BOSC

BOARD OF SCIENTIFIC COUNSELORS

October 12, 2021

Wayne E. Cascio, MD
Acting Principal Deputy Assistant Administrator for Science
Office of Research and Development
U.S. Environmental Protection Agency

Dear Dr. Cascio:

On behalf of the Board of Scientific Counselors (BOSC), I am pleased to provide you a review report addressing charge questions posed by two of the Office of Research and Development's (ORD) six National Research Programs.

The BOSC was reconstituted in 2017 with an Executive Committee and five subcommittees aligned with each of the National Research Programs (part of the Health and Environmental Risk Assessment program is reviewed in conjunction with the Chemical Safety for Sustainability program). Three of the subcommittees, Chemical Safety for Sustainability and Health and Environmental Risk Assessment, Air and Energy, and Sustainable and Healthy Communities, met in May–June 2021 culminating in an Executive Committee meeting in September 2021. This report represents the cumulative effort of the subcommittees and the Executive Committee.

We anticipate that this report will assist ORD in evaluating the strength and relevance of these two research programs and aid in guiding further course adjustments to each program. We will be happy to provide any additional information concerning the review or answers to any questions you may have, and we look forward to working with you in the future on these programs.

Sincerely,

Paul Gilman, Ph.D.
Chair, BOSC

Lucinda Johnson, Ph.D.
Vice Chair, BOSC

Cc: Bruce Rodan, Associate Director for Science

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BOARD OF SCIENTIFIC COUNSELORS

REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAMS

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EPA Contact
Tom Tracy, Designated Federal Officer

September 20, 2021

A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development

CONTENTS

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BOARD OF SCIENTIFIC COUNSELORS

REVIEW OF U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT'S RESEARCH PROGRAM

BOSC Homeland Security Subcommittee

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EPA Contact
Tom Tracy, Designated Federal Officer

September 16, 2021

A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development

CONTENTS

LIST OF ACRONYMS

AI	artificial intelligence
AnCOR	Analysis for Coastal Operational Resiliency
API	application programming interface
AWS	Amazon Web Services
BOSC	EPA Board of Scientific Counselors
COTS	commercial off-the-shelf
COVID-19	Coronavirus Disease 2019
CBRN	chemical, biological, radiological, and nuclear
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESER	EPA Center for Environmental Solutions and Emergency Response
DWMM	disaster waste and materials management
EPA	U.S. Environmental Protection Agency
ESAM	Environmental Sampling and Analytical Methods
ESF-10	Emergency Support Function #10
GIS	Geographic Information System
HEART	Homeland Security Emergency Action and Research Times
HSRP	EPA Homeland Security Research Program
IAFC	International Association of Fire Chiefs
NASTTPO	National Association of SARA Title III Program Officials
NIMBY	Not in My Back Yard
NRF	National Response Framework
ORD	EPA Office of Research and Development
OSC	on-scene coordinator
RADAR	RemediAtion Data Repository
RCRA	Resource Conservation and Recovery Act
SBIR	Small Business Innovation Research
SERF	Stormwater Emergency Response Framework
STAR	Science to Achieve Results
StRAP	Strategic Research Action Plan
SWMM	Storm Water Management Model
TOTS	Trade Off Tool for Sampling

INTRODUCTION

The U.S. Environmental Protection Agency's (EPA's) Homeland Security Research Program (HSRP) addresses science gaps related to remediation of environmental contamination that threatens public health and welfare, as well as science gaps related to environmental quality before, during, and after a disaster. HSRP helps EPA carry out its homeland security and emergency response mission by working closely with its partners to understand the potential threats and consequences of hazardous substance, oil, and chemical, biological, radiological, and nuclear (CBRN) releases. HSRP coordinates with partners and stakeholders to conduct the research necessary to provide decision makers with the information they need for their communities and environments to rapidly recover after a disaster.

HSRP is focused on addressing two primary research objectives:

- Advance EPA capabilities to respond to wide-area contamination incidents; and
- Improve the ability of water utilities to prevent, prepare for, and respond to water contamination that threatens public health.

Research to address HSRP partner needs is organized into seven research areas. The research areas are descriptive of the program and align with EPA's response decisions supporting recovery under the National Response Framework (NRF), specifically with respect to EPA's lead role under Emergency Support Function #10 - Oil and Hazardous Materials Response Annex (ESF-10). EPA can also respond, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Oil Pollution Act authorities as appropriate. These response decisions are highly interdependent, with one decision impacting other decisions. The research areas are designed to reflect and support this interdependent system of activities through coordination across the program in support of HSRP's objectives.

HSRP research areas are: (1) Contaminant Fate, Transport, and Exposure, (2) Contaminant Detection/Environmental Sampling and Analysis, (3) Wide-Area Decontamination, (4) Water Treatment and Infrastructure Decontamination, (5) Oil Spill Response, (6) Waste Management, and (7) Tools to Support Systems-based Decision-Making.

The Board of Scientific Counselors (BOSC) Homeland Security (HS) Subcommittee reviewed HSRP program planning in 2019, through its Strategic Research Action Plan (StRAP). The BOSC HS Subcommittee is now charged to review program implementation under each of the research areas. The previous BOSC HS Subcommittee implementation review in 2020 was focused on two research areas: Research Area 4 - Water Treatment Infrastructure Decontamination and Research Area 5 - Oil Spill Response. The focus of the current BOSC review is on research implementation to support wide area incident response, to enhance and inform capabilities for response and remediation of areas contaminated by acute incidents, such as natural disasters or acts of terrorism.

CHARGE QUESTIONS AND CONTEXT

The HS Subcommittee was charged with addressing a series of questions about research implementation to support wide area incident response, focused on Research Areas 1, 2, 3, 6, and 7. Charge questions were as follows:

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee have on balancing/enhancing the use of widely available capabilities with the incorporation of innovative new approaches and technologies to address HS priority sampling and analysis needs?

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee have with respect to ensuring that the decontamination capabilities developed by the program contribute to reliable and field-usable decontamination capabilities, balancing specialized technologies with commercial off the shelf (COTS) equipment?

Q.3. What suggestion(s) or recommendation(s) does the Subcommittee have on the current and planned direction of HSRP's research to provide products that contribute to reliable and field-usable capabilities for waste management in responding to HS incidents and other disasters (hurricanes, wildland fires, tornadoes, etc.)?

Q.4. What suggestion(s) or recommendation(s) does the Subcommittee have on the current and planned direction of HSRP's research to provide products that contribute to reliable and field-usable integrated decision-support tools and ensure applicability to economically, socially, or environmentally disadvantaged communities?

The responses of the HS Subcommittee to the charge questions are provided in the following section.

SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Charge Question 1

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee have on balancing/enhancing the use of widely available capabilities with the incorporation of innovative new approaches and technologies to address HS priority sampling and analysis needs?

Narrative

The HS Subcommittee recognized the importance of finding or optimizing the balance between sampling and analysis approaches and technologies based on widely available materials/methods and more innovative solutions, but also recognized that unguided "balance" can be subjective or misdirected, or if balance was the primary objective, not the effectiveness of a solution, non-optimal solutions might be selected by pursuing balance. The Subcommittee elected to address the more fundamental question raised by Charge Question 1: "What process and what considerations should be used to arrive sampling and analysis solutions that optimize the balance between use of available and innovative approaches in the context of specific solution requirements and available resources?"

HSRP has a strong program for engaging partners to define research and development needs in the sampling and analysis area. However, the Subcommittee found that the approach for making decisions about how solutions are selected, specifically how choices that balance available and innovated methods are made, is not clear. This limitation is reflected in the charge question itself, which asks how best to balance use of widely available and more innovative solutions, instead of asking the more relevant question, "which solutions offer the ideal balance between meeting specific requirements for a solution, and the cost and time available to develop the solution?" More specifically, the EPA PARTNER Process

appropriately engages partners/users to identify needs and the general gap between the intended future state and the current state required to meet the need. What appears to be missing is a clearly articulated, structured analysis that matches a carefully developed list of requirements for a solution, e.g., sampling criteria, analytical criteria, environmental robustness, or applicability, against potential solutions from an array that includes widely available materials/methods and those requiring research and development. Such an analysis is the optimal approach to determine and justify what the ideal balance is between widely available solutions and more innovative approaches that may require resources not available to EPA or require a timeline unsupportable by the current HSRP planning cycle.

Strengths

- EPA's research focus has been on developing practical (field deployable, fit to purpose, Geographic Information System, or GIS integration, leverages existing COTS) response tools as needed. This is mission appropriate and effective. Innovation is employed when needs gaps are identified that require research to overcome.
- EPA has developed a set of impressive, practical, and useful tools (Environmental Sampling and Analytical Methods, or ESAM, Trade Off Tool for Sampling, or TOTS, etc.). These tools were originally innovative but have now progressed, through various enhancements, to widely available capabilities. Widely available capabilities are the goal of research programs. For example, ESAM provides one-stop shopping for sampling and analysis, and to date there have been over 191,000 page views, and 160 countries are using this resource.
- EPA tool enhancements include elements that will help with the management of real events (implementation costs, sample site GIS, etc.).
- EPA leverages existing commercially available platforms to build new tools (virtual reality game engine framework for sample collection training application) in a cost effective and more timely manner.
- EPA has demonstrated a strong ability to effectively respond to emergencies or emerging issues (anthrax, Ebola, Coronavirus Disease 2019, or COVID-19, fentanyl, etc.).
- EPA has a strong, resourceful an entrepreneurial research staff that continue to develop beneficial tools and information, despite significant limitations imposed by COVID-19.

Suggestions

- Detail barriers (non-monetary) to innovation and rapid deployment (especially this) and briefing EPA's Office of Research and Development (ORD) leadership or engaging them in a solution. The Subcommittee heard about slow adoption of drones, of new software, etc. What other barriers are there, and what is the opportunity cost to partners if these issues are not addressed?
- Assess the completeness, timeliness, and effectiveness of HSRP's approach to identifying COTS and other technologies (U.S. Department of Defense, U.S. Department of Homeland Security, or DHS, industry) and what could improve the approach, e.g., a network of experts to engage and consult with.
- Assess the effectiveness of processes in place for moving innovations from development to field use. For example, what is that process for rapidly operationalizing something in a real-time emergency response scenario?
- Evaluate how effectively HSRP builds first responder familiarity with the sampling and analysis tools and methods used in emergencies. Determine if there is a need for EPA to enhance its efforts in this area, initially via key professional associations and its large members (cities, utilities, waste management companies, regulators).

Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

Recommendation 1.1: Engage critical end user professional associations* to both increase awareness of capabilities and inform the balance between off-the-shelf and more innovative solutions based on field needs and requirements defined by responders. This could involve:

- Initial research planning including goal development and project
- Ongoing research (peer review - Project Advisory Committee)
- Tool and information outreach

*Professional associations might include **water** (American Water Works Association), **wastewater** (Water Environment Federation), **mass transit** (American Public Transportation Association), **landfill operators** (Solid Waste Association of North America), laboratories (Association of Public Health Laboratories or American Council of Independent Laboratories), and others (State Emergency Response Commissions and Local Emergency Response Personnel).

EPA Response: HSRP has a dedicated stakeholder engagement working group that develops yearly plans to increase interactions with key state, local, and tribal partners including Environmental Council of the States (ECOS), Environmental Research Institute of the States (ERIS), Association of Public Health Laboratories (APHL), American Water Works Association (AWWA), National Association of County and City Health Officials (NACCHO), Association of State And Territorial Solid Waste Management Officials (ASTSWMO), Tribal Waste and Response (TWAR) steering committee, and others. We will continue to engage these and expand outreach to other identified organizations.

Recommendation 1.2: Develop and articulate a formal process for a structured analysis to select solutions with the greatest impact in the context of available resources (time, funding) based on a comparison of a prioritized list of performance requirements for a solution (e.g., sampling criteria, analytical criteria, environmental robustness or applicability), against an array of potential solutions that includes widely available materials/methods and those requiring research and development. Identify barriers to innovation and engage leadership in finding solutions.

EPA Response: EPA appreciates this recommendation. Going forward, HSRP has completed a more thorough and improved PARTNER (Program to Align Research and Technology with the Needs of Environmental Response) *process to collect response gaps and needs and develop potential solutions for inclusion in the upcoming Strategic Research Action Plan (StRAP). These identified gaps and potential solutions will be prioritized based on impacts to partner emergency response capabilities and capacities. The PARTNER Process is comprehensive and mutli-staged, engaging our Program and Regional Office Partners in each stage including threat prioritization, scenario development, capability gap identification, development of research needs, and identification of research activities to address those needs.*

Charge Question 2

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee have with respect to ensuring that the decontamination capabilities developed by the program contribute to reliable

and field-usable decontamination capabilities, balancing specialized technologies with commercial off the shelf (COTS) equipment?

Narrative

HSRP has made significant strides in meeting its mission to provide accurate, timely, and value-added solutions to stakeholders. Their dedication to developing off-the-shelf products and modifying their application for use in decontamination from the bench-scale to field-scale is notable.

Strengths

- HSRP has conducted exemplary work developing data, products, and tools for responders using COTS. HSRP publishes an informative online magazine documenting these tools for regions and program offices, the Homeland Security Emergency Action and Research Times (HEART).
- HSRP has developed significant technical applications, such as the Decontamination Selection Tool and Stormwater Emergency Response Framework (SERF), providing value for planning, and increasing public capacity to conduct self-rescue and self-decontamination. These efforts are critical to ensure the provision of appropriate guidance for the use of appropriate existing tools and methods.
- The Subcommittee recognizes HSRP's strong record of effectively conducting operational research and implementing practical solutions, and is impressed with the extent to which HSRP dedicates resources to leveraging partnerships such as the Idaho National Laboratory to examine material variability.
- Considerable progress has been made to ensure HSRP research associates gain field-level experience through participation in actual responses in support of the EPA Center for Environmental Solutions and Emergency Response (CESER) mission. Further, this field-level experience provides a vehicle to ascertain impressions of solution effectiveness from stakeholders.
- Successful stakeholder capacity-building efforts in the field of emergency management have been made through utilizing stakeholders to train their peers (train-the-trainer). Consideration should be given to using similar peer-to-peer methods to engage stakeholders and to inform them of these useful tools and resources.
- HSRP has a strong focus on assessing customer need and developing practical solutions that are field-deployable and a good balance between research and development.
- HSRP has developed an effective method of maintaining support with deployed responses. HSRP should ensure this effective method of communication and provision of support so accurate response plan development continues.

Suggestions

- Successful efforts have been made in the emergency response community through utilizing stakeholders to train a broad and diverse population of stakeholders (train-the-trainer). HSRP should consider utilizing peer-training (train-the-trainer) for stakeholders to train a broad and diverse population of additional stakeholders, including vulnerable and marginalized populations, and to inform them of tools and resources developed for informed decision-making during emergency response.
- HSRP has a strong record of effectively conducting research from the bench-scale to pilot-scale and ultimately to field-scale. While all research is conducted within the certain constraints, consideration should be given to leveraging partnerships with other public and private entities to scale-up projects, widening test variables such as material variation, environmental conditions, and other conditions.

- There are recognized similarities between various decontamination methods, including the commonalities among some pesticides and certain chemical warfare agents. HSRP should consider leveraging decontamination studies of common pesticide contamination to inform on decontamination methods for chemical warfare agents.
- HSRP should continue partner engagement and publication and dissemination of methods and planning models. They should continue to focus on innovation that seeks to use COTS creatively or research integration of COTS for new purposes.

Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

Recommendation 2.1: Develop a complimentary social science research program that produces data, analyses, and knowledge that can be used to assess and improve the field effectiveness of HRSP-produced decontamination capabilities by understanding the critical role community members play in implementation. Among many others, this might include studying the public's willingness and ability to purchase off-the-shelf products from offers in their community.

EPA Response: EPA has received and appreciates the BOSC input regarding the importance of social sciences across its research portfolio. For HSRP, this recommendation will be addressed in a newly established Research Area in the StRAP (Research Area 8: Communities, Resilience, and Remediation).

Recommendation 2.2: Provide additional resources and supporting research to bolster the public's ability to perform self-rescue and self-decontamination, ensuring inclusion of vulnerable and marginalized populations. During a community-scale disaster, these efforts could result in lives saved.

EPA Response: Consistent with this BOSC recommendation, the current HSRP's partners have identified risk reduction measures (self-help or private party guidance) as a capability gap needing research support. This will continue to be addressed in the next StRAP by developing associated research efforts, with emphasis on vulnerable populations, in a collaborative manner under the new Research Area: Communities, Resilience, and Remediation.

Recommendation 2.3: Dedicate resources to ensure information about developed tools and resources is effectively communicated to responders and the concerned public, including vulnerable and marginalized populations. HSRP has implemented the online magazine HEART, but efforts should be made to ensure this resource is effectively distributed. Communication of this information may include conference presentations (e.g., National Association of SARA Title III Program Officials, or NASTTPO, the International Association of Fire Chiefs, or IAFC, Hot Zone, etc.), public outreach, and social media outlets (see also, Recommendation 1.2).

EPA Response: HSRP continues to work on improving communication and outreach with a dedicated communication team. HSRP appreciates the recommendation and will expand outreach to the identified organizations. Also, the PARTNER process will include regular communication and solicited feedback from the partners throughout the StRAP cycle.

Charge Question 3

Q.3. What suggestion(s) or recommendation(s) does the Subcommittee have on the current and planned direction of HSRP's research to provide products that contribute to reliable and field-usable capabilities for waste management in responding to HS incidents and other disasters (hurricanes, wildland fires, tornadoes, etc.)?

Narrative

Deliberate pre-incident planning of waste management in anticipation of CBRN disasters is essential to waste minimization and safe handling. This concept is the driver of HSRP modeling, laboratory experiments, and field-scale activities related to waste management. Decontamination and waste management responses to CBRN incidents will vary with contaminant types, location, spatial distribution, and the availability of remediating resources. The decontamination approaches used dictate the types of wastes and amounts generated and how they should be handled and disposed. Waste characterization is core to all waste management activities including minimization, on-site and off-site treatment, transport, and disposal. Operationally relevant focus areas related to waste management include social science considerations related to implementation challenges, waste and materials management planning and response tools, waste treatment, and decision making.

CBRN disaster response decision making is enabled by web-based support tools. Originally, the tools were standalone solutions that addressed particular needs. HSRP is currently migrating legacy tools and databases, plus developing new ones, to https://cloud.gov/ where government agencies and stakeholders will access them through a common dashboard. User and tool access to supporting information and data will be through a new online RemediAtion Data Repository (RADAR).

Another new research area considers social issues in disaster waste and materials management (DWMM) in determining how to dispose of wastes in ways that do not further disadvantage overburdened populations. Staff are currently reviewing literature to identify relevant documents, social variables, and case studies, and holding interviews or focus groups to identify DWMM decision points and conflicts for different waste streams. Results are expected to aid state and local capabilities in avoiding or mitigating conflicts during a response.

HSRP performs laboratory research to develop sampling, analysis, and decontamination methods, which are then field tested to determine efficacy and needed improvements. The development of waste handling methods is generally more speculative. Smaller scale incidents can be addressed with ad hoc waste management solutions such as the semi-permeable bags used in the Analysis for Coastal Operational Resiliency (AnCOR) field test; however, a truly wide area, urban incident could require new approaches not yet fully considered. For all these incidents, it will be critical to characterize the waste to inform decisions about waste transport and disposal and to evaluate the effectiveness of waste treatment. Ultimately decisions come down to distance necessary for transportation of waste and the costs associated with moving that waste from one location to another (the underlying cause of Not in My Back Yard, or NIMBY). Further, the availability of tools to manage wide-scale contamination all-hazards incidents is important, but these tools must be well integrated, supported, and updated frequently. Simulating wide-area incidents at full scale would disrupt local populations and be prohibitively expensive; therefore, HSRP is developing a virtual reality-based software tool to simulate wide-area CBR incidents to identify technology gaps, train response personnel, and evaluate alternative response strategies whenever needed. The functionality of each tool is developed between EPA principal investigators and intended end-users. In some instances, tool development and maintenance is contracted out.

Alternatively, tools are developed internally and can involve post-doctoral researchers and interns, potentially with some sharing of intellectual property.

Responding to the struggle to keep stakeholders engaged is important because waste management is not a day-to-day priority for them. There might be local concerns about accepting waste from these events. The waste management plans are developed at the local level and there could be environmental justice implications. Early and broad stakeholder engagement will elevate challenges to location usage issues and waste acceptance and even laboratory selection by developing consensus on staging, analysis, and disposal locations, prior to actual need. Stakeholders should include federal, state, and local governmental agencies plus private partners such as stadiums, hospital parking lots, park owners, etc.

The future research directions shown by HSRP point to a need for greater technical diversity among its research contributors. For example, software projects are a growing part of HSRP's portfolio and resources are limited. Advanced knowledge/skills in this area could benefit HSRP's software processes in terms quality and costs. This could be obtained from industry-leading advisors via consulting and/or BOSC membership. Additionally, competitive hiring constraints might be mitigated by looking into other hiring authorities (e.g., Title 42), partnering with commercial entities (possibly through Small Business Innovation Research, or SBIR, funding), and via academia through the EPA Science to Achieve Results (STAR) program.

Also, there are apparent knowledge gaps and opportunities in decontamination and waste management for wide-area incidents. For example, combined chemical and biological decontamination and waste volume reduction (for disposal efficiency) from some waste streams should be feasible. Knowledge from leading industrial, chemical, and mechanical engineers and scientists experienced in developing large scale combined chemical and mechanical processes in industries, e.g., mining and pulp and paper, could be transformative. Advisors could be identified through relevant professional societies.

Strengths

- Clarity of research direction and relationships to needs.
- HSRP staff gain experience and expertise in collaborations with state, federal, and foreign agencies in exercises and, invaluably, actual incidents such as Ebola, Fukushima (Japan), and the Novichok poisonings (United Kingdom).
- Integration of computer-based planning tools and databases. Migrating legacy tools and developing new tools for deployment on https://cloud.gov/ to improve access.
- Use of widely available materials and equipment to develop CBRN remediation techniques.
- Leveraging GIS and visualization technology in tools. Investigating virtual reality approaches for data visualization and training.
- Anticipatory field research that supports international concerns related to carcass disposal.
- Beginning social science research on issues such as effectively communicating with locals and getting them involved in cleanup. It is exciting for all scientists to be thinking about social science aspects.
- Use of interns and post-doctoral students to develop necessary software tools for waste management and disposal modeling and calculations.

Suggestions

- Waste management plans should consider competing uses of facilities (buildings, parking lots, roads, etc.) identified in local response plans (emergency shelters, food/water distribution, etc.).

Consideration must be given to who has the authority to designate or take control of these needed staging areas. It is important to have a pre-established incident command structure predetermined.

- Expand efforts to explore reuse or recycling of disinfected and cleaned personal protection equipment.
- Resolve barriers to accepting demolition materials at the Resource Conservation and Recovery Act (RCRA) Subtitle D facilities without testing and limiting long-term liability.
- Involve the U.S. Department of Transportation to ensure treated contaminated waste can be safely transported.
- Social consideration research needs to clarify what outcome it seeks, make a strong case for the impact, choose something specific to focus on that meets a specifically defined need, bring in social scientists who might have immediate knowledge about the research, and clearly define the product that stakeholders can and will use.
- Before the Configured Fireside Simulator is pursued any further, resolve all software licensing and use issues to ensure it can be broadly used similar to other tools HSRP has developed.
- HSRP should consider the following when establishing research priorities: methods to sample the waste such that they meet criteria (e.g., temperature, preservation, size) for laboratory acceptance for analysis; building trust and social relationships in resilience and remediation work; social impact of remediation activities; decontaminating the surfaces and media when the effectiveness might vary depending on surface characteristics and environmental conditions; potential impact to the material (especially critical equipment and high value structures) from decontamination; guiding individuals or privately hired contractors in their efforts to clean-up their properties; managing the large amount of data from wide-area cleanup; and fate and transport of biological agents in urban settings.

Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

Recommendation 3.1: Establish clear priorities for research and development of solutions for environmental cleanup challenges in wide urban settings from the large list of those challenges.

EPA Response: HSRP will continue to improve on its PARTNER process to identify response gaps and needs with clear priorities and in consultation with leadership, partners, and researchers. HSRP will develop a structured analysis method to identify prioritized solutions based on holistic assessment of performance requirements and innovation.

Recommendation 3.2: Develop early engagement plans for meeting with local stakeholders to develop staging and disposal plans for CBRN events prior to actual incidents. This will elevate challenges to location usage issues and waste acceptance and even laboratory selection by developing consensus on staging, analysis, and disposal locations, prior to actual need. Stakeholders should include federal, state, and local governmental agencies plus private partners such as stadiums, hospital parking lots, park owners, etc.

EPA Response: HSRP will continue to support EPA's program office (the Office of Resource Conservation and Recovery (ORCR)) that supports federal, state, and local governmental agencies in implementing waste management activities. HSRP will help improve local stakeholder preparation for waste staging and disposal in response to CBRN incidents.

Recommendation 3.3: Develop a set of creative solutions for meeting staffing needs, overcoming knowledge gaps for consideration in the development of the next StRAP. This might include partnerships, consultants, advisors, or unique ways of hiring or leveraging other EPA employees.

EPA Response: HSRP acknowledges the resource limitations that have generated this BOSC recommendation and will continue looking for additional expertise to meet staff needs and gaps to plan and implement the next StRAP.

Charge Question 4

Q.4. What suggestion(s) or recommendation(s) does the Subcommittee have on the current and planned direction of HSRP's research to provide products that contribute to reliable and field-usable integrated decision-support tools and ensure applicability to economically, socially, or environmentally disadvantaged communities?

Narrative

To advance the capabilities of EPA as well as state, tribal, and local partners to prepare for, respond to, and recover from incidents involving large-scale contaminated areas and water systems, HSRP/CESER has developed tools to support systems-based decision making (HSRP STRAP 2019–2022). The response community, for instance, benefits from tools and models that:

- Facilitate rapid assessment, including access to emerging technologies that enable responders to survey, detect, and monitor the event in the case of a wide-area incident;
- Provide metrics and decision support to inform decision makers readily and rapidly on appropriate technologies for characterizing or remediating environments contaminated with various CBRN agents, thus improving the timeliness of the recovery process;
- Consider the timeframes and costs (both social and economic) associated with viable remediation approaches, and maintain flexibility given the complex, dynamic, and uncertain character of a wide-area incident; and
- Enable stakeholders to assess their community environmental resilience to disaster.

Strengths

- HSRP manifests a development culture in which user input comes early and often. There is a feedback loop that gathers user comments on reliability and field usability of tools and products to drive improvements. This user-centric, continuous development culture is very positive.
    - Ex: HSRP researchers have incorporated artificial intelligence (AI) in decision-support tools in a way that respects the fact that their main customers, the on-scene coordinators (OSCs), "don't want to have a computer telling them what to do. Using it for recommendations seems more acceptable."
- HSRP has more fully adopted a social science/human factors perspective. By working systematically to understand both product end users and the broader social contexts in which they operate, HSRP is well equipped to develop decision-support tools that are behaviorally realistic, and are thus, "field usable," and that can also apply to disadvantaged communities.

  - Ex: HSRP systematically surveyed OSCs to understand the social networks in which OSCs operate so that products address the interpersonal and organizational dynamics that underlie successful cleanup (e.g., public trust).
- Over the past few years, the HS Subcommittee has witnessed a marked improvement in the software tool and product development capability in the program. Modern development methods employing up-to-date application hosting platforms deliver highly useful software, and often, 'voice of the customer' is captured to ensure that end-user feedback makes it back to those who need to hear it so the software can be continuously improved. Among notable achievements:
  - Adoption of Cloud.gov platform on Amazon Web Services (AWS): This will lend to interoperability, and more young developers will be engaged by using modern development platforms.
  - Intention to go "open source when possible" and on the advancement of AI, machine learning, neural network modeling principles.
  - Google Partnership: Tapping into wealth of technical expertise is to be encouraged further.
  - Emerging data and application programming interface (API) standards: Partner engagement should inform future developments.
  - HSRP's simulation tools capture/convey the complexity of managing low-probability, high-consequence events. These products constitute the most efficient way to plan, evaluate, and assess the response to events; they also represent the future of training first responder personnel. HSRP has successfully integrated dispersion modeling, fate and transport, and human actions (treatment, remediation, waste removal, cleanup etc.).
- AnCOR is a great example of a long-term effort from bench-to-field and of integration and partnership (e.g., EPA, DHS, U.S. Coast Guard). The full spectrum of tools and approaches comes together in a systems approach. A process of starting at that bench, and then building out to an ultimate test in the field, leads to a realistic assessment of capability, gaps, etc. The anthrax fate part of the Storm Water Management Model (SWMM) in a field study with surrogates is commendable.
- RADAR on Cloud.gov will be the single place to find tools and data. This will increase adoption and consumption of both by stakeholders, remediating a prior statement that it was difficult for end-users to find things, especially during a crisis.

Suggestions

- Incorporate the potential social costs (e.g., the disproportionate exposure of specific disadvantaged groups to potentially hazardous materials) of waste staging/storing location suitability, into the all-hazards waste logistics tool, putting environmental justice-related data alongside factors such as land use and soil types.
- Recruit more to 'build the bench.' The HSRP team is highly talented, deeply engaged, and delivers excellent and innovative research. At the same time, research opportunities might go unmet due to lack of staff. In addition, conducting future HSRP hires with diversity and inclusivity principles in mind can foster an environment conducive to innovation and ensure that the workforce is even more representative of the populations that they seek to protect.
- Break procurement logjams that prevent very talented people from simply getting the tools they need (or even scare off prospective hires). The right technologies are being used to do the science, but researchers are often hamstrung due to the lack of flexibility or appropriately modern lab and computing tools. For example: a researcher should not be forced to do AI and machine learning on an elderly, 10-year-old PC. Modern, high-performance hardware is quite inexpensive.
- Migrate legacy application development 'ways of working' to new ways and platforms. Using modern "dev platforms" and tools like Python and GitHub for code versioning and repository, etc., are exactly

what young developers would be expecting to find in a professional work environment. It will also be easier to maintain and improve application code by keeping it in a modern code repository.

- Balance automation through integration and AI with customer-driven decision making. Using it for recommendations seems more acceptable.
- Evaluate opportunities to establish a longer time horizon; the 4-year funding cycle is too short for meaningful development.

Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

Recommendation 4.1: Ensure that HSRP staff (current and future) have access to modern lab equipment, computing resources, and other technical inputs to maintain an edge in the development of reliable and field-usable integrated decision-support tools.

EPA Response: Since the last BOSC subcommittee meeting in May, the Agency's computer refresh has made significant progress. Many staff members are now equipped with more up to date computers. In addition, the Program Director will work with management to identify any bottlenecks in hardware and equipment for research.

Recommendation 4.2: Expand the universe of HSRP state/local partners beyond emergency management, public health, and water utility associations to include groups/leaders (e.g., state directors for minority health or health equity) who can provide unique insights into environmental health challenges of disadvantaged populations.

EPA Response: ORD has organized a series of Environmental Justice workshops with EPA and state/ local stakeholders to understand their EJ challenges and to inform the breadth of StRAP development. HSRP will continue to expand outreach to state, local, and tribal stakeholders beyond the usual program partners to gain further insight into the environmental health challenges of disadvantaged populations related to the HSRP portfolio.

SUMMARY LIST OF RECOMMENDATIONS

Charge Question 1: What suggestion(s) or recommendation(s) does the Subcommittee have on balancing/enhancing the use of widely available capabilities with the incorporation of innovative new approaches and technologies to address HS priority sampling and analysis needs?

- **Recommendation 1.1:** Engage critical end user professional associations* to both increase awareness of capabilities and inform the balance between off-the-shelf and more innovative solutions based on field needs and requirements defined by responders. This could involve:
    - Initial research planning including goal development and project
    - Ongoing research (peer review - Project Advisory Committee)
    - Tool and information outreach

  *Professional associations might include water (American Water Works Association), wastewater (Water Environment Federation), mass transit (American Public Transportation Association), landfill operators (Solid Waste Association of North America), laboratories (Association of Public Health Laboratories or

American Council of Independent Laboratories), and others (State Emergency Response Commissions and Local Emergency Response Personnel).

- **Recommendation 1.2:** Develop and articulate a formal process for a structured analysis to select solutions with the greatest impact in the context of available resources (time, funding) based on a comparison of a prioritized list of performance requirements for a solution (e.g., sampling criteria, analytical criteria, environmental robustness or applicability), against an array of potential solutions that includes widely available materials/methods and those requiring research and development. Identify barriers to innovation and engage leadership in finding solutions.

Charge Question 2: What suggestion(s) or recommendation(s) does the Subcommittee have with respect to ensuring that the decontamination capabilities developed by the program contribute to reliable and field-usable decontamination capabilities, balancing specialized technologies with commercial off the shelf (COTS) equipment?

- **Recommendation 2.1:** Develop a complimentary social science research program that produces data, analyses, and knowledge that can be used to assess and improve the field effectiveness of HRSP-produced decontamination capabilities by understanding the critical role community members play in implementation. Among many others, this might include studying the public's willingness and ability to purchase off-the-shelf products from offers in their community.
- **Recommendation 2.2:** Provide additional resources and supporting research to bolster the public's ability to perform self-rescue and self-decontamination, ensuring inclusion of vulnerable and marginalized populations. During a community-scale disaster, these efforts could result in lives saved.
- **Recommendation 2.3:** Dedicate resources to ensure information about developed tools and resources is effectively communicated to responders and the concerned public, including vulnerable and marginalized populations. HSRP has implemented the online magazine HEART, but efforts should be made to ensure this resource is effectively distributed. Communication of this information may include conference presentations (e.g., National Association of SARA Title III Program Officials, or NASTTPO, the International Association of Fire Chiefs, or IAFC, Hot Zone, etc.), public outreach, and social media outlets (see also, Recommendation 1.2).

Charge Question 3: What suggestion(s) or recommendation(s) does the Subcommittee have on the current and planned direction of HSRP's research to provide products that contribute to reliable and field-usable capabilities for waste management in responding to HS incidents and other disasters (hurricanes, wildland fires, tornadoes, etc.)?

- **Recommendation 3.1:** Establish clear priorities for research and development of solutions for environmental cleanup challenges in wide urban settings from the large list of those challenges.
- **Recommendation 3.2:** Develop early engagement plans for meeting with local stakeholders to develop staging and disposal plans for CBRN events prior to actual incidents. This will elevate challenges to location usage issues and waste acceptance and even laboratory selection by developing consensus on staging, analysis, and disposal locations, prior to actual need. Stakeholders should include federal, state, and local governmental agencies plus private partners such as stadiums, hospital parking lots, park owners, etc.
- **Recommendation 3.3:** Develop a set of creative solutions for meeting staffing needs, overcoming knowledge gaps for consideration in the development of the next StRAP. This might include partnerships, consultants, advisors, or unique ways of hiring or leveraging other EPA employees.

Charge Question 4: What suggestion(s) or recommendation(s) does the Subcommittee have on the current and planned direction of HSRP's research to provide products that contribute to reliable and

field-usable integrated decision-support tools and ensure applicability to economically, socially, or environmentally disadvantaged communities?

- **Recommendation 4.1:** Ensure that HSRP staff (current and future) have access to modern lab equipment, computing resources, and other technical inputs to maintain an edge in the development of reliable and field-usable integrated decision-support tools.
- **Recommendation 4.2:** Expand the universe of HSRP state/local partners beyond emergency management, public health, and water utility associations to include groups/leaders (e.g., state directors for minority health or health equity) who can provide unique insights into environmental health challenges of disadvantaged populations.

APPENDIX A: MEETING AGENDA

Monday, May 17, 2021

Time	Agenda Activity	Presenter
12:00 - 12:10	Introduction and FACA rules Welcome and Opening Remarks Introduction of BOSC HS Subcommittee Members	Tom Tracy, Designated Federal Officer Paula Olsiewski, BOSC Homeland Security (HS) Subcommittee Chair
12:10 - 12:25	ORD Welcome – 10 min CESER Welcome – 5 min	Jennifer Orme-Zavaleta, PhD ORD Principal Deputy Assistant Administrator for Science Chris Frey, PhD ORD DAA for Science Policy Greg Sayles, Director Center for Environmental Solutions and Emergency Response (CESER)
12:25 - 12:50	Homeland Security Research Program Overview	Shawn Ryan, HS National Program Director Sang Don Lee, HS Principal Assoc. NPD
12:50 - 13:10	**CQ1: Overview of Sampling and Analysis Research** ***Additional Resource:*** Sampling & Analysis Webpage	Sarah Taft, CESER
13:10 – 13:20	Break (10 min)	
Lightning session for Characterization		
13:20 - 14:45	*1-Environmental Sampling & Analytical Methods Program (ESAM) Video (Play YouTube Video by host) - 8 min* *Additional Resources:* ESAM Webpage, ESAM Webinar	*Kathy Hall*, CESER
	2-Trade-Off Tool for Sampling (PI screen share Demo) - 15 min	Tim Boe, CESER
	3-Development of Sampling and Analysis Methods for Outdoor Environments (Video in slide) - 8 min *Additional Resource: B. anthracis* Story	*Worth Calfee*, CESER
	4-Resuspension of B. anthracis Surrogates on Underground Subway Surfaces - 8 min	*John Archer*, CESER

Time	Agenda Activity	Presenter
	5-Development of Activity-Based Aggressive-Air Contained Sampling System - 8 min	*John Archer, CESER*
	6-Bio-Agent Analytical Methods Development - 8 min	*Sanjiv Shah, CESER*
	7-Bio-Sampling Training Simulator (PI screen share Video) - 15 min *Additional Resources:* Virtual Reality Story, Virtual Reality Webinar	*Tim Boe*, CESER
	8-Fentanyl Sampling and Analysis - 8 min	*Stuart Willison,* CESER
	9-Innovative Sampling Methods for HS Chemicals (Video in slide) - 8 min	*Lukas Oudejans*, CESER
14:45 - 14:55	Break (10 min)	
14:55 – 15:10	*10-Sampling and Analysis Plan Resources - 5 min*	*Erin Silvestri*, CESER
	11-Data Visualization/Management (PI screen share Demo) - 10 min	*Timothy Boe, CESER*
15:10 – 15:50	**Partners Round Table**	Larry Kaelin, EPA Office of Emergency Management (OEM) Leroy Mickelsen, EPA OEM Jim Mitchell, EPA Region 5
15:50 – 16:00	Break (10 min)	
16:00 – 17:00	Additional Q&A, Discussion, and Subcommittee Worktime	

Tuesday, May 18, 2021

Time	Agenda Activity	Presenter
13:00 - 13:15	**CQ2: Overview of Wide Area Decontamination Research** ***Additional Resource:*** *Wide-area Remediation Webpage*	Lance Brooks, CESER
	Lightning session for Decontamination	
13:15 – 13:45	Biological Decontamination 1- Soil Decontamination for Non-spore agents -10 min 2- Material compatibility of Sporicides Neutralization of Ricin Toxin - 10 min 3- Personnel Decontamination Systems - 10 min *Additional Resource:* Ricin Webinar	Worth Calfee, CESER Joe Wood, CESER John Archer, CESER
13:45 – 14:10	Chemical Decontamination 4- Personnel Chemical Decontamination Line Options for the Responder – 5 min 5- Surface Decontamination Methods for Pesticides – 5 min 6- Decontamination of persistent Chemical Warfare Agents & DeconST (PI screen share for demo) – 15 min *Additional Resources:* Pesticide Story, CWA Webinar, Fentanyl Story, DeconST Webinar	John Archer, CESER Lukas Oudejans, CESER

Time	Agenda Activity	Presenter
14:10 – 14:40	Radiological Decontamination 5- Integrated Wash-down, Treatment, and Emergency Reuse System (IWATERS) - 10 min 6- Roofing Material Decontamination - 10 min 7- Integrated Rad Remediation Decision Support - 10 min	Matthew Magnuson, CESER Kathy Hall, CESER Tim Boe, CESER
	Break (15 min)	
14:40 – 15:10	8- Stormwater & Washdown Research -15 min (PI screen share for videos) 9- Supporting CBRN Cleanup Decisions -15 min (PI screen share for demo)	Anne Mikelonis, CESER Tim Boe, CESER
15:10 – 15:50	**Partners Round Table**	Mark Durno, Region 5 Jason Musante, Region 9 Scott Hudson, EPA OEM
15:50 – 16:00	Break (10 min)	
16:00 – 17:00	Additional Q&A, Discussion, and Subcommittee Worktime	

Wednesday, May 19, 2021

Time	Agenda Activity	Presenter
13:00 - 13:20	**CQ3: Overview of Waste Management Research** ***Additional Resource:*** Waste Management Webpage	Emily Snyder, CESER
	Lightning session for Waste Management	
13:20 – 14:20	*1-Configured Fireside Simulator – Simulations for Treatment of Biologically and Chemically Contaminated Waste - 10 min* *2-Biological Waste Treatment: A Scalable Approach-AnCOR - 10 min* *3-Carcass Management: Assessment of Methods to Support Outbreaks of Foreign Animal Disease (ASFv example) - 10 min* *4-Demo of Waste Staging and Logistics Tools - 20 min (PI screen share for demo)* *5-Social Considerations of Disaster Waste Management - 10 min* *Additional Resources:* I-WASTE Webinar, Waste Tools Story	*Paul Lemieux*, CESER *Paul Lemieux* *Paul Lemieux* *Tim Boe*, CESER *Keely Maxwell*, CESER
14:20 – 15:00	**Partners Round Table**	Alan G. Woodard, Ph.D., NY Dept. of Environmental Conservation Catherine Young, EPA Region 1 Gary Flory, VA Dept. of Environmental Quality Kim M. Kirkland, EPA Office of Land and Emergency Management
15:00 – 15:10	Break (10 min)	
15:10 – 16:00	Additional Q&A, Discussion, and Subcommittee Worktime	

Thursday, May 20, 2021

Time	Agenda Activity	Presenter
12:00 – 12:15	**CQ4: Overview of HSRP Systems and Resilience Tools**	Sang Don Lee, HS Principal Assoc.
Lightning session for Systems and Resilience Tools		
12:15 - 13:00	**Systems Tools** **1-Simulation for Evaluating Decision Making Following a Large-Scale Incident** *(Video in slide) - 10 min* **2-Evaluating the Use of Commercial-off-the-shelf (COTS) Three-dimensional (3D) Engines** *(Video in slide) - 10 min* **3-Tool Integration/Dashboard** *- 10 min* **4-Remediation Data Repository** *(PI screen share Demo) - 15 min*	*Tim Boe*, CESER
13:00 – 13:30	**Resilience Tools** **5-Social science of decontamination & environmental cleanups** *- 10 min* **6-Environmental Resilience Tools Wizard** *(PI screen share Demo) - 10 min* **7-Equitable Resilience Builder** *- 10 min*	*Keely Maxwell*, CESER
13:30 – 13:45	Break (15 min)	
13:45 – 14:25	**Analysis for Coastal Operational Resiliency (AnCOR) Field Study with Partners** *(Videos in slide)* ***Additional Resources:*** AnCOR Webpage**,** AnCOR Story	Shannon Serre, EPA OEM Worth Calfee, CESER
14:25 – 14:45	**Operational Testing and Evaluation of Chemical Remediation Activities (OTECRA) Field Study with Partners**	Larry Kaelin, EPA OEM Lukas Oudejans, CESER
14:45 – 15:05	**Managing Research during Emerging Challenges** ***Additional Resource:*** COVID-19 Research Webpage	Shawn Ryan, HS National Program Director Sang Don Lee, HS Principal Assoc.
15:05 – 15:20	Break (15 min)	
15:20 – 16:00	Questions and Answers; Final Remarks	
16:00 - 17:00	Subcommittee Worktime	

APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

- Meeting Agenda
- Charge Questions
- Zoom Virtual Participation Guide

Material Provided During or After the Meeting

- Homeland Security Research Program – Links to Products
- Homeland Security Research Program – Meeting Presentation
- COAB Meeting 2021 Homeland Security Research Program Partner – Homeland Security Research Program FY20-21 Annual Update Presentation
- 2012 Partner Process Fact Sheet
- 2021 Decontamination and Waste Management Tools: HEART (Homeland Security Emergency Action and Research Times for Regions and Program Offices)

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EPA Contact
Tom Tracy, Designated Federal Officer

August 24, 2021

A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development

CONTENTS

LIST OF ACRONYMS

BMP	Best Management Practices
DBP	Disinfection byproducts
EPA	U.S. Environmental Protection Agency
LID	Low impact development
MSX	Multi-Species eXtension
NTM	Nontuberculous mycobacteria
ONPWS	Onsite Non-potable Water Systems
OPPP	Opportunistic premise plumbing pathogens
ORD	EPA's Office of Research and Development
OW	EPA's Office of Water
SCMs	Stormwater control measures
StRAP	Strategic Research Action Plan
SWMM	Storm Water Management Model
WRF	Water Research Federation

CHARGE QUESTIONS AND CONTEXT

The SSWR Subcommittee was charged with addressing a series of questions about water treatment and infrastructure, focused on Research Areas 7, 8, 9, 10, and 11. Charge questions were as follows:

> Q.1. What suggestion(s)/recommendation(s) does the Subcommittee have on ORD's implementation of its drinking-water and distribution research, and in particular on how these research activities can be comprehensively integrated to ensure safe disinfectant levels, while minimizing or eliminating exposure to lead, opportunistic pathogens, and DBPs in small treatment and distribution systems and in disadvantaged communities?
>
> Q.2. Please comment on the implementation of ORD's water reuse research, and what suggestion(s)/ recommendation(s) does the Subcommittee have regarding SSWR's water reuse research for helping to innovatively augment water supplies and improve resiliency by identifying promising alternative water sources?
>
> Q.3. In addition to evaluating ORD's stormwater research activities, what suggestion(s)/recommendation(s) does the Subcommittee have to improve the utility of these research activities to provide integrated decision-support tools for stormwater management in disadvantaged communities?

The responses of the SSWR Subcommittee to the charge questions are contained in the following section.

SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Charge Question 1

> Q.1. What suggestion(s)/recommendation(s) does the Subcommittee have on ORD's implementation of its drinking-water and distribution research, and in particular on how these research activities can be comprehensively integrated to ensure safe disinfectant levels, while minimizing or eliminating exposure to lead, opportunistic pathogens, and DBPs in small treatment and distribution systems and in disadvantaged communities?

Narrative

The Safe Drinking Water Act is the Agency driver for this area of research, and the foci now are on lead and copper analysis and reduction, emerging microbial contaminants, disinfection byproducts (DBPs), and environmental justice. Goals include improved and new treatment strategies that states, consultants, tribes, and water system managers can use directly to reduce lead and copper levels at consumer's taps; improved better management practices (building and utilities) aimed at reducing risks associated with *Legionella* and opportunistic premise plumbing pathogens (OPPPs); more effective management of disinfectant residual and DBPs in distribution and premise plumbing systems while effectively reducing OPPPs; and the ultimate goal of providing the U.S. Environmental Protection Agency's (EPA's) Office of Water (OW), states, tribes, small systems, and underserved communities with updated information to fill research gaps impeding/preventing regulatory determinations. The goal of achieving safe disinfectant levels while minimizing health risks from these various sources of risk requires developing and applying a

comprehensive model that includes risk profiles for each of these sources, and that describes their interdependence in quantitative terms. Such a model can serve as a guide to achieving the desired degree of safety.

Strengths

- EPA's Office of Research and Development (ORD) presented a portfolio of cutting edge, focused research on DBPs, pathogens, and heavy metals, that is timely and relevant.
- The team is both using and developing highly effective models to understand fate, transport, and transformation of chemicals of concern in drinking water.
- The subcommittee commends ORD research for collaborating closely and integrating the technology with small businesses. The subcommittee believes there is excellent communication and collaboration among different groups, such as among modelers, chemists, and risk assessment scientists.

Suggestions

- Although *Legionella* is part of the research agenda, other opportunistic pathogens do not appear to be, such as nontuberculous mycobacteria (NTMs) and Pseudomonas. There has been great improvement over last 10 years, but still a poor understanding of how it gets into small systems, storage tanks, and greater distribution systems. More research is needed into the effects of temperature, water quality, disinfectant, and growth over time. Lastly, several approaches supporting specific building water management strategies to control *Legionella* have been developed. However, current science lacks evidence identifying whether these approaches actually work. The subcommittee suggests increased research efforts to establish which specific building water management strategies effectively control Legionella.
- Increased attention should be given to research on the poorly understood health risks (toxicities and human exposure profiles) of some of the non-regulated DBPs.
- The desirable goal of reducing or preventing DBP formation requires researching the factors governing their creation and methods to control their influences.
- Continue research on lead forms and transformations in water, with emphasis on removing it and working with research teams to create effective filtration.
- Copper should have been mentioned in the charge question. In addition, other metals might need additional research such as arsenic or chromium.
- We heard about industry partnerships for technical development, and how successful these relationships are. However, we feel EPA should further prioritize and support these relationships, along with excellent and increased support for the small business grant program.
- The subcommittee suggests conducting further research on specific anthropogenic chemicals (e.g., pharmaceuticals and personal care products). The subcommittee believes development of the research plan requires systematic reviews and evidence mapping of existing literature that takes into account co-occurrence patterns, concentration levels, and health endpoints, with data from an increased number of sites.
- Residential structures and commercial buildings have unique plumbing characteristics. The subcommittee suggests research teams develop risk models describing likely lead or microorganism exposures, based on specific premise plumbing characteristics. Such models could help inform homeowners and building managers to make wise choices regarding plumbing materials and filtration devices for optimum health and well-being.
- The subcommittee believes EPA needs to focus on understanding the differential research needs of disadvantaged communities and the different water quality threats to different communities.

Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

Recommendation 1.1: Focus on developing a risk-based model integrating research findings on disinfectants, pathogens, and DBP risks, and, if relevant, on lead-related risks. This would involve optimizing and integrating existing models of individual components and would also show how changes in the risk of one component would affect the risks of the others. For example, EPA must optimize models of DBP formation (both regulated and unregulated) enabling the models to communicate with other models such as health risk models, especially for unregulated DBPs. Having the model created, even if it cannot yet be executed, would be a great tool for further research and data gap identification.

EPA Response: SSWR agrees with the Subcommittee's recommendation to optimize and integrate existing models in a more cohesive manner. ORD researchers are currently working with Program Office partners to improve the Water Treatment Plant model (WTP) to include DBP formation in support of the Six Year Review of the microbial and disinfection by-product rules (MDBP). In addition, future SSWR research will evaluate linking several existing models for exposure, including the Stochastic Human Exposure and Dose Simulation Model (SHEDS), as well as absorption, distribution, metabolism, and excretion models (e.g., physiologically-based pharmacokinetic models-PBPK), and toxicity data to better characterize overall risk from regulated and unregulated DBPs. ORD already has experience with linking SHEDS and PBPK models for evaluating lead exposure and risk, which should help facilitate the effort with DBPs.

Recommendation 1.2: Focus on developing a more user friendly EPANET-MSX (Multi-Species eXtension) model that would include built-in DBP and disinfection models so users can apply them easily. EPANET is a tool used to address hydraulic issues (like mixing in storage tanks and residence time), and also fate and transport issues (for disinfectants, DBPs, natural organic matter, etc.). However, there is a need to make its application as simple as possible, especially for small systems. EPA should integrate these models with risk information in a decision support tool to better meet the needs of small systems and disadvantaged communities. Such a tool could easily highlight the risks of DBPs along with the benefits and costs of different strategies to reduce/prevent DBP formation.

EPA Response: SSWR agrees with this recommendation and appreciates the need for simpler versions of EPANET to help small systems and disadvantaged communities. ORD has recently released tools to help drinking water systems in the implementation of chloramine disinfectants. SSWR research will explore the integration the newer chloramine chemistry model with other models for chlorine disinfection, DBP formation and risk (see response to Recommendation 1.1 above) and aim to simplify tools for small systems and disadvantaged communities.

Charge Question 2

Q.2. Please comment on the implementation of ORD's water reuse research, and what suggestion(s)/ recommendation(s) does the Subcommittee have regarding SSWR's water reuse

research for helping to innovatively augment water supplies and improve resiliency by identifying promising alternative water sources?

Narrative

ORD has chosen to bypass the largest reuse source, treated municipal wastewater, and focus their research on alternative reuse water sources. The subcommittee endorses this direction as municipal wastewater reuse research is saturated and EPA's investment there would not have a large impact on the field's direction. In contrast, ORD has correctly identified a dearth of research regarding several alternative sources, for which EPA's effort are potentially impactful.

However, the research plan could be improved by providing a more comprehensive vision for how the data ORD generates will help EPA prioritize a range of alternative sources. In absence of that integration, the agency is left with disjointed research on a range of chemical removal and pathogen disinfection processes.

Strengths

- Addresses a need. The country has water deficiencies in a variety of regions across the country and developing new sustainable sources will benefit society. Even in areas where water is not in short supply, having a portfolio of alternatives adds to the nation's water security.
- The research on alternative disinfection and treatment strategies for chemical and microbial contaminants will add to our knowledge base.
- They have a clear idea of how this research will enhance EPA's Water Reuse Action Plan.
- They are well-integrated with other research entities in this field, particularly the Water Research Federation (WRF) and Integration with WRF and the National Blue Ribbon Commission on Onsite Non-potable Water Systems (ONPWS).

Suggestions

- As part of developing an integration strategy, ORD should continue four parallel/integrative activities: (1) Identify the volume potential for each reuse strategy, (2) Assess the unique chemical and biological contaminant characteristics of each water type, (3) Determine the chemical/biological treatment challenges for each of these types of water, and (4) Calculate the costs associated with those treatment technologies. Collectively, those activities will allow to better focus the national water reuse strategic plan.
- There will be several parts of the activities above where the information is presently unavailable and not being worked on by others. Those information needs form the basis for future research directions.
- An additional factor that EPA might consider is the energy cost of each of the potential reuse strategies. Besides providing the basis for lessening the national carbon footprint as part of a reuse strategy, there are particular areas where low-energy, low-cost treatment technologies would be particularly valuable, such as in agricultural settings and proven strategies around subsurface flow wetland treatment utilized in Europe.

Recommendations

The Subcommittee offers this recommendation to support the relevant Agency priorities:

Recommendation 2.1: The research vision should further define how the various individual research projects will be integrated into a synthesis product that will inform communities that must prioritize among a range of alternative water reuse sources.

EPA Response: SSWR agrees with this recommendation. Risk assessment research aimed at determining the level of treatment needed for a given combination of source and use has been and will continue to be a research priority. As this research matures, a synthesis document able to communicate these different risk levels and treatments will be a useful tool that EPA will be able to share with communities. One powerful tool that may aid this effort is the Non-Potable Environmental and Economic Water Reuse (NEWR) Calculator, which is a simple to use web-based tool for screening-level assessments for source-water options in urban, decentralized settings. Future SSWR research can build on the NEWR approach through integrating research projects to provide users with additional tools for fit-for-purpose water reuse at multiple scales and settings. To help highlight and define the research vision for water reuse, SSWR is also developing a new Research Area "Alternative Water Sources for Climate Adaptation" in the new Strategic Research Action Plan (StRAP), which starts in fiscal year 2023 and will focus on reuse as well as enhanced aquifer recharge.

Charge Question 3

Q.3. In addition to evaluating ORD's stormwater research activities, what suggestion(s)/recommendation(s) does the Subcommittee have to improve the utility of these research activities to provide integrated decision-support tools for stormwater management in disadvantaged communities?

Narrative

Stormwater management involves a wide range of technical challenges. Based on a diverse portfolio of research activities, ORD has successfully advanced research to tackle many of these challenges. Different social, economic, and regulatory factors create regionally unique challenges to the design, operation, performance, and maintenance of stormwater management solutions. ORD has a history of conducting successful stormwater management research with and in disadvantaged communities across the country. While technical research questions on the performance of stormwater treatment systems to achieve certain objectives (e.g., water quality improvement, hydrologic mitigation) are generally relevant regardless of where the systems are installed, research questions pertaining to the full life cycle of stormwater management solutions require community-specific considerations. For example, prior work in disadvantaged communities has yielded valuable insight into community values and perspectives on stormwater management solutions, from siting to amenity priorities. These lessons learned have often emerged as an added benefit, rather than from stated initial goals of the research projects.

A potentially unique opportunity to advance ORD's stormwater management research in disadvantaged communities is in the topic area of system maintenance. Stormwater treatment systems in disadvantaged communities suffer disproportionally from lack of long-term maintenance, thereby compromising community acceptance and, potentially performance, over time. Research opportunities arise to document how the performance of stormwater treatment systems changes over time or what specific

maintenance activities are effective on maintaining runoff management. Neither of these topics are rigorously studied to date.

Maintaining focus on programmatic goals, including research within disadvantaged communities, is challenged by competing demands and potentially shifting goal posts. For example, developing critical stakeholder, non-governmental organization, and community relationships to conduct research in disadvantaged communities, and delivering robust data sets from field-based research, each require long timelines often exceeding the duration of a Strategic Research Action Plan (StRAP) or the length of an administration. The growing recognition of ancillary benefits over and above technical solutions for mitigating stormwater sometimes results in competing priorities for implementation and diverts resources from projects to advance knowledge on how to plan for and achieve water resource protection goals.

Strengths

- ORD is pursuing initiatives that make up a diverse portfolio of research. Specific program strengths include:
    - A large network of field monitoring projects across the country, including work in many disadvantaged communities.
    - Investments to enhance the Storm Water Management Model (SWMM), the most widely used tool across the world for stormwater management planning.
    - A focus on aquifer recharge, which is essential for regions of the country expected to see drier climates.
    - Timely projects on pathogens that are informed by research in non-stormwater management sectors; for example, identifying better indicators of human health risk from fecal contamination and assessment techniques.

Suggestions

- ORD's stormwater management research portfolio covers a diverse array of well-developed technical questions which contributes to the strength of the program; however, activities appear to be siloed. ORD stakeholders, including the broader public, would benefit from better articulation of how research initiatives integrate into a cohesive overall approach to advancing stormwater management tools and technologies.
- Technical questions and approaches to data collection are regionally specific. Considerations of social and community benefits, ecosystem services, and environmental justice also need a regional approach. Consider documenting the process of developing and implementing regional research programs to synthesize into a national framework for promoting implementation of stormwater management solutions.
- Provide a more explicit explanation of how climate change impacts are being considered in the field and modeling programs. How these research questions contribute to evaluating and developing solutions for disproportionately impacted communities with failing infrastructure, which are often economically disadvantaged communities, is of particular interest.
- Contribute data from field monitoring programs to resources such as the National Stormwater Quality Database (characterizing untreated runoff/ stormwater quality) and the International Stormwater Best Management Practices (BMP) Database (for monitoring data from stormwater management technologies that may be called BMPs, stormwater control measures, or SCMs, low impact development, or LID, green infrastructure effectiveness, etc.). These freely available databases

(www.bmpdatabase.org) are already supported by EPA and represent the largest repository of stormwater management monitoring data, yet the majority of existing ORD data are not yet included.

- Additional considerations from a programmatic perspective are to develop:
    - optimization tools to solve site-specific runoff problems with the type and location of stormwater management technologies.
    - appropriate metrics to interpret context-specific performance (especially with respect to receiving water goals, and translating between site-scale and regional technologies), and set operational standards over the lifecycle of the system. Metrics should be supported by standardized protocols for stormwater management monitoring.
    - design approaches to promote appropriate pollutant removal mechanisms to target specific pollutant types in stormwater, including optimizing use of novel materials.
    - investigations on issues of emerging concern as they relate to stormwater management, such as pollutants of emerging concern, climate change, road salt-related contamination, etc.
    - research projects to investigate the direct influence of specific maintenance activities on restoring or enhancing stormwater management technology performance.
    - SWMM's ability to accurately model hydrograph and pollutant transformations through stormwater management technologies (e.g., calibration and validation of the LID controls).
- Programmatic considerations for conducting stormwater management research in disadvantaged communities should include:
    - Developing integrated performance metrics and decision support tools for stormwater management systems with multiple benefits (e.g., stormwater treatment, recreation, amenity, ecosystem services).
    - Engaging with appropriate experts and local community stakeholders to develop and communicate program priorities and metrics for evaluating success.
    - Providing training for local partners to continue research after ORD has completed its scope. Continuing research is anticipated to engender community acceptance and long-term care (maintenance) of stormwater management facilities, as well as provide critically absent, industry-wide data on lifecycle performance.

Recommendations

The Subcommittee offers these recommendations to support the relevant Agency priorities:

Recommendation 3.1: Develop new sensors or tools to enable remote performance monitoring of stormwater management technologies. This would reduce challenges of physically conducting monitoring and/or where funds or professional capability are not readily-available.

EPA Response: SSWR agrees with this recommendation and is currently supporting sensor development efforts primarily through open innovation challenge mechanisms. For these competitions, prize money is provided by the "Seeker," and "Solvers" develop either a sensor design or a prototype, depending on the type of Challenge. Recent efforts include a Septic System Nitrogen Challenge and a Water Toxicity Sensor Challenge, along with support for sensor Challenges organized by other Agencies, including the Bureau of Reclamation. SSWR researchers also have extensive experience applying sensors and using the data for green infrastructure and stormwater management studies and to support modeling through EPA-developed programs, such as the Stormwater Management Model (SWMM) and the National Stormwater Calculator. SWMM

modeling can help with the placement of monitoring equipment and sampling sites to evaluate the efficacy of stormwater approaches and technologies, thereby facilitating the effective use of sensors. Future SSWR research will focus on making these resources simpler to use and applicable to helping disadvantaged communities with stormwater issues.

Recommendation 3.2: Implement research that considers the entire lifecycle of a stormwater system (including design, installation, maintenance, and decommissioning) in disadvantaged communities. Such research should address both biophysical/technical issues as well as community capacity (social, economic) with the objective of developing a decision framework.

EPA Response: SSWR agrees with this recommendation. One approach that can be built upon is the use of communication tools with local communities, such as the Proctor Creek Watershed Story Map. This resource provides information for citizens in the watershed on where green infrastructure has been or may be located and relates stormwater management to human health issues and quality of life. Future SSWR research results can be integrated into broader applications for stormwater management at local scales, along with communication tools such as story maps.

SUMMARY LIST OF RECOMMENDATIONS

Charge Question 1: What suggestion(s)/recommendation(s) does the Subcommittee have on ORD's implementation of its drinking-water and distribution research, and in particular on how these research activities can be comprehensively integrated to ensure safe disinfectant levels, while minimizing or eliminating exposure to lead, opportunistic pathogens, and DBPs in small treatment and distribution systems and in disadvantaged communities?

- **Recommendation 1.1:** Focus on developing a risk-based model integrating research findings on disinfectants, pathogens, and DBP risks, and, if relevant, on lead-related risks. This would involve optimizing and integrating existing models of individual components and would also show how changes in the risk of one component would affect the risks of the others. For example, EPA must optimize models of DBP formation (both regulated and unregulated) enabling the models to communicate with other models such as health risk models, especially for unregulated DBPs. Having the model created, even if it cannot yet be executed, would be a great tool for further research and data gap identification.
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- **Recommendation 1.2:** Focus on developing a more user friendly EPANET-MSX (Multi-Species eXtension) model that would include built-in DBP and disinfection models so users can apply them easily. EPANET is a tool used to address hydraulic issues (like mixing in storage tanks and residence time), and also fate and transport issues (for disinfectants, DBPs, natural organic matter, etc.). However, there is a need to make its application as simple as possible, especially for small systems. EPA should integrate these models with risk information in a decision support tool to better meet the needs of small systems and disadvantaged communities. Such a tool could easily highlight the risks of DBPs along with the benefits and costs of different strategies to reduce/prevent DBP formation.

Charge Question 2: Please comment on the implementation of ORD's water reuse research, and what suggestion(s)/ recommendation(s) does the Subcommittee have regarding SSWR's water reuse research for helping to innovatively augment water supplies and improve resiliency by identifying promising alternative water sources?

- **Recommendation 2.1:** The research vision should further define how the various individual research projects will be integrated into a synthesis product that will inform communities that must prioritize among a range of alternative water reuse sources.

Charge Question 3: In addition to evaluating ORD's stormwater research activities, what suggestion(s)/recommendation(s) does the Subcommittee have to improve the utility of these research activities to provide integrated decision-support tools for stormwater management in disadvantaged communities?

- **Recommendation 3.1:** Develop new sensors or tools to enable remote performance monitoring of stormwater management technologies. This would reduce challenges of physically conducting monitoring and/or where funds or professional capability are not readily-available.
- **Recommendation 3.2:** Implement research that considers the entire lifecycle of a stormwater system (including design, installation, maintenance, and decommissioning) in disadvantaged communities. Such research should address both biophysical/technical issues as well as community capacity (social, economic) with the objective of developing a decision framework.

APPENDIX A: MEETING AGENDA

Wednesday, May 26

Time (EDT)	Topic		Presenter
11:45-12:00	Sign on and Technology Check		
12:00-12:15	Welcome and Opening Remarks		Tom Tracy (DFO) Joseph Rodricks (SSWR BoSC Chair) Robert Blanz (SSWR BoSC Vice Chair)
12:15-12:30	ORD Welcome		Jennifer Orme-Zavaleta (ORD Acting Assistant Administrator)
12:30-12:40	SSWR Overview and Charge Questions		Suzanne van Drunick (SSWR National Program Director)
12:40-1:15	ORD Center and Grants Overview		Greg Sayles (Director, CESER) Rusty Thomas (Director, CCTE) Mary Ross (Director, OSAPE)
1:15-1:25	Water Treatment and Infrastructure		Chris Impellitteri (Associate NPD, WTI Topic Lead)
1:25-4:30	Overview of Research Area 7: *Drinking Water Treatment and Distribution Systems*		Hale Thurston (ACD, CESER)
	1:30-2:00	Output 1: Resources and tools for characterizing and mitigating lead and copper release in drinking water distribution systems and premise plumbing	Darren Lytle (ORD, CESER) BoSC Q&A
	2:00-2:30	Output 2: Best practices, tools, and information for assessing and controlling pathogens and biostability in drinking water systems, managing disinfectant residuals, and minimizing DBPs	Eric Villegas (ORD, CEMM) BoSC Q&A
	2:30-3:00	Output 3: Analytical methods, occurrence, health effects, and treatment assessments to aid regulatory decision-making	Jane Ellen Simmons (ORD, CPHEA) BoSC Q&A
	3:00-3:15	Break	

Thursday, May 27

Time (EDT)	Topic		Presenter
11:15-11:30	Sign on and Technology Check		
11:30-11:40	Welcome – Day 2		Tom Tracy (DFO) Joseph Rodricks (SSWR BOSC Chair) Robert Blanz (SSWR BOSC Vice Chair)
11:40-12:00	ORD Centers Overview		Tim Watkins (Director, CEMM) Jamie Strong (Associate Center Director, CPHEA)
12:00-1:30	Overview of Research Area 9: *Wastewater and Water Reuse*		Ann Grimm (ACD, CEMM)
	12:05-1:00	Output 1: Analytical methods, exposure and effects assessment processes, and tools for wastewater and fit-for-purpose water reuse Output 2: Treatment technologies for wastewater and fit-for-purpose water reuse	Jay Garland (Associate Director, CESER)
1:00-1:30	BoSC Discussion of Charge Question 2		Joseph Rodricks (SSWR BoSC Chair) Robert Blanz (SSWR BoSC Vice Chair)
1:30-1:45	Public Comments		Tom Tracy (DFO)
1:45-2:00	Break		
2:00-3:45	Overview of Research Area 10: *Stormwater Management*		Ann Grimm (ACD, CEMM)
	2:05-2:20	Output 2: Stormwater Management as a Resource for Enhanced Recharge, Capture, and Use (Informational only – no charge question)	John Johnston (ORD, CEMM) BoSC Q&A
	2:20-2:45	Output 1: Planning, Implementing, and Monitoring Stormwater Management Practices	Matt Hopton (ORD, CESER)
2:45-3:15	BoSC Discussion of Charge Question 3		Joseph Rodricks (SSWR BoSC Chair) Robert Blanz (SSWR BoSC Vice Chair)
3:15-3:30	Break		
3:30-4:30	Charge Question Breakout Groups (Committee members will be preassigned to specific charge questions)		BoSC & ORD
4:30-5:15	Charge Question Breakout Group Reports (15 mins each report)		Charge Question Leads

Time (EDT)	Topic	Presenter
5:15-5:30	Next Steps	Joseph Rodricks (SSWR BoSC Chair) Robert Blanz (SSWR BoSC Vice Chair) Suzanne van Drunick (NPD, SSWR) Joe Williams (Principal Associate NPD, SSWR) Tom Tracy (DFO)
5:30	Adjourn	

APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

- Meeting Agenda
- Charge Questions
- Presentations
- American Water Works Association – Public Comments
- March 8, 2021 Next Steps on Implementation of Executive Order 13985
- Zoom Virtual Participation Guide

Material Provided During or After the Meeting

- All Presentations
- Zoom Recordings