WEF Biosolids National Convening Meeting Synthesis

November 20-21, 2019 | Alexandria, Virginia

Introduction

The Water Environment Federation (WEF) convened a gathering of invited experts in biosolids management November 20-21, 2019. Attendees engaged in facilitated discussions around successes, opportunities, and pressures facing biosolids now and into the future, and collaborated on potential solutions to overcome challenges.

The convening agenda was structured around discussion of key themes and challenges facing biosolids today, which evolved into a proposed set of actions to be taken in support of filling identified needs and gaps in biosolids management. Participants heard an overview of national perspectives, including an update from the U.S. Environmental Protection Agency (EPA) on biosolids-related activity at the Agency.

Prior to the convening, participants were provided with a background memorandum summarizing key themes around challenges and opportunities facing biosolids. Over the course of the two-day meeting, attendees discussed these topics in depth, considering gaps, needs, and potential actions in the areas of programmatic concerns, communication gaps, and research needs. They participated in facilitated small-group discussions followed by plenary debrief and refinement. On the second day, participants refined their ideas into several categories of actions for consideration by WEF and the broader biosolids management community to improve the state of biosolids management going forward.

This convening synthesis contains brief descriptions of meeting presentations, summaries of the meeting participants' discussions around needs and gaps and attachments that summarize three content areas of discussion, and four attachments that provide more detail on the discussion, including a suggested model for biosolids leadership going forward.

Updates on Biosolids Activities

The Convening began with a series of updates from EPA, WEF president Jackie Jarrell, and Chris Peot of DC Water. Deborah Nagle, director of the EPA Office of Science and Technology (OST), provided an update on EPA's current and planned activities related to biosolids. She reflected that biosolids is an important topic, and that OST is focused on making changes to the biosolids program to better address gaps and needs. These changes, both ongoing as well as planned, include hiring more people to work on biosolids at EPA, becoming current on biennial reviews, refining a screening model for identifying pollutants that should go on for a full risk assessment, improving engagement with EPA regions and stakeholders (including a workshop to be held in spring 2020 with states and tribes), and working on a process to address resource recovery. She also shared reflections on the 2018 Office of Inspector General (OIG) report on the biosolids program, expressing agreement that the program does have some areas that are in need of improve, and noted that OST had already been working on some of the areas noted in the report, and is in the process of working on several additional non-programmatic changes to address items noted in the report. These include making the website more transparent and easier to use and generally improving communication.

Jackie Jarrell, the current WEF president and interim deputy director of Charlotte Water, charged the convening attendees to think creatively about concrete actions that can be taken to help ensure that biosolids programs remain sustainable. She emphasized the need for improved communication with the public and coordination across states, regions, and federal levels, growing the biosolids workforce, helping the agricultural community, and addressing CECs as a whole rather than through a piecemeal approach to the chemical of the day.

Chris Peot of DC Water gave an update on the biosolids program at that utility. In the past, the program faced challenges with unpredictable product quality and odor concerns. To address these deficiencies, DC Water funded research to reduce variability in and improve the overall quality of its biosolids product and implemented the first U.S. anaerobic digestion process using thermal hydrolysis to produce a Class A product. These actions helped gain the trust of regulators and odor complaints fell dramatically, helping spur a substantial drop in public concern. He shared that DC Water is responding to Maryland's recent release of their Clean and Renewable Energy Standard goal to shift to 100 percent renewables by 2040. He noted that biosolids support those goals via carbon sequestration and healthy soils, while there is a need to build bridges via research and communication to make that link better known to public officials and the general public. Finally, he shared that the utility is building exciting relationships with environmental groups like the DC chapter of the Sierra Club, partnering with them on research into contaminants.

Biosolids Challenges and Opportunities Discussions

Program Needs

The convening attendees, over the course of two days of facilitated discussion, reflected on the most important program challenges and opportunities facing biosolids programs including legislation, regulations, policy, technical assistance, compliance oversight, and guidance. Discussions included the most important program modifications that are needed to address those challenges, and ideas about what actions could be taken to ensure those modifications become implemented. The discussions produced several proposed areas of emphasis for biosolids

activity going forward into the near future. A table of the identified areas for program improvement and proposed actions is included in Attachment A, and general descriptions of the gaps and suggestions are provided below.

1. **Elevate Biosolids Product and Management Program Quality.** Convening participants signaled one of the most effective ways to maintain and enhance support for biosolids beneficial use is to ensure both biosolids products and management programs are of the highest quality. In this context, participants discussed seeking to elevate the importance of well-run biosolids programs with the executive management of utilities, defining and promoting the elements of an effective, well-run biosolids program, providing guidance for effective municipal contracts with biosolids land application contractors, and ensuring the full range of biosolids benefits are 1) better characterized through research and 2) more effectively communicated through renewed public engagement initiatives (see the communications and research sections below for more on these two areas of future work).
2. **Update the 503 Regulations to Support New Operating Contexts and Innovation.** Participants discussed the need to examine opportunities for Part 503 Rule updates based on a combination of new technological advances and enhanced science related to such parameters as vector attraction, pathogen reduction, nuisance conditions, and contaminants of emerging concern. Additionally, participants discussed the concept of creating a "Part 504" regulatory framework to provide greater clarity and certainty to the process of gaining approval for innovative products (alternative approval mechanism for innovative product validation) that currently fall under the "derived from sewage sludge" clause of the Part 503 regulation.
3. **Establish A More Sound Science Basis for, and Reasoned Response to, CECs.** Participants expressed substantial concern regarding the potential for the mere presence of a CEC in biosolids (irrespective of the concentration level, exposure potential, and actual risk to public or ecological health) to torque public opinion and result in ill-informed regulatory measures that substantially upend biosolids management options. Participants recognized that, although PFAS compounds are currently in the public and policy spotlight, the water sector can anticipate continuing cycles of CEC pressures that requires a systemic response. In this context, participants discussed the need for: enhanced CEC research and development of risk assessment methods (see research section for more details); the formation of a CEC Technical Review Committee that could provide a rapid response capability when new CECs emerge (review available literature, coordinate review, formulate a response, disseminate to states, etc.); establish the capability to monitor developments on a state-by-state basis; and the preparation of a water sector policy statement in support of extended producer responsibility regarding persistent compounds.
4. **Bolster Oversight and Technical Assistance Capabilities and Capacities.** There was general acceptance that disinvestment in the 503 program at the Federal and state levels has left biosolids management vulnerable to criticism and a reduced capability to respond to questions and concerns. Participants indicated that disinvestment had undermined both capacity (the number of individuals engaged in biosolids oversight and management) and capability (the depth of knowledge available to the sector). To address these conditions, participants discussed: establishing a nationwide system of training and mentoring designed to leverage current biosolids professionals with deep knowledge to assist new recruits in advancing their knowledge; creating standardized training templates (that can be tailored at the state level) to reduce the burden of providing training at the state level; enhancing investment in inspector training; and improving on (both accessibility and content) existing biosolids information clearinghouse capabilities.
5. **Elevate Societal Acceptance and Endorsement of Biosolids as a Valuable Resource.** Participants indicated a sense that the water sector has missed a substantial opportunity to convey the role biosolids beneficial reuse plays in community sustainability and circular/green economy initiatives. Participants saw a need for a WEF-led advocacy strategy designed to elevate public and decision-maker appreciation of the full range of

biosolids benefits. There was interest expressed to link this strategy to other organizations that may share common cause (such as the Soil Health Institute) and reach to other key partners in the agricultural community and NGO environmental and ecosystem health/sustainability communities. Participants saw both an important role for research (see research section related to biosolids benefits) and communications (see communication section related to biosolids benefits communications initiatives).

6. **Next Generation of Management Options and Addressing Market Pressures.** Participants signaled the importance of maintaining (and enhancing) a forward-looking agenda that will keep biosolids management innovation moving forward. Several ideas were shared in support of maintaining emphasis on innovation: leveraging the LIFT program to find and catalogue emergent technologies and practices, as well as advocate for advanced technology funding in such contexts as the SRF, Farm Bill, DOE, and private equity; considering formation of an urban utilities subgroup to focus on making connections between biosolids and community resiliency (including the relationship to green stormwater infrastructure, high-rate treatment, and remediation efforts); and making a connection between advanced biosolids management technologies and addressing climate concerns (e.g., energy and resource recovery).

Communications Needs

Participants discussed the need for a significant shift in approach to communicating with the public about biosolids. The discussion focused on the most pressing communication deficiencies hindering the success of biosolids programs today, as well as what key messages should be communicated and the actions that might be explored to evolve the state of biosolids messaging. A table of the identified areas for communications improvement, and proposed actions, is included in Attachment B. General descriptions of the gaps and suggestions are provided below.

- **Elevate public understanding of the complete benefits profile of biosolids.** To address this need, meeting participants suggested that biosolids practitioners should establish a foundation of trust with the public to spread a positive story about the role biosolids can play as a pillar of sustainability in a green economy. Actions should include building a beneficial relationship with the media, communicating with the public about the urgency of doing something with biosolids and the benefits of land application, and conducting demonstration projects.
- **Improve overall communication with the public about biosolids.** Meeting attendees expressed that facilities need to engage in much more robust relationship-building with the public, including school tours and outreach to municipal associations. They also focused on the need for biosolids communications to embrace social media (e.g., Facebook, Instagram, podcasts, video success stories and testimonials, etc.) as a part of public communications strategies to effectively tell the story of biosolids benefits to a broad audience.
- **Targeted communications to key constituency groups.** Farmers and agricultural groups, sustainability and green solution advocates, and environmental advocates are all potential partners for biosolids practitioners. While some within these groups have recently expressed concerns about biosolids, there is potential to share key information related to the full range of sustainability benefits provided by biosolids. This information can position biosolids within these key advocacy communities as a pillar of and critical to achieving sustainability and circular economy aspirations.
- **Elevate understanding of the relative risks of CECs.** Meeting attendees expressed a significant need to improve the understanding among the media, the general public, and elected officials of the relative risk of

CECs compared to background levels and in different exposure pathways. To meet this need, meeting participants suggested that wastewater facilities could engage in communications efforts to educate and persuade the public of the benefits of biosolids, such as video testimonials, social media campaigns, and podcasts. Focus groups could help pinpoint the most effective messages and tactics for conveying this understanding to the public.

- **Equip facilities with resources to establish positive communication channels and respond to negative stories and events.** Participants shared ideas for how facilities, especially small ones, might best be supported in their need to better communicate about biosolids application, including sharing benefits and responding to negative stories. Ideas included establishing a national-level champion to promote the benefits of biosolids and be available for communication when needs arise; establish regional and state organizations (such as the Northeast Biosolids and Residuals Association) where they don't already exist to provide regionally tailored communications support; establishing a technical expert in each region who can be deployed to communicate with the public or elected officials; and cultivating knowledge among all staff at a facility to speak about the benefits of biosolids.
- **Improve communication among the states and between states and EPA.** Participants suggested that there should be more meetings and webinars where EPA and states can communicate and coordinate about what actions should be taken.

Research Needs

Meeting participants discussed the key categories in which there are important gaps in established research on biosolids, including around CECs, nutrients, new technologies, and other areas. Additionally, participants acknowledged a deficiency in communicating the results of research which has already been conducted, which could assist in addressing gaps. Group discussion included a focus on the gaps and weaknesses in current biosolids-related research capacity. Within the categories of suggested research focus, discussions addressed the specific research questions that need to be answered. Participants also made observations about the context for research and how that can shift. A list of the identified research areas and associated research questions is included in Attachment C. A general description of the specific research needs is provided below.

- **CECs.** Meeting participants signaled support for research on PFAS-focused questions, including toxicity, fate and exposure, and relative risk in biosolids. They expressed that there is a need for development of a standard research and assessment process for CECs that can be used both now and in the future for other chemicals that emerge into public attention. Questions in need of scientific exploration include the plant uptake of CECs from biosolids, effects of long-term storage, accumulation in cattle that graze on biosolids-applied land, and the composition of incinerator stack emissions from combustion of biosolids, especially with respect to PFAS.
- **Benefits of biosolids.** Attendees said that there is a need for research into the benefits of biosolids. Specific areas of inquiry include the amount of carbon sequestration that biosolids provide; comparison of the carbon footprint of biosolids vs. commercial fertilizers; crop yield benefits from biosolids-treated land; whether biosolids-grown crops show increased drought resistance; and benefits of biosolids on an ecosystem scale.
- **Nutrients.** Meeting participants discussed research questions around nutrients, including identifying the comparative contribution of different nutrient sources of algal blooms; the role biosolids may play in sustainable phosphorus conversion; and the micronutrient makeup of biosolids.

- **Emerging technologies.** Participants signaled an interest in more research into the benefits of hydrothermal liquefaction; a more complete understanding of pyrolysis and gasification technologies; and the benefits of phosphorus extraction. Participants expressed support for a process that would bring new technologies to market more quickly, suggesting there might be a way for WEF or others to identify new markets and help foster their development.
- **Co-Digestion**. Meeting participants expressed interest in research to answer the question of how to optimize co-digestion to increase biogas production through balancing proportions of components. Other areas of inquiry include the impact that co-digestion may have on effluent discharge; and the possibility of developing better co-digestion models. Of critical importance is to ensure the existence of markets for the use of increased biogas and biosolids production, and the climate benefits of co-digestion of diverted organic waste.
- **Odors**. Meeting participants expressed a need for more research into biosolids odors. Specific areas of inquiry include how we can reduce odors, determining odors from new technologies and better understanding odors from existing technologies, and determining the effect of odor-reducing products on biosolids' efficacy and quality.
- **Social and Communications Research**. Meeting participants signaled support for research into "social science" around biosolids; i.e., communications and public relations research into effective communications strategies. Focus groups could help determine the best way to tell the story of biosolids.

Key Elements for Action: Elements of a Biosolids Agenda

Asked to look across the programmatic, communications, and research discussion areas during the last session of the convening, participants brainstormed what they saw as key elements for building out an overall biosolids action agenda. Nine areas for focused attention bubbled to the top during these discussions.

1. Establish an Empowered Steering Committee and Biosolids Champion –participants saw the need to assign resources and drive industry leadership towards a strong, focused, high-profile, and ongoing advocacy that could take the form of a steering committee with representatives from WEF, NACWA, and WRF and a full-time Biosolids Champion to lead and coordinate efforts. The Steering Committee could be chaired by WEF and comprised of an empowered Board member or volunteer from each organization to ensure that each organization provides the maximum benefit according to their strengths and business interests. Also in this context, participants discussed enhancing collaboration among existing biosolids-related groups (e.g., RBC, 4170, etc.) to better leverage knowledge and expand influence.
2. Creating a Research Plan for CECs – participants viewed CECs as a substantial vulnerability to biosolids management options and signaled a need for a research agenda focused on risk assessment protocols, the ability to speak to the comparative risk aspects of CECs in biosolids, and treatment process options.
3. Developing CEC Communication Materials – as a direct corollary to the research plan for CECs, participants saw an urgent need for CEC communication materials focused on improved risk communication (including comparative risk), as well as indicating the current and anticipated progress on CEC research.
4. Enhancing Benefits of Biosolids Communications – participants believed conducting additional research on the full range of biosolids benefits then communicating those in the context of community sustainability and the circular/green economy can substantially elevate public and decision-maker appreciation of the

value of biosolids. This area of discussion included the interest in engaging in social science research to better understand how best to reach and communicate with a full range of community interests.

5. Building Broader Partnerships – expanding on the need for greater and more effective biosolids advocacy efforts, participants signaled a need for building new or stronger partnerships with key constituencies including community sustainability/green economy advocates, agricultural leaders (e.g., American Farm Bureau), soil health proponents, and environmental NGOs.
6. Re-invigorating the ABC Biosolids Operator Land Application Certification Initiative – with the importance of well-run biosolids programs recognized by participants as a cornerstone of public credibility and acceptance, interest was expressed in drawing on past efforts by ABC to provide a basis for operator certification.
7. Engaging LIFT to Move a Next Generation Agenda Forward – in response to interest in maintaining a focus on biosolids management process and technology innovation, participants saw a role for the LIFT program to coordinate with other established biosolids groups (e.g., RBC) to prepare and advance an innovation agenda.
8. Defining a Sustainable Program – participants believed an opportunity exists to leverage existing materials (such as those created for the National Biosolids Partnership) to define and communicate what the elements are of an effective and sustainable biosolids program.
9. Preparing an Advocacy Letter for Submission to EPA – participants saw a need for the preparation of a letter to EPA to 1) support its enhanced biosolids program efforts, 2) advocate for increased funding for training and coordination efforts with the states, and 3) further emphasize the need for risk assessment tools and guidance relating to CECs.

Anticipated Next Steps

At the close of the convening, WEF reviewed its anticipated next steps.

- Finalize the Convening Summary and Action Plan – anticipated steps include:
    - Develop a draft summary and action plan to be vetted by WEF and the convening planning committee (including coordination with other organizations to identify roles and responsibilities for carrying the action agenda forward) (January 2020).
    - Present Action Plan to WEF board (February 2020).
    - Unveil Action Plan and report on immediate next steps at WEF RBC (March 2020).
- Finalize WEF biosolids communications plan and continue on-going efforts (WEF).
- Organize research agenda-setting workshop (WRF).
- Provide agenda suggestions and input for upcoming EPA/State regulators meeting (WEF lead, with NACWA and CASA).
- Conduct targeted outreach to specific groups (all partners).
- Continue regular coordination meetings with WEF, NACWA, EPA, WRF, and regional organizations (WEF).

Attachment A: Program Area Needs

Meeting participants discussed needed changes to biosolids programs, including proposed actions and strategies for execution. Those ideas are summarized in the table below.

Gap/Need	Suggested Solutions to Address Need	Specific Actions
Establish significant resources and develop a biosolids leadership mechanism, e.g., empowered steering committee and visible champion	WEF, NACWA, and WRF should establish an empowered steering committee and/or a visible national champion by late March 2020.	• A steering committee should be formed, with representatives from WEF, NACWA, and WRF. A full-time Biosolids Champion should be appointed to lead and coordinate efforts. The steering committee could be chaired by WEF and comprised of an empowered Board member or volunteer from each organization to ensure that each organization provides the maximum benefit according to their strengths and business interests. • Existing biosolids-related groups (e.g., RBC, 4170, etc.) should enhance their collaboration, to better leverage knowledge and expand influence.
Elevate product and management program quality	Keep biosolids on the radar of senior management at utilities (to ensure a high quality biosolids program is established and maintained as a priority)	Individual utilities need to become more proactive about biosolids product and program quality, and WEF can provide assistance and support through identification of effective program characteristics.
	Define what a quality biosolids and sustainability program is	Develop a framework for defining biosolids quality using a market-based approach and customer focus to consider desirable characteristics.

	Certification and education (producers of biosolids, regulators, and land-appliers – three-legged stool)	ABC developed an existing certification; WEF or others could renew working to raise awareness and adoption of this certification and provide messaging about it to utilities.
	Guidance for municipal contracts	WEF's Residuals and Biosolids Committee (RBC) could establish this guidance and distribute to small utilities.
	Standard practices guidance or certification	National Biosolids Partnership could be drawn upon as a basis to develop standard practices guidance and/or the basis for program certification.
Update 503 regulations to support new operating contexts and desired intent	Improve regulations and policies for vector attraction, pathogen reduction, and nuisance	• For improved credibility, the WEF RBC could advise on polices and protocols for VAR sampling Part 3 and 4 (such as air drying). • WRF could sponsor research on VAR methods and processes. • WEF RBC could work with EPA to identify gaps in the guidance on Control of Pathogens and Vector Attractions in Sewage Sludge (a.k.a. the "White House document) including sampling and pathogen reduction • Seek input from W4170 group • New biosolids leadership should consolidate findings from the above activities and advocate to EPA for enhancements • EPA should communicate to regions and states about the new regulations and policies
	Need for greater understanding of cumulative loading of CECs.	[Refer to CECs gap/need]
	Evaluate and leverage research on CECs and determine guidance and possible regulatory changes	• WRF should conduct research. • NACWA or new biosolids leadership should advocate to EPA for enhancements. • WEF should mobilize RBC and Member Associations to assist EPA in review of the new screening model for identifying pollutants that should go on for a full risk assessment. EPA will be seeking this input in 2020.

	Evaluate and leverage research on biosolids benefits and determine program enhancements and possible regulatory changes to provide EPA support of tangible biosolids benefits	• New biosolids leadership should consolidate research findings and communications outputs to identify tangible sustainable benefits. • New biosolids leadership should consolidate biosolids risk research data and assist EPA in enhancing identification of risk management strategies.
	Support EPA implementation of risk assessment methodologies	• WEF should lead and effort through RBC to assist in the review of new risk assessment methodologies. • Seek input of W4170 committee • Consolidate findings and make recommendations to EPA.
	"Part 504 regulations": Identify process for innovative resource recovery product validation, e.g. phosphorus harvesting, biochar	• New biosolids leadership should conduct advocacy to work with EPA to identify alternative approval mechanisms. • New biosolids leadership should assign to a LIFT program, involve EPA to put together protocol that will align with existing program.
Establish a more sound science basis for, and reasoned response to, CECs.	Need for EPA guidance to the states	EPA should provide guidance to the states, as well as conducting a new Targeted National Sewage Sludge Survey (TNSSS).
	Need for review of research as it emerges	Form a CEC technical review committee, to include RBC and other relevant communities and academics: -Experts on this committee would review toxicity literature that feeds into guidance values/MCLs etc. -Academic participation in the committee will be critical. -This committee would provide a white paper on proposed thresholds to evaluate their validity, and coordinate their review with WEF and NACWA to help develop and disseminate educational materials to local, state, and federal elected officials and other stakeholders. -The committee would also be responsible for a literature review of contaminated vs. background sites, where

		other agricultural exposure are entering the food web, and ongoing identification of additional research gaps.
	Need for standardized protocol for evaluating CECs	WEF, RBC, WRF, and W4170 could all lead this effort to develop new protocol for evaluating CECs. The protocol for the California expert panel on CECs may have use for these protocols.
	State-by-state monitoring of legislation with strategy for coordinated response and collaborative assistance	Regional associations, such as NEBRA, could pursue this to a greater extent than they currently are doing.
	Monitor liability-related developments and formulate defensive strategy to protect municipalities	Regional associations can conduct regular reviews of these developments and communicate about them.
	Need for proactive approach to communications around CECs, with a potential emphasis on extended producer responsibility	WEF could develop a policy statement about keeping persistent compounds out of non-essential products.
	Need for additional research on CECs	Research could be conducted as part of W4170 on the fate and transport of PFAS under real-world land application conditions, including sampling across multiple matrices (e.g., groundwater, soils, porewater, tile drainage, storm runoff, and crop uptake).
Bolster oversight and technical assistance capabilities and capacities	Need for self-regulation/oversight at the level of individual biosolids producers to improve standards and quality of products and of land application	EPA should recommend that all biosolids generators have an operator in responsible charge (ORC) who is responsible for the biosolids program and is trained in land application; WEF can recommend that EPA include this as an agenda item in spring 2020 meeting with the states.
	Need for reinvestment into EPA staffing and training, including inspector training	WEF can recommend that EPA include this as an agenda item in spring meeting with states.

	Standardized training templates that can be used across the U.S.	WEF can recommend that EPA include this as an agenda item in spring meeting with states.
	Need for contract oversight and for reinvestment in triple-bottom line approach to improve quality of product and of land application	Biosolids programs could require training and certification for land appliers and producers and create criteria for contractors to pre-qualify to be considered prior to bidding. Facilities should train new practitioners on new technology, nutrient management, and the benefits of biosolids. WEF could create standardized templates for use in establishing these pre-qualification criteria, which states could modify for their circumstances.
	Networking and communication	A national biosolids champion can help with identifying key biosolids groups in each state and improving their communication with each other; one tactic could be a one-stop clearinghouse of information and shared resources like research and training opportunities.
Elevate societal acceptance and endorsement of biosolids as a valuable resource	Need for a multifaceted education campaign that conveys the value of biosolids to the public	A multifaceted education campaign should be headed by WEF and supported by a dedicated full-time staff person. This could include a "Soil Week" or "Carbon Week" in collaboration with organizations like the Soil Health Institute to spread awareness of the benefits of biosolids. WEF may be able to become a member of the Soil Health Institute.
	Need for communications guidance for utilities, especially smaller facilities	-WEF has existing vehicles that could be leveraged to create communications guidance to highlight successes, case studies, and lessons learned from unsuccessful cases. WRF could assist with this, and RBAs could help utilities implement it. -A communications protocol for outward-facing programs could be written in to

		contractors' contracts; WEF could lead the creation of a protocol.
	Social science and communications research is needed to develop and test key messages	WRF could conduct social science research on the effectiveness of biosolids messaging ideas.
Next generation of management options and market pressures	Need for a clearinghouse of emerging technologies where people can access information about emerging and nontraditional approaches	WEF could establish a public-facing clearinghouse for resources and information.
	Need to explore funding options to advance technology	-SRF, DOE and the Farm Bill are potential new sources of funding. LIFT could take a lead role to explore these. -Private equity is another potential source of funding for advancing technology.
	Need for coordination among urban utilities, which have similar challenges with both resiliency and funding	RBC or a WEF committee could conduct a deep dive into urban use and discussions around resiliency funding and convene an urban utilities subgroup. LIFT also could play a supporting role to this item.
	Need to continue to conduct research to evaluate new technologies	WRF can conduct research to evaluate new technologies.
	Need for research into technologies that tap into climate considerations, including energy and resource recovery	WRF can conduct research into climate-related technologies.

Attachment B: Communications Needs

Meeting participants discussed needed changes to biosolids communications, including proposed actions and strategies for execution. Those ideas are summarized in the table below.

Gap/Need	Suggested Actions to Address Need
Elevate public understanding of the complete benefits profile of biosolids to embed it as a pillar in the progressive sustainability green economy narrative.	Establish a foundation of trust with the public, tapping into "trusted advisers," i.e., people the community trusts for information. Tap into agricultural extension services to help lead this effort.
	Enlist professional communications expertise on the following: • Communications/PR firms • Focus groups • How to target messaging • Partner with other organizations e.g., biogas to conduct PR work • Funding
	Build a positive relationship with the media: Share positive stories regularly, even if focused on other facilities than your own.
	Create public-facing appealing, accessible, understandable, and compelling communications pieces. Modernize communications tools: • Videos • Podcasts • Social media • Infographics • Website (easily findable, accessible, understandable) • Improve municipalities' websites
	Communicate urgency/the costs of not doing land application, especially to regulators and policy-makers.
	Demonstration projects: • Gardens at treatment facilities or at schools • Guidance from WEF on how to do a demo project • Communications (e.g., videos) to promote the projects

	• Develop cost matrix for disposal/reuse options
General improved communication to the public about biosolids	Outreach to municipal associations, e.g., mayors' conference.
	Utilize a symbol akin to Smokey the Bear to publicize and grab public attention.
	Coordinate responses to the media.
	Communicate the positive story of both wastewater treatment generally and biosolids specifically with the public: • K-12 tours • Develop a curriculum to share with schools • Farmers markets • State Fairs • Video testimonials of success stories
Target communications to key constituency groups: • Farmers and agricultural groups • Sustainability and green solution advocates • Environmental advocates	Conduct targeted outreach to farmers and agricultural associations, including to youth organizations like 4H and Future Farmers of America, and share success stories of farmers who have used biosolids.
	Communicate with environmental and other "concerned" groups and build relationships with them; offer them tours of wastewater facilities; tell them the positive story of biosolids.
	Learn how to target messages to specific audiences; understand the drivers for each group.
Elevate understanding of the relative risk around CECs (background levels, industrial sites, biosolids all present very different risks; the need is to improve public understanding of the distinction between exposure paths).	Communicate risk assessment and relative risk to help people understand the multiple ways they are exposed to CECs and the difference in risk from one exposure path versus another; background levels.
	Promote and communicate existing research.
Need to equip utilities (especially smaller facilities) with the resources to establish positive communication channels and respond to negative stories and events	Establish regional and state organizations (for those that lack them).
	Appoint a national-level biosolids champion.
	Resources that small utilities can access when negative publicity occurs.

	Establish a technical expert in each region who can be deployed as needed.
	Cultivate everyone in the organization to be an advocate internally.
Improve communication among states and between states and EPA	Convene state-EPA meetings and webinars, in addition to regular communication.
	Promote regular dialogue about effective strategies across all gaps and needs between states and with EPA.

Attachment C: Research Needs

Meeting participants discussed areas of inquiry that would be helpful topics for scientific research into biosolids, as well as observations about the context for research and needed shifts. Those ideas are summarized in the table below.

Area of Research	Specific Research Needs and Questions

CECs	• PFAS:
	  ○ Toxicity
	  ○ Fate and exposure, including temperatures and conditions at which it degrades and what it degrades into.
	  ○ There is a need for definitive analytical methods.
	• Development of a research process that can be used for the next chemical "du jour" so there is a standard protocol in place and ready to implement when a new concern emerges. EPA is beginning this with its risk assessment work.
	• Develop indicator compounds for CECs.
	• Research on exposure under real world conditions in the field.
	• Relative risk of CECs in biosolids versus background levels and other exposure pathways.
	• To what extent are CECs present in combined sewage overflows (CSOs) vs. sanitary sewer overflows (SSOs)?
	• Research into the plant uptake rate of CECs.
	• Finding out the extent to which CECs adhere to soil.
	• Research on CEC sources of exposure, and ways to control those sources .
	• What are the effects of long-term storage treatment?
	• Is there CEC accumulation in the meat of cattle fed on crops grown with biosolids?
	• What is the composition of stack emissions from incineration of biosolids containing CECs?

Benefits of Biosolids	• How much carbon sequestration does biosolids land application provide?
	  ○ What is the fate of land applied carbon in regional (i.e., varied) soils?
	  ○ Is there a way to optimize carbon sequestration?
	• There is a need for research comparing biosolids to fossil fuel-based fertilizers, including:
	  ○ Carbon footprint
	  ○ Biogenic carbon release
	• Updated crop yield benefits, including work to be done on test plots at utilities.
	• Is there a reduction in chemical use when producing commercial fertilizers versus biosolids?
	• Do biosolids-grown crops show drought resistance?
	• What is the role of biosolids in the circular economy?
	• Are there synergies with biosolids and green infrastructure?
	• What is the benefit of organic matter related to conditions such as soil health and erosion?
	• Need for research into engineered soils using biosolids.
	• Is there any effect on the benefits of biosolids in the context of no-tilled vs. low-tilled land?

	• What are the benefits of biosolids to the entire ecosystem?
Nutrients	• Can we identify the sources of algal blooms, whether biosolids or something else? • Can we manipulate the end nitrogen and phosphorus values in biosolids through creating "designer" biosolids products? • What role do biosolids have in the sustainable phosphorus conversation? • Research should be done into a life cycle analysis of phosphorus extraction from biosolids versus mining. • What is the micronutrient makeup in biosolids beyond nitrogen and phosphorus? Can we quantify the nutrients in biosolids better?
Emerging Technologies	• More research on the benefits/efficacy of hydrothermal liquefaction. Are there enough end users to support this technology? • How can new technologies be brought to market faster? Is there a way to identify new markets and develop new ones? • What size do new technologies need to be to be economically sustainable? • There is a need for research into SCWO, pyrolysis, and gasification to fully understand these technologies. • Research should be done to explore whether it is possible to utilize existing technologies to retrofit with new technologies, rather than needing to develop entirely new technologies. • Research should be done into NEREDA (granular sludge). Does it work? What impact does it have on solids? • More work on phosphorus extraction and the efficacy of these technologies.
Co-Digestion	• Is there a way to optimize the feedstocks/proportions co-digested with biosolids to increase biogas production (e.g., food waste, slaughter house waste, FOG, zoo waste, etc.)? • Determine a baseline biogas value for wastes to help with RIN issue. • What impact does co-digestion have on effluent discharge? • Co-digestion and ammonia toxicity. • Is there a way to develop better co-digestion models?
Odors	• How can odors be reduced, and through what processes? • Determine odors from new technologies and better understand odors from existing technologies. • Develop new VAR methods. • What is the effect of odor reducing products on biosolids efficacy and quality? • What odors are coming from various types of biosolids?
Communications Research	• How can we reach the "persuadable" audience? • What drives "anti-biosolids" opinions? What drives "pro-biosolids" opinions? • How to convince people they "need" biosolids versus just talking about the benefits.

Attachment D: Potential Biosolids Leadership Model

Meeting participants discussed the need for proactive and coordinated national leadership on biosolids. A possible model for this leadership structure is depicted in the illustration below.