Center for RURAL Pennsylvania
A LEGISLATIVE AGENCY OF THE PENNSYLVANIA GENERAL ASSEMBLY

Biosolids Disposal in Pennsylvania

November 2024

Introduction

In 2007, the Center for Rural Pennsylvania published a research study to assess biosolids management practices and associated costs for Pennsylvania's municipal wastewater treatment plants (WWTPs). In addition to data provided by the Department of Environmental Protection (DEP), that study incorporated findings from a survey distributed in 2005 to 870 active WWTPs that requested information on solids handling processes, biosolids disposal or recycling practices, and costs related to biosolids management. The Center repeated the same methodology for this study, with these two sources of data to provide an update to those research findings in this fact sheet. See the Appendix for definitions utilized throughout this fact sheet and details on the survey and other methodology.

Key findings include:

- There are 841 active municipal WWTPs in Pennsylvania, with 614 reporting the type of disposal method they use for their biosolids to DEP. These data show that the majority of WWTPs (43 percent) landfill their treated biosolids.
- Small facilities, which tend to be located in rural counties, are more likely to transfer their biosolids to another WWTP for final disposal instead of undertaking the disposal processes themselves.
- Municipal wastewater authorities that responded to the survey indicated that cost and regulatory requirements were their highest priorities, which was unchanged from the previous study.
- Survey respondents raised significant concerns over impending regulation of per- and polyfluoroalkyl substances (PFAS), noting that increased regulation is likely to reduce the use of biosolids in agricultural production or mine land reclamation.
- According to survey respondents, it costs more than three times as much for small facilities to landfill their biosolids than it is to apply them to agricultural or mine land.
- Survey respondents suggest that biosolids disposal costs have generally declined over time, when adjusted for inflation.

Background

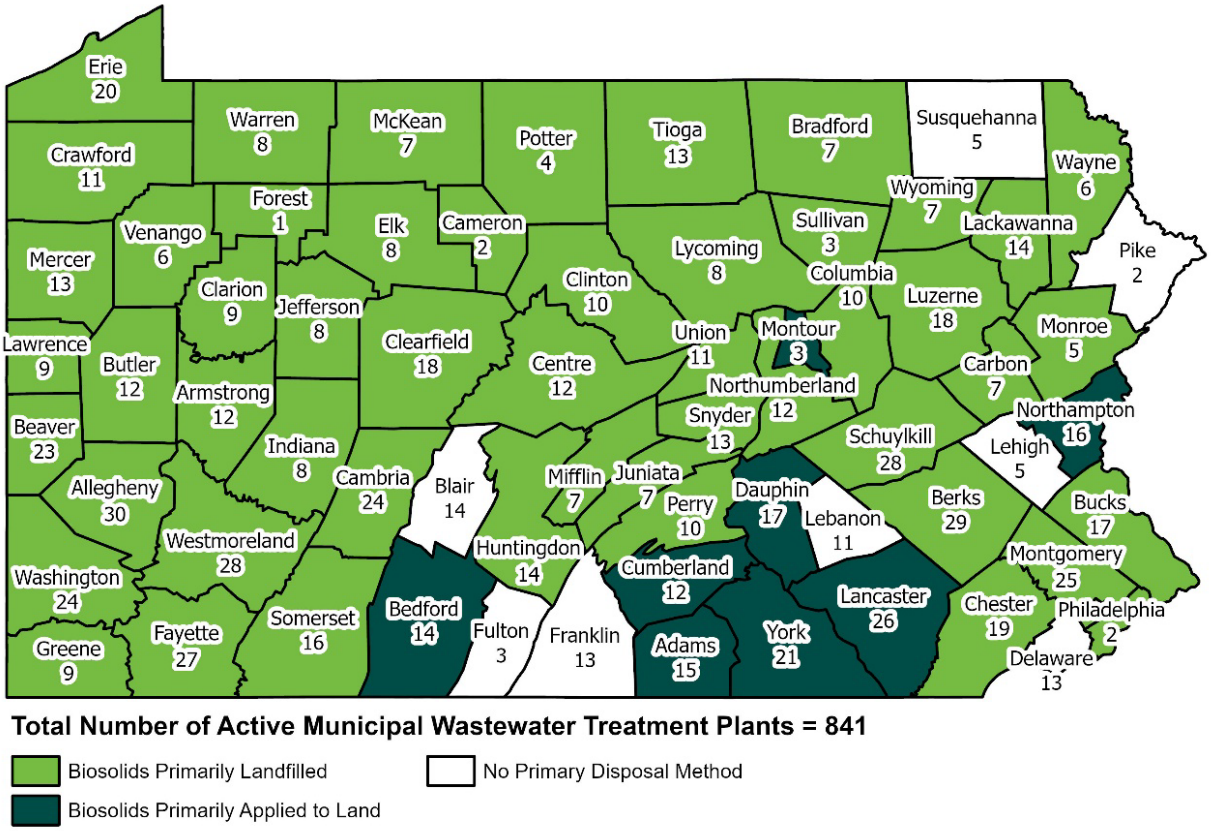
Biosolids are solid organic matter recovered from sewage as a byproduct of the wastewater collection and treatment process. Once properly treated, these solids are generally disposed of through three main processes: (1) landfilling, (2) agricultural or mine land application, or (3) incineration. In Pennsylvania, municipal wastewater authorities are responsible for the collection and treatment of wastewater in public sewer systems. The chosen disposal processes are influenced by many factors, such as utility and labor costs, space requirements, proximity to farmland or landfills, local climate conditions, odor control needs, and regulatory requirements.

In general, the land application method is perceived as beneficial to the environment because it recycles nutrients back into the soil; however, there are other ways that landfilling and incineration can be beneficial. For example, treated biosolids may be used as landfill cover over the top of otherwise toxic debris, or properly treated ash from incinerated biosolids can be applied as fertilizer to agricultural land.

Inventory of Biosolid Disposal Methods

Based on data from DEP, as of 2024, there are 841 active municipal WWTPs in Pennsylvania, compared to 870 reported in the 2007 study. However, only 614 (73 percent) of those 841 facilities reported the type of disposal method they use to DEP. Figure 1 displays the distribution of these WWTPs by county and the primary method they use to dispose of their biosolids (if available). As shown in the figure, most WWTPs (261, 43 percent) landfilled their biosolids, although WWTPs that applied treated biosolids to the land (63, 10 percent) were more common in the South Central region of the state. Only five WWTPs across four counties (Blair, Delaware, Lehigh, and Montgomery) disposed of their biosolids through incineration, and less than 1 percent of WWTPs composted their treated biosolids. Roughly 17 percent of WWTPs reported using a combination of any of the disposal methods.

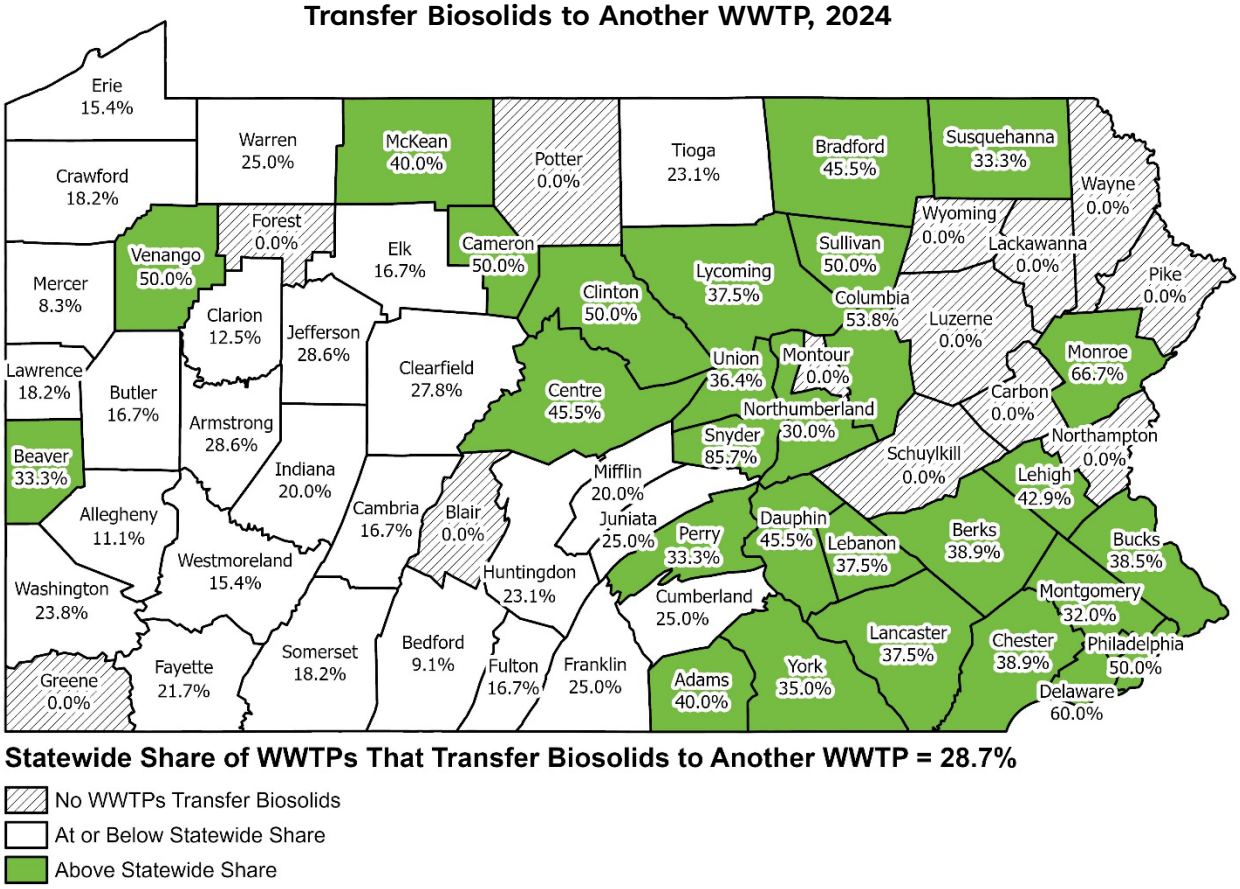
Figure 1: Number of Active Municipal Wastewater Treatment Plants (WWTPs) by Primary Method for Biosolids Disposal, 2024



Source: Pennsylvania Department of Environmental Protection.

Although not a direct disposal method, it is important to note that about 30 percent of WWTPs indicated that they send their treated biosolids off to another WWTP. This other facility then undertakes the final disposal of these materials. Figure 2 displays the county shares of WWTPs that transfer their biosolids to another WWTP for disposal. Berks (14 WWTPs), Montgomery (8 WWTPs), and York (7 WWTPs) had the most WWTPs that transferred their biosolids to another WWTP in the Commonwealth. Thirteen counties reported that none of their WWTPs transfer their biosolids; this seems particularly prevalent in the northeastern part of the Commonwealth.

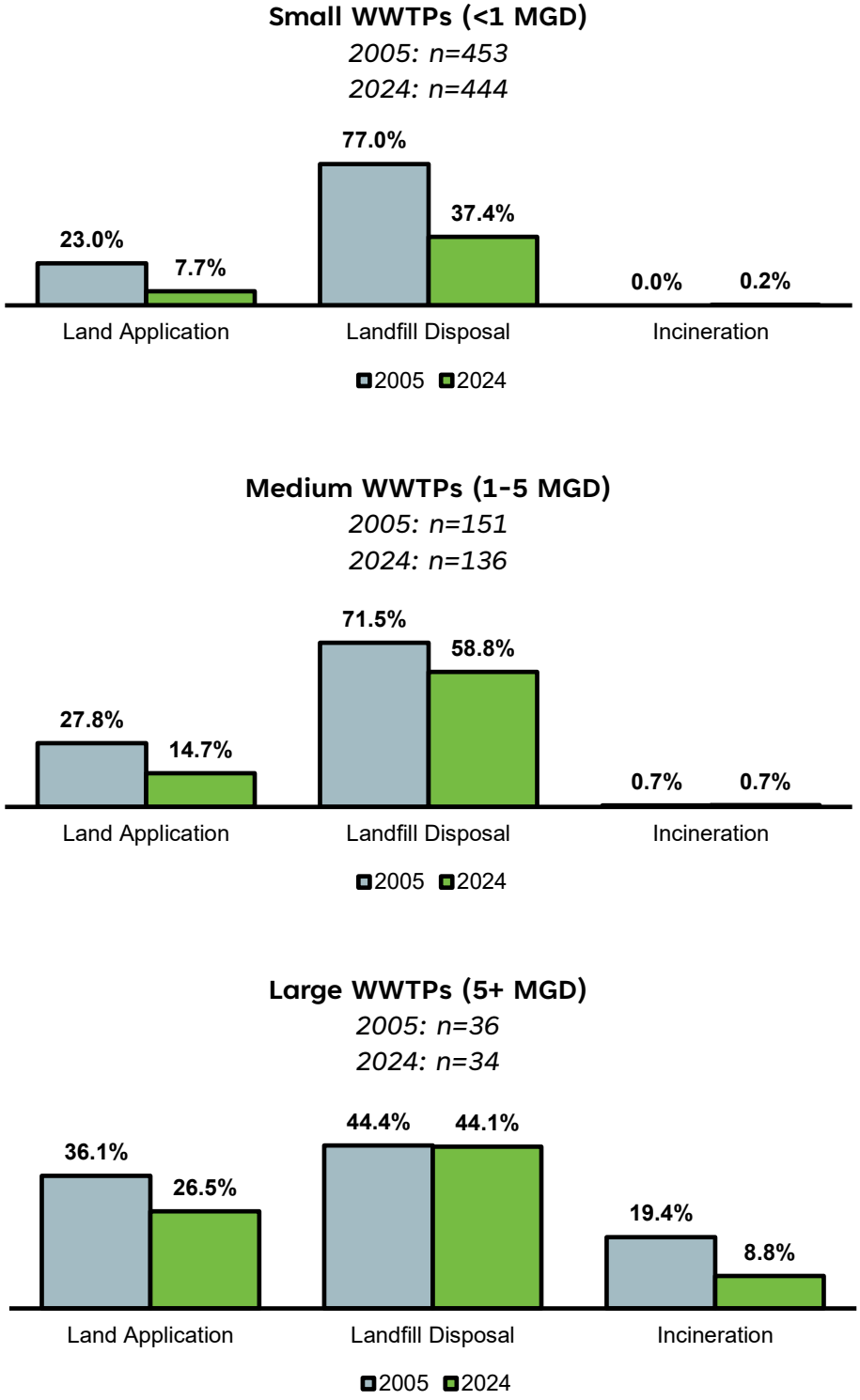
Figure 2: Share of Municipal Wastewater Treatment Plants (WWTPs) That Transfer Biosolids to Another WWTP, 2024



Note: Excludes WWTPs that did not report a biosolids disposal method or county of location.
Source: Pennsylvania Department of Environmental Protection.

Figure 3 displays the disposal methods by facility size and compares the current inventory of municipal WWTPs to the 2007 study (data year 2005). For all three facility sizes, there was a decline in disposal through the main three methods (land application, landfill disposal, and incineration). This is likely due to more facilities opting to utilize a combination of methods (e.g., landfill and land application) rather than relying upon a single process for disposal of their biosolids.

Figure 3: Share of Municipal Wastewater Treatment Plants (WWTPs) by Disposal Method and Size, 2005 and 2024



Note: Excludes WWTPs that did not report a biosolids disposal method. MGD is millions of gallons of wastewater treated per day.
Source: Pennsylvania Department of Environmental Protection.

Another reason for the decline, particularly for small facilities (less than one million gallons of wastewater treated per day), is due to a higher number of these facilities opting to transfer their biosolids to another facility for final disposal. The 2007 study estimated via survey that approximately 30 percent of WWTPs categorized as small transferred their biosolids to another facility. For 2024, the data indicate that approximately 38 percent of small WWTPs send their treated biosolids off to another WWTP for disposal. This would suggest an eight-percentage point increase in the share of small WWTPs that send their biosolids away for disposal.

Moreover, small WWTPs are typically located in rural areas (70 percent of small facilities), so it is likely that many of these smaller, more rural facilities are transferring their biosolids to large, urban facilities that have the capacity to dispose of them. Therefore, these larger WWTPs may be importing wastewater from areas much further out from their municipality, increasing hauling, transportation, and other related costs.

Survey on Biosolids Disposal Management Practices

To supplement data from DEP, the Center sent a survey to all active municipal WWTPs in the Commonwealth requesting information on solids handling processes, biosolids disposal or recycling practices, and costs related to biosolids management. An invitation letter was sent via mail to all 841 wastewater treatment plants on August 5, 2024, inviting them to participate in the online survey by October 15, 2024, with a reminder letter sent on September 9, 2024. A total of 191 responses were gathered from that survey, providing a response rate of 23 percent.

The survey included responses from 129 small WWTPs (67 percent), 43 medium WWTPs (23 percent), and 19 large WWTPs (10 percent). Population-wide data from the DEP database show that 72 percent of WWTPs are small, 22 percent are medium, and 6 percent are large. There was also representation from rural counties, with 108 responses (57 percent) coming from municipalities located in those areas, while 83 responses (43 percent) were from urban counties. DEP data indicate that 63 percent of municipal authorities are located in rural counties, compared to 37 percent for urban counties.

Seventy-four of the facilities surveyed (39 percent) reported that they landfill their treated biosolids, while 49 facilities (26 percent) send their biosolids off to be applied to agricultural or mine land. Another 23 facilities (12 percent) stated they send their biosolids off to another WWTP. The remaining facilities that responded (45 WWTPs, 23 percent) used other disposal methods like incineration and lagoon or reed bed accumulation.

Prioritization of Disposal Methods

The survey asked participants to rank the importance of six factors (cost, flexibility, reliability, public acceptance, regulatory requirements, and liability concerns) that influence the selection of disposal methods utilized by their WWTP in order from 1 to 6, where 1 is the most important and 6 is the least important. In total, 143 respondents

provided rankings for all six factors. Figure 4 shows the priority rankings for all WWTPs in order of highest priority (as indicated by the factor that received the most 1's and 2's) to lowest priority (received the most 5's and 6's).

Based on the survey results, cost outranked all the factors for the majority of municipalities, with 70 WWTPs (49 percent) indicating it as their number 1 priority in selecting a disposal method. Fifty-four respondents (38 percent) selected regulatory requirements as their number 1 priority. On the other hand, public acceptance ranked relatively low with most WWTPs, with only 9 respondents that highlighted it as their highest priority, and 71 respondents (50 percent) scoring it last with a 6.

Figure 4: Prioritization of Disposal Methods by Surveyed Municipal Wastewater Treatment Plants (WWTPs), 2024

Note: Scale from 1 (most important) to 6 (least important). Highest Priority indicates the factor received a ranking of 1 or 2 and Lowest Priority indicates the factor received a ranking of 5 or 6.
Source: Data from survey conducted by the Center for Rural Pennsylvania in partnership with the Penn State Center for Survey Research.

The results mirror the findings from the 2007 study. It is not surprising for cost to be assigned the highest priority because municipalities must operate within budget constraints, thereby making affordability an important consideration. However, many comments included in the 2024 survey responses indicated recently heightened concerns over anticipated regulations, particularly with regard to per- and polyfluoroalkyl substances (PFAS) and other "forever chemicals". Respondents noted that increased

regulation over the disposal of these chemicals is likely to reduce or even make it impossible to use biosolids in agricultural production or mine land reclamation. Other respondents mentioned that they chose to end their land application programs in favor of landfilling due to impending PFAS regulations, which they believed would increase liability for any WWTP to follow the new protocols. In this way, the rising importance of regulatory requirements appears to overlap in part with concerns over cost.

Table 1 displays the cost data from survey respondents by the reported size of their facilities. Out of the 191 surveyed in total, only 86 WWTPs (45 percent) provided useable responses regarding their disposal costs. Therefore, these cost data may only provide a snapshot of the entire diversity of costs undertaken by municipalities across the Commonwealth. More data will be necessary to make broader conclusions. As for this survey though, costs for land application among respondents ranged from 55 cents to $171 per wet ton, while those for landfilling ranged from $11 to $322 per wet ton, suggesting the potential for significant cost variability across the Commonwealth.

Table 1: Median Costs for Landfill and Land Application Disposal Methods by Facility Size, 2024

	Landfill	Land Application
Small Facilities (<1 MGD)		
Number Surveyed	16	19
Median Cost per Wet Ton	$89.00	$26.00
Medium Facilities (1-5 MGD)		
Number Surveyed	16	9
Median Cost per Wet Ton	$66.00	$35.00
Large Facilities (5+ MGD)		
Number Surveyed	5	6
Median Cost per Wet Ton	$83.00	$48.59

Note: MGD is millions of gallons of wastewater treated per day.
Source: Data from survey conducted by the Center for Rural Pennsylvania in partnership with the Penn State Center for Survey Research.

Similar to the 2007 study, the results highlight a paradox, where although cost is listed as the most important factor when determining a disposal method, and, it is significantly more expensive to landfill than it is to beneficially use the treated biosolids in agricultural production or mine land reclamation, landfilling continues to be the primary selected method for disposal. Over 40 percent of facilities utilize this approach,

with another 29 percent sending their biosolids off to another treatment plant for final disposal, meaning the total share of facilities landfilling biosolids is higher.

On a pure cost basis, land application appears to be less expensive than landfilling, with respondents showing a median cost of $27 per wet ton, compared to $69 for landfilling (not shown in table). This is particularly true for small facilities, where landfilling is more than three times as expensive as land application.

Unlike the 2007 study, which presented the average costs for landfilling and land application, the Center selected the median cost for this update's table due to a notable number of outliers in the collected survey data that skewed the average cost figures.[1] However, if the averages are compared to the 2007 study, adjusting for inflation, landfilling costs have declined roughly 16 percent since 2005, while land application costs have declined 52 percent since then. Landfilling costs for small facilities notably increased though, growing around 50 percent over time, even with inflation taken into account.

Conclusion

In many ways, this update shows how little has changed for Pennsylvania's municipal WWTPs. Cost and regulations still rank the highest in terms of importance, and it still costs less on average to utilize biosolids in agricultural or mine land reclamation instead of landfilling them. However, there are a couple noteworthy factors that were highlighted by the survey respondents as areas of concern that should be researched further.

First, the regulation of PFAS and other "forever chemicals" should be carefully considered, as many respondents warned of a continued decline in the beneficial use of biosolids via land application if their regulatory burden is increased too significantly. This is especially true for rural areas where local capacity remains a concern among municipal governments. The sentiment among respondents is that, although it costs more to landfill biosolids, the regulatory burden associated with beneficially applying them to agricultural or mine land is much higher. In other words, they perceive it is worth the price to landfill in order to avoid the liability associated with land application processes.

Second, some respondents noted it has become more difficult to find farmers willing to accept their treated biosolids as fertilizer on their lands. While public perception of disposal methods was a relatively low priority among survey participants, this comment suggests it should still be considered when designing policies that regulate biosolids disposal. If these trends continue, it will be increasingly difficult for facilities to choose land application over landfilling, resulting in a greater need for space at those landfills over time.

[1] See the Appendix for more information on how costs were calculated between both reports.

Appendix

Definitions

A ***municipal wastewater treatment plant (WWTP)*** is a facility operated by a local government authority in Pennsylvania where sewage from public waterways is treated and disposed of according to health, safety, and environmental regulations.

Biosolids are organic solids that are the by-product of wastewater treatment and meet microbial and chemical contaminant standards, making them suitable for land-based recycling.

The process of ***landfilling*** involves the disposal of biosolids in a municipal solid waste landfill and is generally viewed as a non-reuse option, with some exceptions.

Land application refers to the addition of biosolids to the soil to introduce nutrients and organic matter. The traditional land application method is the use of biosolids on agricultural land to enhance crop growth, although it can also be used to reclaim abandoned mine lands. This method of disposal is generally viewed as a beneficial reuse option.

Incineration is the drying and combustion of dewatered wastewater solids that produces a relatively inert ash. Since the resulting ash is usually landfilled, this method is considered a non-reuse option, but in some cases, such as being used as a component in cement production, it can be reused for other purposes.

Per- and polyfluoroalkyl substances (PFAS) are manufactured chemicals that have been used in industry and consumer products since the 1940s that have now permeated into the water, soil, and air systems of the environment. Recent studies have shown that exposure to certain levels of PFAS may lead to certain health risks in the population.

Cost per Wet Ton Calculations

The survey instrument from the 2007 study requested that respondents put their costs in units of dollars per wet ton. The Center followed this same methodology to maintain consistency between the two reports. However, the final data presented in that study was in dollars per dry ton. As a result, in order to accurately compare the current results with what was included in the 2007 study, the Center translated the costs per wet ton collected from respondents into costs per dry ton. This calculation was performed using the industry standard calculation for dry tons, which is average percent solids multiplied by wet tons. Since the average percent solids figures were also requested from participating facilities, the costs per wet tons could be divided by the average percent solids to obtain the costs in dry tons. From this, the Center could approximate the relative percent change in costs since the 2007 study. All other cost figures included in this update are as they were reported by survey participants.

Survey Methodology

The Center for Survey Research at Penn State Harrisburg (CSR), sponsored by the Center for Rural Pennsylvania (CRPA), administered the 2024 Pennsylvania Wastewater Treatment Solids Beneficial Use/Disposal Survey from August to October 2024. Survey questions were adapted from a previous survey conducted for the purposes of a study that was published in 2007. The survey was programmed by CSR in the Qualtrics online survey platform. Individualized survey links were created for all facilities on the list provided by the CRPA.

The survey was fielded from August 5 to October 15, 2024. Throughout the fielding period, team members at CSR and CRPA were available to provide assistance to respondents. On August 5, an invitation letter was sent in the mail to all 1,116 facilities on the list provided by the CRPA. The number of surveys sent exceeds the number of reported active facilities in the database provided by the Pennsylvania Department of Environmental Protection (841) due to concerns of mistakenly excluding facilities that were incorrectly labeled as inactive or terminated in the dataset.

On September 9, a reminder letter was sent to 1,007 facilities, and on September 24, an email reminder was sent to 744 remaining facilities that had an associated email address on the list. Throughout the survey fielding period, facilities were removed from future reminders if they had already completed the survey, their invitation letter had been returned as undeliverable, or if they indicated that they were not eligible for the survey (e.g., facility did not provide biosolids treatment services).

Four facilities were added to the list throughout the fielding period by the CRPA and were sent appropriate survey invitations. Additionally, one facility requested a second survey link so that they could provide information about their facility's second plant. In total, 1,121 facilities were invited to participate in the survey. Of these, 74 facilities either had an invitation letter returned as undeliverable or indicated that they were not eligible for the survey. Therefore, 1,047 eligible facilities received an invitation to participate. Note that there may be ineligible facilities included in this number if they did not reach out to the CSR or CRPA during the fielding period.

The CSR removed responses from the dataset if they did not provide substantive responses to any of the questions (e.g., did not advance past the facility verification screen, left all survey questions blank, etc.). Partial responses were left in the dataset if they provided at least one valid response. In total, 193 responses were included in the final dataset provided to the CRPA. Subsequent cleaning of the data performed by the CRPA removed 3 additional blank responses and added 1 response from a facility that input data for two of their plants on the same entry, bringing the total responses to 191.

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