance needs for aging infrastructure | 60 |
| Connecticut Incineration | 13,254 | 20 | 4 | 5 | 3 | Maintenance needs for aging infrastructure | 60 |
| Vermont Landfills | 6,841 | 21 | 3 | 5 | 2 | No change anticipated for sludge acceptance over next 5 years | 30 |
| Connecticut Land Application | 5,804 | 9 | 3 | 2 | 5 | Connecticut Public Act 24-59 (An Act Concerning the Use of PFAS in Certain Products, signed 6/5/24) prohibits the use of biosolids that contain PFAS as a soil amendment. | 30 |
| New Hampshire Landfills | 2,823 | 6 | 2 | 2 | 5 | North Country Environmental Services Landfill (Bethlehem) expected to close in 2026 with no expansions planned. | 20 |
| Massachusetts Landfills / Monofills | 7,157 | 7 | 3 | 2 | 3 | Hull Sanitary Landfill remaining life not to exceed 5 years with no expansions planned. Bourne Landfill remaining life currently not to exceed 5 years; expansion planned, increase in airspace unknown at this time. | 18 |
| New Hampshire Land Application | 3,571 | 6 | 3 | 2 | 3 | Screening standard to be finalized in 2025 | 18 |
| New York Land Application | 18,270 | 9 | 4 | 2 | 2 | In light of climate change, New York state has expressed support for increasing biosolids recycling. Current PFAS limits are low but not overly restrictive. Future limits will likely be based on federal regulation. | 16 |

| Table 7-1. Market Risk Analysis of Massachusetts Sludge Management | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sludge Management Strategy | 2023 Sludge Processed (Dry U.S. Tons) | Number of MA POTWs Served | Consequence Rating – Volume Processed | Consequence Rating – Number of POTWs Served | Disruption Probability Rating | Probability Rating Explanation | Total Risk Score |
| Canada Land Application | 10,490 | 4 | 4 | 1 | 3 | Increasing regulatory / public concerns with PFAS in biosolids in Canada, including Quebec moratorium on land application of U.S. biosolids | 12 |
| New York Landfills | 3,416 | 3 | 3 | 1 | 4 | Chemung County Landfill is anticipating a decrease in WW sludge accepted over the next 5 years. Expansion is predicted for the Ontario County Landfill; increase in airspace unknown at this time, however, facility anticipating a decrease in WW sludge accepted over the next 5 years. | 12 |
| Erving POTW #2 | 15,242 | 1 | 4 | 1 | 2 | Erving POTW #2 is operated by Erving Industries and primarily manages paper mill sludge | 8 |
| Maine Landfills | 3,937 | 1 | 3 | 1 | 2 | Private landfill is planning to install a thermal dryer in the coming years | 6 |
| Pennsylvania Land Application | 3,927 | 1 | 3 | 1 | 2 | | 6 |
| Virginia Land Application | 2,168 | 1 | 2 | 1 | 2 | Susceptible to increasing hauling costs | 4 |
| Vermont Land Application | 1,556 | 8 | 1 | 2 | 2 | New limits in interim residuals strategy are very low | 4 |
| Ohio Land Application | 1,612 | 1 | 1 | 1 | 2 | Susceptible to increasing hauling costs | 2 |
| Other State Land Application | 1,318 | 2 | 1 | 1 | 2 | Susceptible to increasing hauling costs | 2 |

*Consequence Ratings based on volume processed (2023) were assigned as follows:*

*5 = 20,000 Dry US Tons or Greater*

*4 = 10,000 to 19,999 Dry US Tons*

*3 = 3,000 to 9,999 Dry US Tons*

*2 = 2,000 to 2,999 Dry US Tons*

*1 = 0 to 1,999 Dry US Tons*

| Table 7-1. Market Risk Analysis of Massachusetts Sludge Management | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sludge Management Strategy | 2023 Sludge Processed (Dry U.S. Tons) | Number of MA POTWs Served | Consequence Rating – Volume Processed | Consequence Rating – Number of POTWs Served | Disruption Probability Rating | Probability Rating Explanation | Total Risk Score |

*Consequence Ratings based on Number of POTWs served were assigned as follows:*

*5 = 20 POTWs or Greater*

*4 = 15 to 19 POTWs*

*3 = 10 to 14 POTWs*

*2 = 5 to 9 POTWs*

*1 = 1 to 4 POTWs*

*Disruption Probability Ratings were assigned as follows based on risk of disruption to the sludge management strategy in the next 5 years:*

*5 = High Risk*

*4 = Moderately High Risk*

*3 = Moderate Risk*

*2 = Moderately Low Risk*

*1 = Low Risk*

*Note: This table is an assessment of market risk, not an analysis of risk to human health or the environment.*

Massachusetts land application (80), Massachusetts incineration (60), and Connecticut incineration (60) received the next three highest market risk scores, which highlights the overall importance of incineration for Massachusetts sludge management. These four sludge management methods with market risk scores of 60-100 total 76,910 dry tons in 2023, which is 45% of the 2028 projected Massachusetts sludge tonnage.

Massachusetts land application was identified as having a high market risk because it is utilized for a high volume of Massachusetts sludge, is utilized by 21 Massachusetts POTWs, and is rated with a moderately high probability of disruption in the next five years. If Massachusetts land application were to be limited due to legislative or regulatory changes, there would be significant impact to the Massachusetts sludge management market. Smaller composting facilities in Massachusetts that predominately rely on local land application for their compost product could face significant challenges with continued operation. MWRA and GLSD would need to haul moderate volumes of dried biosolids currently land applied in Massachusetts for longer distances, which presumably would increase costs for their customers. The Hawk Ridge Compost Facility in Maine is primarily used by Massachusetts POTWs, and this facility returns 64 percent of its compost product to Massachusetts to be land applied. Because there is already a land application ban in Maine, the Hawk Ridge facility would be further challenged to find biosolids outlets, which could result in reductions in sludge acceptance from Massachusetts.

## 7.3 Potential for Sludge Management Beyond the Northeast

Interviews with representatives of several leading corporations in the waste management industry suggested that there is current and anticipated (within 5-10 years) capacity for some Massachusetts wastewater sludge at management facilities outside of the Northeast. For example, when Maine became the first state to ban land application of biosolids in 2022, the lack of viable sludge outlets quickly precipitated a "sludge crisis." Maine wastewater sludge was hauled as far as the Passaic Valley Sewerage Commission's facility in New Jersey. Currently, contracted haulers haul Massachusetts sludge beyond the Northeast when local sludge management outlets cannot be identified, usually due to unavailable capacity. This practice relies on a complex network of private contracts and informal agreements. Sludge management contracts in Massachusetts often require contractors to remove sludge from the POTW on a daily basis, yet its destination is often left to the contractor's discretion based on local outlet available capacity. As one interviewee described it, "we'll pick it up and take it where it makes sense to take it [today], but it might be taken somewhere else tomorrow." Noting that "there's no place to go," interviewees consistently cited the delicate sludge management market for cost increases of 30 to 40% in recent years, which is consistent with escalating costs estimated from POTW Sludge Management Survey responses. Nevertheless, several potential future outlets for Massachusetts sludge are in development, with planned startup within the next 5-10 years. Mine reclamation, composting, lime stabilization, landfill, and deep well injection are among the sites under development in Alabama, Kentucky, Ohio, Pennsylvania, and Virginia, for example. Along with existing capacity in the Mid-Atlantic and Midwestern regions, these projects would expand sludge disposal options beyond the Northeast, although significant logistical and financial challenges can limit the practicality of hauling Massachusetts sludge to these facilities.

There are concerns with the sustainability of long-distance hauling by truck or rail for Massachusetts sludge primarily because it is not cost effective at the municipal level due to weight restrictions and the extensive time required for transport. Massachusetts allows gross trucking weights up to 99,000 lbs.; outside of the Northeast, maximum gross truck weights are typically 80,000 lbs. The inefficiency of hauling less material over longer distances ultimately takes the form of cost increases.

Long-distance trucking requires dedicated trucks and drivers which are then not available for other jobs. For example, hauling sludge from Springfield, MA to a landfill in Ohio could take as many as three days to accommodate essential rest time for driver safety. To maintain continuous service, haulers incur high capital costs to develop a fleet of specialized tanker trucks and dump trailers sufficient to meet hauling demand. The limited availability of licensed truck drivers extends beyond the sludge management industry, but interviewees noted the unique challenge of recruiting and retaining drivers to handle wastewater sludge materials. Furthermore, hauling sludge is made even less efficient and less attractive to would-be drivers by the long lines and hours of waiting to unload sludge at its destination. Several interviewees noted increasingly long lines for haulers to offload sludge, parallelling the decline of viable local or regional sludge outlets.

A potential solution to the rising trucking costs associated with sludge disposal is moving to a rail-based disposal system. However, development of the rail industry faces similar challenges. Installing a rail spur requires a significant capital investment, rail cars cost upwards of $65,000 each, and specialized sludge containers can cost $8,000-$9,000 for each (approximately) 22-dry-U.S.-ton container. With limited rail infrastructure, interviewees noted that it can take months to ship out a full container and get the empty one returned, so municipalities or contract haulers would need to invest in 90 to 100 containers to provide continuous service. Additionally, loading containers for rail transport requires specialized equipment that has had a lead time of six months or more in recent years, and few sludge management sites are directly served by rail. These major startup costs can be prohibitive to municipalities.

There are several challenges beyond cost and infrastructure that can impact sustainability of long-distance sludge hauling, particularly in cases where sludge cake must spend multiple days or longer in hot trucks or railcars. Odor generation is a real risk, with potential impact both along the hauling route and at the destination facility. One landfill in Alabama, for example, gained national attention in 2018, when it began accepting sewage sludge from wastewater treatment facilities in New York City. Dozens of containers of sludge sat on railroad tracks in the greater Birmingham area for weeks at a time while waiting to be unloaded, generating reports of extreme odors as far as 20 miles away (Pillon 2022, AL.com). Further, there is risk of sludge separation along the route where liquid can separate from the sludge cake and the sludge cake quality degrades. Ultimately, these long-distance transport issues increase the risk that distant outlets for Massachusetts sludge can be disrupted and reduce their long-term sustainability.

When asked what advice they would give to a Massachusetts POTW in need of sludge management, industry professionals unanimously indicated that dewatering and stabilization processes would be critical for continued hauling. Dewatered sludge cake with a solids content of at least 20%, although preferably at least 25%, is considered easier to dispose than liquid sludge. Most landfills are unable to dispose of sludge less than 20% solids, such as those in New York, Vermont, and Pennsylvania. While facilities that process sludge to produce biosolids for land application have more flexibility, they usually charge a premium to process liquid sludge or “wet” cake. This is consistent with the interest demonstrated in planned or possible dewatering facility upgrades among POTW Sludge Management Survey respondents. Handling sludge cake that does not meet specifications can cause process disruptions or maintenance issues for the receiving management facility.

While some sludge management outlets have attempted to discourage POTWs from sending “wet” cake by levying additional fees, sludge management facility representatives report limited success in driving POTWs to produce cake with higher solids. One interviewee speculated that it may be cheaper for municipalities to pay a surcharge than upgrade outdated equipment. Additionally, there are significant costs associated with managing unstabilized sludge. Based on industry professionals’ experience, Massachusetts has a comparatively low rate of anaerobic digestion or other sludge stabilization processes compared with other jurisdictions. This limits sludge management outlets; for example, unstabilized sludge cannot be disposed via landfill in Pennsylvania. There have been cases in which a sludge management entity has had to “bump” stabilized sludge from one management location to another that will only accept stabilized sludge to accommodate unstabilized Massachusetts sludge diverted from another facility due to a process disruption. With this phenomenon increasingly common, hauling resources are further strained, and increased costs are passed on to municipalities.

Industry professionals interviewed especially emphasized the urgent necessity of local and regional management outlets to reduce costs and minimize GHG emissions associated with long-distance hauling. Mobile dewatering units have been used successfully elsewhere in the U.S. and may be a promising solution for a cohort of small communities that could not otherwise dewater their sludge. However, participating communities would need to have capacity to store liquid sludge onsite for up to several weeks while waiting their turn for the mobile dewatering unit. There is very little storage space available for sludge in Massachusetts, as discussed in Section 7.1.2. Nevertheless, early-stage plans are underway for regional dewatering facilities in the Central and/or Southeastern regions, whether or not either would be a mobile unit. In addition, EPIC, a Synagro subsidiary, reports development of a potential rail transfer station in Central Massachusetts.

Long-distance hauling of Massachusetts sludge is a feasible component of an interim 5- to 10-year sludge management strategy for Massachusetts. As discussed in Sections 4, 5 and 6, there are sludge management facilities outside of the Northeast that have capacity for landfilling, biosolids processing, or incineration of Massachusetts sludge. However, there are a number of logistic considerations that may limit the long-term sustainability of this strategy for Massachusetts. Limitations with trucking sludge long distances, including truck driver availability, rest requirements, and trucking equipment availability, impact the availability and cost of this option. There are similar challenges with rail transport, including rail car needs and loading and unloading facilities. In addition, there are concerns with odor generation and sludge cake degradation from long distance transport. GHG emissions will be increased to haul sludge cake outside of the Northeast, and sludge management costs will also be significantly higher. Finally, it is ultimately reasonable to expect that sludge management market challenges and the regulatory climate developing in the Northeast could expand to other regions, which could impact the capacity of these regions to accept large volumes of Massachusetts sludge. While sludge management outside of the Northeast may be an effective interim strategy for Massachusetts, the factors noted above combine to make reliance on sludge management outside of the Northeast a risky and potentially unsustainable long-term strategy.

## 7.4 Greenhouse Gas Emissions & Energy Cost Analysis

GHG emissions and sinks were evaluated for each sludge management approach using the Biosolids Emissions Assessment Model (BEAM*2022 or “BEAM”). BEAM was originally developed by the Canadian Council of Ministers of the Environment in 2009 and has been used by biosolids programs and consultants around North America and has been widely cited. The model is used to estimate GHG emissions and compare emissions from different biosolids management scenarios and is useful for understanding the factors that have the greatest impact on GHGs. BEAM*2022 was released with updates from NEBRA and Northwest Biosolids that integrated recent research and reviews. The updated model is intended to be a widely used model for biosolids management with standardized emission factors and assumptions.

BEAM summarizes results based on international standards for the different "scope" of emissions:

- **Scope 1 emissions**: Those directly emitted by the operations of the organization. Examples for biosolids management include fugitive methane emissions, onsite use of natural gas, hauling and nitrous oxide emissions from land application.
- **Scope 2 emissions**: Emissions from the offsite production of energy (electricity, heating, cooling, steam) by others. For this analysis, Scope 2 emissions are those associated with electricity use by processing equipment. Emissions from electricity generation, except as noted below, were based on the EPA emission factor for electricity generation in Massachusetts (Northeast Power Coordinating Council – New England; 2020 update).
- **Scope 3 emissions**: Emissions associated with the production and transportation of materials used in operations. These are the Scope 1 emissions for suppliers that were in effect caused by the demand from facility operations. Scope 3 emissions can be negative if the land application of biosolids replaces the use of man-made fertilizers.
- **Biogenic emissions**: Since organic matter takes up carbon dioxide from the atmosphere as it grows, when this carbon is re-emitted as that organic matter breaks down it has a net-zero impact on the CO2 concentration in the atmosphere. So, while these emissions do not have a net negative effect on climate change it is best practice to account for these emissions.
- **Offsets**: There are several climate benefits associated with biosolids digestion and land application. Rather than showing net climate impacts (emissions – offsets) as is the default for BEAM the results are presented below with emissions and offsets associated with, for instance, digester operation shown separately. The use of electricity or heat generated from biogas in other areas of the facility offsets the use of electricity from the grid or pipeline natural gas. Land applying biosolids results in the sequestration in the soil of some of the applied carbon and the nutrient value of biosolids offsets the production of inorganic fertilizers.

Results are presented by Scope in Appendix F; however, results are presented in an alternative methodology in the body of this report to highlight more clearly the specific activities contributing to climate impacts. Results are aggregated as:

- **Processing emissions**: Emissions associated with the usage of natural gas and electricity, as well as emissions of methane and nitrous oxide during processing (e.g., from the storage of piles of biosolids). Note that the focus of this report is sludge management so process emissions are limited to those associated with processing sludge for land application (e.g. drying, composting, alkaline stabilization), or burning in an incinerator. Specific process emissions by process are listed below.
- **Composting**: Diesel fuel and electricity use from compost and related equipment and methane and nitrous oxide emissions evolved during composting and storage.
- **Alkaline Stabilization**: Fuel and electricity use, and emissions associated with the production of **lime**.
- **Drying**: Natural gas and electricity usage of thermal drying and related equipment. As noted in Table 7-2, where biogas is known to offset natural gas usage in the dryer or is used to produce electricity for the POTW emissions are reduced accordingly.
- **Incineration**: Natural gas and electricity usage for incineration and related equipment. Methane and nitrous oxide emissions from combustion.
- **Cogeneration**: The Erving POTW #2, which primarily receives flow from the Erving Industries paper mill, sends some dewatered solids to a cogeneration facility in Quebec. Details of the cogeneration facility are not available, so assumptions were made about the GHG emissions. The

dewatered cake from Erving is a relatively high total solids concentration (46%) and likely has a higher volatile solids content than typical wastewater sludge. It was therefore assumed that the material would burn autogenously—that is, without the need for external fossil fuel. Paper mill sludge also has comparatively lower nitrogen levels and so should have lower nitrous oxide emissions. Due to these factors, process emissions from processing the Erving Center dewatered cake at the cogeneration facility are assumed to be zero.

- **Hauling emissions**: Emissions from vehicle fuel used to transport sludge to processing facilities and to transport products (e.g., compost, dried biosolids, ash) from these facilities to end use locations. Where known, actual hauling distances are used, otherwise they are estimated based on state averages or typical trip lengths for the given material.
- **End use emissions and offsets**: Emissions from land application equipment (e.g., spreaders), methane and nitrous oxide generation at landfills, as well as climate benefits such as carbon sequestered in the soil or avoided emissions where biosolids offset the use of inorganic fertilizer production. Specific end use emissions and sinks by management type are listed below.
- **Land application (compost, alkaline stabilization, drying), mine reclamation)**: Emissions from the fuel use of spreading equipment. It is assumed that all alkaline stabilized, mine reclamation, and compost spreading is performed with industrial equipment requiring fuel, while 25% of dried biosolids are applied with fossil-fuel-fired equipment, with the rest being applied manually (reflective of homeowner and landscaping uses). It is assumed that the carbon content of the lime used in alkaline stabilization will be emitted as carbon dioxide after land application. BEAM includes two climate benefits for land applying biosolids. A portion of the carbon applied will remain sequestered in soils for a very long period, effectively reducing the amount in the atmosphere. And when biosolids are applied in lieu of inorganic fertilizers there is an offset associated with the avoided emissions from the production of fossil-fuel-intensive inorganic fertilizers.
- **Landfilling**: Even modern landfills with landfill gas collection systems will still leak a significant portion of the methane generated from the anaerobic degradation of organic matter in a landfill. A portion of the nitrogen in biosolids will also be converted to nitrous oxide in landfills. Some carbon is also assumed to be sequestered in the landfill (and not released as carbon dioxide or methane), partially offsetting emissions. The “typical” landfill assumptions in BEAM also assume that 50% of the methane generated in a municipal solid waste landfill will be captured and converted to electricity, so a credit is provided to account for offsetting avoided emissions from electricity generated on the local electrical grid. Sludge monofills in Massachusetts are not known to capture methane so it is assumed that all methane generated at monofills is emitted to the atmosphere.
- **Incineration**: The disposal or use of ash as alternative daily cover in a landfill is assumed to have no climate impact since the material contains essentially no organic matter or nitrogen compounds, and so will not have appreciable generation of methane or nitrous oxide when placed in the landfill.

Results are shown broken out by facilities in Massachusetts and outside the state.

In addition to the assumptions specific to different management types in Table 7-1, the following general assumptions were used in calculations:

- **Hauling distance**: Where known, actual distances are used. Assumed to be 40 miles for all final materials (dried biosolids, compost, ash and alkaline stabilized biosolids) based on typical hauling distances in the region for these materials. For sludge that was hauled to an unknown destination the median hauling distance for all known destinations based on data obtained from the survey and regulatory reporting (66 miles) was assumed.

- **Total solids**: Where solids concentration was not known, state averages were used based on the material type (i.e., 3.7% TS for thickened sludge and 22.8% TS for dewatered cake).
- **Volatile solids**: Assumed to be 80% of total solids.
- Products are applied to soils with 50% fine texture and 50% coarse texture.

Unless otherwise noted, the standard emissions factors in BEAM*2022 were used in calculations.

**Table 7-2. Assumptions for GHG Calculations**

| | |
|---|---|
| **Compost** | |
| Compost technology | Aerated Static Pile (nearly all facilities that processed Massachusetts sludge in 2023 are ASP facilities) |
| Storage time (including curing) | 69 days annual average |
| **Thermal Drying** | |
| Final product total solids | 92%TS |
| GLSD dryer fuel | 40% biogas; 60% natural gas |
| GLSD electricity | 100% biogas |
| Biogas heating and power emissions | GHG emissions-free |
| **Landfilling/Monofilling** | |
| Monofilling Emissions | Assumed to be the same as a Municipal Solid Waste landfill |
| Percent of captured methane used to generate electricity | 50% ("typical" scenario in BEAM) for landfill,<br>0% for monofill |
| **Incineration** | |
| Heat recovery | 25-30% of available heat on average for the year |
| **Mine Reclamation** | |
| Storage time | 5 days annual average |
| **Alkaline Stabilization** | |
| Liming source | Not derived from a waste product (e.g., cement kiln dust) |
| Storage time | 39 days annual average |

### 7.4.1 Current Conditions

Around 60% of Massachusetts sludge is landfilled or incinerated (on a dry weight basis), but these management approaches have disproportionate negative climate impacts, accounting for 87% of the net GHG emissions estimated to be associated with sludge management in the state (Figure 7-3). The total annual net emissions were calculated to be 127,600 $MTCO_2e$. Landfilling and incineration produced 52,300 $MTCO_2e$ and 57,500 $MTCO_2e$, respectively, in 2023.

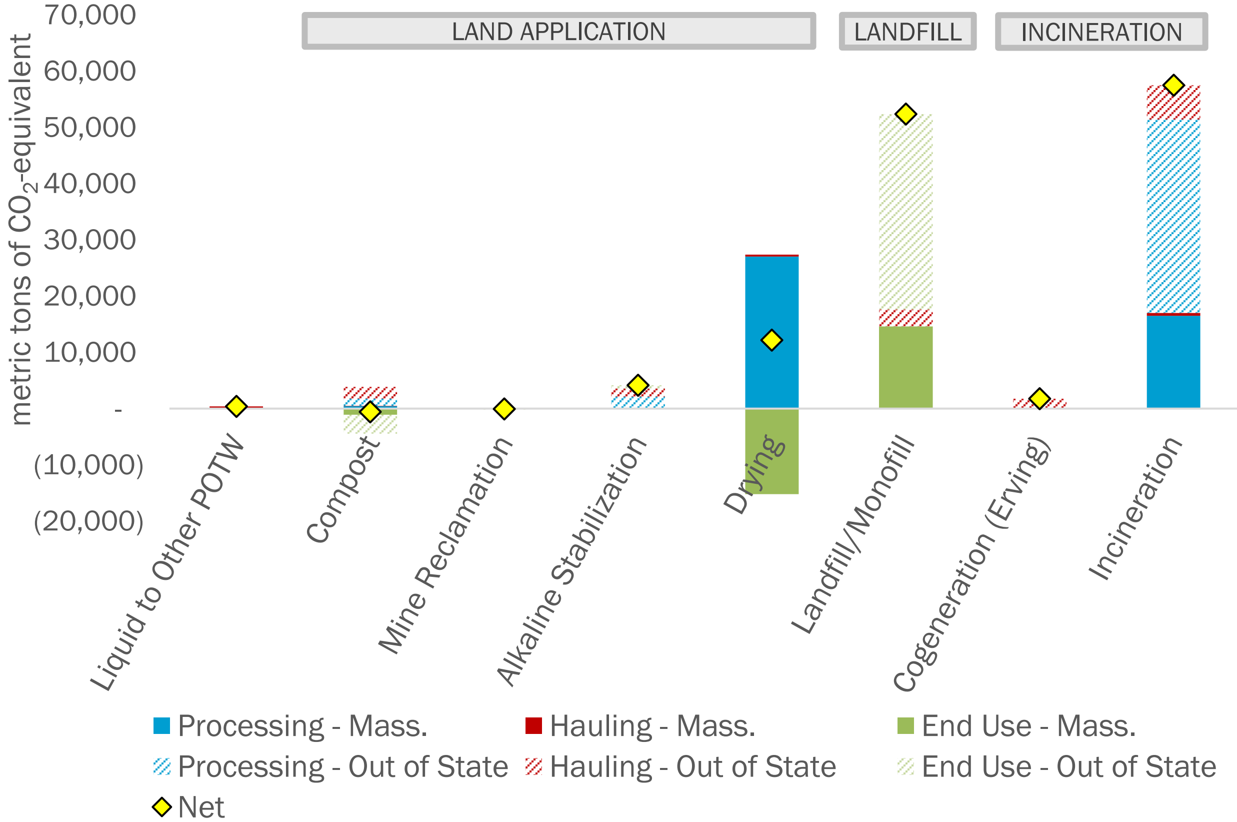


**Figure 7-3. GHG impact by management type for all sludge generated in Massachusetts – 2023.**

While Figure 7-3 shows the total GHG emissions for each sludge management method for all Massachusetts sludge, Figure 7-4 shows the emissions for each sludge management type normalized on a per-ton basis. As shown in Figure 7-4, landfilling and incineration have significantly higher net unit emissions per dry-ton of sludge processed and therefore have a disproportionately high climate impact. When any material containing organic matter, such as wastewater sludge or food waste, is put into a landfill, methane will be released as the organic matter breaks down anaerobically. Some landfills have systems to capture some of this methane, but even the best run gas collection systems will not capture all of the methane and will leak. Methane is a potent GHG, and so even small releases have a large climate impact.

Incineration has two primary climate impacts. Many incinerators use natural gas to provide supplemental energy (beyond the energy generated from breaking down the organic matter). More research is needed, but under certain operating conditions it is likely that incinerators also emit some nitrous oxide, a very potent GHG. BEAM assumes significant nitrous oxide emissions at typical operating temperatures (850°C), and a marginal amount of methane emissions.

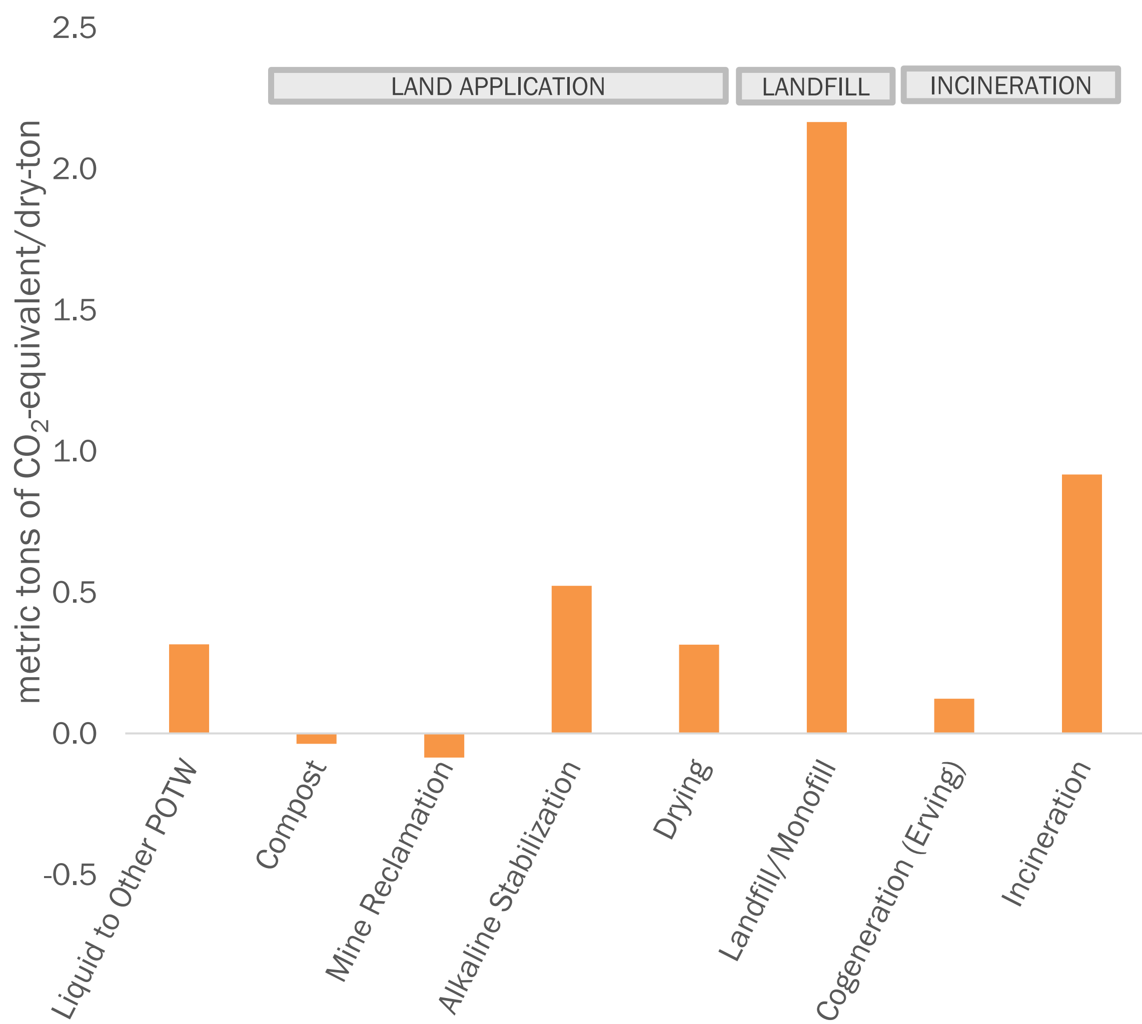


**Figure 7-4. Net GHG impact per dry-ton of sludge by management type - 2023.**

Hauling thickened ("liquid") and dewatered sludge to other POTWs, biosolids processing facilities, landfills and incinerators, and final compost, dried biosolids and incinerator ash (red bars in Figure 7-3) accounts for a relatively small proportion of GHG impact from sludge management. Despite the long hauling distances for many of the POTWs in the state and the low fuel efficiency of the trucks used to haul sludge and biosolids, process emissions from fossil fuel use and generation of methane and nitrous oxide, two very potent greenhouse gases, far outweigh hauling. However, hauling does require a significant amount of energy—estimated to be nearly 1.4 million gallons per year of diesel. The emissions associated with this total diesel use (14,100 $MTCO_2e$/year) is equivalent to the emissions associated with all the electricity used by nearly 2,800 typical U.S. homes in a year.

Interplant hauling of liquid sludge from one, smaller POTW to another larger POTW for treatment is shown separately in Figure 7-3 as this essentially amounts to the sludge management approach for the smaller POTW. The emissions associated with the ultimate end use of the liquid hauled sludge is then attributed to the end use (land application, incineration of landfilling) of the larger facility.

Figure 7-3 includes an indication of the net emissions as some biosolids management have a net climate benefit—such as carbon sequestered in the soil or avoided emissions where biosolids offset the use of inorganic fertilizer production. Composting and mine reclamation actually have a net climate benefit in these calculations—meaning the emissions produced are more than offset by the emissions reductions or offsets. Land applying dried biosolids has a climate benefit, but drying also uses a significant amount of fuel for heating (typically from natural gas). The production of lime is carbon intensive, so alkaline stabilization has relatively high net emissions despite the carbon sequestration and avoided inorganic fertilizer benefits.

As climate regulations in Massachusetts, other states, and at the federal level become more stringent, processes that produce significant GHG emissions, like landfilling and incineration, will likely come under pressure. This will further complicate the regulatory and public perception landscape for sludge management.

### 7.4.2 Anticipated Future Conditions

GHG emissions were estimated for the future management conditions detailed in Section 7.1.2. Figure 7-5 shows the estimated climate impact in 2028. Net emissions are estimated to increase 1.2% relative to 2023 to 129,200 $MTCO_2e$/year. For the purposes of these GHG calculations, it is assumed that half the sludge without a clear outlet in 2028 identified in Section 7.1.2 will go to compost facilities in Canada and the other half will go to landfills. The Canadian compost facilities are the only facilities identified with significant amounts of additional capacity, and these facilities also reported potential expansions in the next five years. This additional tonnage to compost facilities largely offsets the projected reduction in tonnage from landfills currently accepting Massachusetts sludge discussed in Section 4.4. The shift from landfills to composting, which has a lower GHG impact, means that emissions are not projected to increase at the same rate that sludge generation is expected to increase over the next five years (2.5%). As mentioned in Section 3.4.1, mine reclamation in Quebec is no longer allowed due to the provincial ban on importing U.S. sludge for land application.

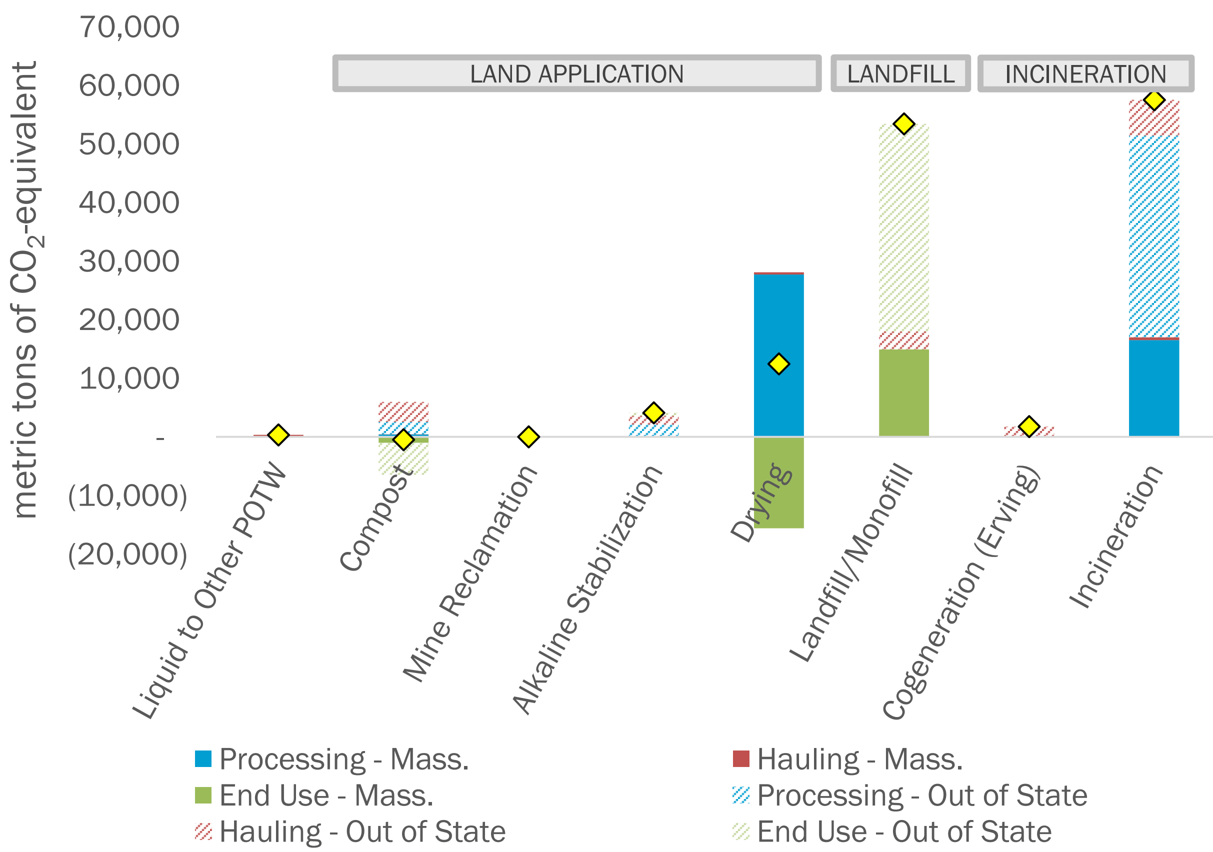


**Figure 7-5. GHG impact by management type for all sludge projected to be generated in Massachusetts - 2028.**

## 7.5 Energy Recovery from Sludge Treatment

There are two primary ways that energy is recovered from conventional sludge treatment technologies: biogas from anaerobic digestion and recovering heat from incinerators. Both are practiced in Massachusetts (see Section 7.4.1).

Pyrolysis and gasification are emerging technologies drawing interest (including from facilities in Massachusetts; see Section 7.4.2) due to solids reduction and promising results for decreasing PFAS concentrations, but they also recover energy. Pyrolysis is the thermal decomposition of organic matter under anaerobic conditions, typically heated in the range of 400 - 800°C. The volatile fraction of the organics is converted to a gas (pyrogas or syngas). Pyrogas or syngas can be condensed and converted to liquid fuel, or the gas can be utilized to heat the pyrolysis reactor.

Gasification is a post-drying process that is like pyrolysis but takes the conversion of solid matter to the gaseous phase further. In gasification, heat (between 800 - 1700°C) is applied under oxygen-starved conditions to the dried biosolids. The thermal conditions convert the biosolids into a product gas with an appreciable fuel value and a solid residue called char during an initial pyrolysis step. The system then introduces a limited amount of oxygen to further convert a portion of the solid char into the gas stream, enhancing the fuel value of the gas and reducing the volume of the char. The fuel gas is typically routed to a close-coupled thermal oxidizer where it is fully combusted and the resulting heat in the flue gas is transferred via heat exchanger into the process air stream that provides the heat for the upfront drying step and potentially other uses if there is excess heat.

### 7.5.1 Current Energy Recovery at Massachusetts POTWs

Anaerobic digestion is not widely implemented in Massachusetts outside of a few large facilities. MWRA's Clinton and Deer Island POTWs, as well as GLSD, Pittsfield and Rockland have operating digesters. Many POTWs have digesters that have been abandoned or repurposed. GLSD imports slurried food waste, which is co-digested in its anaerobic digesters. The additional biogas generated allows the facility to generate more power than the facility uses—claiming they are the first and only POTW in New England to do so.

The UBCW incinerator recovers heat from its MHIs. The heat recovery system supplies heat to buildings when needed.

### 7.5.2 Possible Future Energy Recovery

As noted in Section 5.5, several facilities are considering installation of additional sludge treatment technology, some of which involve energy recovery:

- MWRA is investigating pyrolysis for PFAS treatment.
- The City of Fitchburg is currently pursuing a vendor for possible anaerobic digestion and gasification.
- The Attleboro WWTF reported interest in a pyrolysis system.
- Taunton has considered a gasification facility.
- The New England Regional Biosolids project being pursued by the Springfield Water and Sewer Commission, UBCW and the Narragansett Bay Commission in Rhode Island could include energy recovery technologies.

# Section 8: Summary and Conclusions

In 2023, Massachusetts produced 165,683 dry U.S. tons of wastewater sludge, and this sludge from Massachusetts was managed by a diverse range of technical solutions located throughout the Northeast and Canada. Sludge data was collected for 98.9% of Massachusetts' total wastewater flow, with the remaining 1.1% of sludge production estimated based on design flow correlations. Sludge was managed with onsite solutions for 39% of Massachusetts sludge, although this was accomplished by only 8% of the POTWs. This highlights that onsite sludge management is dominated by a few larger facilities, such as MWRA, GLSD, UBCW and Lynn, but that the majority of POTWs in Massachusetts rely on offsite solutions for their sludge management.

Approximately 34% of POTWs reported utilizing sludge dewatering technologies, with the majority of POTWs utilizing thickening and liquid sludge hauling. Sludge dewatering is predominantly utilized by larger facilities, and smaller facilities predominately utilize liquid sludge hauling. Most sludge transferred from one Massachusetts POTW to another Massachusetts POTW is via liquid. Similarly, the two Rhode Island incinerators in Cranston and Woonsocket primarily accept liquid sludge, and these incineration facilities tend to serve POTWs located in the southeastern and central regions. Recently, the Woonsocket, RI incineration facility indicated its intent to eventually stop receiving hauled-in liquid sludge. While still in the preliminary stages, this transition would substantially impact the 15 Massachusetts POTWs that hauled 13,673 dry U.S. tons of liquid sludge to Woonsocket in 2023. Further, this change would also impact an additional 16 Massachusetts POTWs that rely on

POTW-to-POTW sludge management in partnership with those 15 directly-impacted POTWs. The Woonsocket incinerator has experienced unplanned outages in recent years, so POTWs that utilize Woonsocket are already aware of the significant impact this change would pose to their operations. These facilities would need to convert to cake hauling, find alternative outlets for their sludge in a regional market with very limited available capacity, or both.

Sludge cake is transported out-of-state to Connecticut incinerators, to biosolids processing facilities in Maine and New York, and to landfills in Maine, New Hampshire, Vermont, and New York. From a regional perspective, western Massachusetts is noteworthy in that there are no large sludge management facilities in that region (only the composting facility at the Hoosac WQD), so sludge from the western region tends to be hauled further to sludge management sites than sludge from other regions.

Massachusetts sludge is largely managed via three primary technologies:

- Landfill disposal is utilized for 14% of the dry tonnage produced by Massachusetts
- Land application is utilized for 39% of the dry tonnage produced by Massachusetts
- Incineration is utilized for 37% of the dry tonnage produced by Massachusetts

The remaining 10% of sludge is managed by other processes or has an unknown sludge management approach. Figure 8-1 summarizes the application of these technologies in 2023. The "other" category is dominated by Erving POTW #2, which transported paper mill sludge to a land reclamation site and a cogeneration facility in Canada in 2023.

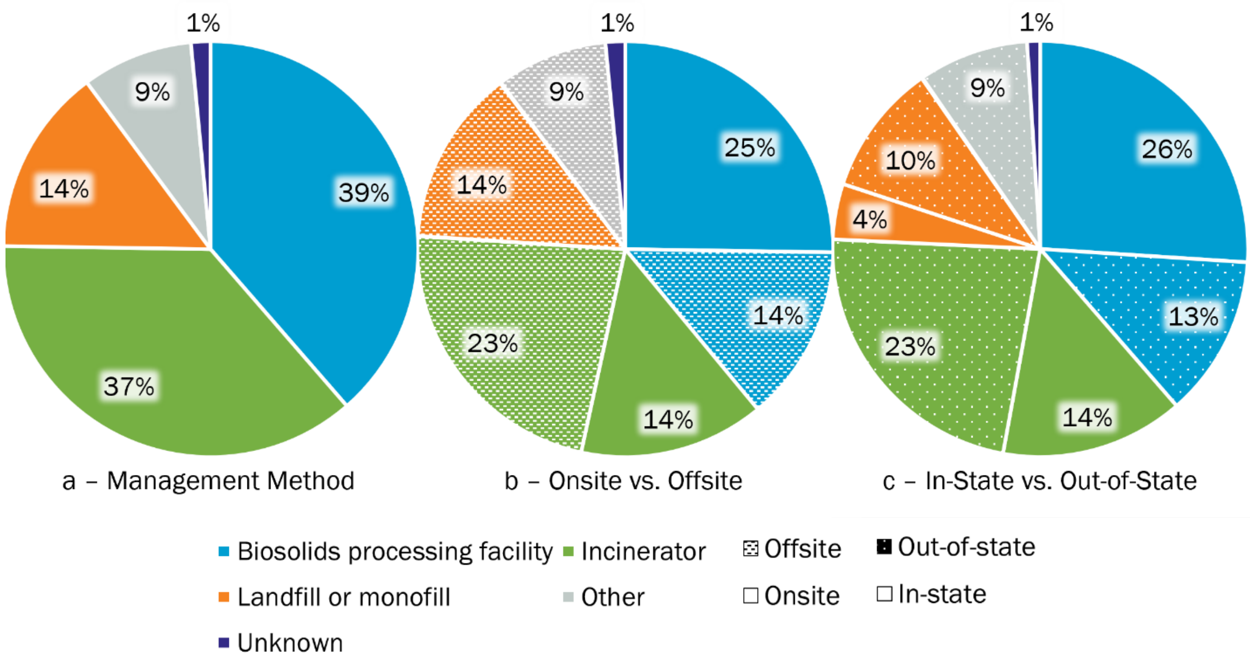


**Figure 8-1. a – Massachusetts sludge (dry U.S. tons) summarized by management method in 2023; b – Massachusetts sludge (dry U.S. tons) summarized by management method and site in 2023; c – Massachusetts sludge (dry U.S. tons) summarized by management method and state category.**
*Categories accounting for less than 1% of Massachusetts sludge generated in 2023 are not shown.*

## 8.1 Landfill Disposal

Landfill and monofill disposal is responsible for roughly 14% of sludge from Massachusetts POTWs. Sludge disposal capacity within Massachusetts landfills is limited and inadequate to satisfy the volumes of sludge produced within the state requiring disposal, especially as several landfills are slated to reach capacity within the next decade. While some facilities maintain a higher capacity for sludge disposal, concerns including odor, leachate quality, and the presence of PFAS appear to dissuade these facilities from accepting additional sludge beyond what is currently accepted.

Landfill capacity within New England and the surrounding region is slightly higher; however, competition for the disposal of wet wastes, including wastewater sludge, within the market is high, with several states in the region experiencing landfill capacity concerns. While capacity in New York is higher by comparison, transporting Massachusetts sludge further distances presents additional concerns, including increased costs and GHG emissions. As landfill capacities within the state, New England and New York continue to decline, wastewater sludge produced in Massachusetts will increasingly require alternative management strategies, including, but not limited to, transportation to out-of-state management facilities such as landfills, incinerators, and composting facilities. There is very limited additional capacity in New England and New York to currently receive Massachusetts wastewater sludge, and the capacity for regional landfills to receive sludge will decline significantly over the next 10 years, as shown in Figure 8-2.

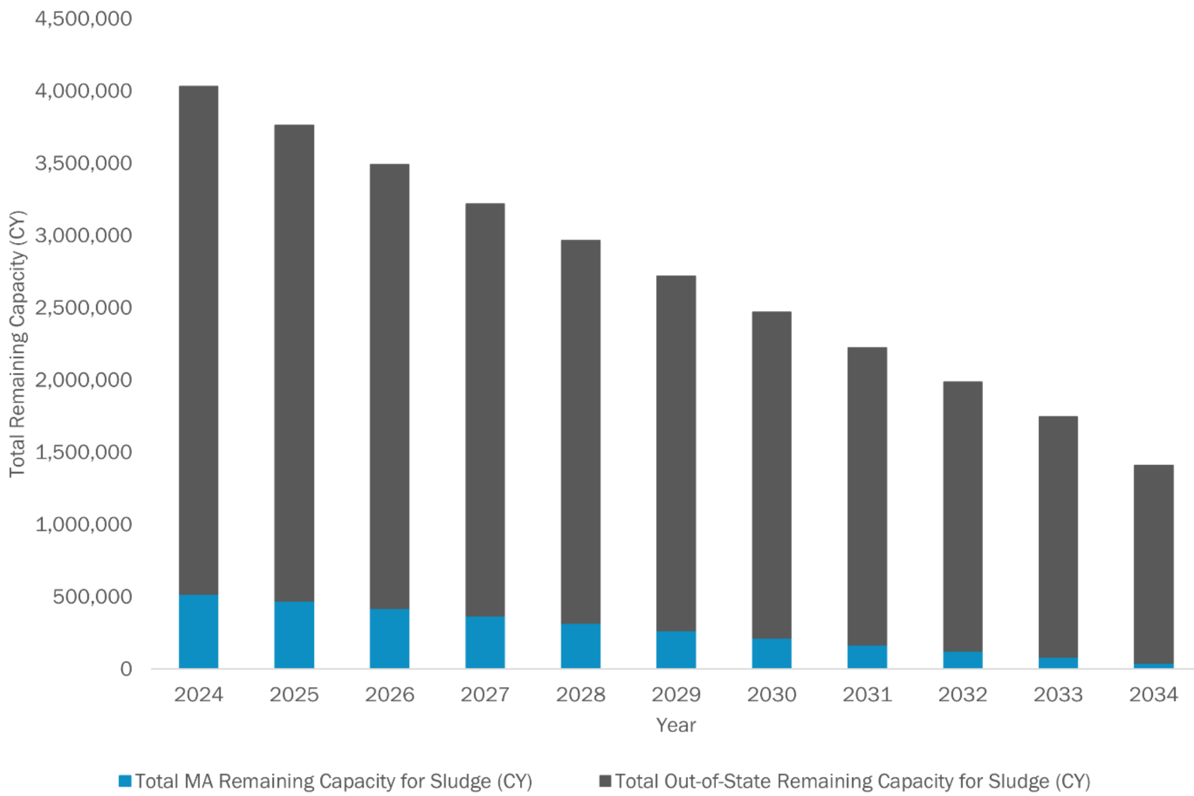


**Figure 8-2. Maximum remaining disposal capacity in New England and New York landfills through 2034.**

*Note: Not all out-of-state capacity is available for use by Massachusetts POTWs for sludge disposal. The remaining capacity available for Massachusetts sludge disposal is anticipated to be much less than overall remaining capacity values.*

## 8.2 Land Application

Biosolids processing facilities currently manage 39% of Massachusetts sludge. Management of the resulting products from these facilities is an important challenge given evolving PFAS regulations in New England states which could limit or eliminate land application as a viable outlet within the region. Thermal drying, composting, and alkaline stabilization processes at these facilities produce Class A product suitable for land application. The MWRA and GLSD thermal drying facilities account for the greatest volume of biosolids production within Massachusetts but are purpose built for the communities they serve and have faced challenges in managing their products within New England. There are a number of smaller composting facilities within Massachusetts, and these facilities expressed increasing challenges in finding outlets for their compost product and are likely to be at the greatest risk for disruption from any future land application legislative or regulatory changes. The Hawk Ridge Composting Facility in Maine and the Grasslands Manufacturing Facility in New York are significant processors of Massachusetts sludge. It is noteworthy that 95% of the sludge composted at Hawk Ridge comes from Massachusetts, and 64% of the compost product is returned to Massachusetts to be land applied. Therefore, any legislative or regulatory changes for land application in Massachusetts would also have a significant impact on the Hawk Ridge facility. Finally, three composting facilities in Canada were also utilized in 2023 to manage Massachusetts sludge; sludges entering these facilities will be subject to interim PFAS regulations in Canada and forthcoming limits in Quebec.

Class A product produced from these facilities was widely distributed to thirteen states and Canada in 2023, as shown in Figure 8-3. The largest land application outlets for Massachusetts biosolids were New York, Massachusetts and Canada, in that order. Class A biosolids generated by thermal drying, composting and alkaline stabilization facilities ultimately require a land application destination, and land application destinations will be highly contingent upon future PFAS regulations in the region. Increasingly stringent PFAS regulations have the potential to significantly reduce or eliminate outlets for these products, which could send them either further away or to landfill disposal, both of which have significant GHG impacts.

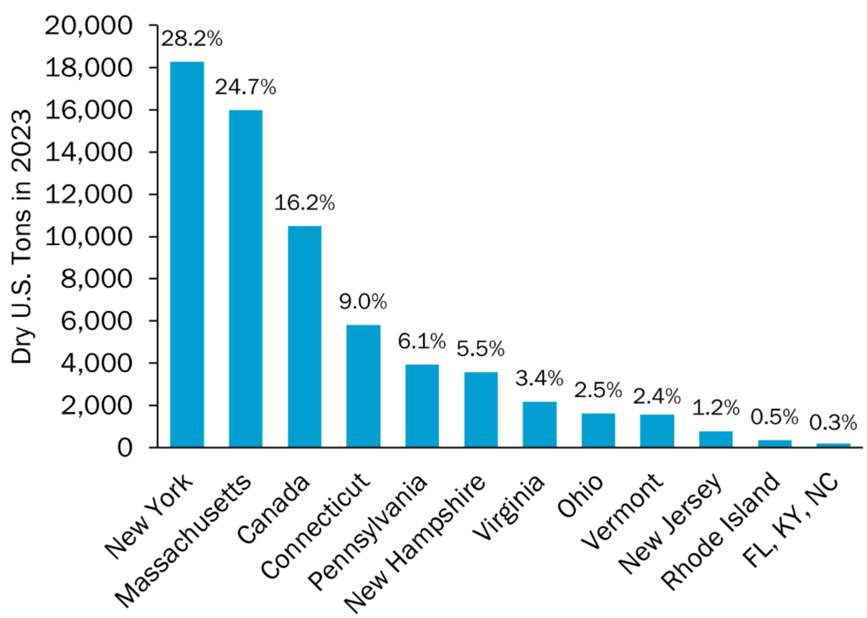


**Figure 8-3. Land application locations for Massachusetts sludge in 2023.**

*The approximate percent of Massachusetts sludge land applied is shown for each location.*

Biosolids processing facilities generally reported intentions to continue to operate for the foreseeable future, although some smaller composting facilities expressed concerns as noted above. Assuming the current regulatory framework remains in place, in 2028, it is projected that 66,458 dry tons will continue to be managed by land application processing technologies at MWRA, GLSD, Hawk Ridge Composting Facility, Grassland Manufacturing Facility, smaller Massachusetts composters, and Canadian composters.

## 8.3 Incineration

Sludge incineration is responsible for processing roughly 37% of sludge from Massachusetts POTWs. In 2023, this value was equal to roughly 60,000 dry U.S. tons of sludge. Incineration capacity is nearly at its limit in the region, with only three facilities reporting additional capacity for an estimated total of 10 dry U.S. tons per day of additional capacity. Note that this additional capacity is a regional estimate and would not be available solely to Massachusetts POTWs. The Woonsocket, RI and Naugatuck, CT facilities treat the highest volume of wastewater sludge in the region. The Naugatuck facility is operating at capacity, and the Woonsocket facility has minimal capacity for additional sludge acceptance. Only two facilities accept sludge from other POTWs and report having a small amount of additional capacity, including the Woonsocket, RI facility and the Buffalo Bird Island, NY facility. When these facilities are out of service due to unpredictable system failures, they either send their additional sludge to other incinerators in the area, or directly to landfills due to capacity limitations.

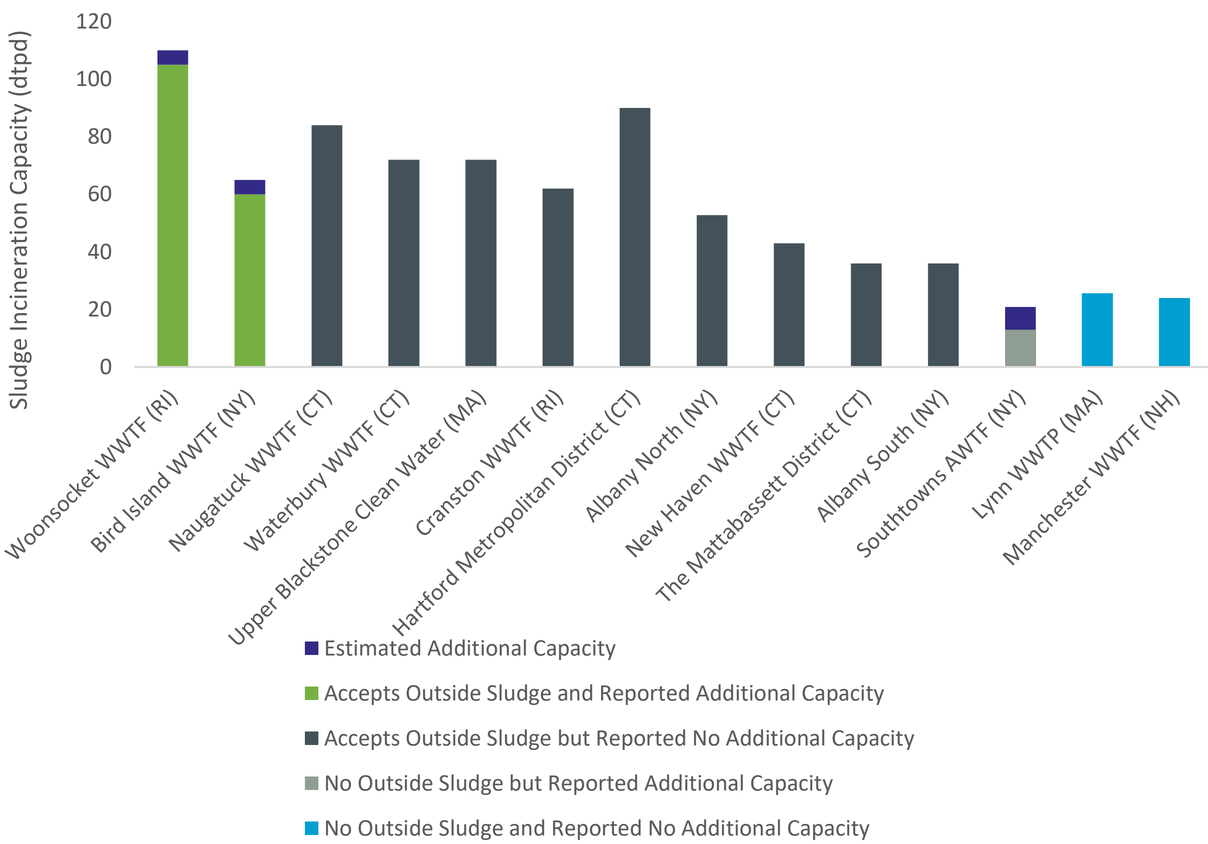


**Figure 8-4. Total capacity of sewage sludge incinerators in New England and New York and ability to accept outside sludge.**

In total, the incinerators in this region produce roughly 40,000 tons of ash per year. Of this number, 32,000 tons of ash are landfilled, and 8,000 tons are beneficially reused as landfill daily cover.

Incineration facilities generally reported that they intend to continue incineration indefinitely, however most had concerns about future regulatory and permitting requirements, particularly regarding air quality and PFAS. The facilities with incinerators that are nearing the end of their remaining useful life, including the Waterbury, New Haven, and Lynn incinerators, plan to upgrade their systems in the next 5-10 years to extend the life of the incinerators by roughly 20 years each. Note that these upgrades will not increase the capacity of these incinerators. The only potential for an increase in incineration capacity planned for this region in the near future is West Haven WWTP's incinerator rehabilitation, which is still being studied for its feasibility, and would increase the total incineration capacity in the region by 54 dry U.S. tons per day. That said, the South Plant in Albany, NY will be closed in the coming years and consolidated into the North Plant. This consolidation will not include incineration, meaning the region will experience a loss of roughly 36 DTPD of sludge incineration capacity. Overall, there is very little additional capacity for incineration in the region, and incinerators are struggling to meet the demands of the current sludge production volumes.

## 8.4 Future Sludge Production

Massachusetts sludge production is projected to increase to 172,249 dry U.S. tons by 2028, based on an assumed 2.5 percent population increase over that five-year period. Further, there is a projected 11,826 dry U.S. ton shortfall in outlets for Massachusetts sludge, based on regional outlets that have historically been used for Massachusetts sludge, as shown in Figure 8-5. Projected decreases in regional landfilling and composting, in addition to sludge production increases, account for this shortfall. As there is very limited spare capacity identified in New England, it is assumed that much of this sludge will likely need to be hauled to more distant sludge management destinations. It is possible that some additional sludge can be hauled to Canadian facilities in the future, with the remainder needing to find other U.S. sludge management facilities located outside of New England.

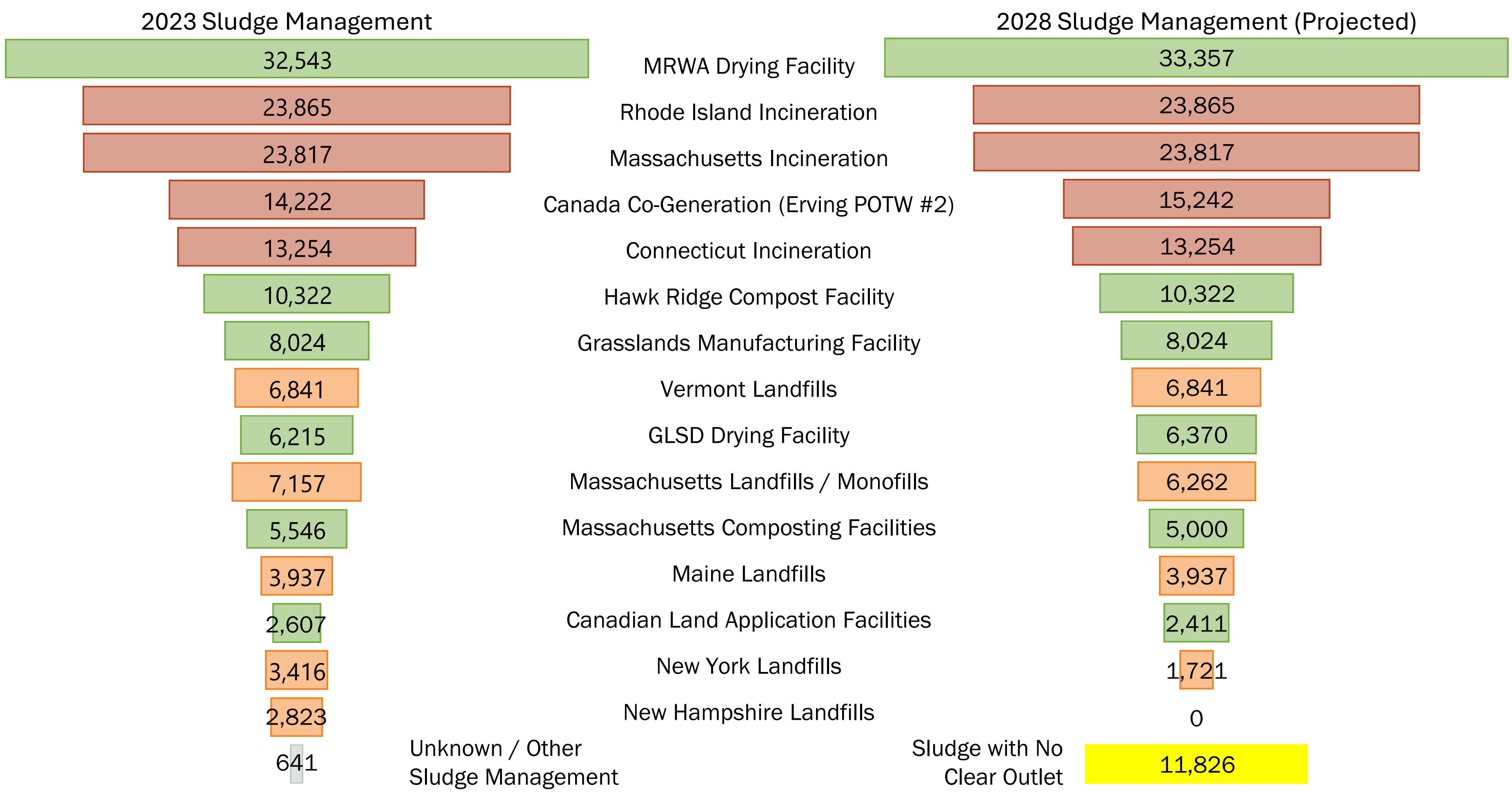


**Figure 8-5. Massachusetts Sludge Management in 2023 and 2028 (Projected) by Processing or Disposal Facility Location**

*(Dry U.S. Tons. Red: incineration; green: land application; orange: landfills/monofills; gray: other)*

## 8.5 Market Risk Analysis

A market risk analysis was performed, considering both consequences of disruption to various sludge management strategies as well as the estimated probability of disruption. The intent of this analysis is to develop an understanding of the highest market risk areas in the overall Massachusetts sludge management portfolio. Consequence of disruption considered both volume of sludge managed by any given strategy as well as the number of POTWs utilizing that strategy. The market risk analysis identified the following sludge management strategies with the highest total risk of disruption:

- Rhode Island incineration
- Massachusetts land application
- Massachusetts incineration
- Connecticut incineration

While the market risk analysis attempts to highlight sludge management strategies that are most susceptible to disruption in the next five years, the near-term future of Massachusetts sludge management remains uncertain, and it is ultimately unknown the extent to which these sludge management strategies will be disrupted in the coming years. However, further sludge management disruptions will only increase costs and GHG emission above the baseline projections identified in this report.

## 8.6 Summary

Massachusetts POTWs utilize a diverse range of approaches to manage their wastewater sludge. This diversity includes technical solutions such as landfilling, land application, and incineration. Further, this diversity also includes a wide range of sludge management locations, including all New England states, New York, other states outside of the Northeast, and Canada. In many ways, this diversity can be considered a strength, as loss of any single outlet through legislative or regulatory change, or shutdown of a sludge management facility, is somewhat tempered by other sludge management strategies at the macro level.

This report concludes that there is essentially no spare capacity for management of Massachusetts sludge within the facilities and regions currently utilized by Massachusetts. Further, there is a projected shortfall of sludge management capacity in the coming years. As a result, the diversity of sludge management alternatives utilized by Massachusetts can also be considered a substantial weakness. Because there is very limited available capacity today, and anticipated shortfalls in the coming years, Massachusetts is highly susceptible to major disruption due to the reduction or loss of any single sludge management strategy. Loss of a major strategy would result in significant shortfalls, with some POTWs seriously struggling to find outlets for their sludge. This is particularly true for POTWs that currently produce liquid sludge, as hauling of liquid sludge out-of-region is likely cost-prohibitive for many POTWs. In short, until new solutions are developed, such as regional sludge management facilities, Massachusetts will be highly susceptible to major disruptions over the next 5+ years due to the wide range of current sludge management strategies that have potential risk for disruption.

# References

**Reports**

*Massachusetts Materials Management Capacity Study, MassDEP, 2019.*

*Solid Waste Disposal Capacity in the Northeast, Northeast Waste Management Officials' Association, April 2021.*

*An Evaluation of Biosolids Management in Maine and Recommendations for the Future, MaineDEP, 2023.*

*Dennis Pillion, February 10, 2022, https://www.al.com/news/2022/02/new-york-poop-train-may-be-back-in-alabama-state-orders-temporary-halt.html*

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# Appendix A: POTW Sludge Management Survey Questions

# POTW Sludge Management Survey

**Purpose**: Thank you for taking the time to answer this survey from the Department of Environmental Protection. By completing this survey, you will be helping Massachusetts and its consultants, Tighe & Bond and Brown and Caldwell, to develop a statewide strategy for how Massachusetts manages sludge and biosolids. This survey will be used for information only and will not be used for compliance.

**Instructions**: The survey cannot be saved and must be completed in one sitting. It will take approximately 20 minutes to complete. Please follow instructions carefully.

- Provide data from 2023.
- We recommend that the following information is readily available prior to completing this survey: sludge production data, sludge management contracts, and sludge management costs.
- Contact us if you wish to edit your responses.
- Your identity and contact information will not be shared and will only be used for essential follow-up.
- The information you provide will contribute to a publicly-available report for MassDEP.
- Survey responses are due by **March 25th**.

Please contact Rachel Tenney (rtenney@tighebond.com or 413-875-1663) with any questions or for assistance.

* Required

## Treatment Overview

Please answer all questions for **your facility in 2023**.

1. Your name *

2. Title / Position *

3. Email *

4. Phone *

5. Facility name *

6. Average daily flow (MGD) *

The value must be a number

7. Permitted (or design) flow (MGD)

The value must be a number

8. What are your facility's **liquid-stream** unit processes? *

Select all that apply.

- [ ] Screening
- [ ] Grit removal
- [ ] Primary clarification
- [ ] Aeration/activated sludge
- [ ] Secondary clarification
- [ ] Nitrification
- [ ] Denitrification
- [ ] Filtration
- [ ] Tertiary treatment / phosphorus (P) removal
- [ ] Chlorine disinfection
- [ ] UV disinfection
- [ ] Other

9. Does your facility have nutrient **permit limits**? *

- ◯ Nitrogen (N)
- ◯ Phosphorus (P)
- ◯ Both nitrogen (N) and phosphorus (P)
- ◯ None

10. Please describe your facility's **nutrient removal** processes, including any changes anticipated in the next 5-10 years.

11. Does your facility have an active, EPA-approved industrial pretreatment program (IPP)? *

- ◯ Yes
- ◯ No
- ◯ Don't know
- ◯ Other

12. Does your facility receive septage? Septage is defined as the liquid, solid, and semi-solid contents of privies, portable toilets, chemical toilets, cesspools, holding tanks, or other sewage waste receptacles. *

**Facilities that receive septage will be asked to complete an additional survey.**

- ◯ Yes
- ◯ No

13. Does your facility receive hauled-in waste *other than septage or wastewater sludge*? *

If you select "yes," there will be follow-up questions on Page 2. If you select "no," you will be directed to Page 3.

- ◯ Yes
- ◯ No

## Hauled-in waste *other than septage and wastewater sludge*

Please answer all questions for **your facility in 2023**.

14. What total quantity of hauled-in waste *other than septage or wastewater sludge* did your facility receive in 2023?

15. What types of hauled-in waste other than septage or sludge from other facilities did your facility receive?

    Select all that apply.

    - ☐ Landfill leachate
    - ☐ Food waste
    - ☐ Slaughterhouse and/or farm waste
    - ☐ Brewery waste
    - ☐ FOG (i.e., fats, oils and grease)
    - ☐ Other

16. Please describe any "other" hauled-in waste, and provide any additional details (e.g., frequency, anticipated changes in the next 5-10 years).

## Sludge Production & Processing

Please answer all questions for **your facility in 2023**.

17. What was the **total annual quantity** of sludge your facility produced? *

Enter a number here; provide units in your next response.

The value must be a number

18. Provide the **units** for the total annual quantity of sludge your facility produced. *

- ◯ Wet US tons
- ◯ Wet metric tons
- ◯ Dry US tons
- ◯ Dry metric tons
- ◯ Cubic yards
- ◯ Gallons

19. What is the average percent solids of sludge produced? *

Enter as a percent (%).

20. What dewatering technologies are used at your facility? *

Select all that apply.

- ☐ Belt filter press
- ☐ Rotary press
- ☐ Screw press
- ☐ Centrifuge
- ☐ Drying beds
- ☐ None
- ☐ Other

21. Answer this question if your facility has a garage for sludge cake loading: What is the largest hauling container you can accommodate?

- ◯ Small dump truck
- ◯ 30-yard roll-off container
- ◯ Open-top truck trailer
- ◯ Not applicable
- ◯ Other

22. Does your facility do any advanced processing or disposal of sludge onsite? *

Select all that apply.

**Facilities with advanced sludge processing onsite will be asked to complete an additional survey.**

Examples of advanced sludge processing: incineration, landfill, beneficial reuse/land application (e.g., composting, thermal drying)

- ☐ Anaerobic digestion
- ☐ Biogas (e.g., methane) capture & recovery
- ☐ Composting
- ☐ Lime stabilization
- ☐ Thermal drying (e.g., belt dryer, paddle dryer, rotary drum dryer)
- ☐ Pyrolysis/gasification
- ☐ Incineration
- ☐ Municipal solid waste (MSW) landfill
- ☐ Sludge/ash monofill
- ☐ None
- ☐ Other

23. Does your facility have a digester(s) that is no longer used as a digester because it was abandoned/repurposed? *

- ◯ Yes
- ◯ No

24. Please describe any changes to **sludge processing** at your facility anticipated in the next 5-10 years.

Examples: Process upgrades, equipment replacements, facility expansions, adding advanced processing, etc.

## Sludge Management Costs

25. What was the **total unit cost** of sludge management in 2023 (including both hauling and end use or disposal)? Please do not include internal sludge processing costs such as labor, chemicals, electricity, etc. *

Enter a number here; provide units in your next response.

The value must be a number

26. Provide the **units** for the cost of sludge management. *

- ◯ $ per wet US ton
- ◯ $ per wet metric ton
- ◯ $ per dry US ton
- ◯ $ per dry metric ton
- ◯ $ per cubic yard
- ◯ $ per gallon
- ◯ Other

27. If available, what was the **breakdown** between hauling costs and end use or disposal costs in 2023?

Answer to the best of your ability.

28. What were your facility's sludge management costs (hauling and end use or disposal only) for **1-5 years prior to 2023**? *

Answer to the best of your ability. List the year and total unit cost (e.g., $ per wet US ton in 2021).
*If this information is not available, enter "NA."*

29. When does your facility's 2023 sludge hauling and management contract expire? *

30. How is sludge managed (i.e., what was the end use or disposal method)? *

Select all that apply.

- [ ] Beneficial reuse/land application (e.g., composting, thermal drying)
- [ ] Incineration
- [ ] Municipal solid waste (MSW) landfill
- [ ] Sludge/ash monofill
- [ ] Don't know
- [ ] Other

31. What disposal providers do you use or contract with? *

32. Are there any new disposal providers you are looking into? *

33. Provide a breakdown of how sludge is managed. *

Please include weight or volume of sludge disposed by each method listed above, identify states that receive sludge from your facility, and include the weight or volume of sludge each state receives.

34. Does your facility maintain backup contracts for sludge management? *

- ◯ Yes
- ◯ No

35. Please describe the nature of the backup contract(s).

Answer to the best of your ability. List total unit cost, cost breakdown, and contract expiration for each backup contract.

36. Has your facility struggled to find a disposal or end use location? *

## Future of sludge management

37. Please describe any **anticipated changes** to sludge management contracts and/or costs for your facility for the next 5-10 years. *

38. Would you be interested in collaborating or participating in a **regional sludge management facility** located in Massachusetts?

Please explain why or why not in the next question.

- ◯ Yes
- ◯ No

39. Why or why not?

40. Do you have any PFAS concerns for your facility over the next 5-10 years?

41. Please share any final thoughts about current and future sludge management practices.

# Appendix B: Landfill Disposal Survey Questions

# Landfill Disposal Survey

**Purpose**: Thank you for taking the time to answer this survey from the Department of Environmental Protection. By completing this survey, you will be helping Massachusetts and its consultants, Tighe & Bond and Brown and Caldwell, to develop a state-wide strategy for how Massachusetts manages sludge and biosolids. This survey will be used for information only and will not be used for compliance.

**Instructions**: The survey cannot be saved and must be completed in one sitting. It will take approximately 20 minutes to complete. Please follow instructions carefully.

- Provide data from 2023.
- Contact us if you wish to edit your responses.
- Your identity and contact information will not be shared and will only be used for essential follow-up. The information you provide will contribute to a publicly available report for MassDEP.
- Please fill out a separate survey for each landfill . Owners/operators for multiple facilities will need to complete multiple surveys.
- 

Please contact Taylor Labbe (tlabbe@tighebond.com or 401-455-4303) for assistance.

* Required

1. Your name: *

2. Title/position: *

3. Email: *

4. Phone: *

5. Facility name: *

6. Landfill address: *

7. Provide the state in which the landfill is located: *

8. Please identify the type of entity which owns the landfill: *

◯ Private

◯ City Government

◯ County Government

◯ Other

9. Please provide the landfill owner's name: *

10. Please provide the name of the landfill operator: *

11. Does the landfill have a solid waste permit or license? *

◯ Yes

◯ No

12. If yes, please provide the license or permit number, and identify the entity which granted the permit or license:

13. Please describe the types of waste materials the landfill is currently permitted to accept: *

14. Please provide the current permitted daily accepted tonnage rate at the landfill, with units: *

15. Please provide the current permitted annual accepted tonnage rate at the landfill, with units: *

16. Please provide the volume of the existing constructed airspace (available landfill capacity) remaining in cubic yards as of 01/01/24: *

17. Please provide the remaining permitted capacity of the landfill (constructed and to be constructed) and an estimate of the expected number of years of landfill site life remaining as of 01/01/2024: *

18. Have expansion areas beyond that which are currently permitted been identified? *

- Yes
- No

19. If yes, please provide the anticipated capacity of the expansion airspace in cubic yards:

20. Do you anticipate any changes to the amounts of tonnage you accept in the next 5 years? *

- Yes
- No

21. If yes, describe how accepted tonnage amounts are expected to change in the next 5 years:

22. Please describe any existing limits on the acceptance of "high-moisture content" or wet wastes at the landfill: *

23. Do you anticipate any changes to the types of waste you accept in the next 5 years? *

- Yes
- No

24. If yes, please describe how accepted waste types are expected to change in the next 5 years:

25. Does the landfill have an active gas collection system? *

- Yes
- No

26. If yes, is the landfill gas beneficially reused in any way?

- Yes
- No

27. If yes, please describe how landfill gas is beneficially reused:

28. Is there leachate collection at the landfill? If yes, please describe how it is managed. *

29. Does the landfill currently accept wastewater sludge? *

- ◯ Yes
- ◯ No

30. If yes, is the landfill a municipal solid waste landfill that accepts municipal sludge, or a sludge only landfill?

31. In the event of limited remaining landfill capacity, does the municipality have a secondary means for wastewater sludge disposal? Describe *

32. Does the landfill receive wastewater sludge from out of Town sources? *

- ◯ Yes
- ◯ No

33. Please estimate the percentage of wastewater sludge your facility receives from Massachusetts vs. other states. *

34. Is your facility considering decreasing its acceptance of wastewater sludge in the next 5 years? *

- ◯ Yes
- ◯ No

35. Please select any challenges posed to the operation of the landfill by wastewater sludge collection, as applicable: *

- [ ] Odor
- [ ] Increase in leachate volume or negative impact to quality
- [ ] Increase in gas production
- [ ] Gas collection
- [ ] Global Stability
- [ ] Slope Stability
- [ ] Availability of bulking/drying agents
- [ ] Drainage/stormwater management
- [ ] PFAS
- [ ] Other

36. Please provide the total tons (wet-tons) of wastewater sludge accepted at the landfill in 2023: *

37. What tipping fees do you charge for wastewater sludge disposal (provide units)? *

38. Is wastewater sludge monofilled at the landfill facility? *

- ○ Yes
- ○ No

39. Are bulking material mixed with wastewater sludge at the landfill facility? *

- ○ Yes
- ○ No

40. If yes, please describe the types, use, and volumes pertaining to the bulking material:

41. Please briefly describe any limitations or restrictions to the acceptance of additional wastewater sludge at the landfill facility: *

42. Would your facility ever consider accepting additional wastewater sludge at the facility? *

- Yes
- No

43. What would need to change for your facility to accept additional wastewater sludge? *

44. Do you have any concerns for your facility related to PFAS? *

45. Does the facility have plans for any future onsite wastewater sludge treatment installations (i.e. composting, thermal drying, or other wastewater sludge processing)? *

- Yes
- No

46. If yes, what type of wastewater sludge treatment is planned?

47. Please use this as an opportunity to provide any additional information not previously addressed by this questionnaire: *

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# Appendix C: Biosolids Processing Facility for Land Application Survey Questions

# Biosolids Processing Facility for Land Application Survey

**Purpose**: Thank you for taking the time to answer this survey from the Department of Environmental Protection. By completing this survey, you will be helping Massachusetts and its consultants, Tighe & Bond and Brown and Caldwell, to develop a statewide strategy for how Massachusetts manages sludge and biosolids. This survey will be used for information only and will not be used for compliance.

**Instructions**: The survey cannot be saved and must be completed in one sitting. It will take approximately 20 minutes to complete. Please follow instructions carefully.

- Provide data from 2023.
- Contact us if you wish to edit your responses.
- Your identity and contact information will not be shared and will only be used for essential follow-up.
- The information you provide will contribute to a publicly-available report for MassDEP.
- Survey responses are due by **March 25th**.

Please contact Rachel Tenney (rtenney@tighebond.com or 413-875-1663) with any questions or for assistance.

* Required

## Facility Overview

Please answer all questions for **your facility in 2023**.

1. Your name *

2. Title / Position *

3. Email *

4. Phone *

5. Facility name *

6. In what city/town and state/province is your facility located? *

7. How does your facility process biosolids suitable for land application? *

- ◯ Thermal drying
- ◯ Composting
- ◯ Alkaline stabilization / lime pasteurization
- ◯ Other

8. Who manages the end use and/or disposal of your facility's biosolids product? *

Select all that apply.

- ☐ Facility owner
- ☐ Facility operator
- ☐ Offsite third-party distributor or applier (no further biosolids treatment)
- ☐ Offsite third-party distributor or applier (with additional biosolids treatment)
- ☐ Other

9. Are biosolids distributed in bulk and/or in bags/containers? *

Select all that apply.

- ☐ Bulk
- ☐ Bags/containers

10. How was your facility's biosolids product distributed? *

Select all that apply.

- ☐ Parks, yards, gardens, landscaping, sports fields
- ☐ Agricultural sites
- ☐ Land reclamation sites
- ☐ Incineration
- ☐ Landfill
- ☐ Offsite preparers (e.g., composter, fertilizer admixture, etc.)
- ☐ Other

11. Indicate volumes of biosolids distributed to each type of site identified above, if available. *

Alternatively, email documentation to rtenney@tighebond.com.

12. Where was the biosolids product distributed? *

Select all that apply.

- [ ] Massachusetts
- [ ] New Hampshire
- [ ] Vermont
- [ ] Maine
- [ ] Connectitcut
- [ ] Rhode Island
- [ ] New York
- [ ] Pennsylvania
- [ ] Ohio
- [ ] Florida
- [ ] Other U.S. state(s)
- [ ] Canada - Quebec
- [ ] Canada - New Brunswick
- [ ] Canada - Other province(s)
- [ ] Other

13. Indicate volumes of biosolids distributed to each state/province. *

Alternatively, email documentation to rtenney@tighebond.com.

14. Please estimate the percentage of your biosolids that you distribute for land application in Massachusetts (vs. outside of Massachusetts). *

15. Pathogen treatment - What class of biosolids (per 40 CFR Part 503) are produced at your facility? *

Select all that apply.

- [ ] Class A / Type I
- [ ] Class B / Type II
- [ ] Not suitable for land application

16. What revenue/cost does your facility earn/incur to distribute biosolids? *

## Thermal Drying

Please answer all questions for **your facility in 2023**.

17. What thermal drying technologies are used at your facilities? *

Select all that apply.

- [ ] Rotary drum dryer
- [ ] Belt dryer
- [ ] Paddle dryer
- [ ] Other

18. Please describe your facility's thermal drying processes. *

19. What is the primary heat source used in the drying process? *

- ○ Natural gas
- ○ Fuel oil
- ○ Biogas (digester, landfill, etc.)
- ○ Heat recovered from other thermal processes
- ○ Electricity
- ○ Other

20. What energy recovery processes does the drying system utilize? *

21. How many thermal drying trains are installed at the facility? *

The value must be a number

22. How many thermal drying trains are **operated** during **average** design conditions? *

The value must be a number

23. How many thermal drying trains are **operated** during **maximum** design conditions? *

The value must be a number

24. What is the design or practical capacity of an individual thermal drying train? *

Please provide units.

25. What was your facility's 2023 annual production of dry biosolids? *

Please provide units.

26. What is the average solids content of the dried product? *

Please enter in **percent solids**.

The value must be a number

27. How many days per year does the facility normally operate? *

The value must be a number

28. Describe any events that resulted in unplanned downtime in 2023. *

29. What total quantity of wastewater sludge did your facility receive in 2023? *

Please provide units (e.g., wet US tons).

30. For municipally-owned facilities, does your facility receive merchant wastewater sludge from other POTWs? *

- ◯ Yes
- ◯ No
- ◯ Not applicable

31. Please describe any merchant wastewater sludge received from other POTWs. *

Please include volume and frequency, from how many POTWs, etc.

32. Please list any contractual or practical **limitations or priorities** for accepting wastewater sludge from other facilities. *

Examples: limits on mechanical sludge receiving systems, permit limitations, sludge quality issues, contractual agreements, etc.

33. Which facilities deliver merchant wastewater sludge to the drying facility? *

Please include how much is delivered and indicate units.

34. What do you charge for merchant wastewater sludge at your facility? *

35. What is the preferred or required total solids content range for merchant wastewater sludge? *

Please enter in **percent solids**.

36. Please describe your facility's backup sludge handling approach if the thermal drying facility is out of service. *

37. What are future plans for the thermal drying facility? *

Select all that apply.

- ☐ Continue thermal drying indefinitely
- ☐ Discontinue thermal drying in the next 5 years
- ☐ Major thermal drying facility upgrade in the next 5 years
- ☐ Move to alternative biosolids processing technology
- ☐ Expansion / increase system capacity
- ☐ Other

38. Any other comments or concerns affecting continuation of thermal drying at your facility?

Examples: equipment age and condition (please specify remaining service life), regulatory requirements (please specify), PFAS or other emerging contaminants of concern, etc.

39. Any other comments that will help establish the current and future status of thermal drying of biosolids in the Northeast?

## Composting

Please answer all questions for **your facility in 2023**.

40. What composting method(s) are used at your facility? *

- [ ] In-vessel composting
- [ ] Aerated static piles
- [ ] Windrow composting
- [ ] Other

41. Please describe your facility's composting process. *

42. What is the design or practical capacity of the compost facility? *

Please provide units (e.g., wet US tons per day).

43. What was the **average** operating usage of the compost facility in 2023? *

Please provide units (e.g., wet US tons per day).

44. What was the **maximum** operating usage of the compost facility during **maximum** design conditions in 2023? *

Please provide units (e.g., wet US tons per day).

45. What was your facility's 2023 annual production of compost product? *

Please provide units (e.g., dry US tons).

46. What was the average solids content of the compost product? *

Please enter in **percent solids**.

The value must be a number

47. What total quantity of wastewater sludge did your facility receive in 2023? *

Please provide units (e.g., wet US tons).

48. How many days per year does the facility normally operate? *

The value must be a number

49. Describe any events that resulted in unplanned downtime in 2023. *

50. Does the compost facility have available capacity to receive additional wastewater sludge? *

If so, please estimate additional available capacity.

51. Please describe any other organic materials processed by your compost facility. *

Examples: yard waste, food waste, agricultural by-products, etc.

52. Please describe bulking agents typically used in the composting process. *

53. For municipally-owned compost facilities, does your facility receive merchant wastewater sludge from other POTWs? *

- ◯ Yes
- ◯ No
- ◯ Not applicable

54. Please describe any merchant wastewater sludge received from other POTWs. *

Please include volume and frequency, from how many POTWs, etc.

55. Please describe any contractual or practical **limitations or priorities** for accepting wastewater sludge from other facilities. *

Examples: limits on mechanical sludge receiving systems, permit limitations, sludge quality issues, contractual agreements, etc.

56. What do you charge for merchant wastewater sludge at your facility? *

57. Which facilities deliver merchant wastewater sludge to the composting facility? *

Please include how much is delivered and indicate units.

58. What is the preferred or required total solids range for merchant wastewater sludge? *

Please enter in **percent solids**.

59. Please describe your facility's backup sludge handling approach if the compost facility is out of service. *

60. What are future plans for the composting facility in the next 5-10 years? *

Select all that apply.

- ☐ Continue composting indefinitely
- ☐ Discontinue composting
- ☐ Major composting facility upgrade
- ☐ Move to alternative biosolids processing technology
- ☐ Expansion / increase system capacity
- ☐ Other

61. Any other comments that will help establish the current and future status of biosolids composting in the Northeast?

Examples: equipment age and condition (please specify remaining service life), regulatory requirements (please specify which ones), PFAS or other emerging contaminants of concern, etc.

## Alkaline Stabilization / Lime Pasteurization

62. What alkaline stabilization / lime pasteurization technologies are used at your facility? *

- [ ] Solid lime stabilization
- [ ] Liquid lime stabilization
- [ ] Other

63. Does your facility use any supplemental solids in addition to lime? *

Select all that apply.

- [ ] Fly ash (from coal combustion)
- [ ] Lime kiln dust
- [ ] Cement kiln dust
- [ ] Other

64. Please describe your facility's alkaline stabilization / lime pasteurization process. *

65. What is the design or practical capacity of the facility? *

Please provide units.

66. What was your facility's 2023 annual production of biosolids? *

Please provide units (e.g., dry US tons).

67. What is the average solids content of the biosolids product? *

Please enter in **percent solids**.

68. What percent of your biosolids product is **Class A / Type I**? *

The value must be a number

69. What percent of your biosolids product is **Class B / Type II**? *

The value must be a number

70. What total quantity of wastewater sludge did your facility receive in 2023? *

Please provide units (e.g., wet US tons).

71. How many days per year does the facility normally operate? *

The value must be a number

72. Describe any events that resulted in unplanned downtime in 2023. *

73. What do you charge for merchant wastewater sludge at your facility? *

74. Please list any contractual or practical **limitations or priorities** for accepting wastewater sludge from other facilities. *

Examples: limits on mechanical sludge receiving systems, permit limitations, sludge quality issues, contractual agreements, etc.

75. What is the preferred or required total solids content range for merchant wastewater sludge? *

Please enter in **percent solids**.

76. Please describe your facility's backup sludge handling approach if the facility is out of service. *

77. What are future plans for the facility? *

Select all that apply.

- [ ] Continue alkaline stabilization indefinitely
- [ ] Discontinue alkaline stabilization in the next 5 years
- [ ] Major alkaline stabilization facility upgrade in the next 5 years
- [ ] Move to alternative biosolids processing technology
- [ ] Expansion / increase system capacity
- [ ] Other

78. Any other comments or concerns affecting continuation of alkaline stabilization at your facility?

Examples: equipment age and condition (please specify remaining service life), regulatory requirements (please specify), PFAS or other emerging contaminants of concern, etc.

79. Any other comments that will help establish the current and future status of alkaline stabilization of biosolids in the Northeast?

80. Do you have any PFAS concerns for your facility over the next 5-10 years?

81. Please share any final thoughts about current and future sludge management markets.

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# Appendix D: Incineration Survey Questions

# Incineration Survey

**Purpose**: Thank you for taking the time to answer this survey from the Department of Environmental Protection. By completing this survey, you will be helping Massachusetts and its consultants, Tighe & Bond and Brown and Caldwell, to develop a state-wide strategy for how Massachusetts manages sludge and biosolids. This survey will be used for information only and will not be used for compliance. This survey is intended for incinerators who process MA sludge.

**Instructions**: The survey cannot be saved and must be completed in one sitting. It will take approximately 20 minutes to complete. Please follow instructions carefully.

- If you are representing more than one incineration facility, please fill out one form per incineration facility.
- Provide data from 2023.
- Contact us if you wish to edit your responses.
- Your identity and contact information will not be shared and will only be used for essential follow-up. The information you provide will contribute to a publicly available report for MassDEP.

Please contact Jessica Nekowitsch (jnekowitsch@brwncald.com or 978.983.2039) for assistance.

* Required

1. Please provide the Name, Title, Contact Email, and Phone Number of the personnel filling out this survey as a point of contact for follow-up questions. *

2. Please provide the incinerator facility name. *

3. Please provide the name of the State in which your incinerator is located. *

4. Please provide the name of the City in which your incinerator is located. *

5. What type of incinerator is used? *

- ◯ Multiple hearth
- ◯ Fluidized bed
- ◯ Other

6. How many incinerators are operable? *

7. What is the design or practical capacity of an individual incineration train? (please include units)

8. Is the incinerator owned by the utility or a separate entity? (If you select "Other" aka separate entity, please indicate who and provide contact information) *

- ◯ Utility
- ◯ Other

9. Who operates the incinerator? *

- ◯ Utility
- ◯ Other

10. Are there permit limitations on the incineration system capacity (e.g., limits on the amount of solids that can be processed in a given amount of time)?

11. How much wastewater sludge was processed through the incineration system in 2023? (Please specify units i.e. wet US tons/year or dry US tons/day etc.) *

12. How much wastewater sludge is processed through the incineration system annually on average? (Please specify units i.e. wet US tons/year or dry US tons/day etc.) *

13. Does the incineration system have the ability to process additional wastewater sludge? *

- No
- Yes

14. How much reserve capacity does the system have? (please include units)

15. Is any sludge brought in from other facilities and incinerated? *

- No
- Yes

16. Which facilities does sludge come from and how much from each? (please include units)

17. What is the preferred or required total solids content (%) range of incoming sludge? *

18. Please list any contractual or practical limitations or priorities of accepting sludge from other facilities, such as: Limits of mechanical sludge receiving systems, permit limitations, sludge quality issues, etc. *

19. Are any materials other than sludge incinerated? *

- No
- Yes

20. Please specify which materials other than sludge are being incinerated and how much total. *

21. How much ash is annually produced on average? (please include units)

22. How is the ash handled?

- [ ] Landfilled
- [ ] Beneficial reuse (please specify in "Other")
- [ ] Other

23. What is the backup sludge handling approach when the incinerators are out of service? *

24. How much downtime did your incinerator have in 2023? (please include units)

25. How many days/weeks per year are the incinerators out of service? (please include units) *

26. What is the facility's approach to handling planned outages? How are participating facilities notified? *

27. Choose which option the incinerator is currently classified as: *

- ◯ 40 CFR Subpart LLL/ 40 CFR 60 Subpart MMMM/"Existing"
- ◯ 40 CFR Subpart LLLL/ "New" per the 2016 MACT Federal Regulations

28. What are the future plans for the incineration system? *

- ☐ Continue incinerating indefinitely
- ☐ Move to new technology in the future
- ☐ Increase system capacity
- ☐ Cease operation
- ☐ Reduce acceptance of wastewater sludge
- ☐ Landfill
- ☐ Land apply
- ☐ Other

29. What is the age and condition of the main incinerator equipment? *

30. What is the estimated remaining life expectancy of the incinerator? *

31. Are there any pending plans to upgrade the incinerator over the next 5-10 years? If so, what is the estimated cost? *

32. Do you have any PFAS concerns for your facility over the next 5-10 years?

33. Are there any energy recovery components of your system?

○ No

○ Yes

34. What energy recovery components does the system have?

35. What are the major drivers affecting the continuation or discontinuation of the incineration system? *

36. What current, pending, or anticipated regulatory requirements are influencing the continuation of incineration at your facility? *

37. Do you have any additional comments you would like to share?

38. How much does your facility charge for wastewater sludge disposal?

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# Appendix E: Landfilling of Massachusetts Wastewater Sludge Addendum to Massachusetts Materials Management Capacity – Sludge Addendum Memo

ADDENDUM

# Landfilling of Massachusetts Wastewater Sludge Addendum to Massachusetts Materials Management Capacity Study

**TO:** Massachusetts Department of Environmental Protection

**FROM:** Tighe & Bond and Brown and Caldwell

**DATE:** June 28, 2024

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This document serves as an addendum to the 2019 Massachusetts Materials Management Capacity Study, prepared by MSW Consultants for the Massachusetts Department of Environmental Protection. The 2019 study assessed the overall capacities of possible material endpoints including facilities involved in disposal (landfill and combustion), transfer, recycling, composting, anaerobic digestion, animal feed operations, food rescue, and materials reuse operations. This addendum was prepared in conjunction with MassDEP's PFAS and Residuals Technology and Management Study – Part 1, and provides information on disposal of wastewater sludge generated by Massachusetts publicly owner treatment works (POTWs) in landfills and monofills.

# Section 1 - Introduction

To better understand the current and future status of landfills receiving Massachusetts sludge as well as their capacity, a survey was sent in April 2024. The survey consisted of 47 questions, which were both qualitative and quantitative and focused on the owner, operator, landfill capacity, merchant sludge acceptance, future plans, and other concerns. Massachusetts landfill disposal data was also obtained through a combination of existing data from Massachusetts, New York, and Maine resources, where available. The capacity analysis provided includes data from landfill facilities located within Massachusetts, as well as out-of-state landfills currently accepting wastewater sludge from Massachusetts POTWs. The following data was acquired and analyzed:

- Facility name, type, location, and other identifying information
- Permitted annual capacity and actual tonnage accepted (2023)
- Estimated remaining capacities and years of landfill life
- Anticipated changes to waste acceptance rates
- Challenges posed to facilities by wastewater sludge collection

Data were evaluated to understand the current and projected future capacities for wastewater sludge disposal in landfill facilities in and around Massachusetts. Additionally, estimated costs for the landfill disposal of wastewater sludge from POTWs in Massachusetts was evaluated as an important consideration in the future of wastewater sludge management.

## Scope of Study

The scope of this study included all in-state landfill facilities, as well as out-of-state facilities in and around New England which accept waste from Massachusetts POTW facilities. Five states, including Massachusetts, were identified as potentially hosting facilities meeting these conditions. Figure 1-1 is a map showing landfill management of Massachusetts sludge. As shown, there are a number of landfills within Massachusetts that receive sludge from Massachusetts POTWs. However, Massachusetts sludge is also hauled considerable distances for disposal in Maine, New Hampshire, Vermont, and New York. No Massachusetts sludge is presently landfilled outside of the Northeast.

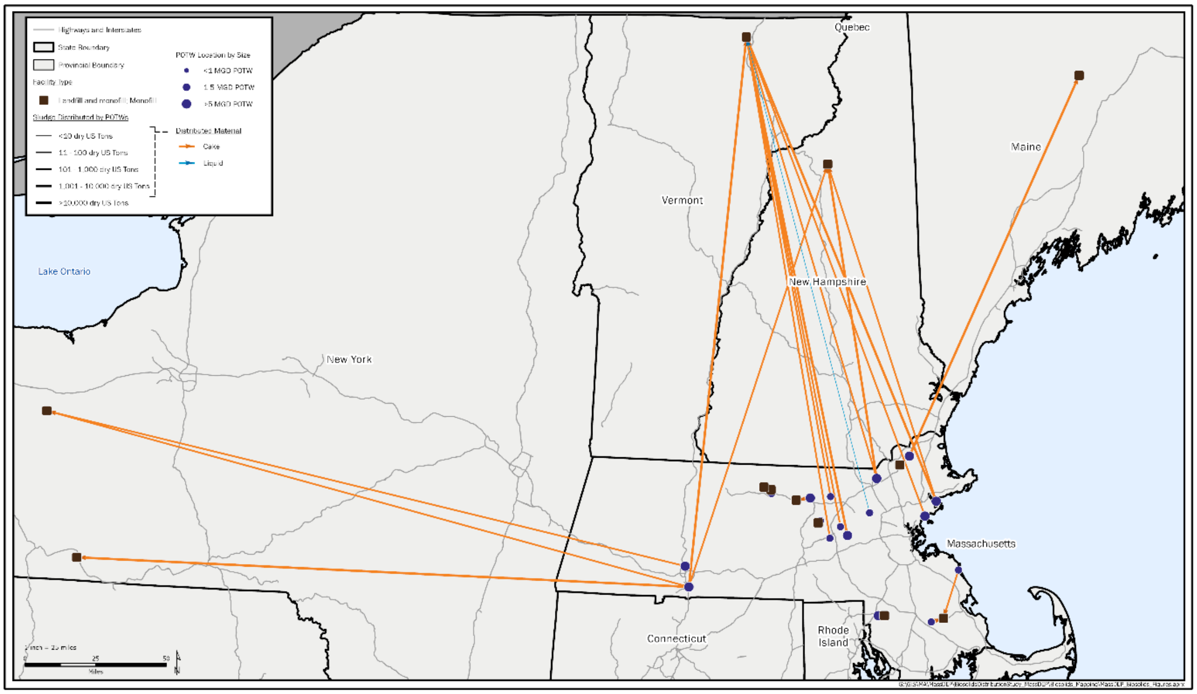



**FIGURE 1-1**
Map of Landfill Management of Massachusetts Wastewater Sludge

# Methodology

For the purposes of this addendum, only data from landfill facilities contacted to participate in the survey is included and analyzed. The following facility types were contacted for participation in the survey, but data provided by these facilities is not included for analysis in this report:

- POTWs
- Sludge processing facilities (incinerators, sludge drying facilities, composting facilities, etc.)

The survey was developed using the original 2019 MassDEP Massachusetts Materials Management Capacity Study as guidance for the types of questions necessary for comprehensive analysis, as well as input from MassDEP. The survey was hosted on an internet based-survey platform, and data was collected and analyzed using Excel. Participants were asked to self-report data.

# Section 2 - Capacity for Biosolids

## Summary of Massachusetts Landfill Providers

In an effort to obtain a comprehensive understanding of landfill disposal practices for wastewater sludge within Massachusetts, a number of landfill facilities were solicited for participation in the survey. A total of sixteen in-state facilities were included in the survey distribution list, from which fourteen responses were received—representing 87.5 percent of solicited facilities. MassDEP Annual Landfill Reports were also reviewed for relevant data pertaining to permitted waste acceptance rates at various facilities. Not all facilities are permitted to accept wastewater sludge, however, these facilities were solicited for participation in order to understand future potential for sludge disposal at each facility, as well as participants' willingness and concerns. Table 2-1 below summarizes the facilities contacted for participation in this study.

| Table 2-1: Massachusetts Landfill Facilities | | | |
|---|---|---|---|
| Facility Name | Facility Address | Wastes Accepted | Response Received |
| Attleboro Monofill | 179 Peckham St, Attleboro, MA 02703 | Sludge/Ash | Yes |
| Resource Control, Inc. – RCI Fitchburg Landfill | 101 Fitchburg Rd RT 31, Westminster, MA | Municipal Solid Waste | Yes |
| Gardner WPCF | 808 West St, Gardner, MA | Sludge | Yes |
| Templeton WWTF | Templeton WWTF 33 Reservoir St, Baldwinville, MA | Sludge | Yes |
| Middleborough Sanitary Landfill | 207 Plympton St, Middleborough, MA | Municipal Solid Waste | Yes |
| Bondi's Island Landfill | 147 M St, Agawam, MA | Ash, limit other wastes | Yes |
| Upper Blackstone Clean Water | 50 Route 20, Millbury, MA | Ash | Yes |
| Specialty Minerals | 260 Columbia St, Adams, MA | Sludge | No |
| Bourne Landfill | 201 MacArthur Blvd, Bourne, MA | Municipal Solid Waste | Yes |
| Clinton Sludge Monofill (Clinton MWRA) | 677 High Street, Clinton, MA | Sludge | Yes |
| Crapo Hill Landfill | 300 Samuel Barnet Blvd, New Bedford, MA | Municipal Solid Waste | Yes |
| Hull Sanitary Landfill | 111 Rockaway Ave, Hull, MA | Municipal Solid Waste | Yes |
| Nantucket Landfill | 188 Madaket Rd, Nantucket, MA | Municipal Solid Waste | No |
| Peabody South Mound Swale | 40 Farm Ave, Peabody, MA | Municipal Solid Waste | Yes |
| Peabody Ash Monofill | 40 Farm Ave, Peabody, MA | Ash | Yes |
| Wheelabrator Millbury Inc. (Shrewsbury Monofill) | 620 Hartford Turnpike, Shrewsbury, MA | Ash | Yes |
| Attleboro Monofil | 179 Peckham St, Attleboro, MA 02703 | Sludge/Ash | Y |
| Resource Control, Inc. – RCI Fitchburg Landfill | 101 Fitchburg Rd RT 31, Westminster, MA | Municipal Solid Waste | Y |
| Gardner WPCF | 808 West St, Gardner, MA | Sludge | Y |
| Templeton WWTF | Templeton WWTF 33 Reservoir St, Baldwinville, MA | Sludge | Y |
| Middleboro Sanitary Landfill | 207 Plympton St, Middleboro, MA | Municipal Solid Waste | Y |
| Bondi's Island Landfill | 147 M St, Agawam, MA | Ash, limit other wastes | Y |

| Table 2-1: Massachusetts Landfill Facilities | | | |
|---|---|---|---|
| **Facility Name** | **Facility Address** | **Wastes Accepted** | **Response Received** |
| Upper Blackstone Clean Water | 50 Route 20, Millbury, MA | Ash | Y |
| Specialty Minerals | 260 Columbia St, Adams, MA | Sludge | N |
| Bourne Landfill | 201 MacArthur Blvd, Bourne, MA | Municipal Solid Waste | Y |
| Clinton Sludge Monofil (Clinton MWRA) | 677 High Street, Clinton, MA | Sludge | Y |
| Crapo Hill Landfill | 300 Samuel Barnet Blvd, New Bedford, MA | Municipal Solid Waste | Y |
| Hull Sanitary Landfill | 111 Rockaway Ave, Hull, MA | Municipal Solid Waste | Y |
| Nantucket Landfill | 188 Madaket Rd, Nantucket, MA | Municipal Solid Waste | N |
| Peabody South Mound Swale | 40 Farm Ave, Peabody, MA | Municipal Solid Waste | Y |
| Peabody Ash Monofill | 40 Farm Ave, Peabody, MA | Ash | Y |
| Wheelabrator Millbury Inc. (Shrewsbury Monofill) | 620 Hartford Turnpike, Shrewsbury, MA | Ash | Y |

## Summary of Out-of-State Landfill Providers

In an effort to obtain a comprehensive understanding of landfill disposal practices for wastewater sludge outside of Massachusetts, landfill facilities in and around New England were solicited for participation in the survey. Landfill facilities located outside of Massachusetts were solicited for participation if POTWs located within Massachusetts reported sending wastewater sludge to the out-of-state facility. A total of eight out-of-state facilities were included in the survey distribution list, from which five responses were received—representing 62.5 percent of solicited facilities. Table 2-2 below summarizes the facilities contacted for participation in this study.

| Table 2-2: Out-of-State Landfill Facilities | | |
|---|---|---|
| **Facility Name** | **Facility Address** | **Response Received** |
| Crossroads Landfill* | 357 Mercer Rd, Norridgewock, ME | No |
| Juniper Ridge Landfill* | 2828 Bennoch Rd, Alton, ME | No |
| Turnkey Landfill | 60 Steele Rd, Rochester, NH | No |
| New England Waste Services of VT Landfill (Waste USA Landfill) | 21 Landfill Lane, Coventry, VT | Yes |
| Ontario County Landfill | 1879 NY 5 & 20, Stanley, NY | Yes |
| Chemung County Landfill | 1488 County Rd 60, Elmira, NY | Yes |
| North Country Environmental Services Landfill (Bethlehem) | 581 Trudeau Rd, Bethlehem, NH | Yes |
| Clinton County Landfill | 286 Sand Rd, Morrisonville, NY | Yes |

**For facilities from which responses were not received, data are supplemented for analysis in this report by the 2023 Maine DEP Biosolids Management Report prepared by Brown and Caldwell.*

# Current Landfill Capacity for Sludge Disposal

Participants of the survey were asked to report the permitted capacity at their facility, as well as the actual wastewater treatment sludge wet tons received. Table 2-3A below shows the data as reported for facilities accepting sludge from their individual municipality or treatment facility only, while Table 2-3B reports the same data for those landfill facilities which accept sludge from other sources. Only facilities from which responses were received or for which data are otherwise available are included.

| Table 2-3A: Landfill Acceptance Rates – Local Sludge Only | | | | |
|---|---|---|---|---|
| Facility Name | Landfill Type | Yearly Permitted Tonnage (Total) | Sludge Wet Tonnage Accepted in 2023 | % of Permitted Tonnage that was consumed by POTW sludge in 2023 |
| **MA Facilities** | | | | |
| Attleboro Monofill | Sludge/Ash Monofill from Attleboro only | No Limit* | 9,521 | - |
| Gardner WPCF | Sludge from Gardner only | No Limit* | 3,284 | - |
| Templeton WWTF (Winchendon/Templeton) | Sludge Monofill for Winchendon/Templeton only | No Limit* | 157 | - |
| Clinton Sludge Monofil (Clinton MWRA) | Sludge Monofill | No Response | No Response | - |
| Hull Sanitary Landfill | Municipal Solid Waste | 6,300 | No response | - |
| Peabody South Mound Swale | Municipal Solid Waste for City of Peabody and Town of Wilmington only | 152,500 | No response | - |
| Peabody Ash Monofill | Ash Monofill for Peabody Only | 547,500 | No response | - |
| Bondi's Island Landfill | Ash, Limited other wastes | 105,850 | No response | - |
| Crapo Hill Landfill | Municipal Solid Waste for member communities only | 115,000 | No response | - |
| Bourne Landfill | Municipal Solid Waste | 219,000 | 0 | 0% |
| Upper Blackstone Clean Water | Ash Monofill for Facility only | 10,000 | No response | - |
| Middleborough Sanitary Landfill | Municipal Solid Waste, Special wastes. Massachusetts only | 60,000 | 1,867 | 3.1% |
| **TOTALS** | | **1,216,150** | **14,829** | **-** |

*While the facility reported not being limited in their yearly tonnage acceptance, it should be noted that these facilities only accept wastewater sludge from local wastewater treatment facilities.*

| Table 2-3B: Landfill Acceptance Rates – Non-Local Sludge Accepted | | | | |
|---|---|---|---|---|
| Facility Name | Landfill Type | Yearly Permitted Tonnage (Total) | Sludge Wet Tonnage Accepted in 2023 | % of Permitted Tonnage that was consumed by POTW sludge in 2023 |
| MA Facilities | | | | |
| Resource Control, Inc. - RCI Fitchburg Landfill | Municipal Solid Waste | 538,000 | 9,294 | 1.7% |
| TOTALS | | 538,000 | 9,294 | - |
| Out-of-State Facilities | | | | |
| North Country Environmental Services Landfill (Bethleham) (NH) | Municipal Solid Waste | 190,000 | 14,708 | 7.7% |
| New England Waste Services of VT Landfill (WasteUSA Landfill) (VT) | Municipal Solid Waste | 600,000 | 52,612 | 8.8% |
| Ontario County Landfill (NY) | Municipal Solid Waste | 917,000 | 53,154 | 5.8% |
| Chemung County Landfill (NY) | Municipal Solid Waste | 250,000 | 33,702 | 13.4% |
| Juniper Ridge Landfill (ME)* | Municipal Solid Waste, Construction & Demolition, Special wastes | No Response | 57,090 | - |
| Turnkey Landfill (NH) | Municipal Solid Waste | No Response | No Response | - |
| Crossroads Landfill (ME) | Municipal Solid Waste | No Response | No Response | - |
| **TOTALS** | | **1,957,000** | **211,266** | **-** |

**Facilities from which responses were not received but for which data are supplemented for analysis in this report by most recent individual DEP Annual Reports.*

While New York facilities appear to contain a higher capacity for wastewater sludge landfill disposal, it should be noted that disposal at these facilities presents high costs associated with transportation. Additionally, longer hauling distances present higher GHG emissions associated with transportation. Many sludge disposal landfill and monofill facilities limit their acceptance of wastewater sludge as a percentage of the total volume of waste accepted. Participants were asked to describe any existing limits on the acceptance of "high-moisture content" or wet wastes. Responses are presented below.

- Sludge is limited to 8 percent of total waste acceptance rate (1)
- Sludge is limited to 10 percent of total waste acceptance rate (2)
- Sludge is limited to 15 percent of total waste acceptance rate (4)
- Sludge is limited to between 25-30 percent of total waste acceptance rate (1)

In addition to limiting sludge acceptance as a percentage of total waste accepted, many facilities regulate the sludge wastes they accept by mandating a minimum ratio of solids to liquid. This results in variable sludge densities when measuring quantities of sludge disposal on a wet-ton basis. In order to present a normalized value for Massachusetts sludge accepted by landfill facilities, distributed quantities of dry sludge is presented in Table 2-4 below. Only facilities from which responses were received or for which data are otherwise available are included.

| Table 2-4: Dry US Tons of Massachusetts Sludge Accepted | |
|---|---|
| Facility Name | Dry US Tons of Sludge Accepted from MA POTWs |
| Attleboro Monofill | 3,332 |
| New England Waste Services of VT Landfill (WasteUSA Landfill) | 6,841 |
| Resource Control, Inc. - RCI Fitchburg Landfill | 1,837 |
| Gardner WPCF | 894 |
| Crossroads Landfill | 3,938 |
| Ontario County Landfill | 1,696 |
| North Country Environmental Services Landfill (Bethleham) | 2,823 |
| Middleborough Sanitary Landfill | 735 |
| Clinton Sludge Monofil (Clinton MWRA) | 300 |
| Chemung County Landfill | 1,721 |
| Templeton WWTF (Winchendon/Templeton) | 27 |
| **TOTAL** | **24,175** |

Participants were also asked about the expected theoretical remaining available space for waste of the facility, as well as the anticipated number of years of remaining landfill life. Available remaining capacity includes currently permitted capacity for expansion as well as capacity that falls within the landfill's plans but is not currently permitted.

Approximately 16 percent of respondents (3) report a remaining permitted available landfill facility capacity between 500,001 and 1,000,000 cubic yards, while 26 percent of respondents (5) report greater than 2,000,000 cubic yards. The average reported remaining permitted available for landfill facilities was approximately 2,236,280 cubic yards including known expansion estimates.

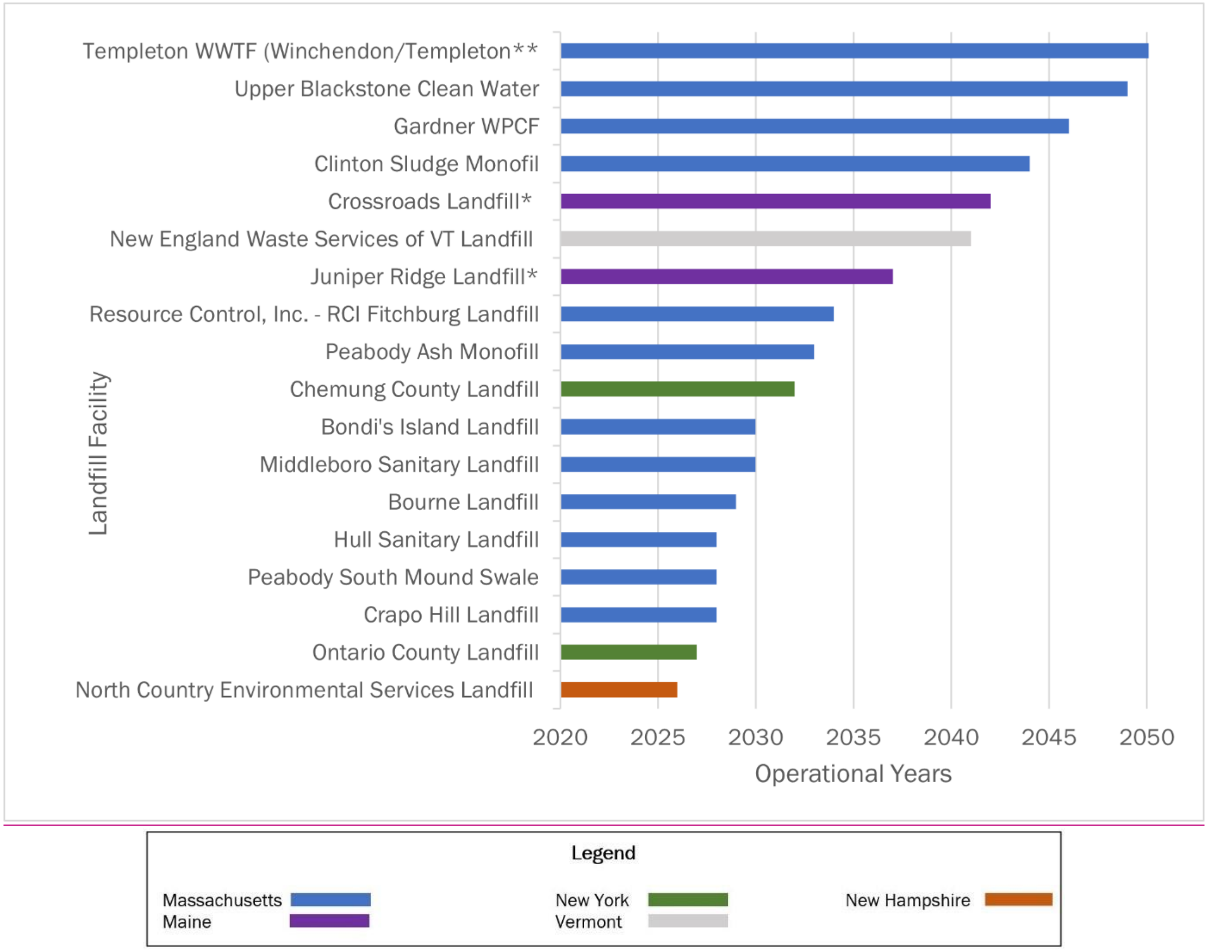
Additionally, participants were asked whether or not expansion areas beyond that which are currently permitted have been identified at their facilities. 47 percent of respondents answered "yes" to this question, representing 8 facilities, indicating that the remaining life of these landfill facilities may increase if those expansions are constructed. It should be noted that landfill expansion is a challenging process, and the feasibility of expansions are highly dependent on local support and opposition. A detailed table of the remaining permitted available capacity of landfills facilities, including potential expansions, is presented below as Table 2-5. Only facilities from which responses were received or for which data are otherwise available are included.

| Table 2-5: Remaining Availability Capacities of Landfill Facilities | | | |
|---|---|---|---|
| Facility Name | Facility State | Remaining Available Capacity at Facility (CY) | Potential Landfill Expansion (CY) |
| Gardner WPCF | MA | 32,313 | 276,500 |
| Hull Sanitary Landfill | MA | Minimal | - |
| Wheelabrator Millbury Inc. | MA | 2,000,000 | - |
| Upper Blackstone Clean Water | MA | 260,000 | |
| Resource Control, Inc. - RCI Fitchburg Landfill | MA | 4,590,680 | - |
| Middleborough Sanitary Landfill | MA | 531,060 | - |
| Crapo Hill Landfill | MA | 730,797 | 669,000 |
| Peabody South Mound Swale | MA | 8,000 | 660,000* |
| Bourne Landfill | MA | 1,197,000 | 3,978,000* |
| **MA TOTALS** | | **9,349,850** | **5,307,000** |
| North Country Environmental Services Landfill | NH | 715,000 | - |
| New England Waste Services of VT Landfill | VT | 1,200,000 | 1,250,000 |
| Ontario County Landfill | NY | 1,500,000 | TBD* |
| Chemung County Landfill | NY | 1,174,201 | 12,000,000* |
| Juniper Ridge Landfill | ME | 7,757,000 | - |
| **OUT-OF-STATE TOTALS** | | **12,346,201** | **13,250,000** |

**These landfill capacity expansions fall within the facility's plans but are not yet permitted for construction and should be considered tentative with regards to capacity projections.*

*Note: Not all out-of-state remaining capacity would be available for use by Massachusetts POTWs for sludge disposal. The remaining available capacity for Massachusetts sludge disposal is anticipated to be much less than overall remaining capacity values.*

The anticipated number of years of remaining landfill life is another important metric in determining remaining landfill capacity for sludge disposal. Figure 2-2 below outlines the estimated year of closure for responding facilities in and around Massachusetts accepting wastewater sludge produced within Massachusetts as of January 1, 2024.




**Facilities from which responses were not received but for which data is supplemented for analysis in this report by the 2023 MEDEP Biosolids Management Report.*
***Landfill closure year was reported between 2673-2723 – true value not shown to prevent large data spread.*

**Figure 2-2. Estimated Year of Landfill Facility Closure**

As illustrated by Figure 2-2, approximately 67 percent of responding facilities (12) reported less than or equal to ten (10) years of remaining landfill life, correlating with a closure year of 2034 (operation through the end of 2023). 28 percent of facilities (5) reported less than or equal to five years of remaining landfill life, correlating with a closure year of 2029 (operation through the end of 2028).

# Future Landfill Capacity for Sludge Disposal

In order to understand how future landfill capacity for sludge disposal is expected to change, participants were asked to describe anticipated changes to sludge acceptance at their facilities. This metric was gauged by asking participants questions regarding the following topics:

- Anticipated increases or decreases in sludge acceptance rates over the next 5 years.
- Willingness to accept additional sludge.
- Challenges posed to the facility with an increase in sludge acceptance.

29 percent (5) of respondents indicated an anticipated decrease in sludge acceptance rates over the next 5 years at their facilities. 12 percent of facilities (2) indicated that they would consider accepting additional wastewater sludge, while 88 percent of facilities (15) indicated that they would not. Figures 2-3A and 2-3B below illustrate trends in landfill capacity in relation to wastewater sludge disposal over the next 10 years through 2034. The remaining

capacity for wastewater sludge was extrapolated from the received data, where 2023 sludge acceptance rates were held constant for each facility unless an increase or decrease in rates was otherwise specified in survey responses.

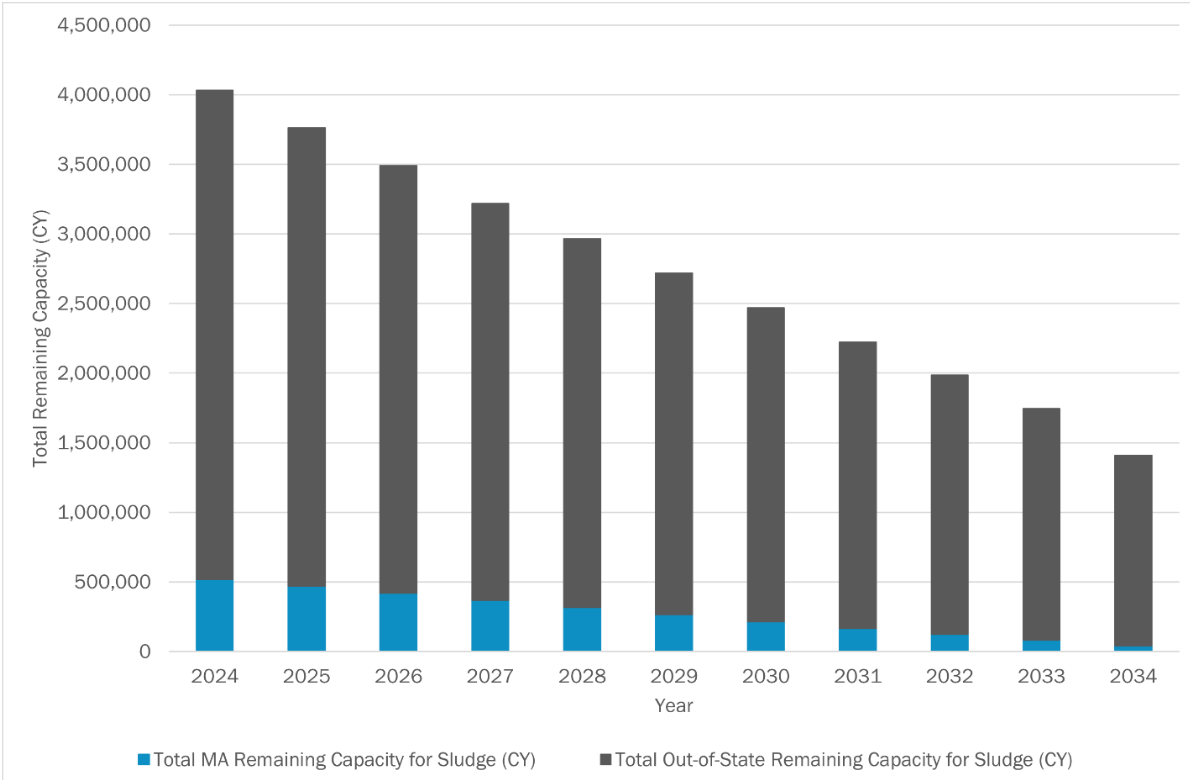



**Figure 2-3A. Maximum Remaining Disposal Capacity for Sludge in New England and New York Landfills Through 2034**

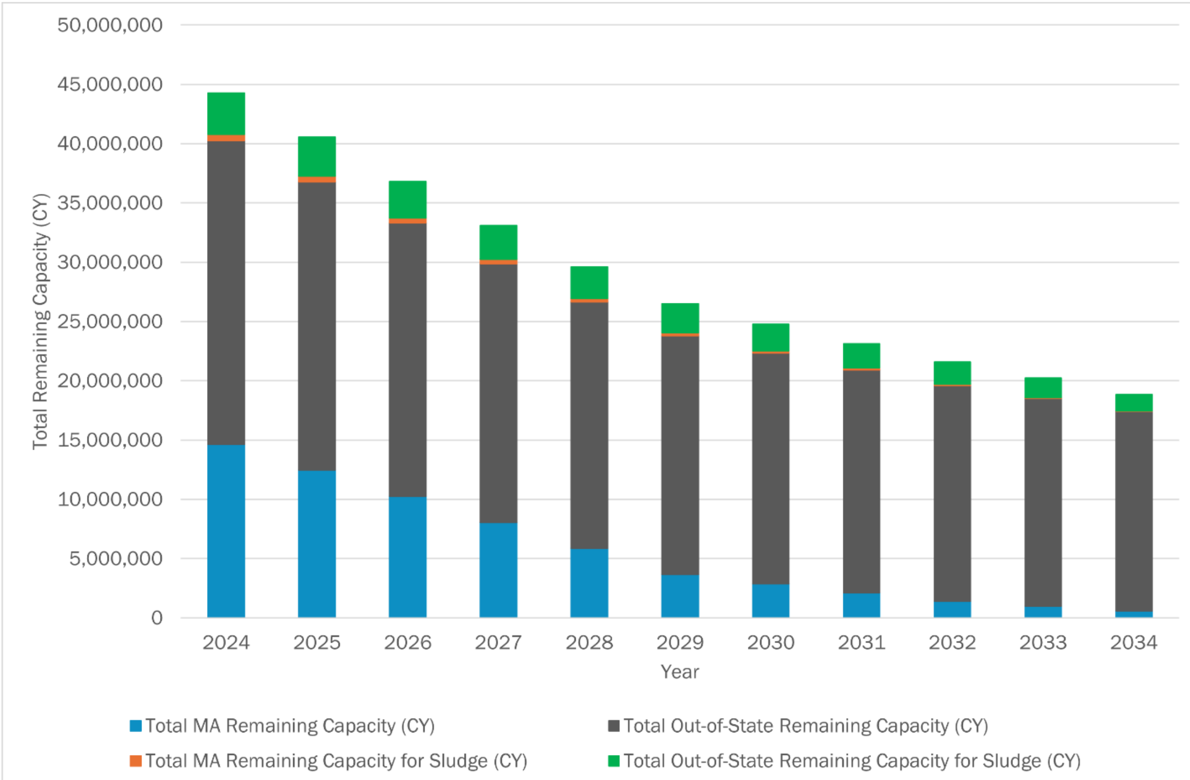



**Figure 2-3B. Maximum Remaining Total Disposal Capacity in New England and New York Landfills Through 2034**

*Note: Not all out-of-state capacity is anticipated to be available for use my Massachusetts POTWs for sludge disposal. The remaining available capacity for Massachusetts sludge disposal is anticipated to be much less than overall remaining capacity values, as demonstrated by Figure*s 2-3A and 2-3B.

As indicated by Figures 2-3A and 2-3B, the total remaining available capacity for solid waste disposal within New England and New York landfill facilities trends downward over the next 10 years, and with it, the remaining capacity for wastewater sludge disposal. It should be noted that while landfill expansions are included in these capacity calculations, some survey participants indicated that while landfill expansions are anticipated for their facilities, the expansion values are not yet known. This may impact the total remaining available capacity in the region; however, it is not anticipated to significantly impact data trends. It should also be noted that out-of-state landfill capacities are not held exclusively for Massachusetts sludge disposal. The remaining capacities demonstrated in Figure 2-3 represent overall remaining capacities, while the capacity available for use by Massachusetts POTWs is likely much less.

Diminishing capacity in Massachusetts and surrounding states' landfills will result in more out-of-state disposal. This will likely result in increased disposal costs and additional GHG emissions due to farther hauling distances, assuming no other outlets become available - although remaining capacity in New York far exceeds that of Massachusetts and surrounding states' landfills.

It should also be noted that while remaining capacity for sludge exists in out-of-state landfills, this capacity is not reserved for wastewater sludge produced in Massachusetts. Demand for disposal in out-of-state facilities, particularly New York, is likely to increase both within New York state itself as well as in states throughout the Northeast region, which may impact the remaining available capacity for the disposal of sludge produced in Massachusetts. Not all available capacity identified within out-of-state landfills, including those located in New York, will be accessible for Massachusetts wastes.

The acceptance of wastewater sludge by landfill facilities is impacted by a variety of conditions. When asked about the challenges associated with the acceptance of additional wastewater sludge, participating facilities provided the following answers:

- Odor (10)
- Drainage/stormwater management (9)
- PFAS (8)
- Leachate quantity (8)
- Leachate quality (8)
- Global stability (8)
- Slope stability (8)
- Availability of bulking/drying agents (7)
- Increase in gas production (1)
- Facility accessibility (1)

Participants were asked to describe circumstances under which they would consider beginning, or increasing, acceptance of wastewater sludge at their facility. Facilities provided the following answers:

- Receiving MassDEP Special Waste Approvals
- Receiving an increase to the permitted accepted tonnage limit
- Facilitation of wastewater sludge delivery to the facility
- Urgent need from community members

Additional concerns and considerations provided by landfill facilities in relation to the acceptance of wastewater sludge are presented below:

- "With the unresolved state and federal regulatory framework surrounding PFAS (CERCLA, RCRA, NPDES, etc.), there is considerable uncertainty projecting the potential future costs and liabilities associated with managing sludge wastes that contain PFAS. Further, the ambiguity in the regulatory environment makes it challenging to predict the ability of the facility to accept sludge waste streams that contain PFAS."
- "Landfill capacity for sludge is not static, rather it is dynamic. The range in sludge percentages stem from operation constraints at the landfill. For example: when starting in a new cell, a base layer of highly pervious municipal solid waste must be placed (the so called "fluff layer") to allow leachate to reach the leachate collection system. During the placement of this fluff layer, less sludge can be accepted at the landfill because there is less waste than can be mixed with the sludge. Additionally, there is seasonality in the flow of solid waste to the landfills. During the period where there is less solid waste, we must reduce how much sludge we accept. Looking at yearlong, or multiyear trends, does not tell the whole story of landfill operations and their ability to accept municipal sludge."
- "In 2018 odor issues at the [Landfill] caused significant public nuisance conditions. The County requested, and [the operator] obliged in reducing the volume of sludge being accepted. [The operator] will not exceed an 8 percent sludge to trash ratio at the [Landfill]."
- "[Our facility] has limited remaining capacity that is mostly being reserved for the future use of our member communities. We are limiting non-member wastes to the greatest extent possible."

## Estimated Costs for Massachusetts POTWs for Landfill Disposal

Major costs associated with the landfill disposal of wastewater sludge from Massachusetts POTWs include tipping fees, hauling and transportation costs, and any additional disposal fees charged on a facility-by-facility basis. Hauling and disposal costs are highly dependent on sludge characteristics, hauling distance, and other contractual terms. In addition, some older sludge management contracts may not fully capture the current sludge market. Figure 2-4 below illustrates typical costs reported by POTW facilities associated with the hauling and disposal costs of wastewater sludge to final landfill disposal facilities. The limited number of facilities represented in Figure 2-4 is a representative example of costs and may not reflect disposal cost conditions on a state-wide basis.

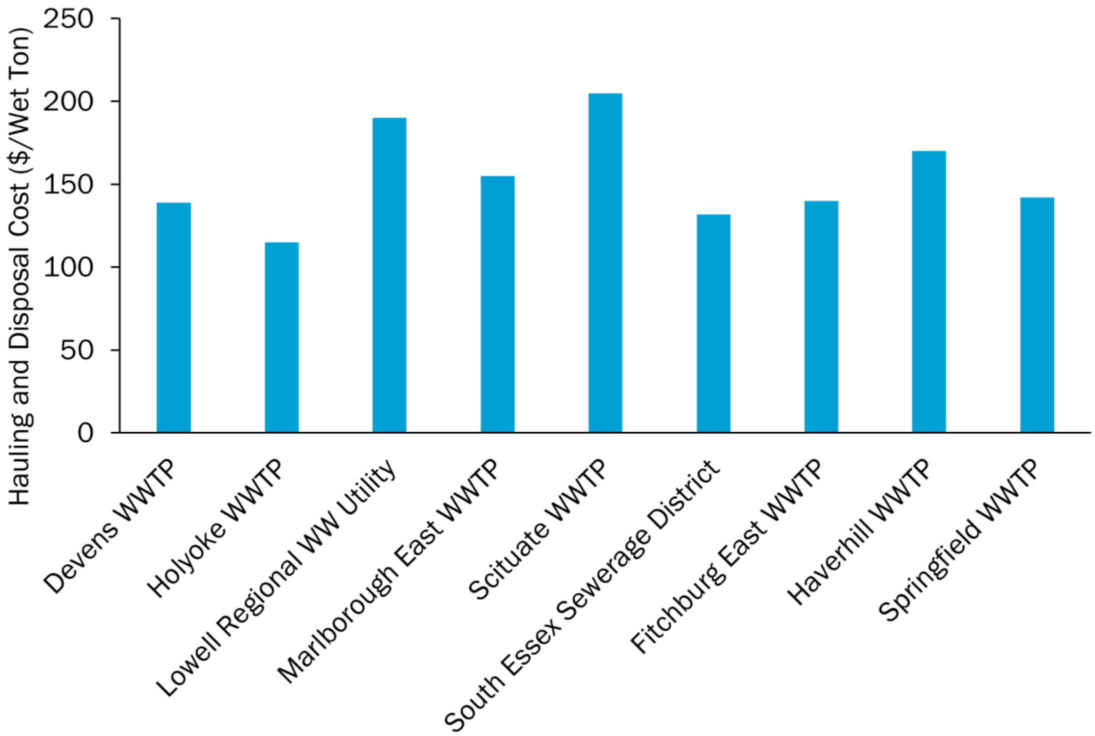



**Figure 2-4. Hauling and Disposal Costs for Wastewater Sludge from Massachusetts POTWs to Landfills**

For hauling and disposal contracts, costs to the Massachusetts POTWs reported in Figure 2-4 ranged from $115 per wet ton to $205 per wet ton. Note that these data do not include actual costs for processing sludge through processes such as dewatering, so the data set is limited to available information on hauling and disposal fees charged by commercially-operated facilities.

Participants of the landfill disposal survey were asked to report tipping costs associated with waste disposal at their facilities. Participants reported tipping fees of between $115-$124 per wet ton, while several facilities indicated that tipping fees are not charged at their facility—generally, this applies to authorized facilities, those which serve specific towns or specific POTWs. Tipping fees associated with landfill disposal of wastewater sludge may result in increased values for hauling and disposal costs through landfill facilities.

As landfill capacities for wastewater sludge in Massachusetts continue to decline, hauling costs associated with sludge transportation are anticipated to increase for POTWs sending waste further away from the point of origin.

## Potential Disposal Outside of Region

When considering the disposal of wastewater sludge at landfill facilities outside of the Northeast region evaluated by this study, the feasibility of and challenges associated with waste transport should be considered. As previously mentioned, increased hauling distances will result in increased disposal costs and GHG emission, including disposal at facilities within the mid-Atlantic and Midwest regions. Additionally, concerns regarding public opinion and local political climates may be considered, where additional transport of foreign sludge waste over state lines may be viewed unfavorably by local constituents.

With these factors considered, landfills outside of the New England region were reviewed to understand the magnitude of existing capacity, and the likelihood of their potential willingness to accept Massachusetts wastewater sludge. It is important to note that these landfills were not solicited for participation in the survey, and projected capacity data was not collected and analyzed as part of this evaluation. Operational municipal solid waste landfill facilities that were identified as potentially having capacity for out-of-state wastewater sludge disposal, and which may be considered as part of a wholistic approach to the future of Massachusetts sludge management, are listed below.

- Tunnel Hill Reclamation Landfill, New Lexington, OH
- Rumpke Sanitary Landfill, Cincinnati, OH
- Keystone Sanitary Landfill, Dunmore, PA
- Alliance Landfill, Taylor, PA
- Taylor County Landfill, Mauk, GA

# Section 3 - Conclusions

## Report Considerations

States surveyed as part of this study include those within and around New England. It should be noted that additional capacity may exist elsewhere, particularly in states such as Pennsylvania and Ohio. As detailed in the 2019 MassDEP Massachusetts Materials Management Capacity Study, many states western of New England contain large, regional landfills, some with rail sidings, which offer an outlet for Massachusetts waste. Because several of the closer disposal facilities are expected to close in the next decade without permit expansions, the distances to the final destinations of out-of-state disposal facilities for wastewater sludge may further increase, though it is beyond the scope of this study to identify specific potential expansion opportunities in these areas.

## Conclusions

As indicated by the data presented in preceding sections, sludge disposal capacity within both Massachusetts sludge monofills and municipal solid waste landfills is limited and inadequate to satisfy the volumes of sludge produced within the state requiring disposal, especially as several landfills are slated to reach capacity within the next 10 years. Four sludge monofills in Massachusetts have more than 10 years of remaining capacity but three of the four are known to only serve a local POTW. The fourth sludge monofill did not respond to the survey and is unlikely to accept sludge from other POTWs. While some facilities maintain a higher capacity for sludge disposal, concerns including odor, leachate quality, and the presence of PFAS appear to dissuade these facilities from accepting additional sludge beyond what is currently accepted.

Landfill capacity within New England and New York is slightly higher; however, competition for the disposal of wet wastes, including wastewater sludge, within the market is high, with several states in the area experiencing landfill capacity concerns, as noted in the 2023 Maine DEP Evaluation of Biosolids Management report. While capacity in New York is higher by comparison, transporting Massachusetts wastes to these areas presents additional concerns, including increased costs and GHG emissions. As landfill capacities within the state, New England and New York continue to decline, wastewater sludge produced in Massachusetts will increasingly require alternative management strategies, including, but not limited to, transportation to out-of-state management facilities such as other landfills, incinerators, and composting facilities.

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# Appendix F: BEAM MassDEP

| Scenario 1 Title: | Compost | Description | Solids generated in Massachusetts that are composted at in- and out-of-state facilities |
| --- | --- | --- | --- |

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | $CO_2$ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Composting | x | -778 | 581 | -2,537 | **-2,733** | 177 | 160 | 37 | **-0.20** | -2,733 | 0 | 0 | - |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Transportation | x | 2,150 | NA | NA | **2,150** | 339 | 307 | 70 | **0.08** | 2,150 | - | - | 0 |
| | | **1,372** | **581** | **(2,537)** | **(584)** | | | | | **-584** | **0** | **0** | **0** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

| Scenario 2 Title: | Drying | Description | Solids generated in Massachusetts that are dried at in-state facilities |
|---|---|---|---|

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | $CO_2$ equivalents (Mg/yr): Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass |
|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Thermal Drying | x | 24,993 | 2,033 | 0 | **27,026** | 520 | 472 | 108 | **0.69** |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Land Application | x | -5,870 | 0 | -9,345 | **-15,215** | 129 | 117 | 108 | **-0.39** |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Transportation | x | 367 | NA | NA | **367** | 161 | 146 | 33 | **0.03** |
| | | **19,490** | **2,033** | **(9,345)** | **12,179** | | | | |

| Unit Process | Mg per year: $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|
| Storage | NA | NA | - | NA |
| Conditioning/Thickening | NA | - | - | NA |
| Aerobic Digestion | NA | - | - | NA |
| Anaerobic Digestion | NA | NA | - | NA |
| Anaerobic Digestion 2 | NA | NA | - | NA |
| Dewatering | NA | - | - | NA |
| Thermal Drying | 27,026 | - | - | - |
| BFT Biodrying | NA | - | - | NA |
| Alkaline Stabilization | NA | - | - | NA |
| Composting | NA | NA | NA | NA |
| Composting 2 | NA | NA | NA | NA |
| Landfill Disposal Typical | NA | NA | NA | NA |
| Landfill Disposal Worst-case | NA | NA | NA | NA |
| Landfill Disposal Aggressive | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | NA | NA | NA | NA |
| Combustion | NA | NA | NA | NA |
| Pyrolysis | NA | NA | NA | NA |
| Land Application | -15,215 | 0 | 0 | - |
| Land Application 2 | NA | NA | NA | NA |
| Miscellaneous Emissions | NA | - | - | NA |
| Transportation | 367 | - | - | 0 |
| | **12,179** | **0** | **0** | **0** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

| Scenario 3 Title: | Landfill | Description | Solids generated in Massachusetts that are landfilled at in- and out-of-state facilities |
|---|---|---|---|

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | $CO_2$ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Typical | x | 49,885 | -558 | 0 | **49,328** | 263 | 239 | 54 | **2.48** | -7,085 | 50,830 | 5,583 | 4,119 |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Transportation | x | 3,019 | NA | NA | **3,019** | 263 | 239 | 55 | **0.15** | 3,019 | - | - | 0 |
| | | **52,905** | **(558)** | **0** | **52,347** | | | | | **-4,066** | **50,830** | **5,583** | **4,119** |

Scope 1 - direct emissions

Scope 2 - purchased electricity, heat, or steam

Scope 3 - production of purchased materials and uses of end products

| Scenario 4 Title: | Incineration-FBI | Description | Solids generated in Massachusetts that are incinerated at in- and out-of-state fluidized bed facilities |
|---|---|---|---|

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | CO₂ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass |
|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Combustion | x | 32,798 | 1,064 | 0 | **33,862** | 303 | 275 | 60 | **1.54** |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Land Application | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Transportation | x | 2,328 | NA | NA | **2,328** | 784 | 711 | 162 | **0.04** |
| | | **35,126** | **1,064** | **0** | **36,191** | | | | |

| Unit Process | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|
| Storage | NA | NA | - | NA |
| Conditioning/Thickening | NA | - | - | NA |
| Aerobic Digestion | NA | - | - | NA |
| Anaerobic Digestion | NA | NA | - | NA |
| Anaerobic Digestion 2 | NA | NA | - | NA |
| Dewatering | NA | - | - | NA |
| Thermal Drying | NA | - | - | NA |
| BFT Biodrying | NA | - | - | NA |
| Alkaline Stabilization | NA | - | - | NA |
| Composting | NA | NA | NA | NA |
| Composting 2 | NA | NA | NA | NA |
| Landfill Disposal Typical | NA | NA | NA | NA |
| Landfill Disposal Worst-case | NA | NA | NA | NA |
| Landfill Disposal Aggressive | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | NA | NA | NA | NA |
| Combustion | 17,114 | 27 | 16,722 | 36,129 |
| Pyrolysis | NA | NA | NA | NA |
| Land Application | NA | NA | NA | NA |
| Land Application 2 | NA | NA | NA | NA |
| Miscellaneous Emissions | NA | - | - | NA |
| Transportation | 2,328 | - | - | 0 |
| | **19,442** | **27** | **16,722** | **36,129** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

Scenario 5 Title: Incineration-MHI Description: Solids generated in Massachusetts that are incinerated at in- and out-of-state multiple hearth facilities

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | CO₂ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass |
|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Combustion | x | 16,300 | 734 | 0 | **17,034** | 141 | 128 | 29 | **1.60** |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Land Application | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** |
| Transportation | x | 2,541 | NA | NA | **2,541** | 1,222 | 1,109 | 253 | **0.03** |
| | | **18,841** | **734** | **0** | **19,575** | | | | |

| Unit Process | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|
| Storage | NA | NA | - | NA |
| Conditioning/Thickening | NA | - | - | NA |
| Aerobic Digestion | NA | - | - | NA |
| Anaerobic Digestion | NA | NA | - | NA |
| Anaerobic Digestion 2 | NA | NA | - | NA |
| Dewatering | NA | - | - | NA |
| Thermal Drying | NA | - | - | NA |
| BFT Biodrying | NA | - | - | NA |
| Alkaline Stabilization | NA | - | - | NA |
| Composting | NA | NA | NA | NA |
| Composting 2 | NA | NA | NA | NA |
| Landfill Disposal Typical | NA | NA | NA | NA |
| Landfill Disposal Worst-case | NA | NA | NA | NA |
| Landfill Disposal Aggressive | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | NA | NA | NA | NA |
| Combustion | 8,927 | 13 | 8,094 | 17,488 |
| Pyrolysis | NA | NA | NA | NA |
| Land Application | NA | NA | NA | NA |
| Land Application 2 | NA | NA | NA | NA |
| Miscellaneous Emissions | NA | - | - | NA |
| Transportation | 2,541 | - | - | 0 |
| | **11,468** | **13** | **8,094** | **17,488** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

| Scenario 6 Title: | Co-generation | Description | Largely paper mill sludge incinerated at a co-generation facility |
|---|---|---|---|

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | CO₂ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Transportation | x | 1,749 | NA | NA | **1,749** | 85 | 77 | 18 | **0.27** | 1,749 | - | - | 0 |
| | | **1,749** | **0** | **0** | **1,749** | | | | | **1,749** | **0** | **0** | **0** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

Scenario 7 Title: **Mine Reclamation** | Description: **Mine reclamation at a facility in Canada**

Notes and Comments

| | | CO₂ equivalents (Mg/yr) | | | | | | | | Mg per year | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Unit Process** | **Enter "x" for all applicable processes:** | **Scope 1** | **Scope 2** | **Scope 3** | **Total** | **Wet tons to each unit process/day** | **Mg (wet) to each unit process/day** | **Dry metric tons to each unit process/day** | **Metric tons $CO_2$ eq/dry metric ton biomass** | **$CO_2$** | **$CH_4$ ($CO_2$ eq)** | **$N_2O$ ($CO_2$ eq)** | **Biogenic $CO_2$** |
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application | X | -13 | 0 | -176 | **-188** | 6 | 6 | 3 | **-0.20** | -311 | 2 | 120 | - |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Transportation | x | 101 | NA | NA | **101** | 6 | 6 | 1 | **0.22** | 101 | - | - | 0 |
| Scope 1 - direct emissions | | **88** | **0** | **(176)** | **(87)** | | | | | **-210** | **2** | **120** | **0** |

Scope 2 - purchased electricity, heat, or steam

Scope 3 - production of purchased materials and uses of end products

| Scenario 8 Title: | terplant haul-liqu | Description | Hauling to another Mass POTW (liquid) |
|---|---|---|---|

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | CO₂ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Alkaline Stabilization | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Transportation | x | 365 | NA | NA | **365** | 99 | 90 | 21 | **0.05** | 365 | - | - | 0 |
| | | **365** | **0** | **0** | **365** | | | | | **365** | **0** | **0** | **0** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

Scenario 9 Title: kaline Stabilizati Description: Solids generated in Massachusetts that are alkaline stabilized at a facility in New York and land applied

Notes and Comments

| Unit Process | Enter "x" for all applicable processes: | CO₂ equivalents (Mg/yr) Scope 1 | Scope 2 | Scope 3 | Total | Wet tons to each unit process/day | Mg (wet) to each unit process/day | Dry metric tons to each unit process/day | Metric tons $CO_2$ eq/dry metric ton biomass | Mg per year $CO_2$ | $CH_4$ ($CO_2$ eq) | $N_2O$ ($CO_2$ eq) | Biogenic $CO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Conditioning/Thickening | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Aerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Anaerobic Digestion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Anaerobic Digestion 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | - | NA |
| Dewatering | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Thermal Drying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| BFT Biodrying | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Alkaline Stabilization | x | 112 | 26 | 1,943 | **2,082** | 88 | 80 | 20 | **0.29** | 2,082 | - | - | - |
| Composting | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Composting 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Typical | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Worst-case | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal Aggressive | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Landfill Disposal CA Regulatory | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Combustion | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Pyrolysis | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Land Application | x | 1,633 | 0 | -1,094 | **540** | 88 | 80 | 20 | **0.08** | -1,328 | 247 | 1,621 | - |
| Land Application 2 | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | NA | NA | NA |
| Miscellaneous Emissions | | NA | NA | NA | **NA** | NA | NA | NA | **NA** | NA | - | - | NA |
| Transportation | x | 1,515 | NA | NA | **1,515** | 88 | 80 | 18 | **0.23** | 1,515 | - | - | 0 |
| | | **3,261** | **26** | **850** | **4,137** | | | | | **2,269** | **247** | **1,621** | **0** |

Scope 1 - direct emissions
Scope 2 - purchased electricity, heat, or steam
Scope 3 - production of purchased materials and uses of end products

# Appendix G: Mass Balance of Massachusetts Wastewater Sludge Management in 2023

**Mass Balance of Massachusetts Wastewater Sludge Management in 2023**
**30-Jun-24**

| POTW Name | Permit Type[2] | Permitted Flow (MGD) | Average % Solids | Sludge Type | Destination Facility | Destination State | Destination Facility Type | Qty Distributed (Dry US tons) | Hauling Distance (Miles) |
|---|---|---|---|---|---|---|---|---|---|
| Acton Wastewater Collection | GWDP | 0.299 | 5.5 | Liquid | Greater Lawrence Sanitary District | MA | POTW | 54.2 | 32.9 |
| Adams WWTP | NPDES | 4.6 | 16.3 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 160.3 | 89.0 |
| Amesbury WWTP | NPDES | 2.4 | | Cake | Agresource/Ipswich Compost Facility | MA | Land application processing facility | 483.9 | 20.6 |
| Amherst WWTP | NPDES | 7.1 | 6.42 | Liquid | MDC Hartford Incinerator | CT | Incinerator | 923.3 | 52.4 |
| Ashfield | GWDP | 0.025 | 2.28 | Liquid | Lowell Regional WW Utility | MA | POTW | 2.0 | 101.1 |
| Athol WWTP | NPDES | 1.75 | 3.97 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 50.2 | 97.0 |
| Athol WWTP | | | | | Upper Blackstone Clean Water | MA | POTW | 298.8 | 55.7 |
| Attleboro WWTP | NPDES | 8.6 | 35 | Cake | Attleboro monofill | MA | Monofill | 3,332.3 | 2.7 |
| Ayer WWTP | NPDES | 1.79 | 3.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 286.7 | 77.1 |
| Barnstable WWTP WPCD - DPW | NPDES | 4.2 | 5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 986.6 | 82.5 |
| Barnstable WWTP WPCD - DPW | | | | | Upper Blackstone Clean Water | MA | POTW | 51.8 | 104.9 |
| Barre WWTP | NPDES | 0.3 | | | | | Unknown | 54.0 | |
| Belchertown WWTP | NPDES | 1 | 4.1 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 97.6 | 85.1 |
| Billerica WWTP | NPDES | 5.55 | 25 | Cake | Casella Hawk Ridge Compost Facility | ME | Land application processing facility | 1,750.8 | 186.2 |
| Bridgewater WWTP | NPDES | 1.44 | 3.5 | Liquid | Bridgewater WWTP | MA | Land application processing facility | 343.9 | 0.0 |
| Brockton WWTP | NPDES | 18 | 26.34 | Cake | Veolia Naugatuck Incinerator | CT | Incinerator | 4,566.0 | 155.4 |
| Charlemont Sewer District | NPDES | 0.05 | | | | | Unknown | 9.0 | |
| Charles River PCD | NPDES | 5.7 | 6.8 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 151.0 | 39.1 |
| Charles River PCD | | | | | Upper Blackstone Clean Water | MA | POTW | 1,771.4 | 29.5 |
| Charlton WWTP | NPDES | 0.45 | | | | | Unknown | 81.1 | |
| Chatham WPCF | GWDP | 1.5 | 25 | Cake | Casella Hawk Ridge Compost Facility | ME | Land application processing facility | 67.8 | 278.9 |
| Chicopee WWTP | NPDES | 15.5 | 31.9 | Cake | Cranston WPCF Incinerator | RI | Incinerator | 116.9 | 91.3 |
| Chicopee WWTP | | | | | Synagro Waterbury Incinerator | CT | Incinerator | 131.5 | 61.5 |
| Chicopee WWTP | | | | | Casella Grasslands Compost Facility | NY | Land application processing facility | 1,098.4 | 276.3 |
| Cohasset WWTF | NPDES | 0.045 | 4 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 87.4 | 63.1 |
| Concord WWTF | NPDES | 1.2 | 5 | Liquid | New England Waste Services (Waste USA) Landfill | VT | Landfill | 6.5 | 208.9 |
| Concord WWTF | | | | | Greater Lawrence Sanitary District | MA | POTW | 204.2 | 25.9 |
| Dartmouth WPCF | NPDES | 4.2 | 22 | Cake | Dartmouth WPCF | MA | Land application processing facility | 992.1 | 0.0 |
| Devens WWTP | NPDES | 4.65 | 15.2 | Cake | New England Waste Services (Waste USA) Landfill | VT | Landfill | 584.2 | 199.7 |
| Douglas WWTP | NPDES | 0.6 | 1.24 | Liquid | | | Incinerator | 63.9 | |
| Easthampton WWTP | NPDES | 3.8 | 18 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 457.0 | 71.0 |
| Edgartown WWTP | GWDP | 0.75 | 17 | Cake | | | Unknown | 171.8 | |
| Erving Center POTW #2 | NPDES | 2.7 | 46 | Cake | Unspecified Co-Gen Facility | QB | Other | 14,222.0 | 322.2 |
| Erving Center POTW #2 | | | | | Jeffrey Mine | QB | Land application processing facility | 1,020.0 | 259.1 |
| Erving POTW #1 | NPDES | 1.1 | 2 | Liquid | Lowell Regional WW Utility | MA | POTW | 16.1 | 72.6 |
| Erving POTW #3 | NPDES | 0.01 | 2.08 | Liquid | Erving POTW #1 | MA | POTW | 0.4 | 1.0 |
| Fairhaven WPCF | NPDES | 5 | 3.1 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 601.2 | 47.7 |
| Fall River Regional WWF | NPDES | 30.9 | 3 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 4,249.4 | 25.0 |
| Falmouth WWTP | GWDP | 1.2 | | | | | Unknown | 216.2 | |
| Fitchburg East WWTP | NPDES | 12.4 | 21 | Cake | Resource Control, Inc. – RCI Fitchburg Landfill | MA | Landfill | 1,837.1 | 6.7 |
| Gardner WPCF | NPDES | 5 | 27.3 | Cake | City of Gardner West St. Sludge Landfill | MA | Monofill | 894.4 | 2.7 |
| Gloucester WPCF | NPDES | 5.15 | 32 | Cake | Casella Hawk Ridge Compost Facility | ME | Land application processing facility | 833.3 | 191.9 |
| Grafton WWTP | NPDES | 2.4 | 4.23 | Liquid | Upper Blackstone Clean Water | MA | POTW | 488.6 | 9.3 |
| Great Barrington WWTP | NPDES | 3.2 | 23.7 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 222.0 | 54.8 |
| Greater Lawrence Sanitary District | NPDES | 52 | 95 | Cake | Greater Lawrence Sanitary District | MA | Land application processing facility | 6,215.0 | 0.0 |
| Greenfield WPCF | NPDES | 3.45 | 4.06 | Liquid | Lowell Regional WW Utility | MA | POTW | 531.3 | 78.8 |
| Hadley WWTP | NPDES | 0.54 | 2.05 | Liquid | Lowell Regional WW Utility | MA | POTW | 88.8 | 84.9 |
| Hardwick-Gilbertville WPCF | NPDES | 0.23 | 2 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 19.9 | 78.3 |

**Mass Balance of Massachusetts Wastewater Sludge Management in 2023**
**30-Jun-24**

| POTW Name | Permit Type[2] | Permitted Flow (MGD) | Average % Solids | Sludge Type | Destination Facility | Destination State | Destination Facility Type | Qty Distributed (Dry US tons) | Hauling Distance (Miles) |
|---|---|---|---|---|---|---|---|---|---|
| Hardwick-Wheelwright WPCF | NPDES | 0.042 | 1.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 9.3 | 70.0 |
| Hatfield WWTP | NPDES | 0.5 | 1.9 | Liquid | Lowell Regional WW Utility | MA | POTW | 26.0 | 87.7 |
| Haverhill WWTP | NPDES | 18.1 | 27 | Cake | Crossroads Landfill | ME | Landfill | 3,937.5 | 169.9 |
| Holyoke WWTP | NPDES | 17.5 | 20 | Cake | Cranston WPCF Incinerator | RI | Incinerator | 62.4 | 90.8 |
| Holyoke WWTP | | | | | Casella Grasslands Compost Facility | NY | Land application processing facility | 1,045.8 | 273.3 |
| Holyoke WWTP | | | | | Veolia Naugatuck Incinerator | CT | Incinerator | 85.6 | 68.5 |
| Holyoke WWTP | | | | | Ontario County MSW Landfill | NY | Landfill | 727.7 | 278.6 |
| Hoosac WQD | NPDES | 6.5 | 22 | Cake | Hoosac WQD | MA | Land application processing facility | 744.0 | 0.0 |
| Hopedale WWTF | NPDES | 0.588 | 2 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 102.1 | 10.3 |
| Hudson WWTF | NPDES | 3.05 | 20 | Cake | New England Waste Services (Waste USA) Landfill | VT | Landfill | 426.6 | 219.8 |
| Hull WWTF | NPDES | 3.07 | 4 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 202.1 | 65.6 |
| Huntington WWTP | NPDES | 0.2 | 5 | Liquid | Westfield WPCP | MA | POTW | 15.0 | 18.8 |
| Ipswich WWTP | NPDES | 1.8 | 18 | Cake | Agresource/Ipswich Compost Facility | MA | Land application processing facility | 425.5 | 2.2 |
| Kingston Sewer Commission | GWDP | 0.5 | 5.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 215.1 | 60.0 |
| Lee WWTP | NPDES | 1.25 | 4.24 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 203.9 | 126.5 |
| Leicester WWTP | NPDES | 0.37 | | | | | Unknown | 66.7 | |
| Lenox Center WWTP | NPDES | 1.8 | | | | | Unknown | 324.3 | |
| Leominster WPCF | NPDES | 9.3 | 4.7 | Liquid | Upper Blackstone Clean Water | MA | POTW | 1,248.5 | 26.2 |
| Lowell Regional WW Utility | NPDES | 32 | 27.6 | Cake | Bethleham MSW Landfill | NH | Landfill | 2,110.9 | 128.1 |
| Lowell Regional WW Utility | | | | | New England Waste Services (Waste USA) Landfill | VT | Landfill | 675.7 | 194.9 |
| Lowell Regional WW Utility | | | | | Casella Hawk Ridge Compost Facility | ME | Land application processing facility | 3,094.2 | 183.3 |
| Lowell Regional WW Utility | | | | | Envirem Organics | NB | Land application processing facility | 1,587.3 | 424.0 |
| Lowell Regional WW Utility | | | | | Synagro Woonsocket Incinerator | RI | Incinerator | 17.6 | 58.1 |
| Lynn Regional WF | NPDES | 25.8 | 24.67 | Cake | New England Waste Services (Waste USA) Landfill | VT | Landfill | 815.7 | 215.9 |
| Lynn Regional WF | | | | | Lynn WWTF | MA | Incinerator | 5,658.2 | 0.0 |
| Manchester By the Sea WWTP | NPDES | 0.67 | 4.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 21.0 | 91.0 |
| Manchester By the Sea WWTP | | | | | Upper Blackstone Clean Water | MA | POTW | 24.4 | 69.8 |
| Mansfield WWTP (MFN) | NPDES | 3.14 | 4.1 | Liquid | Lowell Regional WW Utility | MA | POTW | 14.6 | 61.4 |
| Mansfield WWTP (MFN) | | | | | Synagro Woonsocket Incinerator | RI | Incinerator | 813.7 | 28.7 |
| Marion WWTP - Marion DPW | NPDES | 0.588 | | Other | Marion WWTP - DPW | MA | Other | 86.6 | 0.0 |
| Marlborough East WWTP | NPDES | 5.5 | 24.3 | Cake | New England Waste Services (Waste USA) Landfill | VT | Landfill | 1,360.4 | 227.9 |
| Marlborough West WWTP | NPDES | 2.89 | 20 | Cake | New England Waste Services (Waste USA) Landfill | VT | Landfill | 669.0 | 224.8 |
| Marshfield WWTF | NPDES | 2.1 | 6.24 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 139.7 | 72.1 |
| Marshfield WWTF | | | | | Upper Blackstone Clean Water | MA | POTW | 170.7 | 75.8 |
| Maynard WWTP | NPDES | 1.45 | 3 | Liquid | Greater Lawrence Sanitary District | MA | POTW | 350.1 | 32.9 |
| Maynard WWTP | | | | | Cranston WPCF Incinerator | RI | Incinerator | 4.4 | 69.0 |
| MCI Bridgewater | NPDES | 0.55 | 4.2 | Liquid | New Bedford WWTP | MA | POTW | 66.5 | 36.1 |
| MCI Concord | NPDES | 0.35 | 5 | Liquid | | | Unknown | 253.6 | |
| MCI Norfolk | NPDES | 0.484 | 5.2 | Liquid | New Bedford WWTP | MA | POTW | 79.4 | 54.6 |
| Medfield WWTP | NPDES | 1.52 | 3.8 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 382.8 | 40.4 |
| Merrimac WWTP | NPDES | 0.45 | | Cake | Agresource/Ipswich Compost Facility | MA | Land application processing facility | 105.0 | 24.8 |
| Middleborough WWTP | NPDES | 2.16 | 20 | Cake | Middleborough MSW Landfill | MA | Landfill | 439.0 | 5.4 |
| Milford WWTP | NPDES | 4.2 | 4 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 796.8 | 9.7 |
| Monroe WWTP | NPDES | 0.015 | | | Hoosac WQD | MA | POTW | 75.6 | 23.2 |
| Montague WPCF | NPDES | 1.83 | 18 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 4.3 | 94.1 |
| Montague WPCF | | | | | Veolia Naugatuck Incinerator | CT | Incinerator | 174.9 | 99.4 |
| Montague WPCF | | | | | Synagro Woonsocket Incinerator | RI | Incinerator | 22.3 | 98.2 |
| MWRA Clinton WWTP | NPDES | 3.01 | 22.6 | Cake | Town of Clinton Recycling Center | MA | Landfill | 330.8 | 1.5 |

**Mass Balance of Massachusetts Wastewater Sludge Management in 2023**

**30-Jun-24**

| POTW Name | Permit Type[2] | Permitted Flow (MGD) | Average % Solids | Sludge Type | Destination Facility | Destination State | Destination Facility Type | Qty Distributed (Dry US tons) | Hauling Distance (Miles) |
|---|---|---|---|---|---|---|---|---|---|
| MWRA Deer Island WWTP | NPDES | 361 | 2.21 | Liquid | Massachusetts Water Resources Authority | MA | Land application processing facility | 32,543.0 | 0.0 |
| Nantucket Sewer Dept. - Siasconset | GWDP | 5.50E-02 | | | | | Unknown | 9.9 | |
| Nantucket Sewer Dept. - Surfside | GWDP | 4 | | | | | Unknown | 720.6 | |
| New Bedford WWTP | NPDES | 30 | 6.73 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 7,311.6 | 48.8 |
| Newburyport WWTP | NPDES | 3.4 | | Cake | Agresource/Ipswich Compost Facility | MA | Land application processing facility | 622.8 | 12.5 |
| North Attleborough WPCF | NPDES | 4.61 | 3.75 | Liquid | Lowell Regional WW Utility | MA | POTW | 91.6 | 59.1 |
| North Attleborough WPCF | | | | | Synagro Woonsocket Incinerator | RI | Incinerator | 563.5 | 16.5 |
| North Brookfield WWTP | NPDES | 0.76 | 16 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 157.6 | 86.0 |
| Northampton WWTF | NPDES | 8.6 | 24 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 1,081.4 | 73.9 |
| Northbridge WWTF | NPDES | 2 | 3.97 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 456.9 | 33.2 |
| Northfield WPCF | NPDES | 0.275 | 1.86 | Liquid | Lowell Regional WW Utility | MA | POTW | 11.3 | 74.7 |
| Oak Bluffs WWTP | GWDP | 0.34 | 2 | Liquid | | | Unknown | 33.4 | |
| Old Deerfield - Historic WWTP | NPDES | 0.25 | 2.29 | Liquid | Lowell Regional WW Utility | MA | POTW | 19.3 | 80.7 |
| Orange WWTP | NPDES | 1.1 | 2.29 | Liquid | Lowell Regional WW Utility | MA | POTW | 29.9 | 63.2 |
| Orange WWTP | | | | | Montague WPCF | MA | POTW | 10.2 | 16.0 |
| Otis DPW | GWDP | 0.03 | | | | | Unknown | 5.4 | |
| Oxford-Rochdale SD WPCP | NPDES | 0.5 | 2 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 56.0 | 31.2 |
| Palmer WWTF | NPDES | 5.6 | 16 | Cake | MDC Hartford Incinerator | CT | Incinerator | 467.4 | 43.2 |
| Pepperell WWTF | NPDES | 1.1 | | Cake | Casella Hawk Ridge Compost Facility | ME | Land application processing facility | 136.0 | 206.0 |
| Pittsfield WWTP | NPDES | 17 | 17.48 | Cake | Casella Grasslands Compost Facility | NY | Land application processing facility | 1,052.6 | 231.4 |
| Plymouth WWTF | NPDES | 3 | 4 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 1,058.3 | 63.6 |
| Provincetown Public Works | GWDP | 0.75 | 3.4 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 126.0 | 126.6 |
| Rockland WWTP | NPDES | 2.5 | 21.24 | Cake | Synagro Woonsocket Incinerator | RI | Incinerator | 279.3 | 55.3 |
| Rockport WWTP | NPDES | 0.8 | 15 | Cake | Agresource/Ipswich Compost Facility | MA | Land application processing facility | 71.0 | 19.2 |
| Royalston WWTF | NPDES | 3.90E-02 | | | | | Unknown | 7.0 | |
| Russell Village WWTF | NPDES | 0.24 | 3 | Liquid | Westfield WPCP | MA | POTW | 8.8 | 8.4 |
| Salisbury WWTF | NPDES | 1.3 | | | | | Unknown | 234.2 | |
| Scituate WWTF | NPDES | 1.6 | 15.6 | Cake | Middleborough MSW Landfill | MA | Landfill | 295.6 | 28.1 |
| Shelburne Falls WWTP | NPDES | 0.25 | | Other | Shelburne Falls WWTP | MA | Other | 19.0 | 0.0 |
| Somerset WWTF | NPDES | 4.2 | 4.2 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 359.1 | 30.3 |
| South Deerfield | NPDES | 0.85 | 2.07 | Liquid | Lowell Regional WW Utility | MA | POTW | 112.5 | 82.4 |
| South Essex Sewerage District | NPDES | 29.7 | 22.6 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 573.5 | 150.7 |
| South Essex Sewerage District | | | | | Casella Hawk Ridge Compost Facility | ME | Land application processing facility | 4,440.0 | 182.4 |
| South Essex Sewerage District | | | | | Bethleham MSW Landfill | NH | Landfill | 314.0 | 151.6 |
| South Essex Sewerage District | | | | | New England Waste Services (Waste USA) Landfill | VT | Landfill | 1,134.5 | 218.4 |
| South Essex Sewerage District | | | | | Synagro Woonsocket Incinerator | RI | Incinerator | 1,283.8 | 78.6 |
| South Hadley WWTP | NPDES | 4.2 | 19.5 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 822.3 | 65.0 |
| Southbridge WWTP | NPDES | 3.77 | 22.25 | Cake | Southbridge WWTP | MA | Land application processing facility | 568.2 | 0.0 |
| Spencer WWTP | NPDES | 1.08 | 5.5 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 263.2 | 38.5 |
| Springfield WWTP - Bondi's Island | NPDES | 67 | 26.9 | Cake | Synagro Waterbury Incinerator | CT | Incinerator | 437.6 | 56.3 |
| Springfield WWTP - Bondi's Island | | | | | Casella Grasslands Compost Facility | NY | Land application processing facility | 4,720.1 | 276.1 |
| Springfield WWTP - Bondi's Island | | | | | New England Waste Services (Waste USA) Landfill | VT | Landfill | 1,168.4 | 221.6 |
| Springfield WWTP - Bondi's Island | | | | | Bethleham MSW Landfill | NH | Landfill | 397.9 | 200.0 |
| Springfield WWTP - Bondi's Island | | | | | Chemung MSW Landfill | NY | Landfill | 1,720.7 | 278.7 |
| Springfield WWTP - Bondi's Island | | | | | Ontario County MSW Landfill | NY | Landfill | 967.8 | 281.3 |
| Springfield WWTP - Bondi's Island | | | | | Synagro Woonsocket Incinerator | RI | Incinerator | 684.5 | 74.4 |
| Stockbridge WWTP | NPDES | 0.46 | 2.8 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 33.0 | 134.8 |
| Sturbridge WPCF | NPDES | 1.3 | 4.2 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 317.9 | 60.3 |

**Mass Balance of Massachusetts Wastewater Sludge Management in 2023**

**30-Jun-24**

| POTW Name | Permit Type[2] | Permitted Flow (MGD) | Average % Solids | Sludge Type | Destination Facility | Destination State | Destination Facility Type | Qty Distributed (Dry US tons) | Hauling Distance (Miles) |
|---|---|---|---|---|---|---|---|---|---|
| Sunderland WWTP | NPDES | 0.5 | 2.28 | Liquid | Lowell Regional WW Utility | MA | POTW | 5.4 | 82.7 |
| Sunderland WWTP | | | | | Montague WPCF | MA | POTW | 26.9 | 11.4 |
| Taunton WWTP | NPDES | 8.4 | 24.45 | Cake | Veolia Naugatuck Incinerator | CT | Incinerator | 1,816.6 | 148.1 |
| Templeton WWTP | NPDES | 0.6 | 16.9 | Cake | Templeton WWTP | MA | Monofill | 27.4 | 0.0 |
| Tisbury Public Works | GWDP | 0.139 | | | | | Unknown | 25.0 | |
| Upper Blackstone Clean Water | NPDES | 56 | 22.8 | Cake | Upper Blackstone Clean Water | MA | Incinerator | 17,988.1 | 0.0 |
| Upton WWTP | NPDES | 0.4 | 4.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 60.8 | 39.5 |
| Uxbridge WWTF | NPDES | 1.5 | 3.21 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 401.2 | 27.2 |
| Ware WWTP | NPDES | 1 | 1.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 169.7 | 81.9 |
| Wareham WPCF | NPDES | 1.6 | | | | | Unknown | 288.3 | |
| Warren WWTP | NPDES | 1.5 | 3 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 39.4 | 80.1 |
| Wayland WWTP | NPDES | 0.09 | | | | | Unknown | 16.2 | |
| Webster WWTF | NPDES | 6 | 3.9 | Liquid | Synagro Woonsocket Incinerator | RI | Incinerator | 518.1 | 25.8 |
| West Stockbridge | NPDES | 7.60E-02 | 2.71 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 11.6 | 134.1 |
| Westborough WWTF | NPDES | 7.68 | 4 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 34.2 | 54.9 |
| Westborough WWTF | | | | | Upper Blackstone Clean Water | MA | POTW | 2,006.2 | 11.6 |
| Westfield WPCP | NPDES | 6.1 | 20.5 | Cake | Veolia Naugatuck Incinerator | CT | Incinerator | 1,056.0 | 61.7 |
| Winchendon WPCF | NPDES | 1.1 | 3.5 | Liquid | Cranston WPCF Incinerator | RI | Incinerator | 187.1 | 93.2 |
| | | | | | | | **Total[1]** | **165,682.6** | |

Notes:

1. Total sludge quantity calculated does not include sludge transferred from one POTW to another POTW for further sludge management to avoid double counting.
2. NPDES - National Pollutant Discharge Elimination System; GWDP - Groundwater Discharge Permit

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