National Biosolids Survey #2 (2018 Data)

METHODS

Final Report
May 30, 2020

State Survey
National Biosolids Regulation, Quality, End Use & Disposal
2018 Data

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- Ned Beecher, Special Projects Manager, North East Biosolids and Residuals Association (NEBRA);
- Nora Goldstein, Editor, *BioCycle;*
- Maile Lono-Batura, Northwest Biosolids; and
- Greg Kester, California Association of Sanitation Agencies (CASA),

with special assistance from Tim Seiple, Pacific Northwest National Laboratories.

INTRODUCTION

The purpose of this project was to identify all existing national biosolids management data and develop the process (methodology) to collect the current national biosolids data (for 2018) regarding the regulation, quality, end use, and disposal of biosolids in the U.S. This involved the following tasks:[1]

Task 6.1: Conduct a Literature Review of existing national biosolids data sets to assess existing available U.S. Biosolids Data.

Task 6.2: Utilize the literature review of existing biosolids data sets — including the critical data gaps identified — to update and/or revise data fields used in the 2007 "National Biosolids Regulation, Quality, End Use and Disposal Survey."

Task 6.3: Finalize data fields and create surveys for both state and wastewater treatment plant (WWTP) questionnaires.

Task 6.4: Conduct pilot tests of the two surveys (state and WWTPs) by having several state biosolids coordinators and wastewater treatment plant operators complete the survey questionnaires and provide feedback on the questions in comment boxes provided.

Task 6.5: Recommend national biosolids data collection project methodology and surveys — incorporating responses and feedback from the pilot tests — to conduct a "2nd National Biosolids Regulation, Quality, End Use & Disposal Survey" (collecting 2018 data).

Proposed Next Steps:

- **June 2020**: Review final report with project Advisors, request their continued participation during implementation of the new national survey.
- **By December 31, 2020**: Complete the 2nd National Biosolids Regulation, Quality, End Use and Disposal Survey (2018 Data)
- **By March 31, 2021**: Complete manuscript for publication in peer-review journal; complete publicity (slide deck, articles in trade publications)

BACKGROUND

In 2007, NEBRA, in collaboration with NW Biosolids, *BioCycle*, and the Wisconsin Department of Natural Resources, with support from University of Maine researchers, released its final report,

[1] As described in the project grant proposal submitted to U. S. EPA Region 4 on September 28, 2018, with an updated schedule submitted December 5, 2018.

"A National Biosolids Regulation, Quality, End Use and Disposal Survey." A comprehensive data collection survey had been conducted, primarily sourcing data from state biosolids management officials and annual reports, utilizing 2004 data. While other biosolids data collection efforts have been conducted since 2007, the NEBRA et al. report remains the most comprehensive to date in scope of data collected and analysis.

In July 2017, Green Blue received a grant from the U. S. Environmental Protection Agency (EPA) Region 4 office to support "Building Composting Alignment and Infrastructure" through advancing The Composting Collaborative, helping accelerate "composting access and infrastructure to improve soil health and divert compostables from landfill." Green Blue was assisted by *BioCycle* in completing five tasks, including the compilation of data on food waste and other organic residuals. In 2018, a grant extension was added to the project to expand the data on organic residuals to include wastewater solids (sewage sludge) that, when treated and tested and meet regulatory standards, are commonly applied to soils as biosolids.

Currently, funds provided by the EPA Region 4 grant extension serve as a "down payment" on a critically needed, comprehensive update of national biosolids regulation, quality, end use and disposal data. Conducting the actual national survey will require additional funds. The purpose of this grant extension — with project completion and this final report — is to identify all existing national biosolids management data sets and content of their data fields, and develop the process to conduct the 2nd National Biosolids Regulation, Quality, End Use and Disposal Survey, collecting 2018 data (2nd National Biosolids Survey).

Project Advisors

The role of the Advisors, who joined the Project Team in May 2019, was to:

- Review the initial Master spreadsheet of data fields to identify missing data fields.
- Review and provide feedback on data fields currently in the spreadsheet — and add missing data fields that are critical to Advisors' work in biosolids management.
- Assist the Project Team in ranking and weighing essential data fields, including assessment of what is available and could be reported in a national survey.
- Several Advisors served as pilot testers of the state and WWTP surveys developed in this project.

Advisors include federal and state officials involved in biosolids management, biosolids managers at wastewater utilities, two researchers, a private sector service provider, a consulting engineer and a national association director.

PROJECT DETAILS AND METHODS

Task 6.1: Literature Review

This literature review — compiled in a separate document to this final report — summarizes existing recent U. S. biosolids data, their focus and quality, and the methods used to compile them. Key national and regional biosolids data reports prior to 2007 are included.

One finding of the Literature Review was that it is futile to try to compile existing data into updated national or state-by-state data sets. The data collection efforts since the first National Biosolids Regulation, Quality, End Use and Disposal Survey report of 2007 have all been too closely targeted on specific aspects of biosolids management (e.g. composting or anaerobic digestion) or have been regional – and only in a few regions. Therefore, this project did not develop an updated set of data, as had been discussed at the outset. Such a data set will have to wait for completion of the 2nd National Biosolids Survey (compiling 2018 data) later in 2020.

In addition, the Literature Review:

- Identifies data gaps that, if filled, would be useful to policy-makers, researchers, and managers of biosolids; gaps to be filled were identified through input from the project Advisors and recommendations from the literature and other sources (the resulting final list of data fields will be delivered separately);
- Recommends next steps for implementing an updated, comparable national biosolids regulation, quality, end use, and disposal survey — the second such survey — focused on 2018 data.

The project team submitted the final draft of the Literature Review to U.S. EPA Region 4 for review on April 10, 2020. No edits or revisions were requested. Thus the final Task 6.1 Literature Review is being submitted to U.S. EPA Region 4 as a separate document to this Final Report.

Task 6.2: Update and/or Revise Data Fields

The Literature Review provided information on

- Which data have been the focus of past biosolids data collection efforts,
- Which data are most useful to stakeholders involved in biosolids and organic residuals management,
- How and in what forms data are best collected, and
- What additional data fields might be important to include in future data collection efforts.

Selecting data fields to use in the survey instruments for the states and wastewater treatment plants was a multi-step process:

1. Review existing data fields from the survey instrument used for the 2007 "National Biosolids Regulation, Quality, End Use and Disposal Survey."

2. Utilize the literature and critical data gaps identified — to update and/or revise data fields used in the 2007.

3. Add to the list of data fields. The compilation of existing biosolids information data fields was shared with the project's Advisors. The Advisors provided recommendations on which data are most important to them in their various positions and what additional data they would find useful. Suggestions came from researchers, WWTP operators and managers, biosolids managers, state and federal biosolids coordinators, and wastewater and biosolids associations and committees. For example, the Water Environment Federation (WEF) Residuals and Biosolids Committee's Outreach Subcommittee is developing an analysis of the economic impacts of biosolids management and requested inclusion of economic metrics in the next survey of biosolids. All Advisors' suggestions were added to the master list of data fields for further consideration.

4. Prioritize the data fields. Which data are most critical to stakeholders? Which are accessible and can be compiled with a reasonable level of effort? This ranking was delineated by utilizing different font sizes and color coding in the master list of data fields. An effort was made to capture the intent of the less critical data fields into the crafting of the survey questions and/or to include them as part of a more critical data field (e.g., biosolids treatment via pyrolysis).

Part of the prioritizing of data fields involved considering how the data will be presented in the final report. The project team developed concepts of dashboards (discussed further below). Dashboards are used to convey summary data in compelling and quickly absorbed ways, often using graphics. The original national biosolids survey report included numerous graphical presentations of data. But far more can be done, especially because the 2nd National Biosolids

Survey (2018 data) will have the opportunity to present trends and comparisons relative to the earlier data. As data fields were prioritized, their place in the dashboard(s) was envisioned. The focus was on answering this question:

Which data are the most helpful in characterizing and understanding the state of biosolids management in the U. S.?

5. Data fields were designated to be employed as follows:
   - Use in state survey only
   - Use in WWTP survey only
   - Use in both surveys
   - For use only by project team to calculate data based on data received or inclusion of data from other sources. Some data of high priority for presentation in a dashboard or final report are based on calculations. Trends are an example. They require calculation by the project team. The project team also recognized that some key data useful to biosolids stakeholders is available from other sources, such as the Clean Watersheds Needs Survey (CWNS). For example, the age of biosolids management infrastructure is a concern, but it is difficult for large facility managers to keep track of, and pilot tests of the WWTP survey found the question about infrastructure age could not be easily answered by most. The project team is discussing this (and similar dilemmas) and will determine whether or not to continue to include this question in the WWTP survey; it may be better to seek similar data from CWNS, for example, to replace the question or to supplement any data that the question manages to access.

Rationale for Selected Data Fields

The original national biosolids survey (NEBRA et al., 2007) was developed after a lengthy review of prior biosolids data collection efforts and with abundant stakeholder input. It provided robust baseline data that have been relied on and widely cited. A primary goal of the 2nd National Biosolids Survey is to use the same data fields and questions to the greatest extent possible, in order to obtain data that is consistent between the two surveys, thus allowing for comparisons over time. Therefore, wording of questions was left the same unless there was a compelling reason to change it.

New data fields added for the 2nd National Biosolids Survey (2018 data) were selected from myriad recommendations provided by Advisors and other stakeholders. They were designed to capture essential concerns, energy production and use, and economics of biosolids management. However, these data field choices were also heavily influenced by an understanding of the availability of data. State biosolids coordinators and WWTPs — the sources of information being relied on for this national biosolids data effort — do not compile

complex energy and economic data. But there are key data — key metrics — that do provide a snapshot of the economics of biosolids management. For example, the most useful, available and consistent metric of one aspect of the economics of biosolids management is the amount paid by a WWTP per wet ton for sewage sludge or biosolids going out the gate of the WWTP. That dollar amount, and how it changes over time, sheds light on the state of the biosolids management market and can be used to calculate estimated overall biosolids management costs and economic activity. It would be invaluable to have this dollar value available each year, as part of a national biosolids data dashboard.

Another challenge which surfaced during the discussion about energy-related data fields was how to best represent the performance of anaerobic digestion (AD)? Is the best measure volatile solids reduction (VSR)? That is a value that most AD facilities track, in part because of stabilization requirements under the federal Part 503 regulations. Can VSR be used to represent biogas production?[2] Or should biogas production data be obtained? The challenge there is that many facilities have little or faulty measurement of biogas production. While VSR data may be helpful in providing a sense of AD function from one situation to another, it may or may not be the most useful data for modeling purposes. These are the kinds of challenges the project team wrestled with in finalizing the prioritized data fields.

Scope

Another key aspect that needed to be reviewed and determined in planning the 2nd National Biosolids Survey was the scope, including:

- Geographic: The original national biosolids survey (NEBRA et al., 2007) covered the 50 states. The second survey, with 2018 data, will attempt to include territories as well (e.g. Guam, Puerto Rico, U. S. Virgin Islands, etc.).
- WWTP size: Most of the data reported by state biosolids coordinators and discussed in the 2007 report are from "major" facilities – those treating more than 1 MGD. However, there are some states that also include data from smaller facilities. It is difficult to obtain consistency among all states. So, as before, the Second National Biosolids Survey will have some variation in whether or not smaller facilities are included, state by state. The project team will ensure that all major facilities are included, and those facilities produce the vast majority of the sewage sludge used or disposed. And the data presentation will clearly indicate how many facilities are being included in each state. This is consistent with the first national survey.

[2] There is published research on this question, and the California Association of Sanitation Agencies (CASA) recently reviewed the science and engineering behind it and has adopted the metric of 15 scf of biogas / pound of VS destruction

Following on and building from the first National Biosolids Survey (2004 data), the current survey (2018 data) includes the same categories of data fields:

- Wastewater treatment and biosolids infrastructure
- Biosolids quantity
- Biosolids end use & disposal / Resource recovery data
- Biosolids quality data
- Biosolids treatment practices
- Biosolids & septage regulation and permitting
- Trends in biosolids management

Two additional categories of data fields were added for the current survey of 2018 data:

- Biosolids-related energy data
- Biosolids-related economic data

Data are collected for each data field through one or more questions in either the state survey or the WWTP survey or both. Or, in a few instances, data for a selected data field is calculated from collected data or obtained from some other source.

Questions related to energy and economic data were not asked in the original National Biosolids Regulation, Quality, End Use and Disposal Survey. Since the time when the original survey was designed in 2006 (collecting 2004 data), there has been a surge of interest in renewable energy generation and energy efficiency at WWTPs. More recently — as discussed and cited in the Literature Review — surveys have been conducted to collect data on renewable energy generation at WWTPs, especially as related to co-digestion. The state and WWTP surveys for this project include some of the same questions (data fields) as those prior surveys along with new ones developed by the current project team and Advisors.

One area where there is currently a distinct void in data relates to the economics of biosolids management. There was consensus among the project team and Advisors that the 2nd National Biosolids Survey (collecting 2018 data) should include data fields related to economics — including tipping fees paid for end use and disposal, tipping fees collected for receiving outside wastes, transport distances to end use and disposal sites, and the per-ton and total costs to manage biosolids. Numerous biosolids management professionals seek economic data, as do technology vendors and other private company stakeholders, researchers, and those developing policy. The viability of policies, systems, and technologies requires understanding of markets and money in the biosolids management space. While one-off, separate biosolids market and biosolids technology analyses are common, no one is tracking key metrics of economic activity and impacts in the biosolids management sector nationwide. The Second National Biosolids Survey will collect baseline data and start building such shared, nationwide economic data.

TASK 6-3: FINALIZE DATA FIELDS AND CREATE SURVEYS

Survey Platform and Design

Once consensus was achieved on the data fields for the state and wastewater treatment plant surveys (Task 6-2), the next step was to craft the questions for those data fields to enter into the online questionnaires (Task 6-3). The original National Biosolids Regulation, Quality, End Use and Disposal Survey used printed paper forms provided to each state biosolids coordinator in May, 2006. While most of the data collected for that project was from those printed forms mailed back to NEBRA by the states, a parallel survey of individual WWTPs was created and provided online using the Survey Monkey® platform. That online survey was considered a test of the potential for collecting biosolids data in this way. More than 250 responses were gathered in a relatively short time, providing some useful data integrated into the 2007 report and proving the concept of online biosolids data collection.

For the 2nd National Biosolids Survey project, the project team did a cursory evaluation of other user-friendly survey instrument platforms, e.g., Google forms, SurveyGizmo, Typeform. Each platform offers a unique variation of features, some of which would be beneficial to this data collection effort. Ultimately, however, it made the most sense to use Survey Monkey again and have the ability to use, as a starting point, the online WWTP questionnaire from 2007. From that, both the state and WWTP questionnaires have been constructed, modified and updated based on pilot testing (see below).

Question Development and Formatting Data

Because the survey used to collect state biosolids management data for the 2007 report had been carefully designed, reviewed, and field tested, and because it was the basis for the vast majority of data in the 2007 report, the current project team prioritized retaining all of the questions and their language and formatting to the greatest extent possible when developing the current state survey. Any adjustments to questions were carefully considered, and rare. This ensures validity in comparisons of the prior report's 2004 data and the current survey's 2018 data and allows valid analysis of trends.

This careful management of the existing questions was supplemented by the addition of two new categories of questions in the current state survey:

- Biosolids energy-related data, and
- Biosolids economic data.

These categories and the questions for them had to be developed. They were refined readily as needed based on feedback from pilot testing of the new surveys.

In comparison, the WWTP survey was only *piloted* for the 2007 report. It was conducted online — versus the paper survey mailed to the state biosolids contacts. Based on the responses received, it was evident that the questions needed to be tweaked and refined. Thus the data

fields and questions in the WWTP survey have been updated and improved as needed based on feedback from WWTP staff who pilot tested the survey in May 2020.

The targeted respondents for the state and WWTP surveys are state officials involved in biosolids management and biosolids managers at wastewater utilities, respectively. In some cases, depending on the size of the WWTP, the plant manager is the respondent, as that individual also serves as the biosolids manager. Project Advisors representing each of these groups agreed to pilot test the survey instruments (see Task 6.4 for more details).

Terms, and definitions of key terms, such as "beneficial use," were carefully chosen during the development of the original national biosolids survey. The same terms have been used in the second survey, except for TWTDS (treatment works treating domestic sewage) has been replaced by "WWTPs." This was done because a) "TWTDS" is not a widely used or recognized term, b) the term has to be used many times in the survey and having something more familiar helps respondents, and c) the meaning – the particular facilities being described by the terms – are very close in definition. There should be no confusion about what facilities are being discussed, especially since the definition provided in the survey emphasizes that WWTPs includes all facilities, public or private, that treat domestic sewage.

For each data field and associated question, the units and formatting of data being requested needed to be determined. Consideration was given to how the data would be presented in the final report and in the data presentation dashboard(s). For example, it was decided that:

- Decisions had to be made about what units to request, based on understanding what measurements are most commonly used at WWTPs and by state biosolids coordinators. Some biosolids quantity survey tools provide respondents a lot of flexibility in units of measurement. For example, the U.S. EPA's ECHO reporting tool enables wastewater treatment plants to use their own units of measurement without noting if they are using dry or wet tons of biosolids, cubic yards, gallons, etc. The net effect, noted a project team member, "is that you end up with a 0.5 mgd plant producing more biosolids than the City of Los Angeles!" The project team considered asking for all quantity data in dry metric tons, but ultimately decided to provide responders with the option to select the unit with which they are most comfortable — dry U.S. tons; dry metric tons; wet tons (with % solids); or gallons (with % solids). The project team will do the final conversions in order to report all quantity data using the same unit. Maintaining control of data conversions within the project team ensures better data consistency. All conversion factors used will be clearly documented in the final report and data presentations for the 2nd National Biosolids Regulation, Quality, End Use & Disposal Survey (2018 data).

- It was decided that data presentation in the future — for example on the state spreadsheets reporting masses of biosolids used or disposed of — should differentiate

between “no data” vs. “incomplete data.” As one project reviewer noted regarding the presentation of the first national biosolids survey data, “we might have used the term ‘incomplete data’ rather than ‘no data’ – because in some instances, like Ohio, we received some data, but not complete data; in such cases, we preferred to report “no data” rather than partial data.” For the second survey, presenting partial data and labeling it as such enhances the value of the project.

- Population numbers presented in the final report or dashboard(s) should be direct from Census data; we prefer to use data in the form reported by a cited source.

Finalizing the Surveys

The same categories of questions were used for both surveys (state and WWTP) to the extent applicable. Both surveys were created online, using Survey Monkey.

Because the current grant enabled pilot testing of the survey instruments, both questionnaires were initially created with Reviewer Comment Boxes after many of the questions. Pilot testing respondents were asked to indicate the following, especially if they could not answer a question:

[ ] We do not collect this data
[ ] Collect data but not easily accessible
[ ] Not sure what question is asking so can’t respond
[ ] Not certain if I can share this data
[ ] Other (please specify)

Feedback on individual questions has helped refine the survey instruments for the nationwide rollout later in 2020. In addition, phone calls were held with several pilot test respondents in order to understand the interpretations of the questions by a variety of individuals, discuss the intent of questions, obtain input on possible wording changes for greater clarity, and to assist them with their responses. All of this feedback was valuable in finalizing question wording and formatting, as well as for crafting the recommendations regarding methodology (see below) and the implementation of the full 2nd National Biosolids Survey, which is expected to be conducted during the remainder of 2020.

State Survey Instrument

The final survey for state biosolids coordinators is 8 pages and has a total of 56 questions (including septage questions). The time estimated to complete the survey is one hour, with an additional hour needed to complete a downloadable state data spreadsheet. The “Welcome” page in the survey has detailed instructions on how to respond to questions, e.g., utilize only numeric responses when requested. There are links to definitions of terms used throughout the questionnaire (https://www.nebiosolids.org/nbii2definitions).

The “Welcome” page states that data requested are about:

- Sewage sludge & biosolids management in your state,
- From public and private wastewater treatment plants (WWTPs) treating domestic sewage,
- Used or disposed of sewage sludge/biosolids in 2018.

For the pilot tests (and for the nationwide rollout), NEBRA created a data spreadsheet for each state biosolids coordinator to download while going through the online survey. The spreadsheet shows the state’s responses from the 2007 report (CY 2004 data) on the left hand side, and, in the same row on the right hand side, requests the 2018 data. The spreadsheet also indicates where a new data point is being requested for 2018, e.g., the number of acres to which biosolids were applied in 2018 – a question not asked in the 2007 survey questionnaire.

The state survey has six categories of questions; the categories on quality, quantity, etc. are combined in this survey, as they are all addressed in the one downloadable spreadsheet for each state:

- Wastewater Treatment Plant (WWTP) and Biosolids Infrastructure
- Biosolids Quality, Quantity, End Use & Disposal, and Treatment Practices (detailed data fields related to this category are in the downloadable spreadsheet)
- Biosolids-related Economic Data
- Biosolids Regulations and Permitting (total of 3 pages of questions)
- Trends in Biosolids Management
- Septage and Other Residuals

Wastewater Treatment Plant Survey Instrument

The final survey for WWTP biosolids managers is 8 pages and has a total of 44 questions. The time estimated to complete the survey is 40-45 minutes. The “Welcome” page in the WWTP survey is very similar to the “Welcome” page in the state survey; it requests 2018 biosolids quality, use, and disposal data for the facility.

The WWTP survey has 8 categories of questions:

- Wastewater Treatment & Biosolids Infrastructure
- Biosolids Quantity
- Biosolids End Use and/or Disposal
- Biosolids Quality
- Biosolids Treatment Practices
- Biosolids Energy-related Data
- Biosolids Economic-related Data
- Trends In Biosolids Management

TASK 6-4: CONDUCT PILOT TESTS, ANALYSIS OF RESPONSES, COMMENTS

Pilot surveys were completed by 3 states and 5 wastewater treatment plants (WWTPs). Respondents to the state surveys included two state biosolids coordinators and, in California, the U.S. EPA Region 9 biosolids coordinator. Respondents to the WWTP survey were staff responsible for biosolids management, but in one case, the director of the treatment authority (a smaller plant) completed the questionnaire. The pilot test respondents provided a good cross-section of types of respondents and situations for each of the surveys.

Of the 56 questions in the state survey questionnaire, only a few are "required fields," i.e., the respondent must provide an answer to proceed to the next page of the survey. Of the 44 questions in the WWTP survey questionnaire, 23 or 52% are required fields. Instructions for both surveys note that if the respondent can't answer a required question, they should put in a zero (0) if a numeric response is requested, and then explain why the question can't be answered, using the Comment Box.

Requiring respondents to answer questions is tricky. If there are too many required questions requesting information that may not be immediately at hand or is unavailable, the respondent can be frustrated by having to enter erroneous or estimated data or a zero (0) to be able to proceed to the next page. On the other hand, there are some data points that are so important to obtain that encouragement to respond is helpful. In the end, the survey designers recognized that state biosolids coordinators are engaged and supportive of compiling these biosolids data, so they will generally be diligent and thorough in their responses. In addition, there are only 50+ of these individuals, making it easy for the project team to follow up with them, if needed. In contrast, WWTP operators may be understandably less motivated to complete a survey and may skip over data that are critical to the success of the survey. Therefore, the survey designers required a response to all of the questions deemed to be of highest priority for understanding biosolids and septage management in the U. S.

For the WWTP survey questionnaire, required questions cover standard information about biosolids infrastructure, quantity, end use and/or disposal practices, quality, and treatment methods (17 of the 23 required questions). Conversely, there are only a handful of required questions in the Biosolids-related Energy and Economic Data sections of the survey — both of which are new categories of questions being asked. The project team decided to keep answers to those questions "optional" in order to (a) gauge availability of the data, and (b) encourage comments as to why the question cannot be answered. In some instances during the pilot testing, respondents didn't provide data for these energy and economic questions but also did not comment as to why.

The pilot test responses and feedback from state biosolids coordinators completing the state survey and from WWTP staff completing the WWTP survey, collected in May 2020, proved extremely helpful on several levels:

- They highlight ambiguity in some questions
- They inform how to tweak questions in order to maximize the ability to aggregate data, i.e., enabling "apples to be added and/or compared to apples"
- They address data collection from cities with multiple wastewater treatment facilities

State Survey Responses

Our summary of responses from the three state survey pilot tests are presented in three categories:

- Strong responses (questions eliciting high rates of response and quality data);
- Strong responses with caveats, e.g., should reword/clarify; and
- Weak responses (questions eliciting low rates of response and/or questionable data).

Our evaluation is based in part on which data fields show potential to aggregate for national metrics.

Strong responses: Questions eliciting high rates of response and quality data

1. Number of operating sewage-sludge-only incinerators in your state in 2018
2. Number of WWTPs in your state that currently have active industrial pretreatment.
3. Units used
4. Does your state collect economic data on biosolids management? No is the simple, common answer from most states.
5. Septage disposal fees. If states have a sense, they can provide a range as requested by this question.
6. Delegation for Part 503. A possible addition might be to ask for explanation of the response to this question.
7. Most of the biosolids regulation and permitting questions are answered, although the answers may include detailed comments about specific aspects of the state's program, which are helpful.
8. Trends – the questions on trends are answered, and additional comments are provided, all of which is illuminating.
9. State pilot test respondents willingly provided six successful biosolids program examples.

Strong responses with caveats

1. Number of WWTPs in the state… Caveat: There are facilities that don't fit neat definitions, and it is hard to know what to do with the many small lagoons and package plants. State coordinators collect different data, even on this one simple metric. The survey report will provide Clean Watershed Needs Survey (CWNS) data for comparison.

The goal for this question is to ensure we include at least all the major (> 1 MGD) WWTPs.

2. Number of separate preparers. Caveat: This has always been hard to define. It often takes discussion to ensure understanding. The intent is to follow the definition of separate preparer in Part 503 – a facility or operation that changes the quality of the biosolids (and is not part of a WWTP).
3. Number of landfills located in your state that take in sewage sludge (as of 2018)… Caveat: Need to clarify whether this seeks the number that were available and able to take in sewage sludge in 2018, or the number that actually did.
4. Number of WWTPs with lagoons in your state. Caveat: Might need to clarify; does this mean "lagoons only at WWTPs, where there is some jeopardy for economic impacts when it comes time to clean out or close?" asked one reviewer. "I did not include non-WWTP facilities with lagoons that are emptied annually."
5. Number of biosolids management jobs in your state in 2018. Caveat: Respondents will provide best estimates, and those may vary widely in how they are developed. But these data will still be valuable for rough baseline understanding.
6. Percentage (%) of your state's sludge/biosolids managed by private contractors. Caveat: This question may need to be reworded. Almost all WWTPs have some private contract help with at least trucking biosolids. Clarify that we want the percentage that rely heavily on private contractors to manage biosolids use or disposal (not just hauling).
7. Does your state require formal nutrient management plans. Caveat: Pilot testing revealed that nutrient management plan needs to be better defined.

Weak responses: Questions eliciting low rates of response and/or questionable data

1. Number of WWTPs in your state sending solids for further treatment at separate preparers in 2018. There is confusion about whether this includes sending solids to another WWTP for treatment. One biosolids coordinator says that would be useful to know also, because it is an indication of the number of WWTPS that depend on others for solids management.
2. Total average daily wastewater flow treated in your state in 2018. Many state regulators will not have this datum; same with the two following. These questions have more success in the WWTP survey.
3. Total WWTP DESIGN capacity wastewater flow in your state (MGD)
4. Total average daily DRY WEATHER flow treated in your state in 2018 (MGD)
5. Contracted fee for sludge/biosolids removal, biosolids product pricing – these and other economic questions received few responses. Most states do not collect biosolids economic data.
6. Acres to which biosolids are applied in the state. Some states collect these data, but they are hard to access. The response rate for this question will likely be very low.
7. Site permits/approvals. Same as previous.
8. Energy-related questions

Pilot Response Takeaways: State Survey

- Pilot test reviewers of the state survey reminded the project team that different people interpret language differently. Even when questions have been carefully written and presented, variations in understanding are to be expected. If consistent data are going to be compiled from this kind of survey effort, the methods must include ways to address this reality. This underscores the importance of the methods used in the 1st National Biosolids Survey, which will be strengthened in the 2nd National Biosolids Survey; specifically:
    - Collecting data from those most knowledgeable in each state
    - Providing abundant opportunity and space to allow respondents to clarify and discuss their answers right in the survey document (it may be advisable to keep the "reviewer comment boxes" in the final survey, to give respondents the chance to critique any question)
    - Interviewing and discussing questions and data with each state's respondent(s), with interviewers trained for consistent interpretations and understanding of the data needs
    - Compiling each state's data into a consistent format and "reflecting" it back to the state respondent for their review, so they can see what they said and confirm it.
- Reviewers raised several challenges related to the basics of the survey. For example, should the survey ask for data from more than one year. One reviewer noted that "it may be easy to get this data for 2019 at the same time that someone is searching for 2018 data." This type of suggestion is helpful to consider; it ensures the project team has developed robust reasoning for every aspect of the survey methodology.
- Several questions are being revised, based on the experiences of the pilot test respondents.
- Several questions have had additional clarifying language added, to enhance understanding of the intent of the question.

Wastewater Treatment Plant (WWTP) Survey Responses

- Our summary of responses from the five WWTPs are presented in three categories: Strong responses (questions eliciting high rates of response and quality data);
- Strong responses with caveats, e.g., should reword/clarify; and
- Weak responses (questions eliciting low rates of response and/or questionable data).

Our evaluation is based in part on which data fields show potential to aggregate for national metrics.

<u>Strong responses: Questions eliciting high rates of response and quality data</u>

1. Average daily flow (mgd)
2. Quantity of biosolids generated
3. Quality, e.g. Class A, Class B
4. % managed on site versus separate preparer

5. % nitrogen and % phosphorus in biosolids — (4 have N; 3 have P; 1=n/a)
6. Part 503 compliance and testing of additional parameters beyond Part 503
7. Type(s) of dewatering technology
8. Use of anaerobic digesters and digester capacity
9. Excess AD capacity and receipt of outside waste (plus quantity of outside wastes)
10. Hauling data
11. Barriers to energy production and pressures on biosolids recycling programs

Strong responses with caveats

1. How managed, e.g., landfilled, land applied. Caveat: Responses were pretty limited to land application and landfilled; one mentioned pelletization. Perhaps too many choices
2. Treatment practices — similar to how biosolids are managed, the 5 respondents pretty much went with anaerobic digestion. Caveat: Whether there are too many options to select from. Could be resolved by winnowing down the list and ask for Other
3. SCF (standard cubic feet) of biogas produced — 4 out of 5 gave a number but 2 were disproportionate given AD capacity, e.g., 500 SCF from 1.0 million gallons capacity of AD Caveat: Perhaps reword questions and/or question format
4. All 5 responded to total cost for biosolids treatment. Caveat: Responses weren't "apples to apples" but instead, apples to oranges. Only one response directly answered the question based on how it is asked: "Total cost for biosolids treatment and end use/disposal (U. S. $/year in 2018). Sludge/solids treatment begins when sludge/solids are removed from the clarifiers and includes thickening, stabilization, dewatering, transportation, end use, disposal, etc." One solution is to separate biosolids treatment costs from biosolids end use and disposal costs.

Weak responses: Questions eliciting low rates of response and/or questionable data

1. Age of biosolids infrastructure. Only 1 of 5 respondents had this data available. In one instance, a respondent providing data for all treatment plants in the city, commented, "Each plant has had different upgrades at different times. Cannot answer this question as asked." A biosolids manager at a very large WWTP commented, "Due to size of operation many portions of the facility are commissioned at different times. I may be able to get more specific information if check our contract records."
2. Number of acres to where biosolids applied. Only 1 of 5 respondents replied although all manage a portion or all of biosolids generated via land application. Primary reason for not responding is a contractor has that data.
3. No responses to this question: "Annual energy generation from your WWTP's biosolids energy recovery system(s) (megajoules/year in 2018, MJ/year). Fill in all that apply." Two WWTP indicated data available but noted it is not accessible.
4. Pricing of biosolids products. Responses were ambiguous perhaps due to the way the question is worded: "What is the price charged for biosolids? Biosolids product pricing in 2018 (average U. S. $/cubic yard or average U. S. $/wet ton). Fill in all that apply." Examples of products listed include:

•Biosolids compost, wholesale (to soil brokers, landscapers, garden suppliers, etc.), $/cubic yard
•Heat-dried pellets or other biosolids in bags, $/~40 pound or 40-quart/1.4 cu. ft
•Bulk Class B biosolids to farms, forest, reclamation, etc., $/wet ton
For land application, it is unclear whether the price reported is actually the cost the WWTP pays per ton for land application versus the price a farmer or reclamation project pays to receive biosolids.

The time required to complete the survey ranged from 45 minutes for one individual to "an entire day" for another. Several general comments were received about the overall WWTP pilot survey:
•"On some of the questions, our operation involving beneficial use of pellets produced by the private entity on-site at the WWTP was not included as an option." The individual also noted that "some municipalities have more than one facility. Therefore, a separate survey will have to be completed for each facility. Also, at our facility, sludge is routed from one facility to another for further treatment such as anaerobic digestion etc. This can make it challenging to enter and to interpret the information."
•"All the numbers shared in this survey will reflect overall production for our city as a system. It is super complex at any level below that."

Pilot Response Takeaways: WWTP Survey
In addition to the takeaways regarding specific data fields and the phrasing of questions, the project team gleaned some bigger picture takeaways that will inform the national rollout of the WWTP survey:

•*Representative sample for national dashboard*: Determine what constitutes a representative sample as it is not feasible to survey every WWTP. In terms of methodology, the goal is to maximize the number of WWTPs that are requested to complete the survey, and receive as many responses as time and budget allows. Concurrently, the project team will work with advisors to develop a statistically robust method to fill in data gaps.
•*Aggregated city data when multiple WWTPs*: Benefits and tradeoffs of using aggregated data for cities with multiple treatment plants. In cities with multiple WWTPs, is it common to have one biosolids manager who can aggregate the data from all the plants, or is it more typical for individual plants within the cities to have requested data? The answer to this question will be informed by state and regional wastewater and biosolids associations.
•*Biosolids-related Energy data*: Responses to the energy-related questions were encouraging although some of the data fields are in need of refinement. For some of the energy-related questions, data for CY 2018 possibly could be culled from several of the reports cited in the Literature Review (see 6.1).

•*Biosolids-related Economic data*: As noted elsewhere in this report, the project team and Advisors identified the need to collect economic data related to the treatment, use and disposal of biosolids in the U.S. as a priority of the 2nd National Biosolids Survey (2018 data). The Literature Review noted a lack of national economic data, therefore data fields were created for both the state and WWTP survey instruments. Based on the responses received, the project team needs to work with its Advisors and biosolids managers to refine the data fields used in the pilot surveys.

TASK 6-5: DATA COLLECTION METHODOLOGY RECOMMENDATIONS

The final task under this scope of work is to provide recommendations based on the outcomes of Tasks 6.1—6.4.

The Literature Review found, without a doubt, that there is a critical need to conduct a 2nd National Biosolids Regulation, Quality, End Use & Disposal Survey. The 1st National Survey collected data for calendar year (CY) 2004. The 2nd National Biosolids Survey will collect data for CY 2018. Based on the pilot survey responses, CY 2018 data are available to complete the state-by-state and wastewater treatment plant (WWTP) surveys.

The need to complete this survey project in 2020 is essential, especially with increased attention to the fact that wastewater treatment infrastructure are more than just treatment plants — and instead are, or have the potential to be, water resource recovery facilities (WRRFs) that yield energy and nutrients as well as clean water. As noted in the Literature Review, in the modern economy, every major commercial activity is tracked and evaluated with data collected routinely and repeatedly, so that the state of the profession and the market and its impacts are visible at particular moments and in trends. Biosolids are products, and their management is a hundreds-of-millions-of-dollars activity in the U. S.

But data are scant. And it is not because of lack of interest in the biosolids management sector: over the past decade, scores of venture capital and investment evaluations have been conducted to assess the value of the biosolids management marketplace, with its technologies, consultants, management, and public contracts. The kinds of data being sought are those found in the National Biosolids Regulation, Quality, End Use & Disposal Survey (NEBRA, 2007). But people also want far more data, including data on economics, jobs, environmental impacts (e.g. nutrients, greenhouse gas emissions), and energy recovery. Unforeseen challenges (i.e. PFAS focus beginning in 2018) will also likely influence the input received and possibly demonstrate relative changes in regulatory and economic trends.

The survey instruments created under the scope of Task 6 are designed to both update more "traditional" biosolids management data baselines (e.g., quantity, quality, treatment methods) *and* collect data for new data baselines related to biosolids-related energy, biosolids-related economics, nutrients, carbon sequestration, and more. The Literature Review cites fairly recent sources of biosolids-related energy data generated via surveys that focus primarily on co-digestion and/or biogas production. These newer sources offer the potential for corroboration of data to be gathered by a 2nd National Biosolids Regulation, Quality, End Use & Disposal Survey. However, as noted by a project team collaborator, "The questions used in some of those survey instruments generate 'Boolean data' responses (i.e., yes/no or true false) so there is a lack of detail/data for example, on biogas utilization, the amount of biogas flared, etc. … The reality is that each source has its data demons." This has been addressed in the survey instruments by providing abundant opportunities for respondents to clarify and comment on the data they provide (as discussed above).

Methodology Recommendations

The project team's research, pilot surveying, and peer-to-peer conversations over the course of conducting Task 6 confirms that the data collection methodology used for the 2007 report to collect data be repeated, but with some refinements. Recommended steps in the data collection methodology — based on the findings in Task 6 of this current project — include these key steps:

1. Review existing data and reports in order to understand the challenges that are encountered in compiling consistent, comparable data. For example, different WWTPs and states use different units for measuring the amount of biosolids produced, and unit conversions must be addressed.

2. Collect data points that can be converted by team into national and state-by-state metrics conveying useful information about biosolids use and disposal.

3. For state data collection, rely on the people in each state or region who are most knowledgeable about local biosolids management. In most states, this includes the biosolids coordinator(s) in the state regulatory agency, as well as a few key consultants and/or biosolids management professionals and, in a few instances, a biosolids regional group and/or EPA regional staff person.

4. For WWTP data collection, rely on the facility or municipal biosolids manager. For smaller WWTPs, the contact may be the treatment plant director, or the individual who oversees all operations. Supplement data gaps with state and/or regional association data that may have been collected more recently, e.g., for CY2018 or CY2019.

5. Utilize an online tool for state biosolids, regulation, quality, and end use and disposal data collection. Supplement the online tool with a spreadsheet that provides each state respondent the data reported for CY2004; that helps them understand what is being requested and helps ensure consistent, accurate data. The spreadsheet is completed offline and then submitted via email to the project team.

6. Schedule a telephone call with every state and territory biosolids coordinator to facilitate the reporting process. For Task 6.4, the project team had conversations with all three of the pilot test respondents who completed the state survey. This proved immensely helpful for both parties. This step does require additional time, but the value in terms of consistent data will make it highly worthwhile. In the pilot testing of the WWTP survey, phone calls were not utilized with the WWTPs. Follow-up emails or phone calls could be done on a case-by-case basis, especially for the larger facilities that represent large amounts of biosolids. But the survey effort just does not have the time and capacity to speak with more than a few WWTPs. Therefore, the survey relies heavily on the clarity of the questions. To ensure their usefulness, the project team plans to pilot test the revised WWTP survey with several more WWTPs before rolling it out to all.

7. Once data is collected and compiled, utilize data points that can be converted by the project team into national metrics that represent the "state of biosolids quality, quantity, end use and disposal" along with metrics related to energy generation and economic factors, e.g., cost/ton for biosolids management nationally, as well as by state and region. Furthermore, an attempt will be made to utilize conversion factors to determine national metrics for nutrients available in biosolids, mass of carbon sequestered, biosolids management's contribution to GNP, and a total value of all biosolids products. These key metrics will be highlights of the dashboard presentations. The team envisions this survey as a tool that supplements and illustrates the value of organic residuals as they relate to ecosystem services and creating a circular economy.

8. Create dashboard tools to summarize the national biosolids landscape. These tools will be made publically available for use by public agencies, wastewater and biosolids associations, biosolids technology and service providers, outreach and education coordinators and many others. Examples of data presentation and dashboard graphics are shown in the Addendum below.

We're approaching the survey instruments and this methodology in the same way that managers of materials (residuals) approach resource recovery: by creating a sustainable, reproducible, receiving, treatment and distribution system for biosolids data that can be utilized into the future. This creates a feedback loop that can be revisited and repopulated at regular intervals.

Using this recommended methodology, the 2nd National Biosolids Survey will address not only the need for data, but also attempt to advance understanding of the usefulness of particular metrics for particular purposes and stakeholders. And it advances the consistency and documentation of the approach and methods, so that future repetitions of the survey will be easier.

ADDENDUM: DATA PRESENTATION AND DASHBOARD OPTIONS

The work completed in this Task 6 of the U. S. EPA Region 4 grant-supported project administered by GreenBlue establishes the literature review and methodology for a future report, "The 2nd National Biosolids Regulation, Quality, End Use and Disposal Survey (2018 Data)." That report will be accompanied by graphics and dashboards that tell the story of biosolids management to a variety of audiences. Some examples of what these might look like are below. The exciting next step is to collect, compile, and analyze this second set of national data – and present it – which is planned for completion by the end of 2020.

In the original national biosolids survey (NEBRA et al., 2007), data were statically presented in spreadsheets. This may be needed for comparisons and presentation of volumes of data:

U. S. TOTALS	Estimated population	Land area (sq. mi.) (www.quickfacts.census.gov)	Pop. Density (pop/sq.mi)
Dry U. S. Tons	293,656,842	3,537,413	83
Total Cropland in Farms (acres, USDA, 2002)	Number of Farms With That Total Cropland (USDA, 2002)	Application rate if all state biosolids (adj. estimate) were applied to cropland (units/ac)	Percentage of acres needed if all state biosolids were applied to cropland at typical rate (~ 3 dry ton/ac)
434,164,946	1,751,450	0.017	0.6%

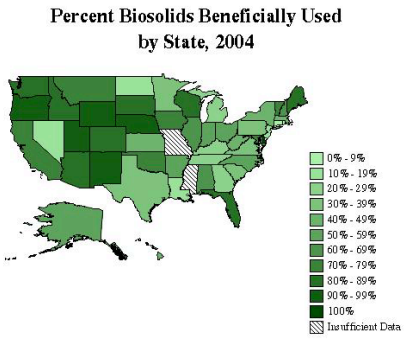
Total Biosolids Used or Disposed in 2004*:	From State Survey	Adjusted Estimate***
	7,171,222	7,180,000
Total Number of TWTDS in 2004:**	From CWNS	From Survey Q24
	16824	8776
Total number of TWTDS sending to Separate Preparers in 2004:		2300
Number of Separate Preparers:		186
Number of operating sludge incinerators^:		90+
Fluidized bed:		28+
Multiple hearth:		42+

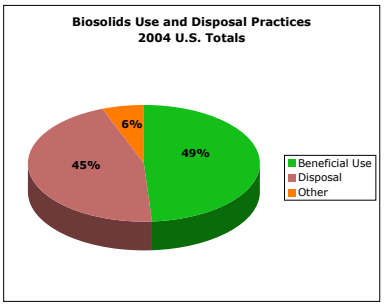
^ Incinerators were underreported; NACWA data notes 105+ multiple hearth alone.

Biosolids Use and Disposal Summary (2004 data)

	Number of Entities (TWTDS & Sep. Preparers) Going To...	Quantity of Biosolids	Percentage (quantity)
Beneficial Use	4639	3,502,845	49%
Disposal	3166	3,247,666	45%
Other (long-term storage, etc.)	1149	420,712	6%
Total	8776	7,171,222	100.00%
Beneficial Use			
	Number of Entities (TWTDS & Sep. Preparers) Going To...	Quantity of Biosolids	Percentage (quantity)
Agricultural	3999	2,620,146	37%
Forestland	28	26,452	0%
Reclamation	94	96,900	1%
Class A EQ Distribution	449	759,347	11%
Total	4461	3,502,845	49%
Other (long-term storage, etc.)	1149	420,712	6%
Disposal			
	Number of Entities (TWTDS & Sep. Preparers) Going To...	Quantity of Biosolids	Percentage (quantity)
MSW landfill (incl dly cvr)	2600	2,023,508	28%
Surface Disposal	54	142,684	2%
Incineration	512	1,081,474	15%
	3166	3,247,666	45%

Other simple graphical presentations may be used again in the 2nd National Biosolids Survey report, following what was used in the 2007 report:





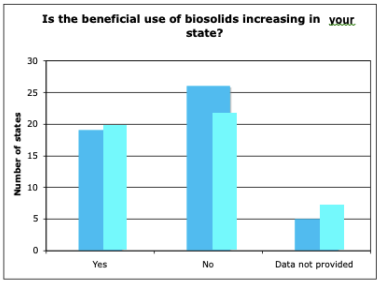
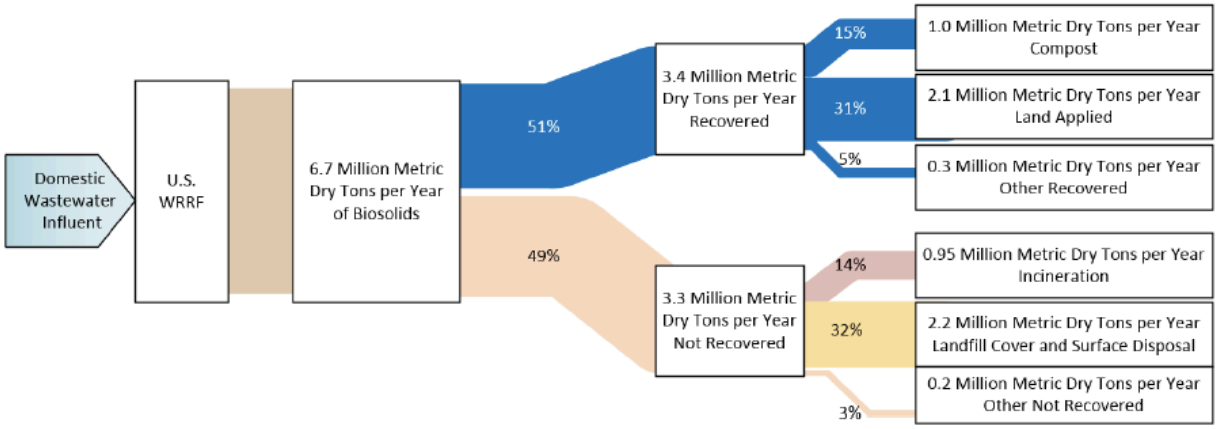


Figure 10 - Is the beneficial use of biosolids increasing in your state? Responses of state biosolids coordinators in 2006 and 2000 (Goldstein, 2000).

Current 2006 data

2000 data

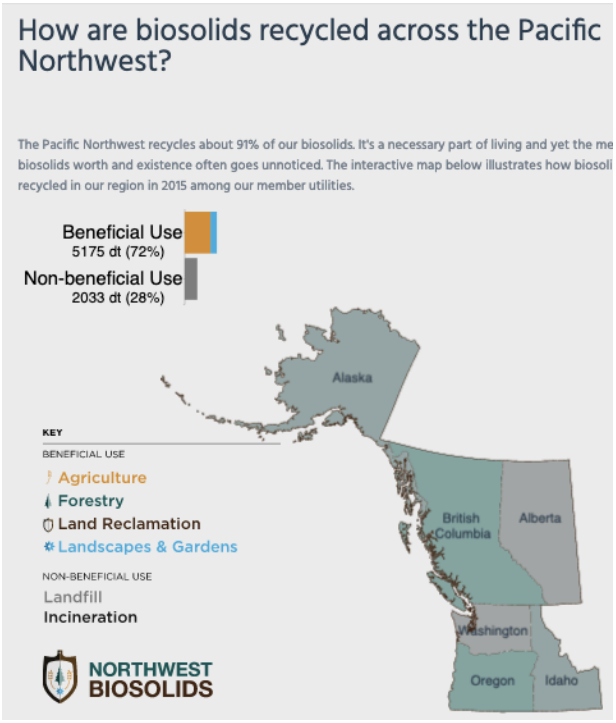
Some data may be analyzed and presented to be consistent with key past reports and data presentations. For example, this graphical presentation from the WEF resource recovery baseline data report could be updated and become a recognizable standard used widely to capture “the big picture.”



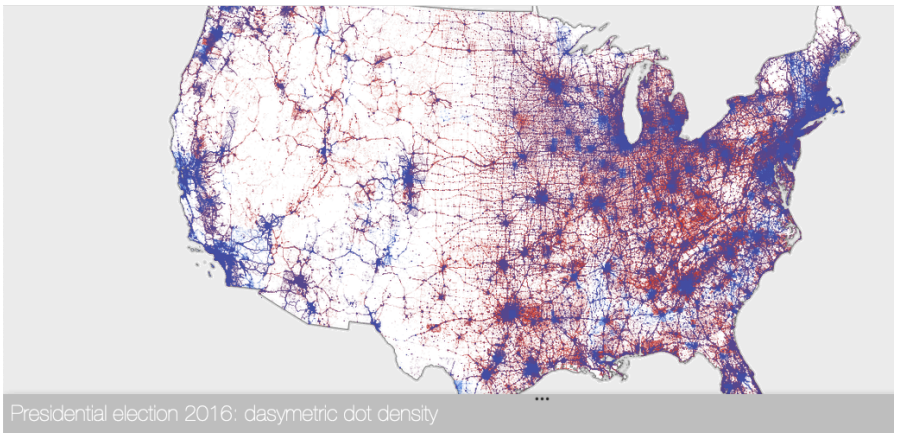
The Sustainable Phosphorus Alliance has used online tools for tabulating, presenting, and mapping of biosolids and manure regulation data (https://www.esri.com/en-us/home). We may coordinate with them to integrate into their system the additional regulatory data we collect.

Maps will present summary data for states, regions, and the national picture:

https://nwbiosolids.org/what-are-biosolids/product-use



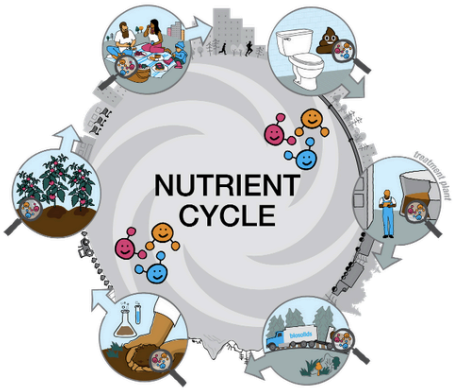
An example of an interactive national map:



https://www.esri.com/en-us/home

Multiple data will be assembled into stories, building on efforts such as the following. (See the full story at: https://sway.office.com/XxHiJZKwDesEDQnz

Scroll for an illustrated journey of the plant and human connection



Dashboards will be created, presenting and tracking the most critical data. They might look something like these:

Additional tools may be used, as needed:

Datapine and Tableau have dashboard tools that can link to Excel:
https://www.datapine.com/
https://www.tableau.com/
https://about.canva.com/canva-for-nonprofits/