B O S C

Board of Scientific Counselors

REPORT OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY BOARD OF SCIENTIFIC COUNSELORS SAFE AND SUSTAINABLE WATER RESOURCES (SSWR) SUBCOMMITTEE

RESPONSES TO CHARGE QUESTIONS

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LIST OF ACRONYMS

ACWA	Association of California Water Agencies
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
BOSC	Board of Scientific Counselors
CEC	contaminants of emerging concern
CWA	Clean Water Act
DOE	U.S. Department of Energy
ECOS	Environmental Council of States
EPA	U.S. Environmental Protection Agency
ERIS	Environmental Research Institute of the States
HAM	harmful algal blooms
NHD	National Hydrography Dataset
NIH	National Institutes of Health
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NTWC	National Tsunami Warning Center
OGWDW	Office of Ground Water and Drinking Water
ORD	Office of Research and Development
OST	Office of Science and Technology
OWM	Office of Wastewater Management
OWOW	One World One Water
PFAS	per- and polyfluoroalkyl substances
SDWA	Safe Water Drinking Act
SSWR	Safe and Sustainable Water Resources
StRAP	Strategic Research Action Plan
TMDL	total maximum daily load
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WRF	Weather Research and Forecasting model

INTRODUCTION

The Safe and Sustainable Water Resources (SSWR) Subcommittee of EPA's Board of Scientific Counselors (BOSC) met on 23-24 April to review the draft SSWR Strategic Research Action Plan (StRAP) for 2019-2022. This report contains the Subcommittee's conclusions regarding the draft StRAP, organized as sets of responses to six charge questions. The report contains a number of suggestions for improving the content and communication power of the StRAP, and seven Recommendations the Subcommittee believes important for strengthening the research program.

BACKGROUND

The U.S. EPA's SSWR is devoted to ensuring safe drinking water and to protecting and restoring watersheds and aquatic ecosystems. The program's activities are designed to be responsive to the mandates of the federal Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), and other legislation.

The SSWR cannot achieve success without well-planned and continuing cooperation with other EPA programs, federal and state agencies, tribes, and other public and private stakeholders. Providing adequate technical support for its wide-ranging Congressional mandates requires, at a minimum, understanding of the needs of the many stakeholders involved in managing risks to our water systems, developing the research needed to respond to these needs, and communicating the results of that research in useful ways. These are significant challenges, especially considering the continuing emergence of new threats to our water systems and the many technical difficulties that arise in efforts to manage existing threats.

The draft SSWR StRAP is the U.S. EPA's proposed plan for meeting these challenges in the 2019-2022 time frame. The BOSC Subcommittee has studied the plan, and also listened to presentations from its authors and the public regarding its foundations and content. The 19 members of the subcommittee have diverse scientific and technical backgrounds, all related to the content of the StRAP, and is well qualified to judge whether the research objectives are sound and respond to the U.S. EPA's mandates to protect our nations waters and the people who consume them, and to ensure that this essential resource is sustained.

STRAP RESEARCH OBJECTIVES

EPA's SSWR National Research Program has four overarching objectives:

- Research Objective 1: Improve Prediction and Early Accurate Detection of Contaminants — Continue advancements in environmental monitoring, modeling, methods, and other information that are needed to rapidly and reliably inform water quality decision-making at the national, state, tribal, and local levels.

- Research Objective 2: Assess Potential Impacts — Improve understanding of exposure pathways and effects of chemical and microbial contaminants on human health and aquatic ecosystems.

- Research Objective 3: Develop and Evaluate Approaches for Prevention and Mitigation — Expand solutions to prevent and mitigate water quality impairments using innovations in technology, market-based incentives, and other approaches.

- Research Objective 4: Translate and Communicate Research – Provide practical solutions to water resource challenges through application of SSWR data, tools, and models, and disseminate this information through outreach activities.

To achieve these objectives, SSWR research is organized into three interrelated topics: watersheds, nutrients and harmful algal blooms, and water treatment and infrastructure. Each topic carries specific near- and long-term goals designed to yield practical tools and solutions for ensuring sustainable water resources. This *SSWR Strategic Research Action Plan 2019–2022* outlines these topics and the overall SSWR program design. The StRAP serves as planning guide for the Office of Research and Development's (ORD's) laboratories and centers to design specific research products that contribute to the identified outputs. SSWR's scientific results and technologies will support the CWA objective to restore and maintain the chemical, physical, and biological integrity of the Nation's waters and the SDWA to protect the quality of drinking water throughout the Nation.

The SSWR Subcommittee has evaluated the research program described in the StRAP, and its evaluation is summarized as sets of responses to the six Charge Questions found in the next section of the report.

CHARGE QUESTIONS AND CONTEXT

The SSWR Subcommittee was charged with six questions as follows:

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?
>
> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?
>
> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019-2022 time frame.
>
> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?
>
> Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Overarching issues

Translational Research as a Guide to Program Development

One of ORD's primary goals is successful transition of technology from the research community to the user community, typically at the state and local level. One of the best ways to achieve that is through collaboration with practitioners during development of those tools. Early interaction ensures that the product development is appropriate to the user needs. It also facilitates technology transfer as the researcher is able to observe, and resolve, transition challenges during the development process. Additionally, successful collaboration during development often creates a champion for transition to a broader audience, as the local practitioner typically has more credibility with the intended user audience than does the researcher.

StRAP includes two projects that will be conducted in collaboration with local users and we applaud ORD for inclusion of such projects. However, they are expressed in the StRAP as one-off projects, with the ORD staff even expressing during our interviews that one of the projects was included only because of a congressional mandate to do so. The StRAP would be improved by creating a separate section of the document highlighting ORD plans to ensure translation of their work, calling out these partnership projects as examples of desirable activities and highlighting incentives being offered ORD staff for implementing such collaborative projects. This section, particularly if it also incorporates the present communication section of the StRAP, would address the Committee's concern that "Translate and communicate research" is called out early in the document as one of the four pillars of ORD research, but is not elaborated on in the remainder of the document with a strategy for achieving that pillar.

Charge Question 1a

> Q.1a. Does the research outlined for the 2019-2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

Narrative

EPA's and ORD Strategic Plans for 2018-2022 each describe three Strategic Goals. EPA's three Strategic Goals are: 1) it's Core Mission to provide the Nation with clean air, land, and water, and to ensure chemical safety; 2) Cooperative Federalism for shared accountability, transparency, and participation with the public; and 3) the Rule of Law and Process to ensure compliance with the Law, create consistency and certainty, prioritize robust science, streamline and modernize permitting and reporting systems, and improve efficiency and effectiveness of its business processes. ORD's three Strategic Goals are: 1) advancing environmental science and technology; 2) Cooperative Federalism to inform and support federal, state, tribal and local decision-making; and 3) enhancing the ORD workforce and workplace. As described in the ORD Strategic Plan, ORD's strategic goals and objectives directly link to EPA's strategic goals and objectives, to ensure that ORD research outputs will assist EPA in achieving its goals and objectives.

To answer this charge question, the four research objectives[1], three research topics[2], and associated research areas and outputs[3] presented in the SSWR StRAP were evaluated against EPA's and ORD's stated strategic goals and objectives. For some EPA and ORD goals and objectives, this evaluation was not deemed relevant since they were not considered research oriented. These included improving EPA's business processes, modernizing EPA's permitting and reporting processes, and enhancing the ORD workforce and workplace.

Strengths

- The research objectives, topics, and areas described in the StRAP are aligned with the strategic goals identified by EPA and ORD. The associated research outputs are therefore expected to support EPA and ORD's strategic goals, especially EPA Strategic Goal 1 (Core Mission) and ORD Strategic Goal 1 (Advancing environmental science and technology).
- The stakeholder engagement described in the StRAP is aligned with and considered to support EPA's and ORD's Cooperative Federalism Strategic Goals.

Suggestions

- The StRAP describes four research objectives[1]. However, the remainder of the StRAP is organized by three research topics with associated research areas and outputs as summarized in Appendix 4. Under the current format, it is not clear how the four research objectives relate to the three research topics and associated areas and outputs. This could be clarified under the Program Objectives section and potentially detailed through a revision of Appendix 4.
- There is clearly programmatic overlap between EPA, its federal and non-federal partners, and other stakeholders in many of the research areas described in the StRAP. Where possible, we suggest that EPA identify such overlap and describe existing or planned coordination activities to maximize research complementarity, minimize duplication, and provide efficient expenditures.
- ORD should consider only using documents or surveys that identify potential research topics that it cannot verify as reliable and credible sources of input. For example, the Environmental Research Institute of the States (ERIS) survey may not be a good source as discussed under charge question 2b. It is further suggested that the stakeholder engagement process be clarified and documented early in the development of the StRAP so the participants, timeline, and expectations are known and transparent as the data is being collected. The approach should focus on gathering input from sources that can provide strategic insights on critical topics and will require interacting with some stakeholders at a higher level of responsibility than currently done.

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[1] The four research objectives identified in the SSWR StRAP are: 1) Improve Prediction and Early Accurate Detection of Contaminants; 2) Assess Potential Impacts; 3) Develop and Evaluate Approaches for Prevention and Mitigation; and 4) Translate and Communicate Research.

[2] The three research topics identified in the SSWR StRAP are: 1) Watersheds; 2) Nutrients and Harmful Algal Blooms; and 3) Water Treatment and Infrastructure.

[3] The three research topics identified in the SSWR StRAP each contain 3-4 research areas and a total of 31 research outputs, as summarized in Appendix 4 of the StRAP.

Recommendations

The Subcommittee offers this recommendation to ensure that the research outputs described in the StRAP support EPA's and ORD's Strategic Goals.

Recommendation 1a.1: While the research objectives, topics, and areas outlined in the StRAP are aligned with EPA's and ORD's strategic goals, it is less clear how success in meeting those goals will be evaluated. ORD's strategic plan talks specifically about measures of progress (e.g., increase the number of research products meeting customer needs under each ORD goal). Where possible, we suggest that the StRAP similarly describe measures of success for the different research outputs.

Charge Question 1b

> Q.1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

Narrative

The SSWR Subcommittee was impressed by ORD's effort to solicit information about the needs of states, tribes, and regions, and to respond by aligning research activities with the needs identified by the partners. SSWR has clearly strengthened its partnership and stakeholder engagement within the EPA organization, including EPA's regional offices. However, results from outreach to state agencies, professional organizations, and academia show room for improvement, both in number of participants that provide input and, in the quality, or relevance of the input received.

Much of the information about partner needs came from ERIS surveys. Important concerns with the survey process were identified. The ERIS survey questions were not general enough to solicit the range of stakeholder concerned issues. The survey questions posed were very limited (11 questions, with "other" listed as question 12) and seemed biased towards specific research interests. For example, the question asking about the concern of "Toxics and Chemicals of Emerging Concern Including PFAS" led respondents to identify per- and polyfluoroalkyl substances (PFAS) over other potential contaminants such as pesticides or pharmaceuticals. The subcommittee was concerned that ORD had no input to survey questions and that there was little transparency about how survey questions were developed. Survey questions to identify partner needs should not be leading questions but rather more open-ended. There needs to be greater transparency over the creation of survey questions and should involve input by ORD when possible. In addition, survey questions should be designed with more participants in mind through strategic partnerships (i.e., NOAA, AWWA, WRF, etc.).

Some research outputs identified by partners were not addressed in the StRAP, with insufficient explanation. For example, a partner in the National Tsunami Warning Center (NTWC) spring 2018 survey identified the research need for a "hydraulic fracturing water reuse study for evaluating ecological impacts." In the StRAP, ORD's response was "this need will not be addressed," with no further justification. Additional items identified by partners that are listed as not being addressed include: a) Groundwater remediation: would be beneficial to see data from past in situ efforts and designs related to hydro technologies; b) Nutrient impact on wastewater reservoirs from water reuse; and c) Human health & ecological effect studies for large vessel ships - dumping sewage and gray water in international

waters. The surveys also identified resiliency challenges that are not addressed. The subcommittee urges greater transparency in explaining why partner-identified requests like these were denied. For example, ORD could respond by saying that these concerns are being addressed elsewhere in the EPA, or by other agencies with some specifics.

It is likely that research activity may not have been completed from the prior StRAP period that needs continuation. Uncompleted items should be mentioned, some of which may not have overlapped with current interests but still need continued attention. In addition, there should be clarification on why certain topics have been continued over topics that are no longer being addressed.

Strengths

- The subcommittee commends ORD for their effort to solicit information about the wide-ranging needs of states, tribes, and regions; and for their use of this information in guiding research program activities.
- The subcommittee commends ORD on the tangible research approaches that have been mapped out to address the key objectives identified by the partners. The research agenda outlined in the StRAP will further assist in providing solutions for safe and sustainable water resources in the states and regions, and to advance environmental protection.

Suggestions

- Justification should be provided for research needs identified by partners that will not be addressed by ORD. The subcommittee understands that research will not be performed for all the concerns suggested by stakeholders for a number of reasons. It is important to maintain as much transparency as possible with these stakeholders and describe why certain topics will and will not be addressed.
- Additional research expertise should be provided by ORD to further support needs of its state and federal partners. ORD has substantial expertise in synthetic data analysis, advanced measurements, and terrestrial and aquatic modeling that could be harnessed to provide specific answers to individual state and tribe needs. For example, ORD staff could work together with individual states to develop localized remediation plans, individual watershed total maximum daily loads (TMDLs), and detailed numeric nutrient criteria; going substantially beyond technical information or guidance toward providing new solutions that the states and tribes can use.
- Further consideration should be given to leveraging research expertise and maximizing the value of research expenditures through strategic partnerships. Given that ORD cannot perform all the potential research outlined either by stakeholders or through internal ORD researchers, partnerships with other federal agencies and private foundations should be explored so that limited funds can be leveraged and provide opportunities for others (i.e., DOE, USGS, NOAA, AWWA, WRF) to champion important research topics.

Recommendations

The Subcommittee offers one recommendation to capitalize on partner-identified needs.

Recommendation 1b.1: The subcommittee understands that there are significant limitations on EPA's ability to conduct surveys of any kind. Yet accurate and complete understanding of partner needs is extremely important for the SSWR. We recommend that ORD explore additional strategies to gather reliable information about partner needs. Information gathering strategies should include best practices for ensuring that unbiased and comprehensive information is obtained, and the information should be

specific to each of the six research areas. Efforts should be coordinated through the Environmental Council of States (ECOS) to ensure State coordination with any identified strategies. The process and schedules for information gathering should be documented in the StRAP so the participants, timeline, and expectations are known and transparent.

Charge Question 1c

> Q.1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019-2022 time frame.

Narrative

The StRAP describes four overarching Research Objectives and then identifies three closely related Topics under which the proposed research efforts are organized (watersheds, nutrients and harmful algal blooms, and water treatment and infrastructure). Presented under each Topic are the broad research areas and programs that are identified by Region, State, and Tribal needs. These lists identify specific research activities intended to be responsive to those needs. The process through which the proposed research will meet these needs are described in a series of 31 Outputs. The 31 Outputs collectively reflect the direction proposed for the SSWR in FY 2019-2022. It is acknowledged that achieving these Outputs will depend upon budgetary appropriations.

The Subcommittee attempted to address this Charge Question by examining the proposed program as a whole. We examined whether the Research Objectives clearly reflect agency and ORD priorities, whether the Topics clearly provide understanding of the program's organizing framework, and whether the research areas and Outputs, taken together, provide a Vision that is both appropriate for EPA's mission and adequate to achieve the Research Objectives.

Strengths

- The StRAP provides a reasonably comprehensive examination of some the important challenges our country faces in providing safe and reliable water supplies within the context of EPA's mission. It also provides guidance on scientific, technological, and translational efforts required to respond to these particular challenges. At a broad level the StRAP communicates how these needed efforts will support the EPA's mission and its various Congressional mandates, to provide a relatively clear path forward for addressing the EPA's highest priority research objectives for safe and sustainable water resources.
- The needs of various stakeholders, as described in the StRAP have been given high priority in the proposed research program, and the 31 Outputs are generally satisfactory responses to those needs. The information, tools, and capabilities described in the Outputs, if delivered in efficient and understandable ways, should provide substantial support for those stated needs.
- At a technical level, the StRAP provides a relatively clear, albeit very broad, vision of the leading requirements for advancing the proposed research efforts. Of particular value is the emphasis on expanded analytical methodologies, continued environmental monitoring, and enhanced modeling capabilities. Moreover, the focus on delivering tools directly to stakeholders is rightly highlighted.
- Overall, the StRAP is a well-conceived and thoughtful guide to (for) addressing many of EPA's and their stakeholder's highest priority issues within the context of EPA's Safe and Sustainable Water Resources research program.

Suggestions

- The Subcommittee believes the StRAP could be improved to provide better understanding of its stated and implied strategic vision.
- Consider introducing some sense of program priorities.
  Are the 31 Outputs all of equal importance? Is there a difference between Outputs that are intended to apply nationally and those that are to apply locally? It is perhaps not critical to identify specific priorities, but a discussion of the topic would be useful as the planning effort moves ahead to identify more specific research undertakings. Some guidance on priorities will support these objectives, as well as development of future budget documents.
- Consider introducing some discussion of how success over the 2019 - 2022 planning horizon will be measured and reported. A plan that does not include an approach for assessment of success of the overall program would seem to be deficient. The StRAP now contains a roadmap for progress but no plan for allowing stakeholders to understand whether objectives are being achieved in a timely manner.
- Consider reorganizing Topics and providing clearer objectives for each of the tasks.
  The three Topics convey quite different messages about how the overall research program is organized, which adversely affects communication of the overall vision. While "Treatment and Infrastructure" reflects the research content clearly, "Watersheds" seems a "force-fit" for its content; "Nutrient and Algal Blooms" is an entirely different category of activities. There is, no doubt, a need for some type of categorization of research areas, but the current Topics impede efforts by not articulating exactly what the SSWR is trying to achieve. Further, the relation between the four Research Objectives and the Topics is difficult to track.
- Consider improving consistency in the wording of Outputs.
  Some Outputs are fairly specific in what is to be expected from the research (e.g. Outputs 1 and 20); some are very broad and less clear (Outputs 5 and 23), and some are in between (Outputs 13 and 29). Not enough effort has gone into communicating specific expected Outputs, and the program vision is somewhat blurred as a result.
- Consider accounting for unanticipated changes in scientific advances and consumer market demands that may require modifying targeted contaminants of emerging concern (CEC) lists. For example, over-the-counter and prescription sales volume or demands of popular pharmaceuticals may quickly or unexpectedly change when newer classes of similar drugs are approved or observed to have unexpected environmental effects. The StRAP responsiveness may be improved by giving thought to such issues. This would assure the agency remains nimble and adaptable when priorities or changes to the threat landscape occurs.
- Consider uncertainties in capturing information on stakeholder needs. The StRAP responds well to the described stakeholder needs, but there is uncertainty regarding the methods used to capture and understand those needs. The StRAP should consider elaborating further on this issue and pointing to efforts needed to improve understanding of these needs in the future.
- Consider identifying unmet needs. The StRAP provides little sense of what is not captured in its research program. A discussion of this matter would not suggest the SSWR program is deficient but would reflect how well the program is in touch with future challenges. No research program is expected to be complete, but a program should reflect an awareness of the challenges that lie ahead.

Recommendations

The Subcommittee offers these one recommendation to improve and expand communication efforts.

Recommendation 1c.1: Research Objective 4 (Translate and Communicate Research) is partially met in the StRAP. The Outputs clearly and appropriately emphasize communication of results (data, tools, models) to stakeholders, and this is clearly essential to the SSWR program's success. There is, however, no mention of how to communicate information on risks to public health and the environment when discovered as a result of agency research. Risk communication is far more complex than is communication of a strictly technical nature. Ineffective or unclear communication concerning human health or negative environmental impacts can have many adverse consequences, including distrust of agency results. The SSWR should review the role of risk communication in its general communication efforts, its value to stakeholders, and of the significant guidance that is available from authoritative sources on appropriate strategies for communicating risk.

Charge Question 1d

> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

Narrative

As the nation's pre-eminent research organization devoted to addressing and solving environmental problems associated with water, ORD has the difficult task of balancing the immediate pressing needs of its clients, with the need for addressing the nation's emerging threats and challenges. The current SSWR StRAP reflects the extensive effort that was invested in communicating with its clients about their needs. However, given the increasing threats to the nation's water resources and supplies (i.e., changing environmental conditions due to climate change, aging infrastructure, increased nutrient and contaminant loading, decreased water quantity and quality), and the potential for unknown threats and stressors resulting from genetic mutations, newly manufactured drugs and chemicals, and novel interactions resulting from extreme climatic events and warming, ORD must develop a parallel strategy for identifying *new and emerging* issues of concern and developing practical and cost-effective solutions.

Strengths

- The Subcommittee commends the extensive communication with clients, including One World One Water (OWOW), Regions, States, and Tribes, to identify critical research needs.
- The StRAP identifies several very high-profile research topics in the Watershed and harmful algal bloom (HAB) programs to develop important technology needs and to integrate and leverage existing innovative technologies, including remote sensing and (unspecified) use of "omics". Also noted were efforts to develop guidelines for the development of safe cyanotoxin levels in drinking and recreational waters.
- The Subcommittee commends the focus on lower food webs dynamics, which can provide an "early warning system" for identifying human and environmental health threats.
- Further, the Subcommittee commends the research emphasis on the emerging contaminants of nano/microplastics and PFAS.

Suggestions

The panel noted a number of areas where new issues could be considered, or improvements could be made to the StRAP. These include:

- Better identify the link between Technical Support and Research, and the criteria used to elevate a request for support to the level of a research question and program. It is not clear to the panel that the survey was a particularly effective tool for identifying the key research questions that would best serve the Regions, States, and Tribes.
- Several pressing environmental problems were noted (pages 3-5) but were not further addressed within the Program Descriptions. These include Stormwater; Diminished Water Availability; and Wetlands.
- Several topics, such as 'omics were identified, but the research directions were too vague to understand ORD's intended direction.
- Although the focus on nano/micro plastics as an emerging contaminant is commended, the StRAP should make clear whether the focus is on developing measurement technology, on developing effects thresholds, or both.
- The StRAP has a heavy emphasis on evaluation of a single chemical group (PFAS), but needs a more holistic strategy for addressing a wider range of emerging contaminants.
- The topic of Resiliency is discussed in the Integration section but is not addressed elsewhere. The Resiliency research topics should be defined in the StRAP along with the recommended increase in focus on climate change effects.
- The Integration section does not address the potential for use of the USGS's new National Hydrology Dataset (NHD) products in the Watershed Program. Furthermore, the panel is unsure whether the list of topics presented in the StRAP for integration represent the full potential to maximize and leverage resources across programs.
- Consider additional strategies for incorporating community-engaged science, including use of Traditional Ecological Knowledge.
- The Communication Strategy relies heavily on traditional media and methods, e.g., peer reviewed papers and workshops for dissemination of results. Innovation in this Communication Strategy is suggested to increase appeal to younger audiences through use of social media and to more broadly disseminate research results through tools such as the EnviroAtlas.

Recommendations

The Subcommittee offers these three recommendations to identify critical emerging environmental needs or fields of expertise and specify topic areas where this program should consider investing resources.

Recommendation 1d.1: ORD should develop a parallel strategy for identifying and prioritizing emerging research opportunities and issues of concern.

The current StRAP was based on extensive communication with its clients about their current needs, but lacked a clear process for identifying and prioritizing horizon scanning research opportunities that are not yet on their client's radar. ORD must have the capacity and a systematic process to identify emerging issues that could threaten human and / or environmental health. Furthermore, institutional resources must be maintained to quickly address threats when they appear.

Recommendation 1d.2: Invest in addressing the ramifications of changing climate.

EPA is not a climate change management organization, but ORD does have responsibility for assessing how climate change will affect water quality management or how local management actions can exacerbate or lessen such effects. In particular, the StRAP should include elements that address the relationship between nutrient inputs and acidification, how shifting hydrologic regimes will affect implementation of the biological community assessment approach that EPA now relies on, and how changing temperature patterns will affect distribution of pathogens and harmful algal blooms.

Recommendation 1d.3: Develop/refine next generation environmental monitoring and assessment tools and technologies.

Monitoring technology is expanding exponentially, and ORD needs to be a leader in that field. The StRAP should consider increased investment in areas such as: a) Enhanced use of genomics for environmental monitoring, including measurement of extracellular DNA, b) Development of an emerging contaminants assessment strategy that includes non-targeted chemistry to assess known unknowns and bioanalytical screening to assess the unknown unknowns, and c) Use of automated monitoring technology development, such as unmanned drones for characterization and sample collection, and sensor development, d) Consideration of methods for incorporating traditional ecological knowledge in monitoring & assessment protocols.

Charge Question 1e

> Q.1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

Narrative

We interpret market based approaches and prizes or challenges as targeting two distinct audiences: (1) industry, and (2) secondary education institutions. In either case, to create successful incentives, it's important to engage and promote end user participation to develop the structure for incentives. We suggest working together with industry associations (e.g. American Society of Civil Engineers, American Water Works Association, and State Water Environment Associations) for a "finger on the pulse" of practitioners.

Regarding educational institutions, we suggest targeting specific populations, but consider that undergraduate engineering programs have very little flexibility and high demands on student time for course work, whereas graduate student schedules are more flexible. High school opportunities are entirely different. To encourage participation, we suggest giving the competition structure support, and give greater recognition to faculty and teachers behind the student teams. Opportunities to engage corporations to partner may raise their corporate profile as good stewards and promote education amongst these stakeholders.

In considering a plan for developing new incentives or challenges, it would be useful to understand the success of previous efforts. To date, how has EPA measured the success of incentives or challenges? These represent substantial investments in time and volunteer work (e.g., for judging, etc.). What evidence is there of a connection between an incentive or challenge to change the broader community's behavior supporting EPA's objectives under the CWA and SDWA? For example, has EPA compiled information on previous competitions or incentives and their long-term impacts? If so, can this be used for public interest/good PR? We consider communicating success stories important.

We are aware of several tertiary education sector challenges. Does EPA have any activities directed to high school audiences?

Strengths

- Partnerships with NIH, USDA, USGS.
- Partnerships with tertiary education institutions such as Campus RainWorks Challenge.
- Programs such as National Municipal Stormwater and Green Infrastructure Awards Program.
- Challenges such as: Nutrient Sensor Action, Advanced Septic Nitrogen Sensor and Arsenic Sensor.

Suggestions

- Have regional EPA offices partner with state regulatory counterparts; in particular, the state regional basin coordinators who are responsible for assuring that the regulated community develops and implements TMDLs in their respective basins or watersheds. The goal of this partnership is to reinforce the implicit rewards that a given sector of the regulated community can realize if they meet the TMDL goals of improved water quality.
  For example, if a wastewater treatment plant with known levels of mercury in its discharge, and the receiving stream is water quality limited for mercury, can develop and implement a mercury minimization plan to effectively reduce the concentration in its discharge, then the state may be able to reduce or lift restrictions on fish consumption.
  A secondary benefit may be that after word of this success story spreads, more anglers will come into the area, boosting the local economy, and providing a safer environment for those who like to eat what they catch.
- Provide incentives for market based approaches such as streamlined or reduced permitting requirements, grants to assist with initial development, or industry recognition to encourage innovative development to reduce nutrients. Methods such as algal harvesting have a great amount of potential.
- Work with innovation incubators and investors to better understand the emerging innovation economy, and better understand where market based incentives might best be targeted.
- Pursue opportunities for EPA staff to serve as visiting instructors. Teachers are more prone to include new material if they do not have to create it all themselves. A co-benefit to EPA staff is to stay current on topics at hand.

- Explore technologies for harvesting and reusing materials captured in storm water treatment practices (aka storm water control measures or best management practices). Heavy metals might be more of an economic incentive, whereas there is generally more data on nutrient capture.
- Develop programs to encourage extracting nitrogen and phosphorus from the soil profile or runoff. N and P are currently inexpensive; thus, it is easier for farmers to continue applying more, rather than harvesting what is already building up in the soil. Successful examples from Southern California nurseries who are harvesting and reapplying their own irrigation water, thus substantially reducing application of new N and P. Programs should be developed to collaborate with Regions, USDA and/or state extension services.
- Create incentives for using agricultural byproducts that would otherwise contribute to nutrient loading and generating electricity. An existing example emerges from a power company that seeks converting methane from hog waste digestion to electricity.
- Create partnerships to address reducing sediment loads from construction, which is not currently mentioned in the StRAP. Construction sediment loading is a significant issue for watershed management, especially in highly developed urban areas.
- Create partnership/incentive for water conservation such as a *Fit Bit* for domestic water use. What would drive/encourage people to continue conservation after droughts and mandatory conservation ends?
- Conduct a detailed literature search of the hundreds of case studies that provide insights on how to introduce more market related incentives for environmental protection, such as *Economic Valuation of River Systems.*
- Evaluate collaboration with Franz Theodore Stone Laboratory, Ohio State University's S. Bass Island Lake Erie campus and Algal and Water Quality Laboratory. The Lab allows researchers to identify plankton, measure chlorophyll content and cyanobacteria toxins, analyze organic and inorganic suspended solids and test for nutrients such as phosphorus and nitrogen.
- Evaluate collaboration with The Great Lakes Protection Fund, a publicly capitalized, private corporation created in 1969 by the governors of states surrounding the Great Lakes. The Fund's mission is to identify, demonstrate and promote regional action to enhance the health of the Great Lakes ecosystem.
- The Agriculture Applied Economics Association includes a large sub-group of environmental and natural resource economists. They have been involved in hundreds of research projects and case studies estimating the benefits and costs as well as market incentives for many forms of environmental protection/pollution control. This could be and existing valuable body of work for ORD to tap into.

Recommendations

The Subcommittee offers these recommendations to capitalize on specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems

Recommendation 1e.1: We recommend EPA Regional Representatives continue to partner with professional groups and other government agencies (e.g., AWWA, ASCE, ACWA, USDA, USGS, NIH, and NRCS), colleges and universities, and high schools, to actively solicit and encourage ideas that include market-based approaches or incentives to addressing water quality/quantity challenges at any and all levels (i.e., local, regional, national). These efforts should include funding mechanisms (e.g., grants, rebates, tax credits, go-fund-me, philanthropic donations, etc.) to support professional organizations, and collegiate and secondary education challenges/prizes for developing the best, implementable methods/solutions to water-related problems.

SUMMARY LIST OF RECOMMENDATIONS

Charge Question 1a: Does the research outlined for the 2019-2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

Recommendation 1a.1: While the research objectives, topics, and areas outlined in the StRAP are aligned with EPA's and ORD's strategic goals, it is less clear how success in meeting those goals will be evaluated. ORD's strategic plan talks specifically about measures of progress (e.g., increase the number of research products meeting customer needs under each ORD goal). Where possible, we suggest that the StRAP similarly describe measures of success for the different research outputs.

Charge Question 1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

Recommendation 1b.1: The subcommittee understands that there are significant limitations on EPA's ability to conduct surveys of any kind. Yet accurate and complete understanding of partner needs is extremely important for the SSWR. We recommend that ORD explore additional strategies to gather reliable information about partner needs. Information gathering strategies should include best practices for ensuring that unbiased and comprehensive information is obtained, and the information should be specific to each of the six research areas. Efforts should be coordinated through the Environmental Council of States (ECOS) to ensure State coordination with any identified strategies. The process and schedules for information gathering should be documented in the StRAP so the participants, timeline, and expectations are known and transparent.

Charge Question 1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019-2022 timeframe.

Recommendation 1c.1: Research Objective 4 (Translate and Communicate Research) is partially met in the StRAP. The Outputs clearly and appropriately emphasize communication of results (data, tools, models) to stakeholders, and this is clearly essential to the SSWR program's success. There is, however, no mention of how to communicate information on risks to public health and the environment when discovered as a result of agency research. Risk communication is far more complex than is communication of a strictly technical nature. Ineffective or unclear communication concerning human health or negative environmental impacts can have many adverse consequences, including distrust of agency results. The SSWR should review the role of risk communication in its general communication efforts, its value to stakeholders, and of the significant guidance that is available from authoritative sources on appropriate strategies for communicating risk.

Charge Question 1d: ORD resources and scientist numbers and hiring have declined over recent years. With the objective of maintaining a dynamic research organization at the forefront of environmental science, and recognizing the importance of addressing the identified partner research needs, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

Recommendation 1d.1: ORD should develop a parallel strategy for identifying and prioritizing emerging research opportunities and issues of concern.

The current StRAP was based on extensive communication with its clients about their current needs, but lacked a clear process for identifying and prioritizing horizon scanning research opportunities that are not yet on their client's radar. ORD must have the capacity and a systematic process to identify emerging issues that could threaten human and / or environmental health. Furthermore, institutional resources must be maintained to quickly address threats when they appear.

Recommendation 1d.2: Invest in addressing the ramifications of changing climate.

EPA is not a climate change management organization, but ORD does have responsibility for assessing how climate change will affect water quality management or how local management actions can exacerbate or lessen such effects. In particular, the StRAP should include elements that address the relationship between nutrient inputs and acidification, how shifting hydrologic regimes will affect implementation of the biological community assessment approach that EPA now relies on, and how changing temperature patterns will affect distribution of pathogens and harmful algal blooms.

Recommendation 1d.3: Develop/refine next generation environmental monitoring and assessment tools and technologies.

Monitoring technology is expanding exponentially, and ORD needs to be a leader in that field. The StRAP should consider increased investment in areas such as: a) Enhanced use of genomics for environmental

monitoring, including measurement of extracellular DNA, b) Development of an emerging contaminants assessment strategy that includes non-targeted chemistry to assess known unknowns and bioanalytical screening to assess the unknown unknowns, and c) Use of automated monitoring technology development, such as unmanned drones for characterization and sample collection, and sensor development, d) Consideration of methods for incorporating traditional ecological knowledge in monitoring & assessment protocols.

Charge Question 1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

Recommendation 1e.1: We recommend EPA Regional Representatives continue to partner with professional groups and other government agencies (e.g., AWWA, ASCE, ACWA, USDA, USGS, NIH, and NRCS), colleges and universities, and high schools, to actively solicit and encourage ideas that include market-based approaches or incentives to addressing water quality/quantity challenges at any and all levels (i.e., local, regional, national). These efforts should include funding mechanisms (e.g., grants, rebates, tax credits, go-fund-me, philanthropic donations, etc.) to support professional organizations, and collegiate and secondary education challenges/prizes for developing the best, implementable methods/solutions to water-related problems.

CONCLUSIONS

The SSWR Subcommittee believes the StRAP for 2019-2022 provides a reasonably comprehensive examination of the important challenges our country faces in providing reliably safe and sustainable water supplies and does so within the context of the EPA's mission and its mandate to partner with relevant stakeholders. The StRAP also provides, at a broad level, guidance on the scientific, technological and translational efforts required to respond to these challenges. The StRAP should hold up quite well to scrutiny by technical experts, based on the review undertaken by the SSWR Subcommittee.

The subcommittee also found considerable strength in the efforts to respond to identified stakeholder needs and noted substantial understanding of and responses to emerging threats, such as those associated with whole classes of perfluorinated compounds and microplastics. Partnerships with other government research organizations and tertiary educational institutions were cited as strengths by the Subcommittee.

The StRAP's elucidation of 31 research Outputs – the expected results of the identified research areas and their relationships to stakeholder needs – was found by the Subcommittee to be a valuable tool for evaluating the strength of the overall research program. The Outputs explicitly define where the proposed research is heading, and its ultimate value in meeting overall objectives.

The Subcommittee provided many suggestions for program and StRAP improvement. The most important of these, as reflected in the emphasis given to them in the charge question responses, concern the value of providing documentable measures of program success; the need to deal with uncertainties regarding the reliability of methods currently used to identify stakeholder needs; the importance of "horizon scanning" for capturing emerging threats; and the unrealized potential of market-based incentives for mitigating risks. The absence of priorities for the proposed research is noted in several suggestions, but

the Subcommittee recognizes that at this early phase of research planning, priority-setting is not a practical step the agency can undertake.

The Subcommittee has eight Recommendations for the SSWR to consider. Several of the Recommendations are focused on clarifying aspects of the StRAP, and in improving communication of its major messages, while others focus on emerging threats that are not sufficiently planned for in the StRAP. The subjects of communicating and translating research in effective ways are also highlighted in the Recommendations.

The subcommittee has also emphasized one Overarching Issue – the potential value for research planning that explicitly incorporates, at an early stage, and in collaboration with stakeholders, the plan for translation of the research results. Future StRAPS might explicitly include strategies for achieving successful translations of research findings.

APPENDIX A: MEETING AGENDA

Environmental Protection Agency
Board of Scientific Counselors (BOSC)
Safe and Sustainable Water Resources (SSWR) Subcommittee

Meeting Agenda
April 23-24, 2019
William Jefferson Clinton East 1153
1300 Pennsylvania Ave, NW Washington, DC 20460

TIME	TOPIC	PRESENTER
April 23, 2019		
8:15-9:00	Registration	
9:00-9:10	Welcome and Opening Remarks	Joseph Rodricks, Chair Robert Blanz, CoChair
9:10-9:45	Subcommittee Introductions	Subcommittee
9:45-10:00	DFO Welcome	Tom Tracy
10:00-10:15	ORD Welcome	Bruce Rodan
10:15-10:45	Review of Charge Questions	Joseph Rodricks, Chair Robert Blanz, CoChair
10:45-11:00	*Break*	
11:00-11:15	Public Comments	
11:15-11:30	SSWR Strategic Research Action Plan Overview	Suzanne van Drunick Joe Williams
11:30-12:15	Topic 1: Watersheds	Rick Greene
12:15-1:15	*Lunch (on your own)*	
1:15-2:00	Topic 2: Nutrients and Harmful Algal Blooms	Scot Hagerthey Hale Thurston
2:00-2:45	Panel Discussion: Office of Water's and Regional Perspectives on SSWR StRAP Benita Best-Wong, OW Principal Deputy Assistant Administrator John Goodin, OWOW Director Jennifer McLain, OGWDW Acting Director Deborah Nagle, OST Director Andrew Sawyers, OWM Director Carole Braverman, Region 5 Regional Science Liaison	Office of Water & Region 5
2:45-3:00	*Break*	

3:00-3:45	Topic 3: Water Treatment and Infrastructure	Chris Impellitteri
3:45-4:00	SSWR Communications and Outreach	Michelle Latham
4:00-5:00	BoSC Executive Session – Establish Charge Question Workgroups	Joseph Rodricks, Chair Robert Blanz, CoChair
5:00	Adjourn	Tom Tracy

April 24, 2019		
9:00-10:00	Subcommittee Discussion SSWR Response to Subcommittee Questions	Subcommittee SSWR Team
10:00-10:15	*Break*	
10:15-12:00	BoSC Executive Session – Workgroup Discussion and Writing	Subcommittee
12:00-1:00	*Lunch*	Subcommittee
1:00-2:30	Workgroup Presentations	Subcommittee SSWR Team
2:30-2:45	Next Steps	Joseph Rodricks, Chair Robert Blanz, CoChair
2:45	Adjourn	Tom Tracy

APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

Materials to Support the Charge Questions

- Agenda
- Charge questions
- Draft SSWR StRAP
- SSWR Overview for BOSC Meeting
- SSWR Research Program Overview
- EPA Strategic Plan https://www.epa.gov/planandbudget/strategicplan
- ORD Strategic Plan

Informational Materials

- Communication and Outreach Highlights
- Consumer Tool for Identifying Point of Use
- Nutrients and Harmful Algal Blooms Research
- Watersheds Resource
- Water Treatment and Infrastructure Research

Additional Material Provided During the Meeting

- BOSC SSWR Subcommittee roster