U.S. Environmental Protection Agency (EPA) Board of Scientific Counselors (BOSC)

Executive Committee

Face-to-Face Meeting Minutes

December 8–10, 2015

DRAFT

Dates and Times: December 8, 2015, 9:00 a.m. to 5:30 p.m.; December 9, 2015, 8:30 a.m. to 6:00 p.m.; December 10, 2015, 8:30 a.m. to 2:00 p.m. Eastern Time

Location: EPA Ronald Reagan Federal Building, 1300 Pennsylvania Ave NW, Washington, DC

Meeting Minutes

Provided below is a list of the presentations and discussions that took place during the meeting with hyperlinked page numbers. The minutes follow. The agenda is provided in Appendix A, the participants are listed in Appendix B, and the charge questions are provided in Appendix C.

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Tuesday, December 8, 2015

The meeting generally followed the issues and timing as presented in the agenda provided in Appendix A of this meeting summary.

Convene Meeting

Thomas Tracy, Designated Federal Officer

Mr. Thomas Tracy, the Designated Federal Officer (DFO) for the Board of Scientific Counselors (BOSC) Executive Committee, formally opened the meeting and welcomed the committee members. He discussed the Federal Advisory Committee Act (FACA) stipulations governing the meeting, which requires that the meeting is open to the public and that there must be time reserved for public comments. He thanked the members for their contributions and made brief announcements regarding the evacuation policies and other general matters pertaining to the meeting. Dr. Deborah Swackhamer, the Chair of the Executive Committee, introduced Dr. Tom Burke, the EPA Science Advisor and Deputy Assistant Administrator at the Office of Research and Development (ORD), and Dr. Robert Kavlock, the Deputy Assistant Administrator for Science at ORD.

Welcome

Thomas Burke, Deputy Assistant Administrator and
Robert Kavlock, Deputy Assistant Administrator for Science

Dr. Burke began his welcome speech by giving a short history of his experience with the BOSC. He expressed his great admiration and respect for the BOSC members and their efforts over the past year. He noted that BOSC committees have always had a frontline view of critical science that shapes not only environmental science but also shapes science policymaking.

Dr. Burke noted that ORD has changed the way science is conducted at EPA. He explained that an SAB review of science integration at the Agency identified "stovepipes" of research, where a systems approach is needed in order to move away from media-specific risk assessment and address broad problems such as cumulative risk assessment, environmental justice (EJ), and climate change. He added that ORD is dynamic and has been restructured greatly over the past few years to meet these new challenges and the Strategic Research Action Plans (StRAPs) have realigned their programs' priorities and management. Dr. Burke stated that the research programs need further guidance from the BOSC on systems thinking in order to truly redefine how ORD research is performed.

Dr. Burke added that the BOSC can potentially help ORD lead the way and be the path of communication with the greater scientific community. He asked for suggestions on how EPA can act to promote healthy and sustainable communities, a research area that is so broad and extensive. He also commented that ORD is the science backbone of EPA's regulatory process. ORD must have high-quality problem formulation, research integration, partnerships with states and local communities, and effective translation of its science. The BOSC will play an important role in helping ORD meet these challenges.

Dr. Burke reflected on Administrator Gina McCarthy's characterization of EPA as a public health agency, rather than simply an environmental regulatory agency. He acknowledged EPA must better integrate ecological and human health issues to make environmental science a more

all-encompassing and integrative field. To get there, he said, ORD and the BOSC need to incorporate systems thinking. ORD also needs to connect its roadmaps and stakeholders, an area where the BOSC has a large role. He concluded by stating that EPA scientists appreciate constructive criticism and recommendations focused on tasks that are the most important to advance the science and move the field forward.

Dr. Kavlock thanked Dr. Burke for his informative welcome and expressed his gratitude to the BOSC members for their participation. He noted his excitement regarding the opportunity for the subcommittees to work across topics with ORD on a permanent basis and was eager to hear their advice. Dr. Kavlock stated that ORD is near the end of the planning process, and there are now six national research program StRAPs on the ORD website that represent $2 billion in research over the next few years. He added that ORD has addressed many states' needs through the collaboration of program offices and regions with the states.

In addition to the national research programs, ORD has chosen four crosscutting programs to push forward on areas where it is important to catalyze integration. The four topics chosen are nitrogen and co-pollutants, children's environmental health, climate change, and EJ. Dr. Kavlock announced they would discuss climate change and EJ that day. He added that these conversations were intended to be discussions on scientific integration, not budget exercises. He asked the BOSC to identify any gaps in the StRAPs and to recommend changes ORD could make to bolster them. He noted the Agency is fully committed to these topics and is trying to adhere to the goal of innovation, which can be hard in a regulatory agency, but it is essential for integration. ORD has developed various project plans and subtasks since previous meetings, two-thirds of which are laboratory and center activities. ORD has pushed initiatives that are solution-oriented to better meet the needs of the research programs and the Agency, more generally. Another main focus in ORD is effective science translation to ensure the regions and states are able to take advantage of ORD work products.

Next, Dr. Kavlock discussed the ORD budget as it pertains to the research programs. The Sustainable and Healthy Communities (SHC) project is the largest, using around 40%. Air, Climate, and Energy (ACE), Safe and Sustainable Water Resources (SSWR), and Chemical Safety for Sustainability (CSS) are all approximately the same size, while Human Health Risk Assessment (HHRA) and Homeland Security (HS) are smaller. Their efforts are all funded through the President's budget. Dr. Kavlock clarified that the budget also depends on appropriations made by Congress, which are unlikely to match the funding levels designated by the executive branch. He explained that ORD works in a resource-constrained environment and each year there is a difficult prioritization process, especially since full-time equivalents (FTEs) have been declining. He noted, however, that ORD experienced a lot of attrition in 2015, and was able to hire more than 80 post-doctoral fellows in the last 12 months.

Dr. Kavlock covered a few common themes he identified among the research programs, which include how to further engage with national laboratories and centers, promote partner interaction throughout the planning and implementation process, and build formal committees between ORD scientists and program offices without over-engaging them. He stated that future interactions will vary by program, as different research program have different needs and resources. He added that ORD has asked the research programs' National Program Directors (NPDs) to formally engage with the BOSC at least three times over the next three years.

Dr. Kavlock then turned the discussion to the general feedback from the Executive Committee. He asked the members for suggestions on how to improve the charge questions in the future. He also asked for input on metrics to quantify ORD's impact on environmental health. Noting the combined review of HHRA and CSS, Dr. Kavlock asked for feedback on whether they should be reviewed independently in the future. He thanked the BOSC members for their time.

Dr. Swackhamer asked if there were any questions for Dr. Burke or Dr. Kavlock. Hearing none, she added her thanks for committees' significant efforts up to this point. She discussed meeting expectations, which she explained were simply to be as helpful to ORD as possible. She then asked the Executive Committee members to introduce themselves.

Introduction of Members

Deborah Swackhamer, Chair

Dr. Swackhamer initiated the introductions by saying she is a recent Professor Emeritus at the University of Minnesota and has worked in the School of Public Health and in the School of Public Affairs. She is a water expert and ran the Water Resources Center at the school for the last ten years. She became involved in environmental policy in the last decade. She served on the BOSC for one year before serving eight years on SAB, three of which she chaired the board.

Dr. Kenneth Reckhow is a Professor Emeritus of Water Resources at Duke University with a background in statistical analysis and water quality modeling from a decision-making perspective. He has been on panels for SAB and Chesapeake Bay program. He has also chaired the NAS review of the EPA Total Maximum Daily Load (TMDL) program and the Chesapeake Bay program.

Dr. Galloway is a Sidman P. Poole Professor of biochemistry in the Department of Environmental Sciences at the University of Virginia. He has been on the SAB for six years and chaired the *ad hoc* subcommittee on the integrated nitrogen strategy.

Dr. Viney Aneja is a Professor in the Department of Marine, Earth, and Atmospheric Sciences at the North Carolina State University. He has experience in agricultural air quality. More recently, he has focused on climate change and is the chair of the ACE BOSC subcommittee.

Dr. Robert Richardson is an Associate Professor at Michigan State University, with a background in environmental economics and climate change adaptation. He serves as the chair of the BOSC SHC subcommittee.

Dr. Courtney Flint, an Associate Professor in the Department of Sociology, Social Work, and Anthropology at Utah State University, examines how communities respond to risks and environmental change and works to integrate the social sciences into the natural sciences.

Dr. Shahid Chaudhry is a Senior Mechanical Engineer at the California Energy Commission. He is currently managing efforts to make water resources more sustainable in California, especially in the context of a changing climate. He expressed that his comments during the meeting will represent his own opinions, and not necessarily the position of the Commission.

Dr. John Tharakan is a Professor of chemical engineering at Howard University, where he focuses on the ethical and EJ implications of engineering and also runs the university's

Engineers Without Borders program. He led the hazardous substances research group at EPA 25 years ago and has participated on the BOSC for about four years.

Dr. Gina Solomon works at California EPA as the Deputy Secretary for Science and Health. She is also a clinical professor of medicine in the Division of Occupational and Environmental Medicine at the University of California, San Francisco. She has also been a Senior Scientist at the National Resources Defense Council, where she ran their public health efforts on the west coast. Her primary interests surround human health risk assessments and exposure science related to air pollutants, climate change, and EJ. She has previously served on the drinking water SAB. She served on the Toxicity Testing in the 21st Century and the Exposure Science in the 21st Century committees, in addition to many others. She serves as the vice chair of the CSS/HHRA subcommittee.

Dr. Ponisseril Somasundaran is a La von Duddleson Krumb Professor at Columbia University, with research interests in solid and hazardous wastes, biomedical engineering, the environmental effects of pollutants, and nanotoxicity. He has worked on the National Academy of Engineering and served on National Science Foundation and Department of Energy panels.

Sandra Smith is a Principal Toxicologist and Project Manager at AECOM and has an educational background in environmental science and toxicology and is a major downstream user of EPA's work products. She works at the local level, looking at pollutants in drinking water, and has worked on the Air Information Clearinghouse.

Dr. Andy Miller is the Associate Director for Climate Change in regards to air related topics at ORD, and is the Associate NPD for the ACE research program.

Kathy Sykes supports the SHC subcommittee and works at EPA as an ORD Senior Advisor.

Dr. Fred Hauchman is the Director of Office of Science Policy (OSP) at ORD.

Dr. David Kryak works at ORD's National Exposure Research Lab.

Andrew Geller is the Deputy NPD for the SHC Research program and is the current lead writer on the EJ Roadmap.

Dr. Dan Costa serves as the NPD for the ACE research program.

Dr. John Vandenberg is the Deputy NPD for HHRA and works as a division director for NCEA.

Dr. Tina Bahadori is the NPD for CSS.

Cindy Roberts is the DFO for SSWR and works for ORD's OSP.

Sarah Major supports the SHC subcommittee and works for ORD.

Marsha Minter is the Associate Director in EPA's Office of EJ.

Mimi Dannel is the Deputy Director for OSP.

Dr. Maureen Gwinn works at ORD in the Office of the Assistant Administrator.

Connected over the phone was Dr. Mike Slimack (NPD for the SHC research program), Ms. Cynthia Sonich-Mullin (Director of ORD's National Risk Management Research Lab), and Mr. Joe Williams (Deputy NPD of SSWR research program).

As a logistical note, Dr. Swackhamer asked all participants to raise their hands before speaking, as she has a hearing deficit.

Review Agenda and Meeting Charge and Process

Deborah Swackhamer, Chair
Dr. Swackhamer stated the Executive Committee's objective and charge is to provide EPA with constructive advice. The main goal for the Executive Committee meeting was to produce a short, concise, and useable report based on the various subcommittee reports that have been written in the past year. She explained that the Executive Committee will need to summarize the individual subcommittee reports and synthesize the recommendations to make a useable and effective final report. She noted that the full subcommittee reports could be included as appendices. The primary focus of the final report should be identifying issues and recommendations that are common across the various subcommittee reports. Dr. Swackhamer stated that the subcommittee syntheses should be a few pages, and the roadmap could be any length, as long as it is concise. She expressed her goal of completing the writing during this three-day meeting, so the members could review the work and reconvene in a teleconference to discuss the next draft. She added that the reason the three day meeting had such an ambitious agenda is to facilitate the completion of the final report by March 1, 2016. Dr. Swackhamer asked the members for any questions or comments.

Dr. Flint asked how the roadmap discussion breakout groups would work in terms of deliberation and writing. Dr. Swackhamer stated the committee would work in subgroups and explained the process. Dr. Alan Hecht, the Director for Sustainability in ORD, joined the meeting in person at this point. Dr. Swackhamer asked the room to start with the first presentation on the EJ Roadmap.

Public Comments

Registered Speakers
No members of the public registered as speakers for this meeting, and the Executive Committee did not receive any public comments.

Presentation

Andrew Geller, Lead for the Environmental Justice Roadmap

Mr. Geller led the discussion on the EJ Roadmap. He stated the committee must relate the science gaps in the field back to distinct scientific challenges and assess whether EPA actions are sufficient to address the issues. More specifically, he said the subcommittee should aim to identify issues ORD does not address adequately rather than gaps in broad topic areas. For example, the subcommittee might note gaps in cumulative risk assessment (CRA), but since ORD engages in the subject area more broadly by researching other forms of impact assessments (Health Impact Assessment and Life Cycle Assessment), the group would not note it as a gap. Mr. Geller then went on to discuss the major gaps the subcommittees had found while also attempting to place the roadmap in EPA's legislative context.

Mr. Geller stated the first gap in the roadmap is related to community engagement and setting the research agenda. He noted that this issue was noted by both the National Environmental Justice Advisory Council (NEJAC) and the BOSC. He added that from SHC's experience with

Community-Focused Exposure and Risk Screening Tool (C-FERST) and Tribal-Focused Environmental Risk and Sustainability Tool (T-FERST), the subcommittee and ORD know that communities hold key information about their problems and have workable solutions that may advance environmental, economic, social, and health sustainability. He clarified that the issue is, in many cases, that these communities lack the expertise or resources required to move forward on their own. The challenge will be engaging communities in setting a research agenda that cuts across and integrates all of the discussed challenges, which include developing "value added" decision support for cumulative assessments and scenario analyses as well as identifying the most pressing issues in health disparities and non-chemical stressors. The research challenges also include encouraging full tribal participation in research and tool engagement and working with communities to identify the most urgent issues in climate vulnerability, preparedness, and resilience.

The second gap is related to assessing outcomes. Mr. Geller noted that the EJ Roadmap states that addressing outcomes is a critical part of its Sustainability Assessment and Management cycle, which has been adapted from the NAS Green Book. EPA's other programs (e.g., Homeland Security research program) similarly include cycles that permit adaptive management. Mr. Geller acknowledged that assessments of the impacts of policy decisions and actions has been rare and has only occurred when there is a dedicated effort to understand best practices or evaluate the outcomes of a risk management action. He pointed out that the subcommittee urged for the use of ORD tools in non-regulatory scenarios, such as equipping motivated citizen scientists in communities and tribes with the tools and metrics to necessary play a critical role in evaluating short and long term impacts of regulatory actions. He added that an initiative of this nature would address science challenges 1 and 3.

Mr. Geller presented the third major gap identified by the subcommittee, which involves prioritizing the training of the next generation and also addresses challenges 1 and 3. This challenge will entail building a community with the capacity to use ORD information and tools to make decisions in their own communities, and to better engage with the expert resources that are available to them.

Mr. Geller explained that while the roadmap contains a set of key questions, the science challenges are somewhat overlapping and that the key questions can be mapped in groups as follows: key questions 1 and 2 address challenge 1, questions 3–6 address challenge 2, question 7 addresses challenge 1 and 2, question 8 addresses challenge 3, and question 9 addresses challenge 4.

Mr. Geller asked for the BOSC members' input on the best way to interact in the future. He then clearly articulated the priorities determined by the subcommittee. ORD should prioritize based on its legislative mandates, which are discussed in EPA's *Technical Guidance for Assessing Environmental Justice in Regulatory Analysis*. The science challenges and questions should be placed in both a regulatory and non-regulatory context, and should be used to determine the scope of scientific activity while ensuring agreement with Agency plans outlined in the 2020 EJ plan.

Mr. Geller ended his presentation with ideas for his next meeting with the subcommittee. He stated that he will revise the EJ roadmap in response to the subcommittee's review of this draft and continue discussions within ORD and across the Agency. He added that this BOSC review

should be comprehensive. Accordingly, he noted that he will provide the subcommittee with additional background material so they will have the full program context to properly review the EJ Roadmap. To make the report comprehensive, the subcommittee should include reference to EPA's *Draft Technical Guidance for Assessing Environmental Justice in Regulatory Analysis*, the final *Technical Guidance for Assessing Environmental Justice in Regulatory Analysis*, the Plan EJ 2014 science plan and progress reports, as well as EJ 2020 Action Agenda. He commented that he will keep the subcommittee apprised of interactions with NEJAC on the EJ 2020 Action Agenda and the development of the Science Tools Implementation plan in that action plan. He also suggested that the subcommittee work with SHC or other programs with expertise in natural, physical, and social sciences, since they will need a well-rounded group of experts to identify the issues that must be addressed to meet these EJ goals.

Dr. Swackhamer asked whether the Executive Committee members had any questions for Dr. Geller. There were no questions, and she dismissed the group for a short break.

Discuss Charge Questions: Environmental Justice Roadmap

Deborah Swackhamer, Chair

Dr. Swackhamer welcomed the committee back from break and explained that the committee would use the next hour to discuss their responses to the EJ Roadmap charge questions. Dr. Swackhamer asked if the committee had any general comments or questions before commencing the detailed discussion of the charge question.

Dr. Flint commented that for too long the EJ conversation has been focused on providing information and recognizing issues of overburdened and disadvantaged communities. She commended this EJ effort for moving beyond this toward the notion of meaningful engagement and access to the democratic process to achieve EJ. She added that the conversation needs to move beyond identification of EJ problems and, in this way, the spirit of the EJ Roadmap was very useful. Dr. Swackhamer voiced her agreement with Dr. Flint's excellent comment.

Dr. Solomon noted that overall she was very impressed and pleased with the roadmap because it was very thoughtful, clear, and well organized and put together. She agreed with Dr. Flint that the next step in moving toward engagement and empowerment was wonderful. She noted that it then begged the question of the following step, which is determining whether EJ communities are actually being improved over time or whether these communities remaining disadvantaged and overburdened. Dr. Solomon explained that determining whether there has been an impact is something California has struggled with. Dr. Solomon added that might be an aspect that was not as well covered in the roadmap.

Dr. Tharakan agreed that the EJ Roadmap was well done and added that one of the key questions he had was about the approach. He clarified that the approach seemed to suggest that this effort was the first time EPA was integrating social sciences into their programs and they were not cognizant of the fact that there has been much work already performed on well-being and EJ. Dr. Tharakan cautioned EPA against duplicating efforts and suggested they pull into the StRAP the community engagement work that already exists.

Dr. Swackhamer stated that the EJ roadmap referenced a tremendous amount material and asked Dr. Tharakan if there was some specific previous work or document that he thought should be explicitly referenced. Dr. Tharakan responded that there was nothing specific, but he felt that the

roadmap did not reflect a lot of existing work available on the topic and asked if that work was incorporated. Dr. Swackhamer summarized Dr. Tharakan's comment as a general caution to EPA to not reinvent the wheel.

Dr. Richardson supported the previous comments that the Roadmap was impressive and well done. He explained that his comment came from SHC deliberations about the language used to discuss EJ issues and how that language may need to evolve. Dr. Richardson explained that, although he understood the relationship discussed in Figure 2 of the roadmap on the interactions between the built and social environment and biological factors, there was more complexity that was not captured. He pointed out the economic and political environment in addition to the concentration of power. Additionally, he identified race, ethnicity, and racial location as drivers of EJ in Figure 3 of the roadmap. He added that the SHC subcommittee debated about language use during their meeting. Dr. Richardson clarified that the SHC subcommittee draft report used the phrase "racial and ethnic minorities," but pointed out that the marginalized portions of many EJ communities are, in fact, the majority within those populations. Focusing on race and ethnicity may overlook issues like poverty and access to resources. Dr. Richardson suggested that these terminology issues are worth considering as the EJ roadmap evolves.

Dr. Swackhamer asked the Executive Committee members for additional general comments and impressions. She noted her agreement with other's comments that the roadmap is well written and clear but stated that she had difficulty mapping the gaps back to how they would be addressed given the identified projects and goals. Mr. Geller responded that he would consider Dr. Swackhamer's comment. He explained that the NEJAC report included many recommendations, specifically for the research enterprise, and it was instructive to look at the report's recommendations table because it displayed topic pieces that were being addressed throughout the report. Some of the biggest gaps that SHC is not yet addressing are listed at the end of the EJ Roadmap. Mr. Geller explained that EPA engages councils like the BOSC and others throughout the Agency to develop their research agenda, but EPA did not work directly with communities. Thus, EPA must think about the mechanisms available for achieving their goals while also avoiding the perception of having biased samples. Dr. Swackhamer applauded Mr. Geller for articulating the gaps in the roadmap.

Dr. Solomon added that Mr. Geller touched upon an important point. She explained that she had conflicting feelings about community engagement. She clarified that it is critically important for EJ, but effective engagement must be long term and, therefore, is resource intensive. Community engagement creates the expectation that the Agency will continue to work with the community. However, Dr. Solomon asked how many communities EPA could realistically work with given budget constraints and Agency scope limitations. She pointed out that, while important, it may not be a realistic recommendation for SHC. Dr. Solomon stated that the approach of engaging communities through academics worked reasonably well and questioned whether the committee should recommend that EPA directly engage with communities. Dr. Swackhamer agreed and added to the issue's complexity by asking when the responsibility of community engagement would fall on EPA verses states or other organizational structures.

Dr. Flint noted that the issue of community engagement is known to be important and added that the overarching point for her was the issue of scales. She pointed out that socially structured, macro-scale issues, such as the socioeconomic and political aspects of power and equity are

difficult to overcome with local-scale community engagement efforts. Dr. Flint challenged the notion that local-level engagement can stand against the powers that created such disadvantage in the first place. She encouraged the committee to further think about these multiscale issues and to think about community engagement in terms of the available mechanisms, if the issue is outside of EPA's mandate. Dr. Swackhamer responded by saying Dr. Flint had an excellent point and she did not have a good answer for the questions Dr. Flint posed to the group.

Dr. Reckhow drew the committee's attention to the box titled "Synthesis and Evaluation" in Figure 1 of the roadmap. He stated that the first three bullets in the box were clear, but asked Mr. Geller what he proposed to do about the fourth bullet that used the word "uncertainty." Mr. Geller responded that he borrowed this term from Dr. Burke and the bullet was added because it illustrated systems thinking and "fit-for-purpose." He clarified that the intent was to call attention to the different kinds of assessments that are needed to address these issues. He added that in terms of uncertainty, one of the challenges of developing technology is how to accurately and understandably represent uncertainty in the tools that EPA produces.

Dr. Reckhow explained that the prescriptive model was good to use when conducting decision analysis and suggested that EPA prioritize hiring decision analysts in a number of areas. He elaborated that when informing decision makers, the two key components are providing information on the actions of meaningful endpoints and valuation, whether it be a cost estimate or utility analysis. The main challenge of dealing with uncertainty is convincing decision makers and stakeholders that they are better off quantifying the uncertainty of a proposed action on meaningful endpoints than having no prediction at all. Decision analysts are often confronted with the reaction that not enough is known about a predicted outcome to take any action beyond the status quo and that more research is needed. He noted that these types of reactions speak to the need for an improved approach for presenting uncertainty.

Mr. Geller noted that he appreciated Dr. Reckhow's comment and that EPA had thought hard about uncertainty. More specifically, he added that SHC had discussed structured decision making approaches and conducted a great workshop in conjunction with Canada, involving recognized specialists on the topic. Mr. Geller explained that one of the reasons that more thought has been put into impact analyses, such as health impacts and other structured approaches, is that decisions have associated costs and may answer one objective but will likely not answer the multiple objectives that surround a given issue. He stated that when putting together the data tables for a multi-criteria decision or other type of utility analysis to compare and develop valuations, the issue may just be directional. For example, there is likely an option that could be identified as the best or worst option for a specific outcome and objective, while uncertainty associated with the scenario is something that needs to be characterized more carefully.

Dr. Reckhow commented that he hopes Mr. Geller and his research program will be able to move beyond the directional aspect of modeling because, in the area of water quality, nutrient reductions are associated with TMDLs. Therefore the direction of the water quality criteria on the meaningful endpoints was known, which makes the directional characterization trivial. Dr. Reckhow agreed that there were multiple objectives in any problem analysis and the most important objectives need to be identified and thoroughly addressed. However, he urged Mr. Geller to consider two additional aspects. The first is identifying the analytic technologies that

propagate error through a probability distribution. Dr. Reckhow added that a lot of work on this topic already existed and it could be implemented fairly quickly. The second consideration is determining how to present uncertainty information so stakeholder and decision makers are comfortable discussing it.

Dr. Swackhamer redirected the committee's attention to the details of the charge questions and added that some of the questions were easy to address while others were more challenging. She suggested the committee begin by discussing the first part of the charge question, which came directly from the *ad hoc* SAB *Science Integration for Decision Making* report that Dr. Burke chaired. Dr. Swackhamer highlighted that Dr. Burke was well aware of the importance of engaging the correct people in the development of a problem statement.

How effective is the Draft EJ Roadmap in presenting a problem statement?

Dr. Swackhamer asked the committee if the problem had been adequately described.

Dr. Tharakan observed that the problem had been broken into a number of specific problems, as exemplified in the nine questions listed on page ten of the roadmap. He directed the committee members' attention back to Figure 1 in the roadmap and noted that he did not see a number of topics included that EPA had emphasized in previous meetings (e.g., transformative science, multidisciplinary science, and citizen science). He asked how these topics fit into EPA's framework for environmental protection and community improvement. He added the goal to see the difference EPA's efforts made on the ground was also not included in the diagram.

Dr. Aneja raised the example of closing plants as a complex issue that is often debated by his students. He explained that if a plant is closed, people lose jobs. However, if there is an accident, the community would suffer more. He acknowledged that these complex problems are difficult to address no matter how much research is conducted, but they are not described in the roadmap. Dr. Aneja suggested these complex problems be identified so people begin to think about the ways different actions can affect a community.

Dr. Solomon observed that the first paragraph under "Expanded Problem Statement and Key Research Topics" on page eight of the roadmap provided a review of the background and introduction section of a 1992 EJ report, including the history and a broad description of EJ. She pointed out that the paragraph discussed the four science challenges, but it was unclear to her if those were the intended problem statement. Dr. Solomon noted that the research challenge and questions that should be embedded in the problem statement were not included and suggested that a few sentences be added to make the problem statement more clear and overarching. The problem statement should then lead into the four science challenges, which she added were great. Dr. Solomon suggested the first paragraph include a justification for why EJ research is necessary over the 2016–2019 timeframe.

Dr. Swackhamer agreed, noting the problem statement that reads: "The goal of ORD research addressing EJ is to strengthen the scientific foundation for actions at the agency, state, tribal, local and community levels to address environmental and health inequalities in overburdened populations and communities." was included on page four but was not repeated in the problem formulation section of the Roadmap. Dr. Swackhamer raised the previously discussed concern that EPA cannot address all disparities and inequalities for all communities and challenged committee members to find EPA's niche in the greater EJ effort. She clarified that EPA's role

within the effort is not clear in the roadmap, adding that the EJ questions addressed in the roadmap are not necessarily EPA-specific and could be applied to other agencies such as the National Institutes of Health (NIH).

Ms. Smith observed that the bottom line of the EJ effort is that science indicates there are communities with unacceptable risks that need to be addressed. She noted that many disparities exist, but suggested focusing on the communities where the disadvantage presents unacceptable risks.

Dr. Richardson noted that he would like to see environmental injustice drivers included, but was unsure if the problem statement or research gaps already included them. He recognized the complexities of his request and explained that there was a lot of overlap when the drivers were broken down by the four research questions. He suggested identifying the issues with common ground that could serve as disparity drivers and develop an EJ community typology to inform policy makers on how to address the current drivers and prevent problems in the future.

Dr. Flint recognized that the committee's discussion consisted of two parts. The first considers how to mitigate existing EJ-related risks and the second is the issue of prevention. She added that preventing health disparities is discussed on page 11 of the roadmap. She noted that the key to untangling the EJ issue is to address the current and future problems. The problem statement should reflect the need for a more complex systems understanding and integrated approach to mitigating and preventing EJ issues.

Dr. Chaudhry agreed with the previous committee members' points. He noted that much data has been gathered, but the real challenge is how the existing data will be used to implement EJ actions and evaluate the impacts of these actions.

Dr. Reckhow responded by noting that Dr. Chaudhry's comment raised the issue of dual objectives between the research and regulatory arms of EPA and asked to what extent the committee should urge ORD to set up pilot studies that may be more appropriate for the Office of Science and Technology or other EPA offices.

Dr. Solomon explained that she viewed ORD's objective as trying to develop tools for use by other programs. Thus, there is an important role for ORD to "sell" what they are creating and determine if the tools they develop are used by program offices. Dr. Reckhow responded that Dr. Solomon's point was interesting but pilot projects are not tasked to ORD.

Dr. Kavlock explained that the Office of Land and Emergency Management (OLEM), previously known as the Office of Solid Waste and Emergency Response (OSWER), deals with Superfund and brownfields sites in communities and views itself as EPA's community lead. He added that OLEM has expressed interest in helping ORD identify communities that face EJ situations that could be extrapolated to other communities. However, there was also tension with OLEM surrounding their concern that ORD would develop tools, such as C-FERST, that communities could use to develop their own views of environmental situations that could result in discrepancies between the views of the community and the views of OLEM.

Dr. Reckhow asked if ORD would fund a pilot study. Dr. Kavlock responded that they do and explained an EPA initiative, launched last year, to make a difference in communities. The Administrator charged the Agency to identify and engage with 50 communities across the country. Dr. Kavlock noted that EPA was engaged with 15 or 16 communities at the time of the

BOSC EC meeting. Mr. Geller confirmed the community engagement effort and added that EPA's involvement in those few communities was an opportunity to conduct transdisciplinary research with communities in mind (e.g., receive comments on the usability of the tools from the communities that used them). He added that SHC already has an ecosystem goods and services project with a community as well as a case studies that examines the efficacy of ecosystem services tools in public health applications. He added that SHC needs help from social scientists to understand community metrics that move beyond economic drivers alone, such as perception of place, well-being, community revitalization, and the success of initiatives to reduce EJ burdens. Mr. Geller further explained that SHC's ultimate goal is to determine how to export their work and engage closely with the regions, who are already conducting these efforts. The goal of some of the models, such as the tribal focused T-FERST tool, is to have tribes assume control over the tool because EPA does not have the resources to continue tool maintenance indefinitely. Mr. Geller concluded that it would not be EPA's ideal outcome if tribes did not take ownership of the tool and EPA hoped to engage use of their tools through the citizen science.

Dr. Swackhamer stated that, although there had been a number of good comments, the committee spent 30 minutes on the first of five charge questions. She asked for any final comments about problem statements and, hearing none, moved on to the next charge question.

How effective is the Draft EJ Roadmap in elucidating key research topics appropriate to the mission of the EPA?

Dr. Swackhamer added that she thought the four key research topics were exciting, but asked the committee to discuss whether they are the correct and only research topics that should be included. She clarified that her concern is the lack of clarity regarding how the four topics were selected.

Dr. Richardson commented that the second key research topic was focused on environmental health disparities, but did not include other types of disparities that relate to EJ. He noted economic disparities that have health implications and profound economic limitations that limit a community's ability to advance. Dr. Swackhamer agreed, noting his comment circled back to the point made about EJ drivers.

Dr. Richardson added that the same point could be made for political disparities in terms of how power is distributed across communities. He clarified that power may be concentrated at the county or state level where decisions are made, but relatively powerless communities are the ones that face a range of disparities.

Mr. Geller commented that when he spoke about environmental health disparities, it included health, or the absence of disease, and well-being, such as social conductivity, among other factors. He asked Dr. Richardson if his concern would be addressed if the language in the roadmap spelled out what was meant by environmental health disparities more clearly. Dr. Richardson confirmed that including the human health and well-being aspects in addition to ecological health aspects would be helpful.

Dr. Somasundaran explained that the comment on economic disparity brought up the previous committee discussion on metrics. He noted that metrics of success should consider health effects, economic effects, and social effects. Dr. Somasundaran recognized the complexity of considering all these factors, but urged for their consideration.

Dr. Tharakan raised his concern that the committee was chasing its tail. The prime driver of EJ was economic disparities, which involves the social system we inhabit. He commented that the social system is outside the purview of EPA. Dr. Tharakan asked the committee whether it is realistic to ask EPA to tackle an issue that they cannot act on, noting the limits of the Executive Committee's recommendations. Dr. Swackhamer thanked Dr. Tharakan for his concise articulation of that crosscutting issue.

Dr. Solomon explained that the four key research topics included in the EJ Roadmap captured the key questions and issues that are heard in the California EPA EJ community and added that it would be useful if EPA could make headway on these issues. She noted, however, that the text at the bottom page ten that reads: "We note that there is a wide spectrum of contaminated sites across the nation, many of which are located in or near overburdened communities and which may have disproportionate impacts on those communities. ORD works closely with the Office of Land and Emergency Management and EPA's Regional Offices to develop remediation technologies that will benefit these communities, but a discussion of this research has not been included in this document." It did not mention legacy sites. She commented that this is an issue, and asked about the thought process behind the decision. Dr. Solomon noted that toxic waste and race are at the top of the EJ timeline and are issues that started the EJ movement. She added that during the CSS/HHRA meeting, the subcommittee discussed possible activities that could address these issues. She discussed uncharacterized contaminants found at California brownfield and superfund sites that made their way into the drinking water supply. She noted that ORD has tools to address these problems and tools designed to screen unknown chemicals should be explored. Dr. Solomon suggested that the committee add text to the report along the lines of "we recognize that legacy sites are an issue for disadvantaged communities and there are a number of activities that ORD is doing that could provide valuable information to addressing this." She added that if she were rewriting this document she would add partnership and tool development as the fifth key research topic on the EJ Roadmap list, but clarified that her recommendation was to just expand the point beyond the footnote at the bottom of page ten.

Dr. Swackhamer noted that ORD's capabilities were implicit in the other four research topics. Dr. Solomon agreed, but recommended that they make the point more explicit. Dr. Solomon explained that the point could be mentioned in each of the four key research topics because it was already included in key research topics 2 and 3. She added that it should be included in key research topic 3 on flooding of brownfield and Superfund sites.

Dr. Flint raised the potential issue of judicial contestedness that arose under the second key research topic when talking about cumulative risk. She explained that the key research topic suggested that the factors are universally recognized, but pointed out in our litigious system it is easy to cast doubt on a single factor under consideration in a court room. Cumulative and integrated assessments are important, but can raise the issue of contestedness for EJ issues.

Dr. Swackhamer stated that Dr. Flint's comment brought the discussion back to the issue of finding a defensible cumulative risk assessment. Dr. Flint clarified that cumulative risk is not just the consideration of multiple effects, but was the interactions among them. She noted that cumulative risk science needs to support that.

Dr. Swackhamer suggested that the committee move on to the third part of the question. She noted that she thought EPA did a good job but did not talk about how to fill the gaps.

How effective is the Draft EJ Roadmap in elucidating important scientific gaps appropriate to the mission of the EPA?

Dr. Tharakan raised his concern, in terms of gaps, that the reference list was composed of all EPA documents. He noted that academic literature focused on well-being and EJ was not included or referenced. Dr. Solomon added that Dr. Tharakan's comment returned to the earlier conversation about EPA's scope, budget, and ability to engage with communities. She suggested that the committee encourage articulation of parameters based on what is feasible for EPA and include material where these feasible parameters were identified.

Dr. Richardson observed the possible gap of understanding drivers and typology of EJ communities. He noted that he was not sure about the appropriate place for his comment, but Dr. Swackhamer assured him that the EJ drivers and typology gap fit under charge question 3.

How effective is the Draft EJ Roadmap in capturing relevant research in each of the six programs?

Dr. Swackhamer asked the committee if EPA had captured all the relevant research.

Dr. Flint noted that there were no checks across SSWR and Tribal Science in the box matrix about EJ research activities and the national research programs. She pointed out that this is a critical nexus that might have been overlooked. Mr. Geller responded that, although it was not a huge area, SHC did have some work on tribal water infrastructure, specifically work on small water systems, so the matrix Dr. Flint was referring to could be updated.

Dr. Richardson added that he had a similar comment for the CSS program. He observed only one check under health disparities and cumulative risk, but noted he could imagine a strong link between climate justice and CSS. For example, the issue of algal blooms caused by chemical runoff in the Great Lakes could be exacerbated by the warming of the lakes which might disproportionality impact certain communities. Dr. Kavlock responded that what Dr. Richardson mentioned would be covered under SSWR.

Dr. Solomon explained that there was a Great Lakes project that is screening wastewater and drinking water for mixtures of contaminants. The screening included analytical chemistry to identify the chemicals in parallel with mixture screenings to elucidate their potential actions. She noted that this is an interesting project relevant to climate. In addition, the contaminant site work of HHRA and CSS, that Dr. Solomon previously mentioned, included the screening of emerging contaminants to identify compounds. She noted that this is also a recommendation from the CSS/HHRA subcommittee.

Dr. Swackhamer asked if any other parts of the research programs were missing. Dr. Flint asked if there were any HS issues that might be unique or underexplored in regards to EJ questions. Mr. Geller explained that the HS program was very small. He added that the only aspect that directly affects EJ issues is community resilience to climate change and severe weather emergencies. He explained that there is research in many of ORD's research areas that serve all communities, but problems are most acute in overburdened communities. He commented that CSS is working to provide toxicity values to the extent possible, but Mr. Geller was unsure whether the program is prioritizing the generation of provisional peer reviewed toxicity values (PPRTVs) for those that are particularly relevant to EJ communities. Dr. Annie Jarabek added that PPRTVs are prioritized by the program to some extent.

Dr. Swackhamer suggested that prioritization within each research program be made more clear and that crosscutting research, which might be outside of a research program's boundaries, does not need to be included in their research plan. In other words, the missing relevant research should be more explicit than implicit.

How effective is the Draft EJ Roadmap in identifying areas of integration across the six programs?

Dr. Tharakan commented that ORD's structural framework is problematic in that it considers the six StRAPs as independent research areas when, in fact, the StRAPs should all feed into SHC, since safe and healthy communities are achieved by addressing all of the other program issues. Thus, in terms of the structural framework, if SHC became the overarching umbrella under which these other programs are operationalized, integration would be natural and the framework would capture the relevant research necessary to impact communities.

Dr. Swackhamer asked EPA if they thought about SHC serving as the overarching program theme when they were formulating the six research programs. Mr. Geller responded that SHC was the overarching framework when the six research programs were conceptualized and still is the overarching theme of ORD. He added that EPA is thoughtful about many different factors when developing tools, since communities experience everything at the local level.

Dr. Somasundaran stated that one important community factor is food security. There are still food and water contamination issues so food security, contaminants, and availability remain important. Dr. Swackhamer responded that food security falls under the purview of the Food and Drug Administration (FDA), not EPA. She added that the only place where EPA has a role in food is issuing national fish consumption advisories. Dr. Galloway suggested that the committee mention that food was not addressed in the roadmap because it is under FDA's jurisdiction. Mr. Geller added that EPA recognized food deserts and safety as important issues, but noted these are not necessarily EPA's issues to resolve. He mentioned that SHC has staff interested in food safety in terms of understanding how it may driver of underlying health disparities. Dr. Swackhamer agreed with Mr. Geller and summarized his point by stating that food security could be to be included in EPA models if, for example, it is an uncertainty variable that drives the model. Ms. Smith added that this notion circled back to the discussion about the problem statement and the need for a clearer statement of EPA's mandates, which will make it easier to identify the issues and links that had not yet been captured.

Dr. Richardson interjected that he would like to respond to the issue of topics outside of EPA's purview. He explained that although these issues cannot be addressed from a regulatory point of view, they are important from the research perspective. He underscored Mr. Geller's point and added that science challenge 2, which touches on improving the understanding of disparities, discussed the link to economic, food, or housing issues. He added that these issues may be under the purview of the Department of Housing and Urban Development (HUD), but still appear relevant to EJ-related science.

Dr. Flint explained that one of the cross-program ideas she found intriguing is the idea of a rapid response program that could provide a rapid science response to emerging issues. She advocated for a rapid response program that would bring integrated teams together. She posed the rapid response program as a potential crosscutting recommendation.

Dr. Kavlock explained that EPA has a similar response team. When an emergency event happens, Dr. Greg Sayles is notified and begins reaching out to organizations to gather the resources required to address the issue. The most recent example was EPA's response team assembled to address the Gold King Mine emergency. Dr. Kavlock added that ORD does have a formal way to handle emergency situations, but noted those methods were not included in their planning documents.

Dr. Swackhamer asked the committee members for any other points of synergy across the six programs. Dr. Solomon noted that, in general, exposure is important in the EJ context and suggested the committee further examine this as a crosscutting issue. She added that CSS has exposure tools, HHRA has ExpoBox, and ACE has numerous sensor technologies.

Dr. Swackhamer asked for other points of intersection that could be identified from the committee's expertise. Hearing none, she suggested moving forward with the agenda. Dr. Swackhamer stated that the committee volunteered Dr. Solomon to take the lead on writing up the science responses to the EJ Roadmap.

Dr. Swackhamer concluded the conversation by noting that the committee would have another opportunity to discuss the EJ Roadmap during the second day of the meeting. The committee broke for lunch.

Presentation

Andy Miller, Lead, Climate Change Roadmap

Dr. Andy Miller began his discussion by noting that climate change touches on all environmental issues. He mentioned specific challenges faced by the program, which are areas for which input from the BOSC will be valuable. One challenge is the complexity of integrating all of the related science and defining what is meant by the term "climate change;" he pointed out that this is not simply a difference in temperatures. Other challenges include the number of contributors to the scientific knowledge base and the multiplicity of drivers, which is dictated by diverse needs and interests. Dr. Miller explained that it is difficult to describe how all of the disparate pieces fit together to form a uniform approach. He noted that the program has attempted to tease out the crosscutting areas for interaction and integration.

Dr. Miller also addressed EPA's legislative mandate. He explained that the major environmental legislations (e.g., Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, etc.) name the issues that EPA addresses and these mandates are the focus of the Climate Change Roadmap. He noted that while some scientific topics may be related to EPA's work, they fall outside of the Agency's mandate. For example, he stated that climate-related work in Alaska is within EPA's mandate, however, broader Arctic issues are not. Dr. Miller acknowledged that the program must work within its directives from Congress and coordinate with other Federal agencies in order to avoid duplicating work. Currently, EPA's role includes providing useful and actionable information to program partners on the topics of near-term climate change adaptation and the potential environmental impacts of mitigation. Dr. Miller noted that the inter-agency interactions and EPA focus areas are described in more detail within the roadmap.

Dr. Miller reiterated that the challenge is determining how to consider all of the diverse needs from the various sources in an integrated, coherent research plan. One of the recommendations from the BOSC was to turn to the states, as each has its own unique needs. He continued by saying that these needs tend to be specific and more specific guidance would be helpful in this area. Related to this is the challenge of delivering short-term, local-focused, relevant information to program partners, which Dr. Miller stated he will seek input from the BOSC on how to do this within financial constraints.

Dr. Miller pointed out that the gaps identified in the roadmap are simply the needs identified by program partners that cannot be met given the program's current funding. He asked the BOSC to consider how his program can prepare for its partner's future needs while also providing information on immediate needs. To do this, he mentioned providing broader states of the science to program partners on emerging topics.

Finally, Dr. Miller noted that the roadmap does not address certain issues, such as tipping points, massive flooding, or how to value the impact of climate change. He explained that addressing these issues would have required excessive amounts of text.

Dr. Swackhamer asked any clarifying questions or comments from the Executive Committee.

Dr. Ponisseril Somasundaran asked for clarification on why Arctic issues related to climate change do not fall under EPA's regulatory authority. Dr. Miller explained that while EPA is responsible for Alaska, the rest of the Arctic is not US territory. He noted that EPA may be involved in these issues through the Agency's membership in various international working groups.

Dr. Viney Aneja asked for clarification on how the Climate Change Roadmap is a departure from the ACE roadmap, where climate change is a central piece. Dr. Miller replied that the Climate Change Roadmap incorporates climate-related work within the SSWR and SHC programs. He added that the purpose is to identify climate-related work in order to see where there are gaps across the programs and where there is room for integration. He commented that a fair amount of water-related work is conducted within ACE, which necessarily connects with the SSWR program. The roadmap shows how the work is tied together across ORD.

Dr. Bob Kavlock, the Deputy Assistant Administrator for science in ORD, stated that a $20 million line item appropriation funds climate research under the ACE program. He clarified that climate-related impacts on water are not "climate funded research" in appropriations language, and in the context of water, climate change is dealt with as an additional stressor. Dr. Aneja followed by asking whether this climate budget includes all climate research. Dr. Kavlock replied that only the formally named climate research under ACE is included. Ms. Smith asked whether there is a line item appropriation for climate research in other programs, and Dr. Kavlock responded that there is not.

Dr. Gina Solomon noted two topics that the roadmap did not cover. She pointed to the interrelation between invasive species, crop disease, land use, and pesticide use. The other issue was the potential environmental co-benefits of climate change adaptation and mitigation actions

and how ORD might play a role in such research. Dr. Miller responded that crop variety varies by geographic location and that some invasive species research is conducted within EPA, but the issue mainly falls under the authority of the U.S. Department of Agriculture (USDA). He added that EPA has not addressed how crop use and invasive species may influence pesticide use. He also explained that environmental co-benefits of climate change mitigation and adaptation actions have been a main focus at EPA, primarily in terms of how reducing carbon emissions impacts air quality. Dr. Miller also mentioned the GLIMPSE program, which considers climate benefits and improvements in health. It will be critical to determine how to monetize both environmental and human health benefits.

An attendee noted EPA has conducted research related to the human health impacts climate change. As a specific example, in 2008, EPA funded seven grants looking into the influences on allergens and asthma. Numerous other potential direct and indirect impacts could be considered, given the dimensionless aspects of climate science. While impacts and co-benefits research might be piece-meal currently, EPA hopes the findings can be integrated. The Agency tries to deliver information to program partners that provides a factual foundation for their decision-making processes.

Dr. Ken Reckhow asked whether the Office of Water (OW) Total Maximal Daily Load (TMDL) program is tasked with assessing TMDLs from the perspective of pollutant loading and climate change. Dr. Miller answered that it is. The program is determining how to incorporate current and future temperatures, particularly related to salmon under the Endangered Species Act. OW is often prompted to demonstrate it is addressing climate change with the best available science, but this is an issue that is broader than OW or EPA. He added that there is broad interest in the development of an approach to identify a combination of climate model scenarios and down-scaling methods that are most appropriate local level scenarios. Dr. Reckhow noted his reservations with that approach. Dr. Miller recognized that EPA shares in his concern about related uncertainties. He added that rather than tease out all of the individual uncertainties, a robust but flexible risk framework might be utilized in the decision making process to assess potential risks instead.

Dr. James Galloway inquired whether there is a reason the roadmap considers near term decisions and who is responsible for considering the long-term issues like tipping points. Dr. Miller responded that the U.S. Global Change Research Program (USGCRP) looks at tipping points and thresholds, but EPA works with them to determine areas where research is needed. He continued that his program meets with the Office of Air and Radiation (OAR) and the Office of Policy (OP) to address these questions within the Agency, particularly regarding the valuation of impacts. He stated that these are issues that do not have a clear home program office currently. Dr. Galloway followed by asking whether tipping points are included in the roadmap. Dr. Miller replied that climate change is a fairly new topic for EPA, and at this point, he is not sure that any program is claiming is as their responsibility. Only in the past few years has the Agency begun thinking critically about climate change. Related to tipping points, he reiterated that EPA must conduct its work within the bounds that Congress sets. Though he acknowledged there is a lot of movement on other climate-related issues within the Agency.

Dr. Aneja asked how EPA is involved in the United Nations Conference of the Parties (COP) 21 climate deliberations in Paris. Dr. Miller responded that EPA Administrator McCarthy participates in the discussions. Any decisions will be incorporated into Agency policy and regulations based on her decisions in conjunction with the State Department. Dr. Aneja-followed by asking whether issues that are not discussed in the roadmap could be incorporated. Dr. Miller clarified that the roadmap is a starting point, underscoring that the Agency is flexible and the program will always address the Administrator's priorities whether or not they are considered in the roadmap.

Discuss Charge Question: Climate Change Roadmap

Deborah Swackhamer, Chair

Dr. Swackhamer read the roadmap charge questions and asked for overarching impressions of the Climate Change Roadmap from the Executive Committee members.

Dr. Chaudhry commented that the roadmap was well written, dynamic, and very nice overall. He added that the road map addressed the strategic goals the planned methods for achieving those goals.

Dr. Richardson noted that the focus of the research program is adaptation, but pointed out that the first four scientific challenges in the roadmap are aimed at understanding the impacts of climate change. Adaptation requires understanding impacts and, thus, perspectives from the social and behavioral sciences. Dr. Richardson summarized his point by saying that understanding impacts is necessary, but not sufficient, for achieving the roadmap's adaptation goals.

Dr. Aneja echoed other comments that the roadmap was well written, but commented that he did not see how EPA planned to integrate with research conducted at other federal agencies, or if it connects. Dr. Swackhamer noted that this information is scattered throughout the roadmap.

Dr. Flint noted that the words "social science" and "human system" were pervasive throughout the document, but these terms are not defined. She added that it appears that the purpose of using the terms is to frame interactions as natural systems, but observed that how human systems relate to climate change was not specified. Dr. Flint added that the roadmap needs a more explicit explanation of how human systems relate to climate. Dr. Miller commented that the roadmap did not reflect the state of the science, but EPA recognizes there are remaining issues to address, one of which is social science.

Dr. Galloway asked Dr. Miller what he perceived as the weakest points of roadmap. Dr. Miller responded that the gaps that were not identified as needs is an area for improvement. He also stated longer term issues and issues associated with social and behavioral sciences as weak areas.

Ms. Smith commented that she thought the problem statement was excellent, especially the first paragraph that summarized ORD's role in climate change research, the limited appropriations, and the role of partnerships. She suggested adding something specific about EPA mandates, such as the signals EPA has received from Congress to help them understand how and where the Agency is allowed to act, although she was unsure if this is appropriate. She stated that she would have liked to see a stronger link between identified needs, current research, and gaps. She

acknowledged that the information was included in the roadmap, but it was spread throughout the document. She also suggested that some of the tables in the appendices be highlighted more.

Dr. Richardson agreed that the first sentence of problem statement was strong and comprehensive. Dr. Richardson suggested that "way of life" be substituted with "well-being" and noted that the points laid out in the fourth sentence in the "Expanded Problem Statement" paragraph that began with "The purpose of climate change is to…" did not appear to address the issues identified in the first sentence. He added that it seems relevant to know the economic impacts of air, water quality, and health as well as the economic and health impacts of climate in an integrative way, but that these areas did not seem to be addressed in the first sentence of the paragraph.

Dr. Solomon drew the committee's attention to the sentence in the "Expanded Problem Statement" text of the roadmap on page six that included the segment "inform regulatory actions and strategies to respond to these impacts." She argued the sentence considers the interactive issue, because it said "inform and evaluate." She added that regulators should be informed at the front and back end, especially when adaptation is being discussed.

Dr. Aneja referenced the phrase "adapt to impacts of climate change" used in the "Expanded Problem Statement" text and explained that it was not clear to him what was implied by the phrase "a changing climate" in the rest of the roadmap. For example, he wondered what degree change in temperature "a changing climate" referred to, noting each degree change would have its own share of consequences on air quality and human health. Dr. Aneja suggested that the phrase be clarified.

Dr. Galloway expanded on Dr. Aneja's comment and explained that the climate change impacts being examined are projections for the year 2100 and range from a two to eight degree warmer world. He suggested that the committee add text to say that the climate was changing and add the context of possible courses.

Dr. Flint explained that it is important to think about the ways to communicate the definition and interpretation of climate change, because it becomes problematic when climate change discussions are only about a degree shift. She added that climate change should be discussed more broadly as a change in extreme events. She also noted that the discussion should be framed to include the local aspects of climate change, such as the fluctuations, uncertainty, and extreme events that interact with social systems.

Dr. Swackhamer summarized that Dr. Galloway and Dr. Aneja had advocated for a more quantitative definition of climate change to which Dr. Galloway clarified that he was advocating for additional context that was compatible with Dr. Flint's comments. Dr. Aneja added that he was looking for clarification on EPA's role in adaptation. Dr. Swackhamer summarized his point by noting that he would like to see something built into ORD's research plan.

Dr. Tharakan agreed that the roadmap needs a clearer definition of what climate change means in addition to exactly what EPA is planning for and responding to. Dr. Swackhamer responded that it was fine to clearly define climate change as used in the context of the roadmap, but cautioned that climate-related work could be derailed politically when extremely specific quantitative

definitions are incorporated. Dr. Miller noted that a climate change definition was a policy question, not a science question.

Dr. Solomon explained that she had serious reservations about crossing into the policy territory of climate change. She seconded Dr. Flint's comment that the real value is added when the broader climate change issue is considered and research is done to understand local implications. She noted that this is what she thought ORD tried to do in the roadmap. She suggested that, regardless of the degree in temperature change the world was facing in future, ORD was interested in better understanding climate change implications for ecosystems around the country so local areas can adapt. She suggested that this should be articulated more clearly in the roadmap.

Dr. Reckhow explained that he was one of the authors of the water chapter in the National Climate Assessment and was tasked with discussing the uncertainties. He noted that he has also conducted TMDL assessments independent of climate change. Dr. Reckhow noted he was very concerned by the fact that when TMDLs are downscaled, the uncertainties are overwhelming and explained that modelers need do uncertainty assessments on their models. He stated that the climate change and sea level rise assessment was re-done using a shorter time line to reduce the uncertainty. He expressed that this reaction underscores his concern about the lack of understanding of predictive model uncertainty by appointed and elected officials at the state and local level that occurs when modelers try to downscale. Dr. Reckhow added that he was not able to offer a solution, but emphasized his concern that quantifying uncertainty seems to overwhelm decisions making, even when forecasting issues of great concern. Dr. Swackhamer followed Dr. Reckhow's comment by nominating him and Dr. Galloway to write the committee's responses to the Climate Change Roadmap charge questions. Both Dr. Reckhow and Dr. Galloway agreed.

Dr. Swackhamer expressed her concern that the problem statement was too broad and the opening sentence too generic. The problem statement paragraph became more refined and focused as it progressed. She commented that the last sentence of that paragraph was the true problem statement and should become the first sentence of the paragraph. In addition, Dr. Swackhamer suggested the language be strengthened. She explained that she struggled with the fact that ORD is unable to control their agenda because it set for them based on the federal climate change research agenda, noting EPA is only one small aspect of the overarching federal climate change effort. She further explained that climate change science was not EPA's primary role in the effort, so the question became how to organize the roadmap when some of the issues are not in EPA's mandate. Dr. Swackhamer noted that this point was not well articulated and suggested that the issues and gaps be better articulated in the roadmap. She commented that EPA's ongoing efforts and gaps used the same language, which was confusing and made it difficult to map the gaps back to their current efforts. For example, the roadmap discussed working with utilities, but it was unclear what EPA's efforts are in this area and what the gaps are. She commented that this made it difficult for the committee to assess if ORD was making progress. Dr. Swackhamer added the caveat that the gaps and ongoing efforts might not have been clear because ORD was not in charge of their agenda, but EPA could better articulate their role in the larger climate change research effort.

Dr. Somasundaran suggested that there was room to address the problem Dr. Swackhamer raised by clarifying ORD's interaction with other agencies on page 14 of the roadmap. Dr. Swackhamer

agreed that EPA's niche, where they can add value and solve problems, needs to be articulated in the roadmap.

Dr. Somasundaran raised the additional point that people should be courageous with models even when there is a lot of uncertainty. Otherwise, he noted, issues are not addressed simply due to the level of uncertainty. Dr. Reckhow agreed with Dr. Somasundaran, but noted that he was unsure how to address the issue as it overwhelms people.

Dr. Solomon added she agreed with Dr. Swackhamer's comment that too many things are included in the roadmap without a clear sense of what ORD's related role is. She also mentioned that an articulation of what value EPA can add to the effort was missing and should be added across both the Climate Change and EJ Roadmaps. For example, invasive species, pesticide issues, and debris management after natural disasters or climate related events are huge issues that EPA has a role in. She noted that debris management is always addressed horribly and there must be a better approach and research that can be done to address the issues of how to effectively, efficiently, economically, and safely deal with all the debris. Another issue she brought up was mold. Dr. Solomon explained that states do not want to deal with mold issues, EPA does not address mold because it is considered and indoor air issue, and the Centers for Disease Control and Prevention (CDC) advised her to call EPA regarding mold. She stated that some agency should considering mold issues. Dr. Kavlock noted that HS does some work on mold and Dr. Swackhamer added that this comment could fall under charge question 5 about integration across ORD's research programs.

Dr. Flint raised the issue that the Roadmap is framed around impacts to communities and not the adaptive capability of communities, which becomes increasingly important when considering vulnerable communities. Community impacts from climate change are based on policy decisions. The impacts are handled at the local level. So the impacts and the ability to adapt are local issues that intersect with local expertise and resources. The issues of limited resources and government capacity will become increasingly important to include when examining vulnerable communities in the future. Dr. Flint added that impacts are included in all of the roadmap research questions, but noted a lack of recognition of social, development, and behavioral drivers that also have implications, such as with the social drivers of air quality issues that exacerbate problems.

Dr. Swackhamer asked for other comments on the key research topics. Ms. Smith asked Dr. Miller to explain the specific audience, purpose, and intended use of the Climate Change Roadmap. Dr. Miller explained that the original audience was the internal program office and researchers, but that the roadmap will become a publicly available document and will speak to a broader audience. He recognized, for this reason, ORD was careful to avoid using ORD-specific language that makes presumptions. He noted that he was unsure if the roadmap moved past the language issue. He added that the basis for placing the roadmap in the context of the broader federal climate research agenda was because the roadmap was originally intended for an internal audience, but acknowledged it could be an issue for broader audiences.

Ms. Smith noted that ORD first determined partners' needs based on their input, but noted that the issues the committee had been discussing likely were not those identified by ORD's partners. She noted that the aim should be to handle those emerging issues and asked what ORD's process is for doing so. Dr. Miller explained that ORD understood that there were additional issues but they were also trying to put bounds on their planning process. He stated that ORD has a good

sense of what the emerging issues are, based on numerous interactions with colleagues at other federal agencies, academia, and local communities. Dr. Miller clarified that he did not intend to say that ORD knows how to solve the issues, but rather that they consistently heard emerging issues and those issues were just not included in the roadmap. He added that including the emerging issues in the roadmap might be something to consider in the future and was a decision ORD would make as they received the BOSC's comments.

Dr. Aneja stated that he saw the five science challenges, but noted that that the multimedia interaction element was missing. He explained that the questions involves how different media interact with each other. He noted, for example, how air impacts water and vice versa. Dr. Aneja asked if multimedia interactions were intentionally left out of the roadmap.

Dr. Miller explained that multimedia interactions were left out on purpose in an attempt to make the Roadmap straightforward. He stated that ORD recognizes that there are interactions, but wanted to keep the Roadmap concise. Dr. Aneja added that this clarification should be included in the roadmap.

Dr. Richardson noted that in the fifth research topic on mitigation, the science challenge and research gaps were framed almost exclusively in terms of emissions from energy production. He noted, however, that emissions come from a range of sources including buildings, industry, forests, agriculture, and others. In addition, impacts on biodiversity were not discussed at all even though they stand to be threatened by climate change and have research needs that need to be addressed. Dr. Swackhamer commented that the roadmap was probably developed using a piecemeal approach so EPA did not step on the toes of other federal agencies.

Dr. Chaudhry stated that ORD is clearly interacting with other agencies, but the partner interactions were unclear. He asked how ORD planned to interact with partners and communities directly. Dr. Miller explained that ORD works directly with communities in some places and some EPA staff collaborated with communities to develop an adaptation framework. He explained that ORD is aware that they need to work with communities and, although they do not have specific mechanisms for interacting with community members such as town mayors or councils more broadly, they do have mechanisms for working with states.

Dr. Flint explained that, because so many climate change issues are local, town councils and mayors are progressive when it comes to climate change. She noted that there are mechanisms for interacting with communities through SHC, which might be an interesting way to bridge the gap between local and federal governments. She added that, in many parts of the country, city governments are taking action where states are not, so bypassing states and collaborating directly with cities might be an effective approach. Dr. Swackhamer added that Dr. Flint's point spoke to charge question 5 and agreed that SHC could be a good point of intersection with the climate change program.

Dr. Swackhamer restated that the committee's discussion had touched on charge questions 1 and 2 and covered a little of charge question 3. She noted the roadmap needs to clarify the gaps versus ongoing research. Dr. Galloway asked for confirmation that he heard Dr. Swackhamer say the document needed to be fundamentally changed and Dr. Swackhamer responded that the document needed extensive editing but no content change was needed.

Dr. Swackhamer asked the committee members if all of the gaps had been identified. Dr. Aneja noted that the air quality gaps explicitly mentioned ozone, particulate matter, and methane, but did not talk about nitrous oxide and asked if there was a reason why. Dr. Miller responded that there is not a particular reason why nitrous oxide was not mentioned, but added that ozone and particulate matter are the major drivers of morbidity and mortality.

Dr. Richardson noted that the first four topical areas of the research gaps focused on understanding impacts but, after one understands those impacts, the question becomes what the social impacts are. For example, he asked what the social and economic adaptive responses would be if Miami was flooding. Dr. Richardson stated that one would need to listen to the community in order to understand the adaptive response options.

Dr. Somasundaran explained that interactions with communities are most important because EPA can only be effective if the Agency has a good relationship with the public. EPA does not communicate well regarding the great work that they are doing. Dr. Somasundaran added that this communication issue was a gap that should be identified and emphasized.

Dr. Flint noted that the integration of climate change impact research across all the programs was a gap that should be addressed. She explained that the impacts act within complex systems and noted that much impact research is still siloed. Air quality, water quality, the built environment, and water treatment systems are all domains with interacting effects. She underscored that climate change impacts are crosscutting and should be integrated across all programs.

Dr. Swackhamer asked if there was other relevant ORD research that should be considered in the Climate Change Roadmap. Dr. Swackhamer reviewed Dr. Solomon's point that research related to invasive species was largely untouched, because EPA does not have a mandate to research it. She noted that research has been conducted on the impacts of climate change on invasive species in the academic world but could not think of a federal agency that had the resources to research it. Dr. Swackhamer added that there other research topics that were not addressed in the roadmap charge questions.

Dr. Solomon asked if that issue could be articulated under the charge question that asked how well the gaps had been identified. Dr. Swackhamer responded that when she thought about issues such as forest sequestration of carbon, the issue would fall under the purview of USDA, so it was difficult for EPA to claim the research unless it is framed through carbon sequestration research, not forests. However, Dr. Swackhamer added that the USDA would never research forest sequestration of carbon, so the fact that research topics could be missed entirely at the federal level is certainly a gap. Dr. Richardson added that U.S. forest land is under USDA's jurisdiction, but noted that deforestation, a driver of climate change, can occur on private land, which may have different governance mechanisms and political boundaries.

Dr. Flint drew the committee's attention to the section on EPA's crosscutting science issues on page 20 of the roadmap and noted that are were a number of places where OAR and OSWER were mentioned. She asked why only those programs were mentioned when there seems to be strong SHC and ACE interactions.

Dr. Galloway stated that the committee was looking for overarching or specific comments that addressed the charge questions and suggested that editorial comments be made offline. Dr. Swackhamer asked the committee members if they had comments on missing interactions with relevant research within ORD or areas for synergism across the research areas that were not already identified.

Dr. Aneja noted that he did not see the relationship between cook stoves and climate change, to which Dr. Miller responded that black carbon and land use were the connection and where the cook stove and climate change issue fit in with EPA. Dr. Kavlock added that the research topic was an Administrator priority, and Dr. Swackhamer suggested that adding some context around that issue would not hurt the Roadmap.

Dr. Richardson asked if the cook stove issue was a U.S. issue, and Dr. Tharakan responded that there were plenty of developing communities with these issues in the U.S.

Process and Next Steps

Dr. Swackhamer opened the discussion of the subcommittee reports. She noted that the purpose of the discussions would be to prioritize action items as well as to summarize and synthesize points across the five reports. To do this, each of the subcommittee (co-)chairs will summarize the points made in their subcommittee report first. The respective National Program Directors (NPDs) will then respond to the subcommittee's report. Finally, the Executive Committee members will discuss the subcommittee's response to the applicable charge questions.

Dr. Robert Richardson, noting that the reports are written by the subcommittees for the Executive Committee, asked what the next step would be. Dr. Swackhamer replied that she thinks the finalized subcommittee reports should become appendices to the main report submitted to EPA. Dr. Kavlock added that EPA will provide formal feedback on the reports after they are finalized and submitted.

Ms. Smith asked whether the chairs and co-chairs have the authority to make decisions about editing the documents without additional review by the respective subcommittees. Dr. Swackhamer replied that the subcommittee chairs and co-chairs may make editorial changes to the reports without further review by the subcommittees.

Dr. Swackhamer then invited the Air, Climate, and Energy Program Subcommittee co-chairs, Dr. Viney Aneja and Ms. Sandra Smith, to present their summary findings.

Air, Climate and Energy Draft Report

Viney Aneja, Chair, and Sandra Smith, Vice Chair

Dr. Aneja opened the session by thanking Dr. Costa, the NPD for the ACE program, his vice-chair, Ms. Smith, and the ACE subcommittee members who participated in developing the recommendations. He welcomed comments on the roadmap.

Dr. Aneja provided some background to the ACE StRAP. He stated that understanding the interconnections between air pollution, climate change, and today's dynamic energy sector is important for developing innovative and sustainable solutions to improve air quality and address climate change. The ACE Roadmap considers how best to protect public health and the

environment, to advance more resilient and sustainable communities, and to reduce impacts of air quality issues. The ACE StRAP for fiscal year (FY) 2016–2019 outlines a four-year strategy for delivering the research results needed to support EPA's mission to protect human and environmental health, fulfill the agency's legislative mandates, and advance cross-Agency priorities in the EPA Strategic Plan. Dr. Aneja continued by saying that ORD has developed the StRAP in close coordination with EPA program and regional partners, input from laboratories and centers collaborating with ACE, and interactions with external stakeholders.

He explained that the BOSC ACE subcommittee was called on by ORD to review the ACE StRAP and deliberate on five specific charge questions, which were provided to the subcommittee along with the necessary supporting materials in early June 2015. The ACE subcommittee reviewed the materials, deliberated on the charge questions, and finalized a report of recommendations for each question. Dr. Anja then summarized the subcommittee's responses to the charge questions and its recommendations for the ACE research program.

Dr. Aneja noted that charge question 1 asked if the research topics and project areas were planned and organized well in order to make good progress on the research objectives during 2016–2019. The ACE subcommittee provided eight recommendations for ACE. The first recommendation is that ORD should increase the emphasis on climate change-related human health epidemiology and environmental impacts modeling. ACE should expand climate change and air quality modeling research to include temperature and humidity. Additionally, the subcommittee recommended identifying strategic research opportunities to characterize climate impacts on pollen and allergic diseases. ACE should also continue to support principle investigator (PI)-initiated research, even when the topic might not be a current need identified by internal EPA partners and stakeholders. Another recommendation involved considering more explicitly scoping a "rapid response" program that provides fast-turn around products, even in preliminary form, to internal partners and clients when crucial needs arise. The subcommittee called on ORD to review the program's balance of intra- and extra-mural research to optimize its ability to meet increased obligations in the face of constrained resources. The subcommittee also recommended articulating how the systems approach is implemented across all ACE project areas, including research related to emissions from oil and gas extraction, which is not well integrated into the ACE program. The final recommendation related to charge question 1 was to periodically review the balance between ACE-sponsored social science research and the more traditional areas of physical, chemical, human health, and biological sciences, and ensuring that the program leverages social science findings from other agencies and programs.

Charge question 2 asked about the effectiveness of the approaches for involving EPA partners in the problem formulation stage of research planning. Dr. Aneja reported that the ACE subcommittee provided three recommendations in response to this question. First, ORD should better articulate the extent to which input in planning is being provided by other offices within ORD. Next, ACE should increase the direct involvement of the states in the problem formulation stage of research planning. Finally, ACE needs to place a high priority on the development and implementation of a systems approach at all stages of the program, including problem formulation.

Charge question 3 asked how well the program responds to the needs of EPA partners, particularly program and regional offices. The ACE subcommittee provided six

recommendations related to the third charge question. Dr. Aneja stated that the subcommittee recommended that ORD consider new ways to include states and regional planning organizations more directly as partners. ACE should also maintain the core areas of research, such as emissions characterization, monitoring methodologies, and atmospheric science, as high priority areas. The third recommendation called for an increased emphasis on research needed to develop new federal reference methods for ambient pollutants. The subcommittee urged ACE to focus its sensor research on techniques suitable for National Ambient Air Quality Standards determination and other emerging air pollutants, such as ammonia. Dr. Aneja stated that ACE must also balance traditional priorities with emerging issues to ensure continuity in core areas of research (e.g., when key staff retire, leave the agency, etc.) as traditional areas of research remain critical to the Agency's mission. Finally, ACE should increase the emphasis on synthesis documents in research planning and implementation, since these outputs are highly valued by program partners.

Charge question 4 asked the subcommittee to comment on the quality of the products delivered by the program and asked if there were additional approaches that could be taken by the program to ensure its products were of the highest caliber. The ACE subcommittee provided six recommendations in this area. Dr. Aneja noted that ACE needs to develop a set of metrics to measure the productivity and output quality of ORD researchers which accounts for differences in fields of research, acknowledges the importance of synthesis and translation work, and rewards collaborative efforts within ACE and external to ACE. ACE should also ensure the continuation of sufficient funding for program reviews by external experts, peer review, and other quality assurance activities to maintain high quality products. The subcommittee also recommended that ACE consider customizing quality assurance procedures specifically for rapid response activities, which might involve releasing research results in a preliminary form, as part of a "rapid response" program and plan of action. ACE should ensure that outreach and engagement efforts are conducted in a manner consistent with state-of-the-science approaches, utilizing results from research in communication and engagement. Another recommendation called for the development of a set of metrics for outreach and engagement efforts that can be tracked, such as website hits, hours spent in public outreach activities, or publications in engagement journals. Finally, ACE should provide the subcommittee with details of the quality assurance procedures in place for different types of ORD projects at the next review meeting so that it can offer informed recommendations on additional approaches to ensure ACE products are of the highest quality.

Charge question 5 asked how well ORD has translated research findings and understanding for the end-users and how they can improve their ability to translate this information. The ACE subcommittee provided three recommendations related to this charge question. First, ACE should use a broad definition of "end-user" that includes other researchers, ACE partners, policy makers, and the public and also reflects the range of ways ACE research is used. The subcommittee recommended replacing the term "end-user" with "user." The next recommendation called on ACE to identify and train the appropriate staff, such as technical FTEs, that are best suited to perform the synthesis and translation of research and establish rewards and incentives for these types of work product. Finally, ACE should facilitate bi-directional communication in order to identify research needs of users and to maximize involvement of users in the problem formulation stage of research.

ACE Program Comments

Dan Costa, National Program Director

Dr. Dan Costa, the National Program Director for the ACE research program, began his presentation by thanking the ACE subcommittee chair, vice-chair, and members for their time and efforts. He explained that subcommittee meeting materials were developed after ACE's cyclical planning process, during which ACE closed deliberations on the project plans. Dr. Costa provided an overview of the program, including planned program changes and work products. Recognizing the importance of face-to-face interactions, he noted that ACE invited their program partners for a meeting where they were encouraged to provide feedback to ACE on areas that were going well and areas that need improvement.

Dr. Costa stated that ACE has a number of ongoing efforts, but noted that it is difficult to speak to the ACE efforts that directly respond to the ACE subcommittee's recommendations. He clarified that this is because it was not clear in their report what the subcommittee identified as gaps verses areas for enhancement. He noted that many of the recommendations included in the subcommittee report were program activities that were already underway and suggested that the subcommittee clarify their recommendations to indicate more explicitly whether they call for new activities or to enhance existing activities.

Dr. Costa expressed that ACE is excited about interacting with the BOSC moving forward, and that this is the first arrangement ACE is participating in that allows the BOSC to provide feedback on a periodic basis. He acknowledged that the new arrangement resulted in a learning curve, but ACE is excited by the prospect of having a small advisory group to work with regularly over the course of several years. He added that ACE was looking forward to developing a relationship with the BOSC members.

Dr. Costa explained that the ACE subcommittee report covered the climate issue extensively. One recommendation suggested the program examine heat and humidity, which ACE took under advisement and has begun examining it in a broader context. Another recommendation the subcommittee made involved the issue of wildfires, which is a major issue EPA has been working on over the last few years by encouraging investigative work on the topic. The research resulted in models for fire and smoke management and emissions evaluation. He acknowledged that the issues of climate change and wildfires are still a major undertaking. A report from the National Oceanic and Atmospheric Administration (NOAA) stated that in 2014, 40% of the mass of particulate matter smaller than 2.5 micrometers ($PM_{2.5}$) was derived from wildfire smoke. Dr. Costa explained that EPA planned to meet with EPA's Office of Air Quality Planning and Standards to examine ozone standards and exceptions in locations with fire issues.

Dr. Costa explained that, as a physiologist, he examines issues through a systems point of view and continues to conduct research on the interactions between particulate matter and the human cardio-pulmonary-neurological system. He underscored the importance of conducting research from a systems point of view when examining how components of a system interact. Dr. Costa stated that EPA is trying to adopt that same kind of thinking into their program and to be more dynamic moving forward.

Dr. Costa noted that the social science field has developed over the last 45 years, and ACE has been hammered continuously by the SAB to do more social science work. He explained that the

approach EPA occasionally took to address those recommendations was to hire a social scientist, and named a few current staff who are critical in addressing social science issues. Dr. Costa admitted, however, that the solution is not that simple. He stated that conducting social science requires identification of the needs and issues in order to develop a problem statement and develop a practical plan to incorporate social science into regulatory thinking.

Dr. Costa commented that metrics of impact are a topic that Dr. Kavlock asked all NPDs to examine. He noted cost savings as one example of a metric to assess regulatory impacts. Examples of metrics to measure success of work products are the number of citations or papers published. ACE is trying to develop a more integrative, innovative program, but they are still grappling with how to measure success.

Dr. Costa stated that he expects ACE to have a real impact on climate change and social science issues in 2015. He provided the air monitoring effort as an example, explaining that ACE invested heavily on sensors and community science. He also highlighted the air monitoring and community training program that ACE implemented the previous summer, which drew participants from 30 different regions within the country. Dr. Costa concluded his remarks by noting that ACE has initiated collaborative efforts and is open to bringing more people onboard to improve the program.

Dr. Swackhamer thanked Dr. Costa and asked him to identify the BOSC recommendations that he thought were unrealistic or could not be accomplished. Dr. Costa responded that there were a few recommendations that ACE has already begun responding to and that there were some that he would tweak, but commented that he would not eliminate any.

Discussion ACE Draft Report

Deborah Swackhamer, Chair

Dr. Solomon stated that her approach was from the perspective of an SAB quality review and asked Dr. Costa how well the subcommittee addressed each charge question. She added that she was particularly concerned about charge question 1 that reads as follows:

Charge question 1: Given the research objectives articulated in the StRAP, are the topics and project areas planned and organized appropriately to make good progress on these objectives in the 2016-2019 time frame?

Considering the current recommendations, Dr. Solomon noted that there are additional issues she would recommend to be included in the StRAP, such as pollen, allergic disease, PI-initiated research, rapid response, and oil and gas extraction. Dr. Solomon noted that she did not see that the subcommittee identified any barriers to achieving program goals in their report.

Dr. Swackhamer asked the two ACE subcommittee co-chairs if their list of additional program activities were new suggestions to replace the projects that ACE currently has underway. She also wondered if the list contained high priority activities that ACE should act on immediately or if it is just a list of interesting ideas. Dr. Aneja explained that the ACE subcommittee responded in an open-ended fashion to the information that they were provided and their recommendations consist of ideas that the subcommittee thought ACE would benefit from incorporating into their existing plans. He clarified that he was not stating that items in the additional activities list were not already included in the program in some manner, but the ideas were additional processes that

were intended to complement or supplement existing program work and provide another vision to the ACE program.

Dr. Costa explained that ACE is trying to develop their wildfire and smoke program in the context of climate and temperature. He continued by saying the humidity issue is one that ACE has dealt with extensively in earlier research, but the program did not emphasize the public health aspect. He commented that ACE has moved away from being a regulatory program to one that conducts multi-pollutant research and is called a public and environmental health program, noting a potential area for integration with SHC efforts. Dr. Costa stated that ACE is not performing highly involved measurements, such as examining the flora regrowth after a forest fire, but they are thinking about them. He added that ACE is working with CDC to forecast smoke and determine how to get that information to the affected communities and address the smoke issue from a public health perspective. He noted that Canada has used prescriptions for inhalers as a measure of community health impacts and stated there are numerous actions that EPA is considering to get involved in this effort.

Dr. Reckhow stated that he agreed with Dr. Solomon that the first three charge questions were general and the recommendations were not written to directly address charge question 1. He added that ACE could find ideas in the text prior to the specific recommendations that could be altered to directly address charge question 1. Dr. Reckhow acknowledged that, although the bulleted recommendations are important, they should be revised so they address the charge question. Dr. Swackhamer suggested that the sentence before the listed recommendations should state that "these recommendations are to complement and supplement the ongoing work at ACE and should not replace current work."

Dr. Aneja confirmed that the subcommittee thought the ACE program was meeting their recommendations and the list of recommendations was meant to supplement what ACE was already doing. Dr. Costa pointed out that the smoke issue demands an understanding of temperature and humidity and the subcommittee highlighted temperature and humidity as an important element of the smoke issue.

Dr. Swackhamer summarized the committee's discussion by noting that something to the effect of "there are things we would recommend that ACE do to enhance, not add to, their ongoing activities" be added to the report.

Ms. Smith agreed with Dr. Swackhamer's suggestion to add text to clarify the ACE subcommittee's list of recommendations and suggested that the point be made in a few sentences. She added that the report could better reflect the subcommittee's feeling that the StRAP was of high quality and very responsive to the objectives and partner's needs.

Dr. Solomon noted that the report's language was directive and suggested the committee add the phrase "additional considerations" to clarify that the recommendations are supplemental. She added that the language nuance she suggested could also address Dr. Swackhamer‘s comment by pulling direct recommendations out of the text. Dr. Solomon also commented that the ACE program has a huge scope and agenda that is coupled with a smaller budget. She stated that part of the BOSC's job is to help EPA focus given their broad agenda and dwindling resources. She suggested her comment as a potential issue to raise later. She further suggested that the

committee list their recommendations by priority, as the committee covered a lot of great material.

Ms. Smith responded that the report included an element of what Dr. Solomon suggested, but acknowledged that the subcommittee was not experienced in terms of capturing what needed to be captured. Dr. Swackhamer noted that many of the BOSC members are new to the process, but stated that the ACE subcommittee report was good. As a general comment on the subcommittee reports, Dr. Swackhamer stated that some of the BOSC subcommittee co-chairs numbered their recommendations and some did not. She asked that all the subcommittee reports include numbered recommendations and clarification on whether they are listed according to priority. Referencing the subcommittee's recommendation for a rapid response program, she commented that ORD already has one. Dr. Aneja explained that the subcommittee was not privy to all of the information, but agreed that it is important that the BOSC does not recommend that ACE reinvent the wheel.

Dr. Somasundaran stated that he liked what the subcommittee did and the approaches they took, but noted he incorporated other questions of importance. Dr. Swackhamer responded that their approach was fine but, in order to enhance the process moving forward, she suggested that the reports are explicit in terms of whether they are replacing, adding, or enhancing ongoing program activities. Dr. Reckhow added that the SSWR subcommittee also discussed this issue. He explained that he spoke with to Dr. van Drunick about the possibility of being more engaged in the charge question development process, because they thought the charge question was not correct. Dr. Kavlock noted that the charge questions were vetted, and Dr. Swackhamer added that the charge questions were vetted by her. She also noted that charge question issue would be good to discuss on the last day of the meeting during the committee's discussion on the BOSC process.

Dr. Somasundaran commented that he was bothered by splitting up the components of the water, air, energy nexus, as they are difficult to split in reality. He asked how EPA could isolate their interactions. Dr. Kavlock responded that ORD had to slice the issues somehow. Dr. Costa added that about half of ACE's climate funding goes to water and the water, air, energy nexus is part of that program. He acknowledged that the subcommittee received lots of information that is difficult to process, but assured the members that the process would become easier moving forward.

Dr. Swackhamer drew the committee's attention to the first recommendation: "Increase the emphasis on climate change-related human health epidemiology and environmental impacts modeling." She asked for confirmation that the subcommittee did not intend to recommend that ORD hire a group of epidemiologists, but rather increase modeling that considers human health impacts. Dr. Aneja responded that, in terms of modeling, the subcommittee envisioned this modeling group serving as a vehicle to add the climate change-related human health and environmental impacts dimension to the process. Dr. Swackhamer explained that as the report is written, the word "modeling" modifies the word "epidemiology" in the sentence and it was the sentence structure that had her puzzled. Dr. Aneja clarified that the subcommittee was asking for an increase in both epidemiology and modeling, which was already taking place as it relates to climate science and modeling. Dr. Reckhow commented that adding one word would make that clear and suggested the word "on" be added after the word "and" in the sentence, so it read

"Increase the emphasis on climate change-related human health epidemiology and on environmental impacts modeling."

Dr. Solomon asked Dr. Costa if ACE conducts epidemiology research. Dr. Costa responded that they did and explained that most of their epidemiology work is now conducted through their extramural grant program. Dr. Aneja added that the ACE subcommittee did not pull the recommendation out of isolation and it was made based on conversations the subcommittee had with the ACE program. Dr. Costa clarified that ACE was not really doing modeling human health impacts, but noted that epidemiology typically incorporates modeling, such as exposure modeling. Dr. Swackhamer asked if ACE's work is incorporating epidemiological results into modeling. Dr. Costa explained that epidemiological results are part of the assessment program that Dr. Miller spoke about earlier on and asked Dr. Miller to provide additional clarification.

Dr. Miller explained that is an area where ORD works with other agencies. He noted that ORD works with NIH and CDC on climate change indices and health impacts. Incorporating epidemiological results into climate change impacts modeling happens at the interagency level. He added that health impacts associated with climate change are an increasingly important topic.

Dr. Swackhamer noted that Dr. Miller's explanation was not clear to her as the report is currently written. Dr. Aneja responded that he would clarify it. Dr. Swackhamer suggested something along the lines of "using epidemiology research results in broader modeling" to the report to clarify that recommendation.

Dr. Costa noted a paper on wildfires that was recently published by EPA staff in the Public Health Division, which used smoke data from the U.S. Forest Service and combined it with their own epidemiological work to conduct predictive analyses. More specifically, the authors used a model of predicted smoke exposures and combined it with a model of how people would use that information to make decisions. He stated that the results indicated that giving people forewarning about fires lowered their exposure to smoke. Dr. Costa added that the results may seem intuitive, but good data on how people use information on fires do not exist, and the study shows how EPA is trying to incorporate social sciences in their research approach.

Dr. Swackhamer reiterated that she read the recommendation as suggesting EPA hire epidemiologists, which would not be a good recommendation in her opinion. She also noted that the recommendation could be better articulated. Dr. Swackhamer stated that she would like the conversation to move forward. She proposed that the committee first ask any clarifying questions on the recommendations and then follow with a discussion about prioritizing their recommendations.

Dr. Kavlock noted that he would like to hear more on the sixth recommendation under charge question 1 that read "Review the ACE program balance of intra- and extra-mural research to optimize its ability to meet increased obligations in the face of constrained resources." He explained that, in terms of budgeting, EPA usually uses intramural research for near term projects and external partners for long term research. Dr. Swackhamer commented that this recommendation comes up in every subcommittee document and suggested it be added to the list of crosscutting comments. She added that the question was critically important and it would be great if the BOSC could give EPA advice on this issue.

Dr. Costa explained that there may be variations from program to program, but ACE's epidemiology strength was increased by the extramural program. Although ACE uses the program in different ways, it allows them to bring in the best people to address the issues. Dr. Swackhamer suggested that the committee recommend that EPA ensure they align their external research dollars and priorities with areas that are critical to their objectives, but cannot be achieved internally. Dr. Kavlock responded that this is always a source of tension that ORD must address. He noted program partners constantly ask ORD why it funds academic partners for long term projects when partners have immediate needs.

Dr. Aneja noted the tension back in May and June when there was a considerable reduction in post-doctoral funding. He noted the subcommittee's concern that the funding reduction would affect future environmental researchers, but clarified that EPA has increased their post-doctoral program once again. Dr. Kavlock clarified that ORD has revitalized their intramural post-doctoral program, but stated their extramural post-doctoral program was still at risk.

Dr. Reckhow raised his concern regarding the definition of a systems approach. He stated that he had a vague idea, but asked for further clarity. Dr. Swackhamer seconded Dr. Reckhow's comment and noted that the third bulleted recommendations under charge question 2 reads: "Place a high priority on the development and implementation of a systems approach at all stages of the program, including problem formulation." Dr. Swackhamer explained that she found the recommendation surprising because she was under the impression that ACE already had a systems approach. She asked Dr. Costa if he questioned that recommendation or could offer clarification on what it means. Dr. Costa responded by asking if the recommendation pertained to something the ACE program is missing or if it was a push for them to do additional work in that area. He explained that the way the recommendation was phrased made it seem as though ACE was not doing work in that area, but Dr. Costa did not think that was intent. Dr. Aneja clarified that the intent was for ACE to continue to do what they were doing in regards to their systems approach. Dr. Reckhow stated that the recommendations needed definition because he saw them as two separate things and Dr. Swackhamer agreed, adding that a definition was needed because "systems approach" means different things to different people.

Dr. Costa explained that ACE's systems approach was very different from what CSS was doing and, although they are both systems, they are very different systems. Dr. Costa stated that, as a physiologist, he tends to look at a systems approach through a biophsyiological lens. Dr. Reckhow countered stating that, as a modeler, he sees a "systems approach" as linked simulation models.

Dr. Swackhamer noted that there was an explanation of a "systems approach" on page four but again the words "develop" and "implement" a systems approach used in the report implied that ACE did not already have a systems approach. She reiterated that she would like clarity on that issue.

Dr. Tharakan explained that, as an engineer, the systems approach is a well understood description of a methodology for resolving problems that considers all of the various sub-systems that are part of the system overall. Dr. Reckhow responded that he understood that specific conceptualization, but the "systems approach" still lacked clarity in the context of the ACE subcommittee recommendation. Dr. Swackhamer agreed that the committee needed a consistent definition. Dr. Tharakan commented that Dr. Reckhow's definition is a very

quantitative way characterizing something more descriptive, such as his own idea of the concept. Dr. Costa agreed and explained that one of the things ACE recognizes as important is the fact that a human system will respond a certain way to a social stressor, but completely differently when another stressor is added to the same system. He added that this notion has augmented his concept of systems thinking.

Dr. Swackhamer restated that the committee needs to clarify and add language to develop the concept of systems thinking. She proposed including Dr. Costa's slide in the report. However, she added that she was still at odds as to what exactly the subcommittee meant and asked the Executive Committee members if they had further questions.

Dr. Chaudhry noted that the subcommittee reports were a group effort. He raised his concern that if the committee prioritizes recommendations at this stage, subcommittee members may disagree with the order they choose. He suggested that the committee leave the recommendations unprioritized and allow ORD to prioritize them based on their resources and feedback from their internal and external partners. Dr. Tharakan responded that by leaving the prioritization to ACE, the committee essentially be asking ACE to complete the task that the program asked the BOSC to accomplish.

Dr. Swackhamer explained that in the first bullet of the recommendations listed under charge question 5 that reads "When considering the "end-user," use a broad definition of end-user that includes other researchers, ACE partners, policy makers, and the public and reflects the range of ways that ACE research is used. It may be helpful to replace the term end-user with user." She noted that EPA traditionally uses the word "end-user" so changing the word would have implications, and asked if others thought view it as a responsible recommendation. Dr. Flint stated that the terms "partner," "stakeholder," "user," and "end-user" needed clarification and asked if they were program-specific terms. She suggested that the BOSC use the terms consistently across subcommittees, since they were used somewhat interchangeably in the subcommittee reports.

Dr. Swackhamer noted that one of the reports defined the terms and clarified that the Agency used consistent terms throughout their programs. Dr. Kavlock further clarified that "partner" is used to describe a part of the Agency that is working with ORD, such as a program office or region. "Stakeholder" describes an external agency that is directly impacted by EPA's research, and "end-user" is anyone who uses a tool. Dr. Swackhamer followed by asking the subcommittee co-chairs to make sure that they use the same definitions across the subcommittees. She noted that page five of the HS subcommittee report defined all the terms except for "end-user," which may need further clarification. Dr. Flint noted that another term used in the report was "client." Dr. Swackhamer asked the co-chairs to adjust that recommendation to make sure that everyone was using the same definitions. Ms. Smith explained that the wording used in that recommendation was due to one ACE subcommittee member who did not like the term end-user, because he thought the subcommittee should be broad when discussing who used EPA's research. The charge question included the word end-user, so the subcommittee presumed everyone knew what that meant. The recommendation was not to be restrictive when talking about who uses EPA tools because they could be partners, stakeholders, academics, and citizens.

Dr. Swackhamer redirected the committee's conversation to the prioritization of the subcommittee's recommendations. She asked the committee for their opinions on what they

viewed as the most important items ACE could act on to improve their program in the next three to four years. Dr. Aneja suggested that there was no single recommendation that was the most important. He noted, however, that not all the recommendations were of equal worth, but thought the subcommittee should be consulted in terms of prioritizing their recommendations. He added that ACE is doing a good job and has undertaken activities that encompass national needs.

Dr. Swackhamer clarified that the Executive Committee counts on the co-chairs to bring their impressions to the final report. Dr. Aneja responded that the subcommittee thought ACE was doing a great job. Ms. Smith stated that she heard the subcommittee discuss the importance of translating and synthesizing work in a time of diminishing resources. She suggested that, from the end-user perspective, it is the products that are most useful. She admitted that her comment stems from her own biases. Dr. Solomon agreed, and stated that was what she took away from the report. Ms. Smith explained that ACE is doing translation work in many cases, and clarified that the subcommittee thought part of their charge was to make sure their recommendations stressed the importance of on-going actions so that broader audiences would be aware. The Executive Committee members agreed with that emphasis, and Ms. Smith acknowledged that the subcommittee could have done a better job conveying that point.

Dr. Richardson stated that the charge question was how to improve the ability to translate research findings and suggested the recommendation be put in that context of program improvements. Dr. Richardson then drew the committee's attention to the recommendation under charge question 2 on page five that reads "Provide a better articulation of the extent to which input in planning is being provided by other offices within ORD." He highlighted that the recommendation is something that appears across subcommittee reports. He asked if the recommendation is a high priority for ACE and whether it should be included in the main body of the Executive Committee's final report. Dr. Costa responded that the recommendation spoke to one of the real challenges in ORD. He explained that the ACE program is still working hard to adopt the systems thinking approach. He added that the second part of this effort is the translation element. Ms. Smith explained that the concept Dr. Costa explained was at the heart of one of the recommendations. She recalled speaking with an EPA's staff member who did outreach activities in a primary school system. She had the impression that her boss did not appreciate that aspect of her work, so ACE recommended that the program credit people for activities other than publications. She added that the subcommittee did not provide details on how to capture those activities, but suggested that the subcommittee could attempt to answer that question during their next meeting. Dr. Costa responded that his impression is that all programs are working to change the way people think about these things.

Dr. Swackhamer noted that two paragraphs in the report are excellent and could be applied to any program. She suggested that the recommendation to credit people for activities other than publications and the recommendation to nourish the related cultural change within the Agency be included in the overarching comments section of the Executive Committee's final report. Dr. Solomon agreed that she would like to extract the last two paragraphs of the ACE subcommittee report as crosscutting points for the Executive Committee's report and apply them to all the programs.

Dr. Swackhamer asked for other comments on ACE priorities.

Dr. Richardson noted that the recommendation that touches on the quality of products and metrics to assess overall program quality, outreach, and engagement under charge question 4 seemed to be of high importance. He suggested that the first and fifth bullet points under charge question 4 be elevated to higher priority and the rapid response recommendation be eliminated. Dr. Swackhamer agreed, noting that those recommendations showed up in several of the other reports. She added that part of the previously constituted BOSC had two members that developed a white paper on how to evaluate the BOSC program, including how to develop metrics. Dr. Swackhamer commented that the Executive Committee should devote time to determining how to advise ORD on this issue early on. She stated that the metrics issue has been articulated in the past, and Dr. Cozzens, who was one of the authors of that white paper, could help with that effort.

Dr. Aneja stated that all of the committee's comments on the ACE subcommittee's report had been helpful and constructive. He asked the individual members who made comments to please email their comments to him.

Dr. Richardson raised his concern that the report did not provide acronyms and suggested that the committee add a single compilation of acronym definitions to the beginning of their report.

Dr. Costa drew the committee's attention to the last recommendation under charge question 4, which touches on the quality assurance program. He asked for clarification on its intent. Ms. Smith explained that the ACE subcommittee was asked to provide comments on how to improve quality, but the subcommittee did not feel they received enough information on the procedures for quality assurance to recommend improvements. Dr. Costa agreed that suggestions to improve quality are dependent on the depth. He added that this topic was one things the Agency was sensitive to. Dr. Swackhamer explained that she thought the quality assurance bullet was intended to recommend that ACE provide the subcommittee information on quality assurance in the future. She suggested the committee add text to clarify that. Ms. Smith confirmed that Dr. Swackhamer's characterization of the recommendation's intent was accurate. She suggested that the subcommittee have another meeting where quality assurance was included in a charge question.

Dr. Swackhamer asked the committee members if they had anything else to add on the priorities and recommendations. Hearing none, she moved to the next agenda item.

Deliberation and Writing Session

Deborah Swackhamer, Chair

Dr. Swackhamer noted that she had ignored the Deliberation and Writing Session agenda item when discussing processes and next steps. She explained that the committee is tasked with drafting the Executive Committee responses to the Climate Change Roadmap and the EJ Roadmap. She clarified that the committee would work in breakout groups to draft the documents. She added that Dr. Solomon would facilitate and organize the Executive Committee response to the EJ Roadmap and Dr. Galloway and Dr. Reckhow would lead the response to the Climate Change Roadmap. She explained that the breakout groups would spend the next hour or so reviewing members' notes to organize their comments into coherent and succinct responses that answer the roadmap's charge questions. She stated that editorial edits could be sent to her and Mr. Tracy for inclusion.

Dr. Swackhamer then invited the Executive Committee members to split into their breakout groups for an hour writing session.

Wrap Up and Adjourn

Deborah Swackhamer, Chair

As the breakout groups spent different lengths of time drafting their summaries, Dr. Swackhamer informally adjourned the first day of the meeting at 5:30 pm.

Wednesday, December 9, 2015

Reconvene

Deborah Swackhamer, Chair

Dr. Swackhamer reconvened the meeting for the second day. She asked new attendees to introduce themselves.

Dr. Cozzens introduced herself to the other Executive Committee members and noted her expertise in research program evaluation.

Dr. Swackhamer invited EPA staff who were not in attendance for the first day of the meeting to introduce themselves. Mr. Jace Cujé introduced himself as the DFO for SHC. Dr. Michael Slimak introduced himself as the NPD for SHC. Ms. Emily Eisenhower and Ms. Mya Sjogren introduced themselves as EPA fellows with the SHC research program.

Sustainable and Healthy Communities Draft Report

Robert Richardson, Chair, and Courtney G. Flint, Vice Chair

Dr. Richardson introduced himself and his co-chair Dr. Courtney Flint. He also recognized all of the sub-committee members.

Dr. Richardson pointed out that the SHC report is a bit longer than the other four reports. This was intentional, so the report could be a standalone document. He added that the report also includes information on the SHC StRAP to provide the necessary context for their recommendations. He also noted that the bulk of the work performed by the subcommittee is represented in the answers to the charge questions.

Dr. Richardson pointed out that the SHC program is unique among EPA's research programs. Its aim is to provide research and tools to community-based decision makers to produce more sustainable outcomes for the environment, society, and the economy. SHC is organized around four research topics: (1) decision support and innovation, (2) community well-being: public health and ecosystem goods and services, (3) sustainable approaches for contaminated sites and materials management, and (4) integrated solutions for sustainable communities.

Dr. Richardson described the process by which the subcommittee developed their report. First, the subcommittee members reviewed program materials provided by the DFO. He noted that the subcommittee held a face-to-face meeting in Research Triangle Park, North Carolina, in September 2015, where the members worked in small breakout groups to address specific charge questions. Based on the breakout groups' inputs, Dr. Richardson and Dr. Flint drafted a report that was discussed by the full subcommittee during a teleconference on November 4, 2015. The subcommittee submitted its report to the Executive Committee Chair on November 17, 2015.

Dr. Richardson reviewed the six charge questions that the subcommittee members were responsible for reviewing (see Appendix C for the list of charge questions).

In response to charge question 1, Dr. Richardson recognized and applauded SHC for its strong and consistent focus on sustainability and systems orientation across its research programs. He added that SHC provides an articulate vision on how integration is accomplished and also noted the considerable challenges SHC faces in addressing the breadth of sustainability. Dr. Richardson also summarized the subcommittee recommendations in response to charge question 1. The first recommendation was to increase integration across programs and topics, as well as across scales in products and tools. The second recommendation was to develop a more systematic and transparent process for the selection of communities and projects. Third, the subcommittee recommended greater focus and emphasis on outcomes. Next, the subcommittee recommended the development of projects under topic 4 that more directly address "integrated solutions." Finally, the subcommittee recommended providing leadership on core concepts of sustainability.

In terms of charge question 2, Dr. Richardson stated that there was limited evidence for conclusive finding regarding partner engagement in research planning, but noted that partners have some level of official involvement in the StRAP and other planning processes. The subcommittee recommended that SHC formalize and improve documentation of the engagement process. SHC should also explicitly define "partners" and their appropriate roles in research planning. Another subcommittee recommendation called for a criteria to assess the effectiveness of stakeholder involvement. Finally, for future meetings with the subcommittee, SHC could provide opportunities for more interaction with staff from the laboratories and centers, as well as stakeholders, in partnering with regions and communities.

Responding to charge question 3, the subcommittee noted a healthy tension between the mandate to support partner needs and the forward-thinking drive toward new research projects. Dr. Richardson stated that the subcommittee viewed this as a positive aspect of the program that will help maintain its responsiveness, especially given shrinking financial resources. He indicated that the subcommittee determined there was limited evidence for a conclusive finding regarding partner engagement in research planning, and that it often appear to be *ad hoc.* The subcommittee recommended that SHC continue to encourage research projects that are forward-thinking, even though they may not reflect immediate partner needs. Next, the subcommittee recommended formalizing the process of identifying partner needs and improving the documentation of the assessment of partner needs. The subcommittee also recommended that SHC consider of a reallocation of resources to partner engagement related activities. Finally, the subcommittee recommended conducting an implementation study.

In response to charge question 4, the subcommittee noted a strong commitment to the paradigm shift away from linear models of human health, toward a socio-ecological system and a more complex model of individual and community well-being, noting that SHC tools are some of the strongest available in the market. Dr. Richardson stated that the first subcommittee recommendation is that SHC expand the conceptualization of relationships between ecological and human health away from linear, unidirectional articulations toward more complex systems thinking and multi-directional relationships. The subcommittee also recommended that SHC use tools that are available from external programs and federal agencies. The third recommendation

encourages SHC to expand the time horizon for investigating the interactions between the environment, human health, and community well-being beyond the typical five-year research plan. The final recommendation is to increase the capacity in the social sciences.

Responding to charge question 5, the subcommittee describe SHC research and tool development as intrinsically linked and not separate. Dr. Richardson explained that there is definitely a greater emphasis on tools than on the hypothesis-driven research, but the subcommittee did not view this as negative. In terms of recommendations, the subcommittee encourages SHC to develop a catalog of tools, particularly those related to ecological and community health. The subcommittee also recommended infusing technology and innovation into regulatory enforcement actions, raising the profile of basic and applied research in StRAP objectives, and including a description of the scales at which "community" is defined in the StRAP.

Referencing charge question 6, Dr. Richardson explained that the subcommittee felt SHC is very responsive to the needs of regional offices through the technical support centers, while also addressing the challenges of balancing short-term and long-term research needs. The subcommittee recommended expanding the program's focus from site-specific mitigation outputs to area and community-level outcomes. The second recommendation encouraged including people-based as well as place-based analytical frames in research and tool development. Finally the subcommittee recommended adopting a holistic approach to research on productive uses of resources that can be translated into well-being outcomes at neighborhood, community, and national scales to provide a conceptual framework that extends beyond the current site-specific framework.

Dr. Richardson concluded by noting the subcommittee's meaningful engagement. He reiterated that the subcommittee found SHC's research topics and project areas were organized well overall. Moving forward, SHC should continue to provide leadership within ORD and EPA, the United States more broadly, and to the world generally, in order to provide conceptualizations of sustainability, communities, and well-being. He added that doing so will require continued movement along the shifting paradigm toward complex systems thinking, which may require additional resources. SHC should also formalize the relationship with partners and systematically document the process of engagement from problem form, implementation, and evaluation across time. For future meetings, SHC should consider providing an opportunity for the subcommittee to have greater interaction with staff on the ground.

Dr. Swackhamer asked for clarifying questions, but there were none.

SHC Program Comments

Michael Slimak, National Program Director

Dr. Slimak thanked the SHC subcommittee for its engagement, adding that their interactions were terrific. He commented that the report was thorough, thoughtful, and helpful. He was pleased to see for the first time the addition of social sciences. To Dr. Slimak, the incorporation of social sciences indicates a movement toward the next era of environmental science, which is all about behavior. For instance, making significant progress against climate change will require motivating individual action.

Dr. Slimak did not find that any of the subcommittee's recommendations were based on misinterpretations of the background information or erroneous assumptions. He added that SHC plans to provide a written response and to meet with the subcommittee continuously to respond to their recommendations. Summarizing the subcommittee's recommendations, he acknowledged that there is a need for greater integration. Regarding the scalar issues brought up by the subcommittee, he stated that all 11 SHC research projects have recently completed project plans that detail the research approach and hypothesis, which he hopes will address their concerns. Dr. Slimak noted that, based on the subcommittee report, SHC's engagement process is not as in sync with its partners as previously thought, and that a measurement metric would be helpful in assessing this. Similarly, he stated that SHC will need metrics to measures the success of SHC's work, as simply counting publications is not enough. He will look to the subcommittee for further guidance on responding to their recommendations.

Dr. Slimak also commended the subcommittee on its clear and succinct definition of sustainability science, which clearly links the social and biophysical sciences. He continued by saying that incorporating social sciences is a paradigm shift at the Agency and in environmental science. SHC appreciates the subcommittee's support in moving forward and its acknowledgement of SHC's consistent focus on sustainability, systems thinking, and the effort to move toward a non-linear model and would like further guidance and recommendations in this area. SHC also appreciates the subcommittee's endorsement the SHC conceptualization of what it means to be a safe and healthy community. Dr. Slimak believes that SHC is a leader in this area and hopes to continue in this role and added that the subcommittee's conceptual framework will be very helpful.

For future meetings, Dr. Slimak noted SHC would prefer to address the individual recommendations by topic, as the need to focus is considerable. He added that SHC can bring in project researchers to give the subcommittee an overview of their detailed work, but the group will need to identify a smaller subset of highest priority recommendations that will have the biggest impact on moving this research forward and make the most difference in communities. Dr. Slimak stated that he is looking forward to future meetings with the subcommittee and thanked them for their hard work once more.

Discussion SHC Draft Report

Deborah Swackhamer, Chair

Dr. Burke thanked the SHC subcommittee for a great presentation. He noted that SHC is challenged by working in a "siloed" organization and determining how its focus areas match against social science, community needs, and EPA work more broadly. Dr. Burke stated that the recommendations are creative and several very important themes emerged: partnership, the importance of incorporating social sciences throughout the process, and addressing longer-term research needs. He closed by praising SHC as a challenging science program that is pushing the field of environmental science forward.

Dr. Swackhamer asked for clarification on why it is confusing who SHC partners with and wondered if they are identified in the StRAP. Dr. Slimak responded that it is likely confusing because SHC did not define internal versus external partners well. He clarified that the first partners are internal EPA offices and regions. He added that those are SHC's traditional program

partners, previously called "clients." This terminology is not used anymore, as SHC does not tell partners what to do; the relationship is a true partnership. Dr. Slimak noted that external partners include outside organizations, such as NGOs, that SHC works with through its program partners. Mr. Geller added that a challenge throughout ORD, including in SHC, is vertical communication. SHC works with program and regional offices at all levels and works with project teams and managers to prioritize the message of regional offices. He acknowledged that messages can get lost. Dr. Swackhamer explained her vision of a table where SHC could list its external partners, internal partners and stakeholders and then create a matrix of how the program interacts with them and engage on problem formulation. She asked if this has not already been done because it is too constraining. Dr. Slimak responded that program partnership and engagement is so ingrained in the way SHC operates, that they had not considered formally documenting it. He added that their communication with partners is constant and SHC reaches out to them in many ways and venues. He noted that documenting this would be helpful for the subcommittee. Dr. Kavlock commented that ORD has a matrix illustrating the engagement process and suggested reviewing it during the break. Dr. Swackhamer reiterated her concern that identifying program-specific stakeholders might be too constraining. Mr. Geller replied that SHC is currently developing a communication matrix now to describe who SHC engages and what information they need to give or receive. Dr. Swackhamer pointed Dr. Slimak and Mr. Geller to a partner engagement diagram included in the National Research Council's 2011 report *Sustainability and the U.S. EPA* that might be helpful. Dr. Richardson added that the charge question about partner engagement simply mentions partners as a homogenous group. He pointed out that internal partners are different and SHC should identify regional and laboratory partners during the problem formulation and research phases, as it would be helpful to know who the partners are and what their roles are. Dr. Swackhamer apologized for the ambiguity related to the definition of "partner," as she vetted the charge questions.

Dr. Reckhow commented that he does not think the report is too long. He asked Dr. Slimak if he felt the need for integration was addressed by the subcommittee's recommendations. Dr. Slimak responded that, in his opinion, the most important recommendation was the recommendations to integrate better. He added that he knows SHC has more work to do related to integration, but the subcommittee recommendation strengthens his appeal for further integration among the laboratories.

Dr. Swackhamer noted that some recommendations acknowledged SHC's great work and identified areas for enhancement, while others called for improvement. She added that these are very different comments and the Executive Committee will try to distinguish between them in the final report.

Dr. Galloway asked Dr. Slimak if there were recommendations he had hoped to see that were not included in the draft report. Dr. Slimak replied that he could not think of anything. Mr. Geller added that the draft report included many helpful recommendations. He stated that he used the subcommittee's conceptual model in a meeting about moving from remediation to community revitalization and it resonated with science researchers and social scientists. He acknowledged that integration among the laboratories is the area for growth within SHC. The recommendations that discuss topic area 4 are welcomed, as those projects have a long way to go to full integration and incorporating the systems approach that is needed. He stated that more specific

recommendations regarding how to engage social scientists with different areas of expertise would also be helpful, as "social science" is not monolith.

Dr. Aneja stated that the response to charge question 1 touched on developing a more systematic and transparent process and asked for clarification on the current process. Dr. Slimak responded that it is an important issue, as SHC is not currently selecting study units randomly. He continued that communities have been "given" to SHC through various mechanisms. Each of the regions have identified communities they have observed to overburdened, so selection is really based on a regions' knowledge of their communities. For the EnviroAtlas program, they selected 50 based on ecosystem types. In this case, the selection criteria were different. Dr. Slimak acknowledged that SHC can make its study unit selection process more clear. Dr. Flint followed by saying that the subcommittee was suggesting that an identified community implies that it has the ability to "raise its hand," which might completely miss the most under-resourced communities. She added that documenting the process and community typology can help identify gaps. Dr. Slimak agreed that SHC could create a typology of communities across the nation, which would help during the selection process. He added that, so far, there does not appear to be a clear typology when accounting for all social determinants that drive well-being.

Dr. Somasundaran commended the subcommittee on its definition of sustainability. He added that there are many definitions with varying focuses, but the members have identified all of the important aspects very clearly. Dr. Richardson noted that the subcommittee drew on existing conceptualizations and that it was a team effort. Dr. Swackhamer noted that the subcommittee may also want to reference EPA's definitions of sustainability. Dr. Somasundaran added that there are many definitions (for example, industry has its own), though none are universally accepted. Dr. Slimak acknowledged that EPA has defined sustainability from its perspective, which is that sustainability cannot be achieved without a good-quality environment. Mr. Geller replied that there are many definitions, but SHC needs to operationalize its own definition by focusing on three main components, which are: the interconnectedness of the economy, health, and the environment, a long-term focus, and the idea that sustainability is tied to well-being. He added that needs are defined by the holistic definition of well-being. Dr. Swackhamer commented that the subcommittee has also done a great job defining "well-being."

Ms. Smith asked whether there was a discussion of preserving anything EPA currently does in the transition away from linear to systems thinking and from site-specific to broader scales. Dr. Flint replied that she did not recall any such discussion and that the subcommittee embraced the complexity of systems thinking in temporal, scalar, and spatial ways. Dr. Richardson added that there was a strong recognition that linear models are insufficient. He noted there was a universal consensus that such linear thinking does not have a place in contemporary research.

Dr. Tharakan raised the issue of the number of definitions of "sustainability" again and asked whether it is really the responsibility of the Agency to have a definition. He added that a safe and healthy community is the essence of sustainability. Dr. Chaudhry followed by asking whether a universally accepted definition is necessary. Dr. Swackhamer replied that she believes EPA needs a single one, even if it is broad and aspirational, in order to operationalize the concept. Dr. Chaudhry noted that although the definitions might be worded differently, the definitions target the same goals and objectives. Dr. Richardson disagreed, stating that some of the industry-level definitions are self-serving. He added that EPA's definition should be broad and ultimately get at

well-being. A number of subcommittee members raised the question of what entity is better positioned than EPA to develop a definition of sustainability and play an international leadership role. Dr. Flint reiterated the subcommittee's strong sentiment that EPA should provide this leadership and the tools to operationalize the definition. She continued, saying that no other entity has the scope or vision that the subcommittee thought SHC has in moving forward, but noted there are others to partner with on the way. SHC shows the capacity to be inclusive in partnering with a wide diversity of players across the world and at different scales.

Dr. Swackhamer asked for any other comments or clarification questions and there were none. She commented that the subcommittee's summary is terrific and is a model for the other groups. She added that the draft report is not too long, as the group cannot assume the reader will know all the intricacies of the issues involved and must explain them thoroughly. Dr. Flint replied that Mr. Cujé was instrumental in helping the subcommittee assemble the structure and select the materials. She added that there are pieces of information that did not get included within the general observations, challenges, recommendations, and opportunities. Dr. Swackhamer noted that the consistent format was very helpful and asked what the committee would like to say regarding prioritization of the recommendations. Dr. Flint said she and Dr. Richardson created a conclusions slide with three substantive recommendations that provide the leadership and integration on these conceptualizations. She added that if they are to select a specific number, she and her co-chair may need more time. Dr. Swackhamer clarified that she did not have a specific number in mind and is just trying to get at the main points. She asked which recommendations should be highlighted in the summary versus stay in the appendix. Dr. Richardson reiterated that the subcommittee feels SHC is doing a great job. He added that more concrete recommendations would involve changes, but that he and Dr. Flint could identify these for prioritization. Dr. Swackhamer acknowledged that the co-chairs seemed to have a handle on the priorities and asked for input from the rest of the Executive Committee. She added that she would underscore that the top recommendation is continue to look for leadership opportunities, within EPA and the Administration in general, and extend leadership on defining these issues for the government and the nation.

Dr. Cozzens asked whether there are specific actions to suggest in the context of the recommendation to "continue to integrate across projects?" Dr. Flint replied that this is a continuation. She added that there is an interoperability workshop.

Dr. Swackhamer reminded the Executive Committee members that the full set of recommendations will be included in the appendix to the final report. The focus now is on summarizing. She clarified that the report will be more like an executive summary and will refer to the full set of recommendations in appendices as chapters of sorts.

Dr. Galloway: commented that, in terms of the definition of sustainability and well-being used in the SHC program, there should be a connection to broader words of sustainability. Dr. Swackhamer agreed, saying it should be more clear how the EPA definition fits.

Dr. Swackhamer noted there were no further comments and thanked the SHC subcommittee for their great work.

DRAFT

Safe and Sustainable Water Resources Draft Report

Kenneth Reckhow, Chair and Shahid Chaudhry, Vice Chair

Dr. Reckhow and Dr. Chaudhry presented on the subcommittee's review of the SSWR StRAP. Before beginning the presentation. Dr. Reckhow noted that the SSWR subcommittee's presentation and draft report have a different structure than the other subcommittees' reports. He explained that he was extremely focused on the wording of the charge questions.

Dr. Chaudhry began the presentation by thanking the subcommittee members for their hard work. He informed the Executive Committee members that the goal of the SSWR StRAP is to protect America's waters through interrelated research in four areas: watershed sustainability, nutrients, green infrastructure, and water systems.

Dr. Chaudhry reiterated that general charge question 1 asked if the research topics and project areas are planned and organized appropriately to make good progress in the time period. He said the SSWR subcommittee crafted tables to reflect the their understanding of how various research programs and projects meet the four specific research objectives, which are: addressing pollutants, waters to resource concept, quantifying water quality benefits, and translating research to solve problems. He explained that the group ranked the projects as either "meeting" or "supporting" the research objectives, or otherwise having a limited connection or no connection with the identified objectives. He noted that many of the projects met or supported the program's research objectives.

General charge question 2 examined the effectiveness of approaches for involving partners in problem formulation. Dr. Chaudhry stated that the subcommittee identified better defined and documented internal coordination, but the coordination mechanism with outside partners and stakeholders was unclear. The subcommittee recommended that SSWR develop a detailed description of interactions with external stakeholders and efforts to leverage research funding. Specifically, they called for the coordination process with external stakeholders to include a database of EPA Science to Achieve Results (STAR) grantees and research areas, the selection process and criteria for topic and project decisions, a measurement of progress and intermediate metrics, as well as a scholastic outreach mechanisms.

General charge question 3 asked how well the program responds to partner needs. The subcommittee pointed out that SSWR is doing a great job aggregating and developing the StRAP to address challenges to the nation's water resources. However, Dr. Chaudhry explained the subcommittee determined that SSWR should identify and prioritize research needs through internal and external consultations and collaborations with organizations such as STAR, ORD laboratories and centers, regional offices, SAB, and BOSC. Dr. Chaudhry expressed that some important stakeholders are missing from consultations and that it is difficult to determine how SSWR ensures priority needs are addressed. He continued to say that this apparent weakness in integration of partners is reflected by an overall weakness in meeting objective 4, the translation of research. He also noted that the current draft SSWR StRAP lacks a discussion of relevant large-scale EPA and federal programs such as the Endocrine Disruptor Screening Program and the ToxCast Program. He acknowledged that these consultations might have occurred without being documented. Therefore, he called for SSWR to explicitly document large-scale interactions within EPA and beyond. Related to nonpoint source pollution specifically, the

subcommittee noted very weak linkages between the 319 grant projects and ORD and recommended that this relationship be strengthened by ORD either conducting hands-on research or providing coordination and planning support. Additionally, the subcommittee recommended that SSWR conduct rigorous analysis of project performance. Another recommendation involved the clarifying the prioritization process for issues such as decaying infrastructure and potable water reuse, which the subcommittee stated is not entirely transparent. And finally, the group recommended that the SSWR research strategy address the gaps identified through the Contaminant Candidate List (CCL) Process. Dr. Chaudhry commented that the subcommittee highly recommends that SSWR find more tangible mechanisms to engage all stakeholders to identify and prioritize research areas and projects.

Dr. Reckhow discussed the subcommittee's responses to the SSWR-specific charge questions. He noted that SSSWR-specific charge question 1 asked how SSWR can streamline model and tool development within the program and across other national programs and partners in order to improve utility, interoperability, and accessibility as well as how the program can measure success. The SSWR subcommittee expressed that ORD should improve model utility by routinely incorporating uncertainty analyses and communicating the meaning of uncertainties in the context of potential impacts of proposed actions to partners and stakeholders. Dr. Reckhow commented that model over-parameterization is also an issue, as a number of parameter sets will fit the model equally well. EPA is aware of this troubling problem. He noted multiple techniques, such as Monte Carlo analyses and generalized linear models, to deal with over parameterization and acknowledged that EPA is doing limited work with these tools to fix the problem, but these techniques should be implemented more widely. He noted that the approach in some programs is to forego an uncertainty analysis and hedge toward more conservative standards. To improve interoperability of models and tools, the subcommittee recommended that SSWR build a comprehensive model that includes and links water and socioeconomic simulations. Alternatively, SSWR could stress that in their model development guidance documents that models be built with seamless integration with other models likely to be linked. Regarding measures of success, SSWR might consider enumerating the number of downloads of each model, cited applications of each model, attendees at modeling courses, and approved TMDLs based on EPA-supported models.

SSWR-specific charge question 2 asked about the unique aspects of resource recovery and water reuse that SSWR is best able to address, and what research products are envisioned to maximize its impact. Dr. Chaudhry explained that the paradigm is shifting, and the terminology has evolved from sewage to wastewater and now to resource water. He commented that the complexity and types of pollutants in wastewater today are not the same as they were in the past, and that nature is unable to take care of the issues itself. He noted that, with treatment, this water can be reused. We get energy, metals, and nutrients out of it, so this is no longer considered wastewater. "Resource water" is a more appropriate term that reflects its economic benefits. This shifting paradigm is mirrored in the engineering field. Dr. Chaudhry added that, regarding research products to maximize its impact, SSWR should consider whether a specific technology is best developed within EPA or within the private sector, but either way SSWR should continue to play a central role in assessing cumulative human health and environmental impacts of contaminants in resource water.

SSWR-specific charge question 2 also asked how SSWR can better translate its research products and disseminate this knowledge to a broader community of stakeholders. Dr. Reckhow stated that SSWR has engaged in a number of workshops, webinars, workgroups, and a variety of other scientific meetings, as well as newsletter, in order to improve its research planning to ensure its programs have a practical effect. The SSWR subcommittee expressed that it was unable to understand the quality and usefulness of these many activities based on the background information provided, so they did not provide comments the value of these activities. Dr. Chaudhry clarified that the subcommittee's point is that SSWR is doing great work, but it could translate the work more effectively to stakeholders. Overall, SSWR should have a greater focus on these tools and the technologies should be better communicated to stakeholders.

SSWR Program Comments

Suzanne van Drunick, National Program Director

Dr. Swackhamer began the discussion by introducing Dr. Suzanne van Drunick, the NPD for the SSWR Research Program.

Dr. van Drunick thanked the committee for their comments and the SSWR subcommittee for their guidance on how to strengthen the program. She stated that the BOSC process is new to everyone and has been a learning experience. She noted and she would limit her comments to areas in the subcommittee report where SSWR would appreciate further clarification.

Dr. van Drunick explained that the SSWR subcommittee had similar issues with the definitions of the terms "partners" and "stakeholders" that had been discussed previously in the context of ACE and SHC. She noted that the lack of definitions complicated the subcommittee's ability to address general charge questions 2 and 3. Dr. van Drunick added that she agrees with the committee's suggestion to incorporate the social sciences into their program, but asked for the subcommittee's guidance on the particular aspect of the research program that should be prioritized to receive social science expertise. She noted, for example, that there was a push for SSWR to become involved in the water reclamation effort, but stated numerous other organizations have been working in that area for years and it is not an area she would want to direct scarce social science expertise toward. However, Dr. van Drunick suggested that there may be another niche for SSWR could work in. She added, for example, that SSWR is discussing bringing economists into their water quality projects to examine the costs of green infrastructure.

Dr. van Drunick stated that the SSWR subcommittee's slide on SSWR-specific charge question 1 helped identify their recommendations. She agreed with the suggestion to number the recommendations in the draft reports. In terms of specific comments on charge questions, Dr. van Drunick mentioned that SSWR would benefit from a clarification of Table 1, and added that she will provide additional, new materials to do so. She elaborated that the StRAP was not developed for all twelve projects to contribute to all four research objectives and that the blank spaces in the table make sense. For example, project two and three were not meant to support the research objective to transform waste to resources. She added that she would also appreciate clarification on the distinction between the terms "meets" and "supports." Dr. van Drunick stated that she assumed the subcommittee used "meets" when that particular research program was aligned with and accomplished a particular research objective and used "supports" when SSWR

will likely contribute to the research objective. Finally, she proposed having another poster session with presentations by project leads so the subcommittee might better understand how the projects and objectives align.

Dr. van Drunick drew the committee's attention to the recommendation under specific charge question 1 that that began with "ORD is to be commended for its efforts to build partnerships with the regions and address needs the regions are experiencing." and specified the need for SSWR to foster additional dialogue and engage partners earlier in the planning process. She noted that this comment was the most surprising, as the text is written in a way that implies SSWR's regional input occurs after the fact.

Dr. van Drunick explained that SSWR initiated conversations with the regions more than eighteen months ago. She added that the regions have voiced their appreciation for being engaged from the very beginning, particularly in each of the topic working groups and project plan writing teams, and feel that SSWR values their meaningful time and efforts. Dr. van Drunick voiced her agreement that the regions are great partners.

Dr. van Drunick agreed that a definition of "partners" and "stakeholders" should be included under general charge question 2 on effective approaches for partner engagement. She explained that she agrees with the subcommittee's recommendation to include external partners, such as the American Water Works Association (AWWA). She acknowledged a past suggestion for SSWR to reach out to the Water Research Foundation (WRF), and explained that SSWR does engage WRF as they provide the organization with STAR grants. Finally, she advocated for leveraging the subcommittee members' experience and networking resources to expand the number of engaged program partners, and suggested adding that discussion as an agenda item for a future meeting

Dr. van Drunick noted the recommendation to identify more tangible mechanisms for engaging water stakeholders and to engage through more formal communications. She asked for clarification on what the committee meant by formal communications, as SSWR is proactive in this area and already provides technical support and webinars for their stakeholders. She added that SSWR has to be careful in the context of partner engagement and remain impartial to funding recipients.

SSWR appreciated the subcommittee's response to SSWR-specific charge question 1. Dr. van Drunick stated that she and Dr. Reckhow have spoken about how to move forward on model and tool development, including the possibility of holding workshops and webinars with SSWR scientists. She added that she would save her comments on SSWR-specific charge question 2 until the end of her presentation.

Dr. van Drunick commented on her commitment to science translation. She added that SSWR has started holding webinars, but noted that developing metrics for their usefulness remains a challenge. She pointed out counting the number of attendees as a possible metric. Dr. van Drunick stated that the last SSWR workshop had about 250 attendees from over 45 states, adding that workshop attendance continues to grow. She stated that it would be helpful for the subcommittee to identify audiences SSWR is not currently reaching and examples of communication projects that they view as useful. She continued by saying SSWR translates for different audience, noting their technical research communications intended for modelers and

fact sheets intended for the broader as examples. Dr. van Drunick explained that the BOSC can help SSWR determine how to communicate complicated technical topics in an understandable and appealing way to broader audiences, noting this area as a program gap.

Regarding SSWR-specific charge question 2, Dr. van Drunick explained that the information on water reuse in the StRAP was added to support the "waste to resource" research objective. SSWR used the term "post-use water" but also discussed using the term "enriched water." She noted that the program asked the BOSC to identify a better name and the subcommittee suggested the term "resource water." She added that water transformation terminology is developing rapidly and SSWR's colleagues have also struggled with it. Dr. van Drunick added that water reuse is an area of growth and investment for SSWR, but clarified that SSWR is not looking to expand their role into the use of traditional source waters, such as gray, rain, or saline waters.

Dr. van Drunick acknowledged ongoing research at private sector organizations and other federal agencies, such as DOE, that might be useful to EPA. She noted, however, that EPA's niche will be identifying new potential sources, such as agriculture return flows, food processing wastewater, and plant processing wastewater. Dr. van Drunick pointed out that SSWR could join the effort to determine water standards for fit-for-purpose use. She explained that EPA focuses standards on public drinking water, which accounts for only six percent of U.S. water withdrawal, and other intended uses may not require water to be treated to the same extent. Providing guidance for clean water standards based on the intended use within particular industries (e.g., energy, agriculture, etc.) may help address water shortage concerns. Dr. van Drunick stated that EPA will need to inform the public on the various levels of water quality from different sources to stem the negative perception and improve confidence in water safety. She highlighted this area as a niche for the Agency. She also commented that EPA communicates with partners such as U.S. Global Resources (USGR) and the U.S. Geological Society (USGS) to ensure they do not duplicate ongoing efforts.

Dr. Swackhamer thanked Dr. van Drunick for her comments and asked Dr. Williams if he had anything to add. Dr. Williams echoed Dr. van Drunick's appreciation for the subcommittee's comments and recommendations. He agreed that SSWR will provide additional materials to the subcommittee as they move forward. He added that he appreciated the community and information translation comments, particularly in the area of systems work with the regions, and would appreciate additional recommendations in that area. He noted his interest in the comments regarding the 319 Grants Program, and would appreciate additional recommendations on how to strengthen that relationship, as well.

Dr. Swackhamer asked if she heard Dr. van Drunick and Dr. Williams comment on inaccuracies in Table 1. Dr. van Drunick clarified that there were not inaccuracies, but reiterated that all twelve projects were not intended to meet all of the four research objectives. She suggested the SSWR subcommittee add a sentence in the report to clarify that the blank boxes was not areas that SSWR is missing research projects. She also reiterated that "meets" and "supports" was not inaccurate, but she would like a more detailed distinction so SSWR can provide the appropriate additional information in the future.

Dr. Swackhamer stated that understood the subcommittee implied that regional input is sought after the fact and Dr. van Drunick clarified that this is not the case. She asked Dr. van Drunick if

she understood that exchange correctly. Dr. van Drunick confirmed that Dr. Swackhamer's understanding was correct. Dr. van Drunick reiterated that SSWR has a two page document that clearly illustrates when the partnership began and how successful that partnership had been, but admitted she had not checked if the document is available on EPA's website.

Dr. Swackhamer then opened the discussion for other clarifications and emphasized that the SSWR subcommittee provided bulleted recommendations in their presentation, but not in their draft report. Dr. Reckhow acknowledged the draft report needs editing.

Discussion SSWR Draft Report

Deborah Swackhamer, Chair

Dr. Swackhamer asked the committee if they had any questions about what was included in the report.

Dr. Flint stated that resource water was a topic of discussion during the joint BOSC/SAB review last summer and asked if the current committee's discussion was a continuation of that conversation. She also inquired if resource water is an area that EPA works in, adding that if it is, EPA did not communicate that effectively last summer. Dr. Flint observed that a recommendation in this area has likely been in the works for quite some time and asked where the committee stands in regards to their resource water recommendation. She also wondered if the subcommittee saw the term "resource water" used in their references.

Dr. Chaudhry responded that he did not see the term in the materials they were provided, but noted that the topic is evolving. He pointed out that the wastewater community knows it cannot use one term for all water (e.g., reclaimed water, reused water, or resource water). He explained that re-cleaned water and reused water are interchangeable terms, and reused water is a component of resource water. He further clarified that resource water contains many components in addition to water and the term reclaimed water ignores these things (e.g., organics, biosolids, nutrients, and heavy metals). He added that the extent of water reuse is a matter of economics, noting that different applications require different levels of treatment. He noted that the relevant technology exists, but the focus should be on achieving more economical and sustainable technologies.

Dr. Swackhamer asked if one of the subcommittee's recommendations was to change the terminology. Dr. Chaudhry responded that it was his suggestion, and the subcommittee agreed that "resource water" is the better phrase. Dr. Reckhow added that the subcommittee discussed terminology at length due to strong feelings on each side, but noted that Dr. Chaudhry was persuasive. Dr. Swackhamer summarized the point by stating that the term "resource water" did not ignore the resource recovery aspect.

Mr. Geller noted that SHC spoke about "material management" in order to recast the water reuse topic. He suggested that this might finesse the idea when discussing water resources.

Dr. Chaudhry stated there is a clear distinction between water and wastewater, but pointed out that the same challenges are faced when it comes to water resource management. He explained that resources are one component of water resource management and all the components should be integrated at the end to make one water resource. He stated his agreement, however, that in

terms of an overarching concept, the water resource discussion is the same as water resource management discussion.

Dr. Flint observed that in the response to SSWR-specific charge question 2, the subcommittee discussed the term, but pointed out that the charge question asked about approaches that will facilitate positive impacts from their research projects. She acknowledged that it is important to discuss terminology, but commented that the rest of the question asks for recommendations beyond a single term. Dr. Flint stated that perhaps the first paragraph under SSWR-specific charge question 2, should be moved to a footnote. Dr. Swackhamer agreed that the paragraph was distracting.

Dr. Somasundaran reiterated that resource water is an evolving topic. He noted that Israel uses two water streams, one for toilet water and another for resource water. He stated it is an example of how wastewater could be managed in this and other countries.

Dr. Swackhamer interjected that she did not want to talk about terms, because the committee was missing the meat of the answers.

Dr. Chaudhry added that the water management approach he described is being practiced in Los Angeles, where they use it as a tool to recharge the aquifer.

Dr. Swackhamer asked the committee for other comments and questions.

Dr. Aneja stated that he would like clarification regarding the comment that the United States has an aging water infrastructure, point out that it is well recognized by EPA. He first asked if the report spoke to those facts. He also asked if the reference to green infrastructure was intended to recommend changing the aging infrastructure to green infrastructure. Dr. van Drunick explained that aging infrastructure is an important issue to EPA, particularly to SSWR. She added that SSWR is not in the business of detecting leaks. She clarified that many private organizations can do leak detections quickly, remotely, and cheaply, so SSWR decided not to invest in this area. She commented that SSWR, however, is interested in contamination due to leaks and interactions of contaminants in biofilms. Dr. van Drunick also commented that the conversation has turned to whether the infrastructure, particularly plumbing infrastructure, is efficient in terms of water conservation, adding that leaks account for 40% of lost drinking water. She noted that developers will always highlight the relative cost of green infrastructure to the traditional systems, so this may not be the best investment area for SSWR. She pointed out that others are researching the issue, and noted a $4 million project funded by a STAR grant that is comparing the lifecycle cost of green infrastructure compared to gray infrastructure.

Dr. Reckhow asked where the committee would put aging infrastructure in the report. Dr. Swackhamer pointed out that the subcommittee acknowledged aging infrastructure in the last paragraph under general charge question 3, noting that the subcommittee referred to it as "decaying infrastructure." Dr. Swackhamer added that she was unsure about whether anything needed to be changed and what the recommendation would be. She added that identifying the recommendation was the job of the subcommittee co-chairs.

Dr. Aneja commented that Dr. Chaudhry indicated the presentation that, overall, SSWR needs to find tangible mechanisms to engage with stakeholders and asked what Dr. Chaudhry meant by that. Dr. Chaudhry responded that SSWR has a clear protocol for interacting with internal partners, but there is no clear documentation of how external stakeholders are engaged. He added

that the subcommittee recommends that SSWR document how external stakeholders are contacted and consulted in addition to how their feedback is interjected into the research process. Dr. Swackhamer observed that this point relates to general charge question 2.

Dr. van Drunick explained that SSWR has held workshops and meetings where partners provided them with updates on their research. SSWR mapped the efforts to avoid duplicating work and to identify gaps. She added that SSWR met with the Global Water Resource Coalition in August and continues to speak with them every two months. Dr. van Drunick noted that SSWR has also been in contact with the WaterReuse Association and has had a workshop with them. She clarified that SSWR is careful not to have discussions that hint at future Requests for Applications, which would be inappropriate. She stated that discussions with external partners are limited to research portfolio comparisons that raise awareness of other organizations' activities and identify topic areas that are not being addressed. Dr. van Drunick stated that SSWR would like the BOSC to identify additional organizations that SSWR should engage with and facilitate those introductions.

Dr. Chaudhry explained that the subcommittee evaluated the material that was provided to them and did not intend to say that partnerships do not exist, but that the subcommittee could not find materials to judge whether they do. He said the recommendation identified the need for EPA to document that external interaction and provide the documentation to the subcommittee.

Dr. van Drunick stated that it was understood that SSWR does not have a formal mechanism for documenting external partnerships, but noted that SSWR could provide a summary of partner interactions to the subcommittee so they might better understand the relationships. Dr. Chaudhry commented that is exactly what the subcommittee needs. Dr. Swackhamer added that, in order to tie those comments together under general charge question 2, she suggested the subcommittee add to their report the phrases "further partner" with them and "expand reach to other organizations" as well as the names of additional organizations. Dr. Chaudhry added that it is great that SSWR already communicates with the organizations Dr. van Drunick mentioned, since this means they are already achieving the recommendation.

Dr. Flint stated that she was beginning to see crosscutting themes across reports and noted that the recommendation that EPA document and increase transparency related to their external partnerships is one of them.

Dr. Swackhamer stated that, in general charge question 2, she did not understand the five questions listed in the middle of page three. She also noted that the STAR grantees are available online, and suggested that the subcommittee remove the related recommendation.

Dr. Reckhow explained that the listed questions were the subcommittee's questions to SSWR to better understand the extent to which the program has contacts or outreach in schools. Dr. Reckhow agreed that the questions could be better worded. He explained that the subcommittee thought part of their task in evaluating ORD's water research portfolio was to evaluate the research priorities. He asked if the STAR grants are an entirely separate issue.

Dr. Kavlock explained that reviewing the direction of the program is fine, but evaluating how STAR grants are reviewed is not within the subcommittee's scope. Dr. Reckhow noted that the text is worded poorly and is not a good characterization of the subcommittee's discussion. He

added that the subcommittee discussed that it was unclear whether reviewing the STAR grants was within their scope.

Dr. Kavlock also noted that the question of how funding is partitioned between external and internal research is appropriate. He explained that ORD has external and internal partnerships and how they partition their resources between those depends on how the extramural work compliments what EPA cannot do intramurally. Dr. Kavlock referred back to Dr. van Drunick's commented on the STAR grant-funded project that considers the lifecycle costs of green infrastructure versus gray infrastructure, and specified that would be an appropriate topic for the BOSC to comment on.

Dr. Swackhamer stated that she did not see how the SSWR subcommittee's questions related to the charge question. She added that it would be appropriate to say that ORD has a major gap in the program that could be filled by extramural research. Dr. Reckhow asked if the subcommittee was to examine external partners, and Dr. Kavlock confirmed that external partnerships were part of the charge question. Dr. Reckhow stated that the subcommittee did not receive information on the STAR grants to which Dr. Kavlock responded that the subcommittee received the StRAP but has not seen its implementation. He noted, however, that the subcommittee will see the implementation of the StRAP as they move forward. Dr. Reckhow noted that he was under the impression that the subcommittee should consider the STAR grants program and Dr. Kavlock responded that external and internal partnerships were indeed part of that. Dr. Reckhow also agreed that the five subcommittee questions listed did not belong under charge question 2 and needed to be reworded.

Dr. Swackhamer noted that the second question could be reworded as a recommendation: "It would be useful for the water program to develop intermediate metrics." Dr. Richardson commented that the charge question asked how effective the approaches were for involving partners and suggested that, at a minimum, the response to the question should address the effectiveness and give supporting evidence. Dr. Reckhow responded that the first three sentences address that and that he and Dr. Chaudhry should pull them out as bullets. He added that the recommendation could be more detailed on how to improve the process, but commented that the subcommittee did not receive enough information to answer the charge question fully.

Dr. Swackhamer suggested adding a sentence that continued beyond what Dr. Reckhow suggested, something to the effect of "It seemed that internal coordination within the various facets of EPA is better defined and documented" which answers what the charge question was asking. Dr. Swackhamer added that she apologized the charge question was not clearer. Dr. Richardson commented that the charge questions explicitly identifies regional and program offices as partners. He added that, because of this, STAR grants and school outreach were not relevant. Dr. Reckhow noted that the subcommittee may need additional clarification on the advice role they will play in terms of the STAR grant program, but added that Dr. Richardson's point was well taken.

Dr. Swackhamer made two observations. The first was that internal coordination is good. The second was that there are deficiencies as EPA expands to outside stakeholders. She commented that the subcommittee should include suggestions of organizations that are missing from EPA's list of external partners.

Dr. van Drunick noted that general charge question 2 asked if the approach for involving partners is effective. She added that in response to general charge question 3, the subcommittee said that SSWR does a good job of implementing the StRAP. Dr. van Drunick explained that SSWR has a spreadsheet with regional priorities, quarterly meetings with office directors, and weekly meetings with the Office of Water in which policy issues are discussed. She suggested these SSWR activities could be the moved under general charge question 2.

Dr. Swackhamer noted that general charge question 3 asked about problem formulation specifically and whether partner needs are being meet. Dr. van Drunick responded that she thought she answered that question, but added the caveat that she may have missed it, because there was a lot of information that BOSC and SSWR struggled with during their meeting in Cincinnati.

Dr. Swackhamer commented that she had a question about the statement in the response to general charge question 3 at the end of the paragraph on the top of page four that reads: "This apparent weakness, with respect to integration of outside partners, is reflected by a general weakness of meeting Objective 4 (translation of research)." She pointed out that while subcommittee said that translation of research is a weakly met objective and all programs struggle with it, there is no evidence of weak translation in Table 1. In fact, she added, the translation piece actually appears as the strongest objective in Table 1. Dr. Swackhamer added that she did not see how their statement agrees with the information in Table 1. She asked for additional clarification on that statement when the report is edited.

Ms. Smith stated that she liked the intent of Table 1, and added that Table serves as a matrix that could help the subcommittee get to an answer. Ms. Smith stated she had the same clarification question as Dr. van Drunick, but commented that the structure of the Table provided an opportunity to add complexity to the charge question's response. She asked the subcommittee how they could use the table to make a recommendation for improving the process to meet the research objectives. Dr. Reckhow responded that the table speaks to the issue that the subcommittee was too narrowly focused in their responses to the charge questions and did not consider what was meant by "meets" and "supports."

Dr. Galloway agreed that he also liked the table and suggested that other subcommittee co-chairs consider including a similar table in each of their reports in the spirit of achieving similar structures. Dr. Swackhamer stated that adding a similar table to each of the subcommittee reports would be difficult to do, as it would require going back to the subcommittees. She added that Dr. Galloway's idea was great to capture and the Executive Committee could consider turning that comment into a future recommendation.

Dr. Galloway stated that he was surprised that nitrogen and co-pollutants were not mentioned in the subcommittee's draft report, as it was a main item in SSWR's StRAP. Dr. Swackhamer pointed out that if it was not in the subcommittee's draft report, the Executive Committee could not include it in their final report. Dr. Richardson noted that nutrients did show up in the subcommittee report, and could be added to the Executive Committee report.

Dr. Richardson also observed inconsistencies between the subcommittee report formats, but noted that he had a comment on Table 1. He suggested that the committee consider using a table similar to the one that came out of EJ Roadmap, which used varying numbers of check marks to

show a greater contribution to that program. Dr. Swackhamer added that Dr. Richardson's suggestion is consistent with what EPA uses and agreed it is a good suggestion.

Dr. Tharakan added that it would be reasonable for the research programs to develop these tables for the BOSC subcommittees, so the subcommittees could make their assessments in terms of the program's self-assessment. He suggested that EPA tell the BOSC subcommittees how the various projects meet the project objectives and ORD provide an articulation of what the check marks meant in terms of how the research objectives are being accomplished. Dr. Swackhamer agreed.

Dr. Flint asked if the BOSC's role is to review or to evaluate the programs, which was very specific and different from reviewing them. She explained that each subcommittee had different charge questions, interpreted their role in a different way, and had different relationships with their program. She suggested that, as the BOSC develops, the BOSC could improve upon expectations and make sure tasks are clear moving forward. Dr. Swackhamer agreed and noted that the committee would discuss these types of issues during their administrative meeting that was to take place on the third day of the meeting.

Dr. Swackhamer asked if there was anything the committee wanted to add to help the SSWR chair and co-chair write their recommendations. Dr. Reckhow acknowledged that he and Dr. Chaudhry should have already done that, but asked the BOSC Executive Committee to share what they extracted from the report.

Dr. Swackhamer stated that she was happy to share what she pulled out of the report, but reminded Dr. Reckhow and Dr. Chaudhry that they know the recommendations best. She added that the draft report contains good recommendations, they just need to be explicitly identified in the next draft.

Dr. Reckhow noted that the committee did not touch on specific charge question 1, which covered uncertainty analysis. He explained that uncertainty appeared to be an issue throughout ORD, but commented that other subcommittees did not mention it. He asked if other committee members viewed uncertainty as an important and crosscutting issue. Dr. Swackhamer confirmed others' agreement, adding that Dr. Reckhow is the expert at the table. She noted that the SSWR co-chairs needed to pinpoint the actual uncertainty recommendation that was very focused. She asked if there were any further questions for the EPA staff on the phone.

Dr. Reckhow thanked Dr. van Drunick, Dr. Williams, and Ms. Roberts as well as the SSWR subcommittee members for their help. Dr. Chaudhry echoed Dr. Reckhow's comments and thanked everyone for their suggestions. Dr. van Drunick thanked the BOSC and noted that she was looking forward to the next SSWR subcommittee meeting.

Dr. Swackhamer added that she hoped Dr. van Drunick and Dr. Williams would be able to join the administrative meeting the following afternoon. She adjourned the SSWR discussion and dismissed the group for lunch.

Chemical Safety for Sustainability and Human Health Risk Assessment Draft Report

Ponisseril Somasundaran, Chair and Gina Solomon, Vice Chair

Dr. Swackhamer asked Dr. Bahadori and Dr. Vandenberg to introduce themselves.

Dr. Somasundaran expressed how impressed he was with Dr. Bahadori and Dr. Vandenberg and that the Agency is lucky to have them. He then quickly reviewed the subcommittee's process for reviewing the entire CSS program and part of the HHRA program, which involved responding to three general charge questions, two CSS-specific charge questions, and one HHRA-specific charge question. Dr. Somasundaran also noted CSS's four research objectives, which are chemical evaluation, life cycle analytics, complex systems science, and solutions-based translation and knowledge delivery. HHRA has three research objectives, which are characterize risk, advance and refine assessment approaches, and enhance data access/management and engage stakeholders.

Charge question 1 asked if the topics and projects were planned and organized to make good progress on the StRAP research objectives. The overall response of the subcommittee was that they were truly impressed by the breadth and depth of the CSS and HHRA research programs and their accomplishments. Dr. Somasundaran noted the program has a clear vision of the overall mission and its plan to reach objectives. The group's research objectives are ambitious, but they are clearly on track to make great progress. For both CSS and HHRA, the subcommittee advised the evaluation of IT resources and infrastructure sufficiency. Another recommendation involved tailoring technical communications to different end-users. For example, technical language can be used for technical audiences, while "plain English" should be used for public or lay audiences. The subcommittee also recommended both groups summarize all deliverables and timelines in a roadmap for efficient operationalization of StRAP objectives. Dr. Somasundaran stated that the subcommittee advised CSS to evaluate and reprioritize its research portfolio based on "proof of concept" evaluations and case studies, as the research portfolio needs to be flexible to evolving opportunities and new thresholds, metrics, and indexes that may arise. The subcommittee also recommended CSS consider working with experts in organizational change to better engage partners and stakeholders.

Charge question 2 asked if the approaches for involving EPA partners in the problem formulation stage were effective. The subcommittee felt that the approaches involved EPA partners in two-way communication via monthly calls, webinars, and face-to-face interactions, even with a limited budget. The subcommittee noted that the groups effectively collaborated with partners by sharing draft StRAPs and soliciting feedback, as well as collaborating with stakeholders on tools, which promotes a sense of ownership. In terms of areas of improvement, the subcommittee identified the need for a more formal program evaluation and holistic needs assessment. Furthermore, both research programs need to recognize partner limitations in regards to time and resources, and should increase capabilities for travel or virtual interactions and encourage more cross-office details. Finally, the subcommittee called for realistic case studies to demonstrate informed decisions for data-poor chemicals within HHRA. HHRA should engage National Institute of Environmental Health Sciences (NIEHS)-funded Superfund Research Programs to respond to regional needs and develop these case studies.

Charge question 3 asked how well the programs respond to program and regional office needs. Dr. Somasundaran expressed the subcommittee's overall impression that CSS research programs have provided important support to the work of the Office of Chemical Safety and Pollution Prevention, and holds the promise of helping with future evaluations of chemicals with little, if any, exposure or toxicological information. Furthermore, he noted that EPA partners expressed great enthusiasm for CSS products such as the RapidTox and ToxCast tools. The subcommittee

is pleased with CSS's products and collaboration, but sees the possibility for the program to evolve and improve. Turning to HHRA, Dr. Somasundaran stated that the program plays a critical role in protecting public health by providing research that informs regional decision-making and policy. Furthermore, HHRA has also played a key role in emergency response actions, such as in the Gold King Mine response or Elk River, West Virginia spill. In terms of recommendations, the subcommittee urged CSS and HHRA to budget for collaboration and plan for continual training needed to ensure successful application of decision support tools. The subcommittee also recommended establishing new outreach positions within both programs in order to effectively translate science and technology to EPA partners. Finally, both CSS and HHRA need clearer and more formal metrics of success.

Charge question 4, specific to CSS, asked for input on the scope and implementation for the topic areas and research objectives of complex system science, lifecycle analytics, and chemical evaluation. In regards to complex systems science, EPA has a unique opportunity to transform the field of environmental toxicology, especially if they can translate the *in vivo* and *in vitro* measurements and predictions of molecular initiating events (MIEs) to modeled measures of response. The subcommittee recommends CSS works backwards from apical endpoints to MIEs and incorporate dosimetry in order to improve confidence in predictions of adverse outcomes. CSS should connect data from high throughput modeling to data indicative of defined adverse outcomes and correlate these tests with risk analysis to bolster hazard analysis. Cross-species extrapolations using molecular similarities should be verified with experimental data from environmentally relevant species. As both CSS and HHRA mature and the science and technology evolve, Dr. Somasundaran stated that it will be essential to include chemical mixtures and interactive effects among multiple factors in the evaluation of risks. Lastly, CSS should develop a proof-of-concept case study that will demonstrate, for an untested chemical, which biological activities defined in ToxCast translate to properties at the virtual tissue level and to apical endpoints *in vivo*. In regards to lifecycle analytics, the subcommittee asserted the ambitious plan is the early phases of implementation, but it included the development of important computational tools such as the Chemical Transformation Simulator. Recommendations included developing a stronger computational chemistry program to build reliable, quantum chemistry tools to predict toxicity and exposure. As the project is relevant to EPA sustainability goals, the subcommittee commented that the links to sustainability should be articulated more clearly. Furthermore, CSS should enhance interactions and knowledge transfer opportunities with the public, as multiple entities undertake their own research efforts related to lifecycle analysis. Finally, in regards to chemical evaluation, the program has established ToxCast, a large database of biological and biochemical data for chemicals, including those with unknown effects, which is an invaluable resource for the scientific community. The recommendations of the subcommittee are to move from concentration-based, single time point biochemical data to dynamic, exposure-based predictions over multiple time points and to incorporate metabolism and metabolites into screening programs. The subcommittee recommended that CSS develop and improve its exposure models and deploy other enhanced approaches to measure exposure. Lastly, the subcommittee urged CSS to consider using structural biology approaches to improve prediction of function and outcomes across species, which can be used for assay development.

Charge question 5, also specifically for CSS, asked the subcommittee to provide input on opportunities and approaches for fit-for-purpose translation and knowledge delivery. The subcommittee commended CSS for the steps the program has already taken to translate and deliver products to agency partners and key external stakeholders. Continued success in this area will require continued prioritization of this component in addition to progress in the other core research topics. The subcommittee noted that there is a general need to increase the scientific literacy of partners on CSS data and tools. In regards to recommendations on areas for improvement, the subcommittee called for an improvement in IT infrastructure and the communication of IT needs to those who can deliver the appropriate infrastructure to the program. Additionally, the subcommittee pointed out that CSS tools and data often undergo updates that are not announced and it is difficult for partners and stakeholders to feel comfortable with the dynamic research products. Related to this, CSS should implement a system to communicate when, and in what way, additions and modifications are made. Finally, CSS needs to outline opportunities for formal interaction with key partners.

The sixth charge question, which was specific to HHRA, asked for comments on the research dimensions of the program and the proposed approaches for characterization of new data and computational methods to improve confidence and build capacity for their application in the context of risk assessment. Dr. Somasundaran stated that the subcommittee felt HHRA is also doing great work. The subcommittee was pleased to see HHRA's open and transparent approach to the efficient use of risk analysis, incorporation of CSS data for novel and emerging chemicals as well as in emergency response situations, the application of genetic and epigenetic data in the consideration of susceptibility and vulnerability, and the development of approaches to cumulative risk assessment. The subcommittee had three recommendations related to this charge question. HHRA should develop acute or non-lifetime reference doses to be used in appropriate decision contexts. The committee also recommended that CSS explore the feasibility of using its tools for preliminary risk-based screening levels for data-poor chemicals and for promoting case studies that are responsive to region needs and data gaps, such as unregulated chemicals identified at cleanup sites. Finally, CSS online tools, especially ExpoBox, would benefit from a guidance document or navigation guide to facilitate comparison and selection of appropriate tools for specific applications at various levels of user expertise.

CSS/HHRA Program Comments

Tina Bahadori, National Program Director and John Vandenberg, National Program Director

Dr. Bahadori began by saying CSS has already begun working on some of the subcommittee's recommendations, and she would like to provide an update on those activities. She thanked Dr. Somasundaran, Dr. Solomon, and the rest of the subcommittee members for their substantial efforts to review two programs. She noted that CSS found the report extremely useful planning a path forward. She added that process in which the chairs managed the review process allowed her to understand the content and the depth of the subcommittee's recommendations, which she pointed out is unusual. She stated that what put their system into motion was the praise CSS received for their efforts to integrate across heterogeneous programs. She added that she appreciated the subcommittee's specific examples.

Dr. Bahadori mentioned the subcommittee recommendation that CSS better illustrate how the different program pieces fit together. She stated that CSS has sought guidance on developing a storyboard where experts can share their thoughts on the best way to accomplish program goals. With regard to problem formulation, she explained that the recommendation was to identify ways to foster creative collaboration with program and regional offices, noting the possibility of bringing their scientists and experts to ORD. She also explained that the subcommittee noted the importance of translating CSS science for use by partners and stakeholders.

Dr. Bahadori commented that the subcommittee's other specific recommendation pertained to complex systems and the four topic areas Dr. Somasundaran referred to. She pointed out that this recommendation is particularly relevant to chemical evaluation (the workhorse of the CSS program), and CSS is maintaining flexibility in this program area. She clarified that if new technologies become available, CSS has the mechanisms to quickly incorporate them into their work. She acknowledged that the rate at which they adapt will affect the way their data are displayed and used by their partners, and noted that CSS will be mindful of this as they move forward. As an example, she mentioned that CSS is about to launch a "challenge" on incorporating metabolic competence into two-dimensional assays. She explained that the data are already being used, so the program had to consider how their changes might impact the end-users.

In the area of life cycle analytics, Dr. Bahadori stated that CSS has already hired three computational chemists since receiving the subcommittee's recommendation. She added that the program plans to screen as many compounds as possible, but noted that the future of the field is in prediction. In terms of chemical evaluation, CSS is not only exploring how to improve the ToxCast and ExpoCast tools, but how to use the lessons learned to advance computational systems science areas. Dr. Bahadori stated that CSS has begun working on this as well, but acknowledged it will require evaluation metrics. She commented that she heard the recommendation regarding IT challenges and stated that it is a high priority. She added that the director of the Office of Environmental Information is aware of the challenges in making their data and tools publicly accessible, noting that public platforms do not always work well.

Dr. Bahadori requested subcommittee input on a few additional topics: incorporating complex systems science into practical decision-making, integrating ecological modeling and population-based studies that focus on endangered species, and developing evaluation metrics.

Dr. Vandenberg reiterated the appreciation for the subcommittee co-chairs and members. He stated that he was very pleased by their efforts to understand the programs and perform a combined review of all CSS and about a quarter of HHRA. He added that their review of the programs' tools, methods, and approaches is the backdrop to the development and application of new science, which is fundamental in moving the field of risk assessment forward.

Dr. Vandenberg stated the HHRA also has begun to make some changes by reaching out to Superfund research centers. He added that the nature of HHRA tools can be overwhelming, and there are direct changes the program can make to change that. In terms of future directions, he commented that the subcommittee provided strong and challenging recommendation, particularly

regarding the development of evaluation metrics. He noted that he plans to engage the subcommittee in this process to develop metrics that will demonstrate the value of the program's large and component parts. He concluded by thanking the subcommittee and reiterating that the report was well-done and useful.

Discussion CSS/HHRA Draft Report

Deborah Swackhamer, Chair

Dr. Solomon asked if the background was specifically for EPA. Dr. Swackhamer replied that the background should be short and just a few paragraphs. Dr. Richardson asked why CSS and HHRA were reviewed jointly. Dr. Bahadori explained it was an in-depth review of all of CSS and a small part of HHRA. Dr. Richardson explained it would be helpful for that to be in the introduction. Dr. Solomon explained the introduction was what they were told when they walked into the room. Dr. Bahadori said the scope of the review was copied and pasted into the report.

Regarding the response to charge question 1, Dr. Flint said the use of the word "roadmap" is confusing and suggested using a different word. She noted that it is an issue across subcommittee reports. She also commented that making vague comments about "needing social science" is not responsible, and pointed out, again, that it is an issue across subcommittee reports. She stated that the assumption might be that social science is relevant only in the context of engagement. She read the statement from the draft report: "It would be a mistake to focus exclusively on the scientific aspects of the research program and ignore the social science that is also involved." She observed that it seems to imply social science is not scientific research. She urged the Executive Committee to call for more specification in terms of the role of the social sciences. Dr. Solomon replied that the subcommittee report called for CSS to consult experts in organizational change. Dr. Cozzens added that the problem with that recommendation is that it does not just call for change in one organization, but for broader changes. Dr. Flint asked for clarification in the draft report in terms of the area for which the recommendation was made (e.g., susceptibility, economic-policy dimensions, and social dimensions of lifecycle assessments). She reiterated that it would be helpful for the discussion of social sciences to be more specific. Dr. Swackhamer agreed that the committee needs to determine exactly what the social science questions are.

Dr. Solomon suggested they delete the phrase "social science." She noted that CSS is trying to change an entire scientific paradigm and, assuming HHRA moves in that direction as well, how risk assessment is conducted in the federal government. She clarified that the point of the paragraph is to determine whether these changes require organizational and social change. Dr. Swackhamer suggested capturing that notion in the draft report, and Dr. Solomon replied that it is captured.

Dr. Reckhow commented that he views the social sciences as important, but acknowledged that he is not have the expertise to prescribe exact areas for involvement. He recommended Dr. Richardson or Dr. Flint assist in that part of the discussion. Dr. Flint named informatics science and information management as potentially relevant disciplines to understand how information moves to transform systems. She reiterated that the program needs to specificity which social science fields would be helpful. Dr. Richardson supported Dr. Flint's statement and said that this

line of discussion that would evolve in the coming years, but the committee should consider the beneficiaries and users of program information. He added that this context will help to determine the research questions around decision making, behavior, and institutional design.

Dr. Swackhamer asked if there were any comments on the recommendations.

Dr. Richardson stated that charge question 4 asks for input on the program's scope and implementation. He noted that he is curious how the subcommittee interpreted the meaning of "implementation" (e.g., feasibility, utility, etc.). Dr. Bahadori replied that CSS has included in its StRAP some case studies designed with their partners on how that would evolve at the ground level. She added that the question was intended to determine if that is a good approach for moving from data generation to application. She noted that CSS has received feedback that the case studies are good, but need to be more relevant to the staff's everyday work.

Dr. Flint highlighted emerging issues and the development of evaluation metrics with partners as additional crosscutting issues. She also asked if the proof-of-concept idea is transportable, as she has not heard the phrase before. She pointed out that an acronyms glossary would be helpful. Finally, Dr. Flint commented that SHC and HHRA both consider environmental health and well-being, and pointed out that these aspects of the two programs could be better integrated. Dr. Vandenberg responded that one of HHRA's major topic areas is community support, which is linked directly to SHC. He added that this is partly in response to the previous BOSC's recommendation to have a rapid response method to address issues like the West Virginia chemical spill. He added that cumulative risk assessment explores both chemical and non-chemical stressors, which is another area that the programs overlap and have a common interest. Dr. Flint proposed that the Executive Committee mention the strong links across programs in their final report.

Dr. Richardson reiterated the tremendous opportunity for integration, and urged the members to return to this point in their discussion on the last day of the meeting. He continued by saying the subcommittee reported pointed out that program resources are scarce. He noted that many universities use joint appointments, and proposed that as a possible mechanism to bridge interdisciplinary gaps, save resources, and improve integration. Dr. Kavlock replied that many of their PIs receive funding for more than one program, but acknowledged it is just where their salary comes from and is not a formal appointment. Dr. Bahadori agreed that it is a common occurrence.

Ms. Smith stated that she was glad to see the subcommittee recommended the use of computational science in prediction. She added that the recommendation to educate tool users is important and will ensure the program's incredible products are used. She pointed out that these recommendation might be relevant across programs, but are particularly relevant for CSS and HHRA.

Dr. Swackhamer asked for clarification on which recommendations called for the programs enhance and improve program activities as opposed to initiate new ones. She explained that this distinction was not clear for many of the recommendations and it is not clear enough that some

of the activities have already begun. Dr. Bahadori clarified that the subcommittee was asked to review the StRAP, pointing out that some of the most recently initiated activities are not actually included in the StRAP. Dr. Solomon added that acute toxicity values is a recommendation for a new activity under HHRA. Dr. Vandenberg explained that this work was stopped for reasons that were outside the control of the HHRA program and that it would require new resources. Dr. Solomon clarified that she sensed there is an interest in the program and thought it was important to highlight it for that reason. She added that she was unsure whether there were recommendations for new activities under CSS. In response, Dr. Bahadori mentioned metrics, and Dr. Somasundaran mentioned modeling of mixtures under changing conditions.

Dr. Swackhamer called attention to the draft report's slightly critical tone. She clarified that the program is a star, and suggested that the subcommittee highlight this more. Dr. Solomon replied that much of the writing was completed in workgroups with little time for back and forth, as they were the last subcommittee to meet. Dr. Swackhamer reiterated that, overall, the program is stellar. Dr. Bahadori noted that she did not perceive the draft report as overly critical, and was very pleased with the subcommittee's comments and recommendations.

Dr. Flint stated that she had a procedural question. She commented that the subcommittee reports were to be written based on consensus, and that is seemed the CSS/HHRA subcommittee might not have had time to meet as a full group. She asked if they needed more time to establish consensus. Dr. Solomon explained that they had 24 hours, and Dr. Somasundaran clarified that there had been no lack of consensus in the room. Dr. Flint pointed out that if anything had been changed in the report since the meeting, it might not represent the consensus and added that the revised draft should be sent to the subcommittee members for consensus.

Dr. Swackhamer asked for any further comments.

Dr. Richardson noted the balance between positive, complimentary observations and the areas for improvement. Dr. Swackhamer noted that Dr. Richardson's comment was very helpful and showed she has a bias. Dr. Flint added the report contained good specificity, too. Dr. Swackhamer thanked Dr. Richardson and Dr. Flint and said it would inform their discussion the following day.

Dr. Solomon asked for clarification on the areas that Dr. Swackhamer had flagged as being negative. Dr. Swackhamer clarified that the report was not necessarily negative, but that there was not enough context about the achievements to date.

Dr. Swackhamer proposed moving to the next agenda item and closed the discussion on the CSS/HHRA subcommittee draft report.

Deliberation and Writing Session

Deborah Swackhamer, Chair

Dr. Swackhamer discussed the next steps, which included drafting the subcommittee report summaries, identifying the crosscutting issues, and discuss the responses to the EJ and Climate Change Roadmaps. Dr. Swackhamer suggested subcommittee co-chairs use the SHC summary

as a model, specifically noting that only the key points, and not specific recommendations, were included. She pointed out that the advantage of having it written is that the Agency would not have to respond formally to each recommendation. She clarified that the intent is to give advice to ORD.

Dr. Aneja asked when the subcommittee summaries are due. Dr. Swackhamer replied that the co-chairs should complete them before the end of the meeting. She added that the main summary will include the key recommendations, unless members disagree. She reiterated that the SHC summary should serve as an example for the other subcommittees. Ms. Smith asked Dr. Richardson and Dr. Flint if they had been selective in what they highlighted. Dr. Richardson replied yes, they were intentionally selective.

Dr. Flint asked if the recommendations for ongoing versus new activities should be split. Dr. Swackhamer stated she would leave the decision to the individual subcommittees.

Dr. Aneja pointed out that Dr. Swackhamer will be receiving five documents, each with their own style. Dr. Swackhamer stated that this would be fine.

Dr. Solomon asked if it would be helpful the CSS/HHRA subcommittee write separate summaries for the CSS and HHRA programs. Dr. Swackhamer suggested that the HHRA summary might be a paragraph among four paragraphs, but would leave the final decision to the subcommittee.

Ms. Smith clarified that the one-page summary should focus on the recommendations that would not be included in the crosscutting recommendations. Dr. Swackhamer agreed.

Dr. Swackhamer asked the subcommittee co-chairs to get the revised draft reports to Mr. Tracy by January 8, 2016. Ms. Smith asked if they should send out the revised drafts for subcommittee comments. Dr. Swackhamer replied that the new version should be sent to all subcommittee members so they have the document, but the co-chairs did not necessarily need to seek formal reviews.

Bringing the conversation back to the overall summary, Dr. Swackhamer stated her opinion that it would be useful to ORD and EPA if the first paragraph indicates whether the program is on track, as SHC did in the “general observations” section of their draft report.

Dr. Swackhamer suggested discussing the overarching recommendations and crosscutting issues the Executive Committee will highlight in the beginning of their final report. She added that otherwise it might not be evident that all five programs could benefit from systemic, versus programmatic, fixes. She clarified that the subcommittees do not need to discuss the crosscutting issues in their individual subcommittee summaries.

Dr. Flint clarified that if the subcommittees remove the crosscutting issues from their document, the program-specific context could be lost. Dr. Swackhamer explained that the full subcommittee reports will be included as an appendix. Dr. Flint asked where they should remove the crosscutting issues from and Dr. Swackhamer replied they should be removed from the subcommittee’s one-page summaries, not the full draft reports. Dr. Richardson replied to charge

question 2 by saying almost every group said they need metrics to assess the effectiveness of engaging stakeholders.

Adjourn

Deborah Swackhamer, Chair

Dr. Swackhamer informally adjourned the second day of the meeting at 6 pm.

Thursday, December 10, 2015

Reconvene

Deborah Swackhamer, Chair

Dr. Swackhamer presented a brief overview of the agenda for the day and then introduced Dr. Paula Olsiewski, the Program Director of the Alfred P. Sloan Foundation and Chair of the Homeland Security (HS) subcommittee, to present the HS subcommittee's draft report.

Homeland Security Draft Report

Paula Olsiewski, Chair and Tammy P. Taylor, Vice Chair

Dr. Olsiewski thanked the committee for having her and then outlined the HS research program mission, which is to conduct research and deliver products that improve EPA's capability to carry out its homeland security responsibilities. She also presented the HS StRAP research objectives, which are to improve water utilities to prepare for and respond to incidents that threaten public health, as well as to advance EPA's capabilities to respond to widespread contamination events. The three priority research topics are characterizing contamination and assessing exposure, water system security and resilience, and remediating wide areas.

Dr. Olsiewski quickly outlined the process the subcommittee used to review the program, stating that the group had five charge questions to answer, two of which were specific to HS. For these five charge questions the subcommittee developed ten recommendations. She noted that a few members wanted to reorganize the StRAP, but this option was quickly taken off the table.

Charge question 1 asked if the topics and project areas were planned and organized appropriately to make good progress on the research objectives. Dr. Olsiewski explained that in the context of this research program, this question asks whether HS is prepared to respond to unforeseen hazards and disasters, such as Ebola waste and the Elk River chemical spill. She noted that it is difficult to plan for resource use such as time, people, and money during an emergency response. Additionally, she stated that the threat of cyber-attacks is increasingly severe. The subcommittee's first recommendation in response to this charge question is that cyber security become a top priority and be moved to the beginning of the FY2016–2019 StRAP timeline. Second, HS should develop a process and strategy that allows responses to, and prioritization of, unforeseen and emerging needs while ensuring that good progress can be made on StRAP research objectives.

Charge question 2 asked about the effectiveness of the approaches for involving the EPA partners in the problem formulation stage. The subcommittee contextualized the question in regards to partners versus stakeholders, products versus outputs, and partner needs. The subcommittee struggled with the definitions of these terms, and found the NPDs helpful in

defining them. Their recommendation to HS was to expand the breadth and diversity of partners, stakeholders, and world class experts to be consulted regarding research needs. They included examples such as first responders, water and solid waste utilities, and professional societies and research entities (e.g., The National Academy of Science, Water Research Foundation, etc.).

Charge question 3 asked how well the program responds to EPA partner needs. Dr. Olsiewski commented that HS does well with internal partners, but had limited interactions with utilities. She also pointed out, as there is a vast difference between research plans and the ability to respond to emerging needs or emergencies, HS could respond better to partners' emerging needs. The subcommittee recommended that HS develop, maintain, and institutionalize the channels of communication needed to support HS research planning, priority setting, and evolving needs of partners, particularly the water and solid waste utilities. Dr. Olsiewski noted, for example, HS should consider incorporating into the project prioritization process a weighing of the costs and benefits of implementing research products from the perspectives of end users.

Charge question 4 asked how well the program has translated research to the end user and how HS could improve their ability to translate research. The subcommittee felt the HS research program has many strengths, but they also may have too many things going on. There are multiple platforms for software tools, but limited engagement with utilities. The HS panel included many quantitative experts who spoke a lot about the need for uncertainty measurements, confidence levels, and validation, as well as a need for data in real time. The first subcommittee recommendation was for HS to develop tools that can be routinely operated and maintained, and have "multi-use" or "all hazards emergency response" capabilities, where appropriate. For example, Dr. Olsiewski noted, with regard to Water Quality Surveillance and Response Systems, HS should develop a plan for supporting deployed tools with future updates, and minimize the number of development platforms. It would be better for water companies if they are able to adjust the settings within a tool software to respond to a new or emergency scenario, rather than them having to change software completely. The subcommittee also recommended that HS broaden its outreach, engagement, and participation in projects to a wider spectrum of utilities. Dr. Olsiewski noted developing more systematic and coordinated approaches to obtaining input and feedback from water utilities, using plain language in communications, and considering the knowledgebase of end users as a few examples. The third recommendation is to develop validation or readiness measures to establish awareness and manage expectations among end users, so that they are aware of the expected performance of the tools, methods, and software. She clarified that some tools are developed quickly under emergency conditions, and it is important to know what they can and cannot do. The fourth recommendation is for HS to develop a strategy for incorporating real-time analyses into their project portfolio and apply emerging technologies to develop mobile, GIS-coupled, real-time chemical sensors. This could include, for example, transitioning away from a laboratory-based approach to a graphical online approach that can identify and quantify chemical, biological, radiological, and nuclear threat monitors.

Charge question 5 asked how HS could infuse social science into the development of their research products in order to improve their usability. Dr. Olsiewski noted this is important because these tools are intended to be used by a variety of individuals, not all of whom are scientists. She added that when the subcommittee met with program staff, there was a deep interest in infusing different areas of social science into the planning and development of tools.

She noted that there is some expertise in-house that could help with this. The consideration of community values is also important for HS to consider. The first subcommittee recommendation is for HS to develop a process that involves partners in a way that incorporates the social sciences into projects when they are being planned. The second recommendation is for HS to develop social science training activities, such as workshops and expert lectures, to orient the staff to potential applications of psychological, sociological, and anthropological aspects, and to make social science an integral part of current and future projects. Dr. Olsiewski commented that HS should strengthen connections with and capitalize on existing assets, such as the Community Involvement Coordinators and Bio-Response Operational Testing and Evaluation initiative.

HS Program Comments

Gregory Sayles, National Program Director

Before beginning his comments, Dr. Sayles introduced the HS Deputy National Program Director, Dr. Snyder.

Dr. Sayles thanked the subcommittee for their time and effort, recognizing they had done a tremendous amount of work. He also thanked the subcommittee co-chairs, Dr. Olsiewski and Dr. Taylor, for their leadership and work toward consensus recommendations.

Turning to the subcommittee's draft report, Dr. Sayles stated his appreciation for their comments. He added that HS was happy to receive the subcommittee's comments on program priorities and how to improve engagement, research translation, and incorporate the social sciences. He pointed out that the report included ten recommendations, so HS will need to prioritize them. He added that all of the recommendations are useful, and HS plans to address them all. Dr. Sayles noted that HS has already begun some of the recommended activities, especially in the cyber security area.

Dr. Sayles commented that he expects the subcommittee will become more familiar with the HS program as the BOSC and HS continue to work together. He noted in future meetings he would like to address the broad bodies of work within the HS program (e.g., sampling, analytics, decontamination, etc.). He added that HS would like feedback on how these things are done within HS and whether the program should continue work in specific areas. He stated that HS has a few nascent topic areas, and mentioned that HS will seek the subcommittee's guidance as they develop them in real time. To conclude, Dr. Sayles reiterated that the recommendations are very helpful and he looks forward to working with the BOSC.

Dr. Swackhamer called attention to the Executive Committee's previous discussion about the definition of "partners," "stakeholders," and "end-users." She noted that the way HS defines the terms may be slightly different than the other research programs, pointing out that Dr. Sayles included water utilities as partners because of their close association with OW. She reiterated the decision to use "partners' to refer to Agency programs and regions. She asked for further clarification on the term "partner," and asked if water utilities should instead be referred to as "quasi-partners" or "stakeholders." Dr. Sayles responded that it is a gray area. He explained that HS engages OW in a separate process and that OW is associated closely with the utilities. He pointed out that it is a multi-way conversation. He clarified that it is not as simple as partnering

with OW on the planning side. HS tries to engage the utilities and ask OW if they have received the same messages. Dr. Swackhamer noted that Dr. Sayles explanation was helpful and this distinguishes HS from the other research programs.

Discussion HS Draft Report

Deborah Swackhamer, Chair

Dr. Swackhamer asked for the subcommittee's comments and questions.

Dr. Flint asked if there are any social scientists on the HS subcommittee. Dr. Olsiewski responded that one of the members is an anthropologist, but could not recall the specific area within the field. She added that the member has done much work related to preparing communities for emergency response. She also stated that HS has a Ph.D. anthropologist on staff. Dr. Flint thanked Dr. Olsiewski for the clarification, and noted that she had observed an anthropology-centered response in the subcommittee's draft report. She added that members understandably will rely on their areas of expertise, but urged the Executive Committee members to incorporate many ways of thinking, as the issues they discuss are broad. Dr. Reckhow followed Dr. Flint's comments by noting that while the HS subcommittee focused on social science, he had focused on his area of expertise, uncertainty, in the SSWR report. He added that uncertainty was absent in other subcommittee draft reports, and asked for a charge question that directly addresses uncertainty in a future meeting. He also stated that the subcommittees should include more decision analysts.

Pertaining to charge question 3, Dr. Richardson asked about the subcommittee's recommendation to develop, maintain, and institutionalize channels of communication. He asked about the particular deficiencies that the subcommittee would like HS to enhance. Dr. Olsiewski responded that the spirit of the recommendation is ensure important work does not end when staff retire or leave the Agency. She clarified that with institutionalized relationships, a protégé can fill in for staff who leave. Dr. Richardson then commented that there appears to be a disconnect, as the second paragraph implies deep interactions. Dr. Olsiewski clarified that this referenced the subcommittee's desire for more direct access to water utilities. She noted the research program's engagement with the Cincinnati water utilities, but noted additional outreach to a broader set of partners (i.e., both large and small city utilities) will be more representative of the country as a whole. Dr. Flint noted the need for cross-program interaction on the topic of resilience, and added that specific SHC tools could be helpful to HS in the development of metrics to measure resilience.

Ms. Smith commented that HS is challenged with planning in the context significant uncertainty. She noted that while other subcommittees need to keep up with emerging issues, HS is especially focused on them. She commented that HS may processes and expertise in handling these emerging issues that the other research programs could benefit from that. Dr. Swackhamer noted it as an example of crosscutting issue with the potential for synergy across programs.

Ms. Smith asked if any of the HS products involve the entire emergency response process or if that is outside the program's purview. She asked what happens during an emergency response

and whether there is an emergency response team. Dr. Olsiewski explained that all response is local. If localities do not have the capabilities they need, Dr. Sayles and Dr. Snyder are called. She added that if HS develops tools that effectively get to the end-users, the regions could employ in conjunction with the localities, avoiding the involvement of headquarters.

Dr. Kavlock suggested Dr. Sayles introduce ORD's ReAChback for Emergency Response (RACER). Dr. Sayles described RACER as an ORD-wide project that facilitates a coordinated ORD response during emergencies. He explained that in emergencies, ORD needs a mechanism to disseminate the best science and technical capabilities efficiently. He clarified that in the past, people in the field rely on individuals they already know, which is an *ad hoc* response that may not utilize the best expertise. He explained that the needs are triaged and response teams are built the same day based on the specific technical needs. He noted that RACER was used in the West Virginia Elk River spill and Gold King Mine responses. Dr. Sayles added that the Emergency Operations Center was set up during that processes. The Emergency Operations Center fields Agency-wide technical questions that are sent to the RACER leadership, as necessary.

Dr. Richardson commented on a number of SHC decision support tools. He asked whether HS has similar tools that might be deployed differently in different emergency situations and whether they are available to regional offices. Dr. Olsiewski replied that the subcommittee mentions decision support tools in their draft report, particularly in the context of how water utilities protect the water supply during an emergency event. Dr. Sayles added that the EPA response is not the typical first response. It involves characterizing the site and a complex set of considerations, including the type of waste, the amount of waste, and the contamination level. He added that HS has tools, but the recommendation to develop them on a common platform was great. He noted that this will be key in developing tools that are more useful to customers.

Pertaining to recommendation 4.4, Dr. Flint asked if the subcommittee had intended to recommend a common platform, not a dashboard. She added that one aspect is conducting real time analyses and another is the visualization results. Dr. Olsiewski stated the focus of the recommendation was on real-time sampling and analyses. She noted that recommendation 4.1 touches on software platforms.

Noting the HS response to Ebola, Dr. Somasundaran mentioned that bioattacks are a main concern. He asked how HS handles the related issues of hazardous material waste and mutation. Dr. Olsiewski replied that she referenced Ebola as an example of a great HS response. She noted that there is not a virologist on the subcommittee, and added that numerous federal agencies work on these issue. She added that the HS budget is modest and the program cannot answer every question. Dr. Somasundaran asked if the program could bring in outside experts. Dr. Swackhamer interjected that Dr. Somasundaran's question is a process question, and the committee should wait to have that particular discussion.

Dr. Flint pointed out that the framework developed by the SHC subcommittee presents a broader way of thinking about outcomes, which might be useful across programs. She added that in emergency situations, the focus is containment. Response teams should consider place-based

implications the different response options. Dr. Swackhamer recognized that this is another crosscutting issue.

Dr. Richardson noted that the subcommittee might benefit from economics expertise. He clarified his point by noting that the timing of certain responses might change the cost. Dr. Olsiewski agreed. She noted that the draft report attempted to discuss costs and benefits, but having an economist would add credibility.

Dr. Flint commented that recommendations should be actionable and measureable over the long-term. She noted that recommendation 4.3 seemed actionable, but establishing awareness and manage expectations among end users can be difficult. She added that the wording of recommendations is important.

Dr. Swackhamer commended recommendation 1.1. She added that recommendation 1.2 is also great, but she asked for clarification on how it would be accomplished. Dr. Olsiewski clarified the basis for the recommendation is enabling appropriate responses to emergency situations and simultaneous progress on regular program work, given the fixed budget and staff. Dr. Sayles reiterated that the intent of the recommendation is to ensure HS has the ability to stop ongoing work to help with emergency technical requests. He noted that he previously understood it to mean that HS should have a process to address emerging issues, since it takes time to add new issues into the planning process. Dr. Olsiewski explained that the recommendation is to develop and document their process for shifting gears to deal with emergencies, rather than saying "we just do it." Dr. Swackhamer asked for clarification on whether the subcommittee was focuses on emergency situations or emerging issues. Dr. Olsiewski replied that both are relevant, and acknowledged that the recommendation might be more aspirational than actionable.

Referencing recommendation 2.1, Dr. Swackhamer recalled that charge question 2 asks whether HS engages the correct partners in problem formulation. She whether HS engages the relevant parties. Dr. Olsiewski responded that HS needs to involve more people and consider a broader range of expertise. Dr. Swackhamer added that HS is doing fine regarding internal engagement, and Dr. Olsiewski agreed. Dr. Richardson added that the subcommittee should also reference the effectiveness of partner engagement.

Dr. Swackhamer drew attention to the use of the phrase "operational offices," which the subcommittee used to reference program offices. She suggested replacing the term. Dr. Sayles noted that "operational offices" might specifically refer to the regions. Dr. Olsiewski clarified that the subcommittee called partners "regional offices" and "program offices."

Dr. Swackhamer stated that she did not agree with recommendation 3.1, and was puzzled by the four examples. She added that she did not understand how cost-benefits are a community issue. Dr. Olsiewski explained the spirit of the recommendation is to increase communication. Dr. Kavlock noted the recommendation might fit better under charge question 1, and Dr. Olsiewski agreed.

Referencing charge question 5, Dr. Swackhamer noted her surprise that risk communication would be reduced. Dr. Sayles acknowledged that HS has done important work in this area and

that the previous BOSC and SAB encouraged HS to research the science questions related to risk communication. He commented, however, that HS has had a difficult time getting their partners interested in it, as many do not perceive it as a researchable area. Dr. Swackhamer followed by asking if HS communicates well enough and, perhaps, if this program's end-users are more sophisticated than other end-users. Dr. Sayles clarified that the issue really is whether HS should conduct research related to improving scientific communication with the public. He added that external review bodies have it is a relevant area for the HS program, but noted that it is a very small piece of the program and did not think the recommendation would have an important impact. Dr. Olsiewski noted the recommendation appeared more negative than the subcommittee intended it to be.

Dr. Swackhamer brought up the recommendation to engage partners in the discussion of incorporating social science into the HS research program. She asked for clarification from the subcommittee co-chairs on whether they were asking for involvement in the planning process. Dr. Olsiewski explained there was an emphasis on the planning process and problem formulation, but noted that the social sciences should be considered throughout the entire process. Dr. Sayles assured that HS does. Dr. Swackhamer suggested they add language to the effect of "throughout the research process" to the draft report. Dr. Olsiewski agreed, noting that the emphasis is to incorporate it from the beginning, as it might influence the experiments or tool development.

Dr. Chaudhry observed that the subcommittee often used the phrase "water utilities" in their draft report. He asked whether they also used "water resource," and Dr. Olsiewski confirmed they did. Dr. Swackhamer noted that she had understood the phrase to refer to municipalities. Dr. Olsiewski clarified that it is intended as a broader reference to various water types (e.g., wastewater, drinking water, etc.). Dr. Swackhamer asked that the subcommittee add a definition early in the report.

Dr. Galloway reiterated that the Agency's role in homeland security is small, and asked if that is clear to program partners. Dr. Sayles replied the program's responsibilities and objectives are outlined in the draft report. He noted that these responsibilities are specific, and their main role is related to water. HS works with partners to prepare for a broad array of disasters within their mission's specific scope.

Deliberation on Report

Deborah Swackhamer, Chair

Dr. Swackhamer explained that she would like this discussion to focus on the Executive Committee response to the Climate Change and EJ Roadmaps in addition to the crosscutting themes that the committee would like to include in their final review of the five research programs. She asked the committee members to send specific editorial comments to Mr. Tracy, the DFO, electronically by the Monday, December 14, 2015.

Climate Change Roadmap Report Discussion

Dr. Swackhamer asked for comments from the members on the Climate Change Roadmap.

Dr. Flint stated that the draft of the response to the Climate Change Roadmap did not capture much of the committee's discussion that occurred on the first day of the meeting.

Dr. Galloway interjected that he would like comment on the workgroup's process, as it might address Dr. Flint's concern. He first thanked Dr. Swackhamer for the opportunity to lead the climate change workgroup and the committee members for their comments. Dr. Galloway explained that the process for writing the Executive Committee response to the Climate Change Roadmap included him drafting the first draft of the document, which was then sent to the Climate Change workgroup members for their review. The Climate Change workgroup then read through the transcribed discussion and tried to summarize the Executive Committee members' comments at a high level profile. He clarified that the draft response did not include everything said around the committee table, but members could send specific comments for inclusion.

Dr. Chaudhry added that the members had not commented on several aspects of the roadmap during the previous day's discussion, noting that the workgroup referenced the discussion notes taken by both workgroup members and contractor support staff. For example, there had been no comments regarding item 3, so the workgroup did not discussed this issue in their draft response. Dr. Swackhamer interjected, saying that she had notes for that section indicating a discussion of research program gaps that include invasive species, legacy cleanup, mold, and biodiversity. Dr. Galloway clarified that the workgroup included those comments under charge question 2.

A committee member suggested that the workgroup move the first paragraph of the draft response under charge question 2.

Dr. Richardson added that he questioned the text under charge question 1, and noted that, based on the committee's previous discussion of the roadmap, there were concerns regarding the problem statement. Dr. Galloway clarified that the workgroup had included those comments in the overarching comments section of the draft response. Dr. Chaudhry recognized that the workgroup may have incorporated comments in inappropriate places, he noted that they had captured most of the discussion points in the draft report. Dr. Reckhow reiterated Dr. Galloway's request that Executive Committee members email any comments they feel were incorrectly omitted.

Recalling Dr. Miller's comment that adaptation is the main focus of the Climate Change Roadmap, Dr. Richardson pointed out that adaptation does not appear in the problem statement. He explained that the problem statement should articulate that adaptation is the main focus of ORD's climate change research. Dr. Reckhow noted that the third paragraph under charge question 2 begins "Adaptation is the main focus of the Climate Change Roadmap."

Dr. Swackhamer summarized the conversation by stating that the committee agreed that they were told climate change adaption is the focus of the roadmap. However, as written, the emphasis of the Executive Committee's draft response is on the impacts of climate change. The first sentence of the third paragraph under charge question 2 sets up the committee's report, but is contradicted by the rest of the paragraph. Dr. Swackhamer suggested that the workgroup add additional text to emphasize adaptation.

A committee member noted that the first half of the second paragraph and the third paragraph under charge question 2 are redundant and suggested the workgroup reconcile the second and third paragraphs in their draft response.

Dr. Swackhamer said that the Executive Committee members had discussed the problem statement at length. She stated that while the draft response implies the problem statement is fine, but there had been significant disagreement about its adequacy. She agreed that the workgroup needs to edit the problem statement paragraph to include the word "adaptation." She also observed that the problem statement is actually the last sentence of the paragraph, rather than the first. Dr. Swackhamer noted that the response to charge question 1 should be something to the effect of "No, the existing problem statement is not adequate. There are editing issues and adaptation is not included."

Dr. Flint suggested that the problem statement should be specific to EPA's climate change research, rather than climate change as a general issue.

Dr. Swackhamer suggested that the workgroup edit the last sentence in the problem statement paragraph to reflect the focus on adaptation and also bold or underline it to indicate that it is the problem statement. Dr. Swackhamer asked the committee members if that edit captured the discussions. Dr. Richardson reiterated that the problem statement's focus should be on EPA's role in climate change research. He clarified that this means focusing on environmental quality as opposed to economic or other impacts. Dr. Solomon pointed out that the paragraph begins by discussing air quality, water quality, communities, and ecosystems, before it discussed economic and way of life aspects. Dr. Swackhamer reminded the members that they had decided to remove the text about "way of life" in a previous discussion. Dr. Flint suggested using the term "well-being" rather than "way of life." She also suggested moving this point under charge question 4, as it asks about linkages to other Agency programs.

Dr. Swackhamer turned the discussion to charge question 2.

Dr. Richardson stated that the paragraph should say something along the lines of "Dr. Miller said that adaptation was the main focus of the Roadmap." Dr. Flint suggested saying "we were told." Dr. Solomon suggested saying "The committee was informed that adaptation is the focus of the roadmap, but that is not immediately apparent when reading the document."

Dr. Richardson reiterated that the second and third paragraphs are redundant and the workgroup needs to harmonize them.

Dr. Swackhamer commented that that EPA did not identify the process used to identify needs. She noted that this point fits in with the committee's crosscutting issues discussion. She suggested including it in the Executive Committee response to the roadmap because the crosscutting issues section will address issues identified in the research program StRAPs, not the roadmaps. She acknowledged that the workgroup discussed it, in part, at the end of their response to charge question 1. Dr. Galloway drew Dr. Swackhamer's attention to the final sentence of charge question 2, and Dr. Swackhamer agreed that the text captured her point. She reiterated that EPA's process for identifying needs should be an articulated process.

Dr. Swackhamer stated that she was not sure what the workgroup meant by multimedia interactions. She clarified that she had assumed that multimedia meant interactions between air, water, and soil, but explained that multimedia is a phrase that means different things in different disciplines. She asked the workgroup to define the meaning of multimedia in their draft response. Dr. Galloway commented that the phrase covers the whole environmental system, including

water, air, soil, and people. Dr. Swackhamer reiterated that the draft response should include a definition.

Dr. Swackhamer commented that the chosen topics appeared piecemeal, as if EPA was avoiding stepping on toes. She added that the roadmap topics seem to be a random list of fossil fuel-related projects, and there does not appear to be an integrated strategy for dealing with emissions. Dr. Swackhamer suggested replacing "energy production" with "energy production from fossil fuels" in the second to last paragraph of the draft response. She also suggested the response list all of the other climate change topics.

Dr. Flint explained that SHC focuses on changes in ecological integrity and uses tools to assess those impacts. She suggested adding a recommendation to make deeper connections between the climate change work and SHC's work in ecological health and well-being.

Dr. Solomon added that there is potentially a role for coordination with CSS on the water quality and human health area of the roadmap, specifically regarding chemical and microbial dynamics. Dr. Reckhow replied that if Dr. Solomon thought of any specific connections, he and Dr. Galloway would note them in the draft response. Dr. Swackhamer suggested noting that most of the relevant research had been captured in the roadmap, and that the committee did not identify significant gaps.

Dr. Richardson noted his confusion regarding the cook stove issue on page 21 of the roadmap, stating that it might be outside of the Agency's mission. Dr. Swackhamer replied that the committee asked EPA to clarify how the cook stove issue became part of EPA ORD's purview. For example, if it is an administrator directive, EPA should clarify that in writing. Dr. Richardson commented that the cook stove issue is the only one that appears to be nondomestic. Dr. Kavlock responded that there is a domestic component, but acknowledged that it is a more significant issue in developing countries. A committee member noted her surprise regarding the amount of text dedicated to cook stoves, given the limited number of Americans affected by the issue.

Dr. Swackhamer commented that she did not recall a section of the roadmap that discussed integration, which indicates that EPA's approach is still siloed. Dr. Richardson responded that integration is mentioned on pages 21–23 of the roadmap. Dr. Swackhamer recognized that the roadmap included a few examples, but stated that it was very difficult to judge whether EPA had taken full advantage of the potential interactions across their programs. Dr. Richardson added that he expected to see something in the roadmap about integration with CDC in relation to vector borne diseases, as it is clearly a relevant issue. Ms. Smith pointed out that the charge question specifically focused on identifying areas of integration across the Agency six programs, not across other federal agencies.

Dr. Swackhamer noted that the largest area for integration is to draw ACE and SHC together around climate, and the Executive Committee should recommend this in their response to the roadmap.

As a general comment, Dr. Swackhamer observed that the workgroup's response to the Climate Change roadmap is very terse and that it would benefit from the addition of committee members' comments that are to be sent to them electronically after the meeting. She also noted that the charge question numbering system the workgroup used is different than that used in the response

to the EJ Roadmap. She asked which charge question is missing. Dr. Flint responded that the response to the Climate Change Roadmap combined the key research topics and important scientific gaps into charge question 2, although the workgroup should have addressed the issues under two separate charge questions. Dr. Swackhamer asked Dr. Reckhow to separate these issues in the next draft of the Executive Committee response to the Climate Change roadmap.

Dr. Swackhamer commented that the climate change related research could integrate with SHC on engaging communities. She added that her point is captured, but asked Dr. Richardson and Dr. Flint to help the workgroup expand the single bullet into five sentences.

Dr. Swackhamer asked for the committee's thoughts on the biggest deficiencies of the draft response. She noted her main concern is that the workgroup did not convey the Executive Committee's main messages, because the document was so terse. She also pointed out that she could not discern what had been identified as gaps as opposed to current efforts, as the sections used exactly the same language.

Dr. Flint stated that the terms "surface rugosity and hydrophilicity" are not likely be well understood by lay audience, and requested that the workgroup generalize that language. Dr. Swackhamer agreed, noting that the whole paragraph is difficult to understand. Dr. Richardson added that the paragraph belongs in the general comments section of the response, as it speaks to the genesis of climate change.

Dr. Swackhamer also noted that the roadmaps mentions a two, three, and eight degree rise in temperature, and clarified that the intent of that section of the roadmap is not to discuss that climate change is occurring but what related research EPA will conduct. Dr. Flint responded that the committee had discussed the hazard of making the issue a point of contention if it is over specified. She added that the committee wanted to capture the essence of climate change in a broader way.

Regarding charge question 4, Dr. Richardson noted that the section called "Opportunities for Further Integration" of page 23 was fairly general. He stated that there is an opportunity for integration with SSWR on the "ecosystem and land" research topic, which emphasizes issues such as flooding and sea level rise. He added that SHC is the lead on the ecosystems and land research, and that all the impacts under that topic are water related.

Dr. Swackhamer stated that the committee had also discussed co-benefits, but noted that it was not included in the draft response. Dr. Swackhamer asked Dr. Solomon if co-benefits would be included in the report under gaps. Dr. Solomon replied that co-benefits are implicit in the document, and agreed that EPA should specifically discuss co-benefits in the roadmap. Dr. Richardson noted that co-benefits are mentioned briefly under "Mitigation and Associated Environmental Impacts" on page 18. Dr. Swackhamer suggested that the workgroup move the co-benefits recommendation under charge question 5. She explained that reduced emissions can be achieved through an effective emissions reduction program, which would require expertise from SHC, ACE, and HHRA.

Dr. Swackhamer raised her concern that the response to the Climate Change Roadmap is missing full sentences, and requires heavy editing. Ms. Smith agreed, stated that it seemed as though the authors had pasted issues into the report before expanding on them. Dr. Solomon noted that the ideas appeared disjointed and the document lacked a coherent flow across the different sections.

She added that the response was repetitious, and that she read the same sentence in multiple places in the draft document. Ms. Smith stated that, in general, the draft response needs a stronger organizational logic to connect the research needs, the ongoing research, and the gaps. She also agreed with Dr. Swackhamer's concern that the language used to describe the needs and the gaps is the same.

Dr. Olsiewski recognized the energy barrier as a crosscutting issue. Dr. Richardson stated that found the energy paradox interesting, but pointed out that the roadmap does not explain the research question. Dr. Olsiewski agreed whether it is an important research topic should be clearer in the roadmap. She added that the Sloan Foundation is researching the energy paradox.

Dr. Swackhamer asked for any final comments. Hearing none, she transitioned the discussion to the Executive Committee response to the EJ Roadmap.

Environmental Justice Roadmap Report Discussion

Dr. Swackhamer noted that the response to the EJ Roadmap contained the level of detail and length she was expecting. The response to the EJ Roadmap is four to five pages and included sufficient context. Dr. Swackhamer asked the climate change workgroup to reference it as an example when editing their document.

Dr. Flint stated that the small workgroup assembled to respond to the EJ Roadmap included members from the CSS, HHRA, and SHC subcommittees. She noted that they may have unintentionally overlooked the other programs, especially in their response to charge questions 4 and 5, and asked for their input in those areas. Dr. Solomon added that the workgroup is concerned about missed opportunities for integration with SSWR, specifically in terms of tribal issues, health disparities, and cumulative risk.

Charge Question 1: How effective is the draft Roadmap in presenting a problem statement?

Dr. Solomon commented that in the second sentence of the paragraph that begins "In addition to the above discrepancies…" ORD's unique contribution to the EJ research agenda should be more clearly articulated.

Dr. Solomon also noted that her intention to split the first paragraph into two paragraphs. Dr. Swackhamer noted that the paragraph, however, discusses a single concept.

Dr. Swackhamer restated that committee members should send their editorial comments and edits to Mr. Tracy electronically.

Charge Question 2: How effective is the draft Roadmap in elucidating key research topics appropriate to the mission of EPA?

Dr. Swackhamer noted the general agreement among the committee members that the four key research topics are great, but reiterated that it is not clear if the four topics are the only four topics or how EPA selected them. She asked the EJ Roadmap workgroup if they made this point in their response, because she did not see it at first glance. Dr. Richardson noted it might be a good lead statement for the section under charge question 2. He explained that the first paragraph highlighted tribal issues, but pointed out that other communities are marginalized, included those dominated by racial and ethnic minorities and those where gender identity and sexual orientation

are relevant. He recognized that tribal issues might be an Administrator priority, but suggested adding a sentence to the effect of "It is not clear why these four research topics were identified, although we do like them." Dr. Swackhamer suggested adding "It is unclear how these four topic were selected and why they rose to the top of the list" after the second sentence, noting the four research topics are appropriate.

Dr. Solomon suggested extending that sentence that begins "However, these research topics may not reflect the full breadth of …" to say "…may not reflect the full breadth of EJ issues and their drivers, and it is not immediately clear to the committee how these four were selected and prioritized." The Executive Committee members agreed.

Dr. Kavlock noted that the committee had not asked for clarification on how EPA selected the key research topics for the Climate Change Roadmap. Dr. Swackhamer responded that the research objectives were clearer in the Climate Change Roadmap, but would double check whether it should also be addressed in the response to the Climate Change Roadmap. Dr. Richardson added that he thought the Climate Change Roadmap research topics were far more comprehensive than the EJ Roadmap's topics.

Charge Question 3: How effective is the draft Roadmap in elucidating important scientific gaps appropriate to the mission of the EPA?

Dr. Solomon noted that, since the draft was printed for the members, she had edited the second paragraph on community engagement to read "However, we caution against overpromising in this area. Long term engagement is the most effective way to involve communities, yet, engaging long term with multiple communities for formulation of a research agenda is a highly resource intensive endeavor." Dr. Solomon explained that she added this to note the balance required when engaging communities. Committee members agreed with the edit.

Dr. Swackhamer raised the previously mentioned concern that all the citations in the roadmap reference EPA documents. She asked the committee members if they would like to include something along the lines of "The research is extensive, but it would be useful to indicate your familiarity with existing research." in the roadmap response. Dr. Olsiewski noted that, although the references were predominantly EPA documents, the EPA also referenced other resources in the roadmap. Dr. Solomon noted that there were only two references in the document that were non-EPA documents. Dr. Olsiewski noted that the comment speaks to the fact that EJ issues are complicated, and EPA should take into account the breadth of available knowledge. Dr. Swackhamer clarified that the document references EPA documents in terms of past work done by the Agency, so their references to only EPA documents is appropriate. Dr. Solomon clarified that Dr. Tharakan's point was about the research available on well-being, specifically, and offered to add text about well-being to the draft response. Dr. Richardson suggested adding the text on well-being to the general observations section, because the reference comment does not address any charge question directly.

D. Flint stated that she thought Dr. Tharakan's comment had been included in the response, and asked Dr. Solomon if his comment had been edited out. Dr. Solomon responded that she did not edit out Dr. Tharakan's comment.

Dr. Chaudhry commented that he did not see text addressing his concern regarding the long term sustainability of EJ efforts. He clarified that ownership of the efforts will need to be transferred

to the local communities. Dr. Swackhamer agreed that the workgroup should note this issue in the draft response, and that they should also discuss how the transfer of responsibility might occur. Dr. Solomon explained that the draft response includes a paragraph on outcome assessment, and asked it that gets at the idea of the sustainability of long term efforts. Dr. Chaudhry clarified that his comment was not about the assessment, but the long term implementation mechanisms that include knowledge transfer, training, and provision of resources. Dr. Olsiewski raised her concern that recommending trainings for the next generation ignored many other ongoing efforts to educate underrepresented groups, and suggested referencing them in the draft response.

Dr. Swackhamer stated that she thought some of the committee's previous comments belong in the section of the report that contained the overall committee impressions of the roadmap. She recalled Dr. Richardson's comment on the use of "minority" versus "majority." She explained that the language assumes that the underprivileged groups are the minority, and asked if that comment is captured in the draft response. Dr. Richardson responded that he did not think the comment was captured. Dr. Swackhamer suggested that the draft response include a subtitle of "general observations" above the charge question responses.

Dr. Solomon stated that she was not sure if she agreed with the language comment, explaining that many studies have found that race is a predictor of health, independent of poverty. Dr. Richardson clarified that the issue is that there are EJ communities where the racial/ethnic minorities are actually the majority of the population. Members agreed to avoid the term minority, and add a sentence to the draft response that captures that sentiment.

Dr. Swackhamer also restated Dr. Flint's earlier concerns about macro-scale issues (e.g., economics, politics, etc.) that affect EJ issues at the local level, asked if the members wanted to include this in the draft response. Dr. Swackhamer summarized several comments by saying that the workgroup should include these comments in the overarching comments section.

Dr. Somasundaran raised the issue of language barriers and asked if that point should be captured in the report. Dr. Swackhamer responded that language barriers is another factor that affects overburdened communities, but explained that the draft response cannot be expected to list every relevant variable.

Dr. Swackhamer mentioned that the EJ program could be an overarching frame for all of the other Agency programs, including the Climate Change program, and asked if it is something the committee members would like to include in the draft response. Dr. Richardson noted that the EJ Roadmap briefly mentions a linkage with climate justice, and suggested that the committee recommend that the link is also included in the Climate Change Roadmap.

Dr. Swackhamer noted that she had trouble mapping the program's gaps back to the needs. Dr. Flint clarified that ORD received a long list of EJ research gaps from NEJAC.

Dr. Swackhamer applauded the EJ workgroup for producing a well-written five page document in less than 24 hours.

Crosscutting Themes Discussion

Dr. Swackhamer stated that the Executive Committee will bullet and number the crosscutting themes and issues in their final report. She added that EPA will formally respond to them, but suggested that the committee note that the recommendations are not prioritized.

Dr. Swackhamer drew the committee's attention to the bullet on the top of page three, and noted that the bullet needed some examples. Dr. Richards mentioned the SHC tools, such as the environmental quality index and the human well-being index. Dr. Solomon added that there might be information from HHRA or CSS that could feed into those tools.

Dr. Richardson asked whether the phrase "technical FTE" is used across the Agency, noting that he did not know what the term meant. Dr. Kavlock responded that the term is not used across the Agency, and suggested using "scientific FTE" or "administrative FTE" instead.

Dr. Flint stated that the first crosscutting bullet should read "each program should clearly define..." rather than "each StRAP should clearly define..."

Dr. Solomon asked how the committee should refer to themselves. Dr. Swackhamer responded that the committee should use "the BOSC."

Dr. Solomon's commented on the second crosscutting bullet on page two of the document, which refers to the need to develop a consistent communication strategy. She noted that the bullet appears repetitive of the sixth bullet, which refers to the need to synthesize and translate information. Dr. Swackhamer clarified that the translation bullet refers to translating their science and the communication bullet refers to two way communication between ORD and their partners. Dr. Solomon noted that communication with partners is included in the second bullet, and asked how the communication aspects differed between the second and fourth bullets.

Dr. Flint stated that the sixth bullet that reads "The BOSC feels that ORD should develop a consistent strategy across the board to inform, educate, and demonstrate partners..." should include language to the effect of "...to include partners and stakeholders." She noted that the bullet needs to capture the concept of multidirectional flow of information between partners, communities, and ORD programs, rather than recommending that ORD educate partners and stakeholders. Dr. Solomon reiterated her concern that the sixth bullet does not contain any new information that is not already included in the second or fourth bullet. Dr. Richardson agreed that the fourth and sixth bullet both address communication, and suggested the bullets be reconciled. Dr. Chaudhry stated that the sixth bullet could be omitted, because most of the content was captured in the second paragraph of the fourth bullet. Dr. Olsiewski commented the sixth bullet is easier to understand than the fourth bullet. Dr. Flint suggested replacing "bidirectional" with "multidirectional" in the second paragraph of the fourth bullet, and members agreed. Dr. Swackhamer suggested combining the second paragraph of the fourth bullet and the sixth bullet into a single communications bullet, followed by a bullet on translation. The members agreed.

Dr. Flint added that she was not sure what "omics" is. Dr. Swackhamer explained that it referred to genomics, metabolomics, and other related fields. Dr. Solomon suggested that "omics" be removed from the bullet, rather than defining it. She clarified that the "omics" issue was raised in the context of CSS, specifically, which uses data beyond "omics" data. She suggested that "omics" be replaced with "big data." Dr. Olsiewski also suggested removing "bioinformatics"

from the bullet, but members disagreed. Dr. Flint suggested that SHC be removed from the listed programs, as SHC sufficiently addresses the topic.

Dr. Olsiewski asked if it would be helpful to add "such as investments in infrastructure" in the IT bullet. Dr. Swackhamer clarified that the bullet also refers to IT staff, so Dr. Olsiewski's suggested language would not work. Dr. Solomon suggested shortening the sentence to read "such investments are an integral component to the continued success of each program and could be a barrier to future success," and remove the language about IT being undervalued. She added that the committee just needed to say that IT is integral.

Dr. Somasundaran drew the committee's attention to the bullet regarding outreach and internal liaison staff. He noted the recommendation to create a steering committee is the most important of all the activities listed in the bullet. Dr. Swackhamer replied that ORD already performs most of the activities listed, and reminded the committee of Dr. Kavlock's comments on the difficulty of having a liaison person in the regions. Dr. Flint added that she is not sure the committee should recommend how ORD should structure their internal interactions, and suggested that the recommendation make a more general statement instead. Ms. Smith suggested the committee acknowledge the value of a liaison position, and ask ORD to direct resources to the position if it is not currently functioning properly. Dr. Swackhamer noted that she had some language to add to that point and would edit the bullet. Dr. Solomon stated that a section of the CSS/HHRA draft report speaks to this point, and suggests that ORD explore opportunities for travel and cross-office details. Dr. Flint added that SHC made a similar recommendation in their draft report.

Dr. Richardson drew the subcommittee's attention to the second to last bullet point, and noted that ORD uses the term "decision support tools," not "decision making support tools." He suggested that the committee use "decision support tools" also.

Dr. Swackhamer asked for any last comments before moving on to the next agenda item.

Summary and Next Steps

Deborah Swackhamer, Chair

Dr. Swackhamer stated that the committee will compile all of the subcommittee draft report sections. She added that she would like to receive the subcommittee's summaries from the co-chairs by the week following the meeting. She asked the members to send their comments on the Executive Committee response to the Climate Change Roadmap and EJ Roadmap to the workgroup leaders and their editorial comments to Mr. Tracy. She noted that when all of the subsections of the final report are submitted, the committee will compile the document and Mr. Tracy will schedule the next teleconference to discuss the committee's draft final report. Dr. Chaudhry asked if the edited subcommittee reports needed to be sent out for full subcommittee review. Dr. Swackhamer clarified that they did not, unless the chairs had made substantial edits.

Dr. Swackhamer asked for any final questions on the next steps of the committee report. Hearing none, she turned the discussion over to Mr. Tracy.

DRAFT

Adjourn

Thomas Tracy, Designated Federal Officer

Mr. Tracy thanked the Executive Committee for its productivity during the two and a half day meeting. He added that he is looking forward to working with the BOSC over the next few years and thanked Dr. Swackhamer for her outstanding leadership. He also thanked the subcommittees and the NPDs for making the BOSC effort a successful one. Mr. Tracy concluded the meeting by thanking Dr. Kavlock and Dr. Burke for their participation and valuable input. He adjourned the meeting at 12 pm.

DRAFT

Appendix A: Agenda

United States Environmental Protection Agency Board of Scientific Counselors (BOSC) Executive Committee (EC)

Meeting Agenda – December 8–10, 2015

Washington, District of Colombia

TIME	TOPIC	PRESENTER
Tuesday, December 8, 2015		
8:30 – 9:00	Registration	
9:00 -- 9:10	Convene Meeting	Thomas Tracy, DFO
9:10 -- 9:30	Welcome	Thomas Burke and Robert Kavlock
9:30 -- 9:45	Introduction of Members	Deborah Swackhamer, Chair
9:45 -- 10:05	Review Agenda, Meeting Charge and Process	Deborah Swackhamer, Chair
10:05 -- 10:20	Public Comments	Registered Speakers
10:20-10:30	Presentation	Andrew Geller, Roadmap Lead Environmental Justice Roadmap
10:30 – 10:45	Break	
10:45 – 11:45	Discuss Charge Question Environmental Justice Roadmap	Deborah Swackhamer, Chair
11:45 – 12:45	Lunch	
12:45 – 12:55	Presentation	Andy Miller, Roadmap Lead Climate Change Roadmap
12:55 – 1:55	Discuss Charge Question Climate Change Roadmap	Deborah Swackhamer, Chair
1:55 – 2:05	Process and Next Steps	
2:05 – 2:20	Break	
2:20 – 3:05	Air, Climate and Energy Draft Report	Viney Aneja, Chair and Sandra Smith, Vice Chair

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3:05 – 3:20	ACE Program Comments	Dan Costa, National Program Director
3:20 – 4:40	Discussion ACE Draft Report	Deborah Swackhamer, Chair
4:40 – 5:30	Deliberation & Writing Session	Deborah Swackhamer, Chair
5:30 – 6:00	Adjourn	Deborah Swackhamer, Chair

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TIME	TOPIC	PRESENTER
Wednesday, December 9, 2015		
8:30 – 8:35	Reconvene	Deborah Swackhamer, Chair
8:35 – 9:20	Sustainable and Healthy Communities Draft Report	Robert Richardson, Chair and Courtney G. Flint, Vice Chair
9:20 – 9:35	SHC Program Comments	Michael Slimak, National Program Director
9:35 – 9:50	Break	
9:50 – 10:50	Discussion SHC Draft Report	Deborah Swackhamer, Chair
10:50 – 11:35	Safe and Sustainable Water Resources Draft Report	Kenneth Reckhow, Chair and Shahid Chaudhry, Vice Chair
11:35 – 11:50	SSWR Program Comments	Suzanne van Drunick, National Program Director
11:50 – 12:50	Lunch	
12:50 – 1:50	Discussion SSWR Draft Report	Deborah Swackhamer, Chair
1:50 – 2:35	Chemical Safety for Sustainability Human Health Risk Assessment Draft Report	Ponisseril Somasundaran, Chair and Gina Solomon, Vice Chair
2:35 – 2:50	Break	
2:50 – 3:10	CSS / HHRA Program comments	Tina Bahadori, National Program Director and John Vandenberg, National Program Director
3:10 – 4:10	Discussion CSS/HHRA Draft Report	Deborah Swackhamer, Chair
4:10 – 6:00	Deliberation & Writing Session	Deborah Swackhamer, Chair
6:00 – 6:30	Adjourn	Deborah Swackhamer, Chair

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TIME	TOPIC	PRESENTER
Thursday, December 10, 2015		
8:30 – 8:35	Reconvene	Deborah Swackhamer, Chair
8:35 – 9:20	Homeland Security Draft Report	Paula Olsiewski, Chair and Tammy P. Taylor, Vice Chair
9:20 – 9:35	HS Program Comments	Gregory Sayles, National Program Director
9:35 – 10:35	Discussion HS Draft Report	Deborah Swackhamer, Chair
10:35 – 10:50	Break	
10:50 – 11:50	Deliberation on Report	Deborah Swackhamer, Chair
11:50 – 12:00	Summary and Next Steps	Deborah Swackhamer, Chair
12:00 – 2:05	Adjourn	Thomas Tracy, DFO

Breaks at the discretion of the chair.

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Appendix B: Participants

BOSC Executive Committee Members:

Deborah L. Swackhamer, *Chair*
Viney Aneja
Shahid Chaudhry
Susan Cozzens
Lisa Dilling
Courtney Flint
James Galloway
Earthea Nance
Paula Olsiewski
Diane Pataki
Kenneth Reckhow
Robert Richardson
I. Leslie Rubin
Sandra Smith
Gina Solomon
Ponisseril Somasundaran
Tammy Taylor
John Tharakan

EPA Designated Federal Officer (DFO):

Tom Tracy, *Office of Research and Development*

EPA Presenters:

Thomas Burke*, Office of Research and Development, Deputy Assistant Administrator*
Robert Kavlock*, Office of Research and Development, Deputy Assistant Administrator for Science*
Andrew Geller, *Office of Research and Development, Deputy National Program Director for the SHC Research Program*
Andy Miller, *Office of Research and Development, Associate National Program Director for the ACE Research Program*
Dan Costa, *Office of Research and Development, National Program Director for the ACE Research Program*
Michael Slimak*, Office of Research and Development, National Program Director for the SHC Research Program*
Suzanne van Drunick, *Office of Research and Development, National Program Director for the SSWR Research Program*
Tina Bahadori, *Office of Research and Development, National Program Director for the CSS Research Program*
John Vandenberg*, Office of Research and Development, National Program Director for the HHRA Research Program*
Greg Sayles, *Office of Research and Development, National Program Director for the HS Research Program*

Other EPA Attendees:

Tim Benner
Susanna Blair
Jace Cujé
Mimi Dannel
Megan Fleming
Emily Gibbs
Maureen Gwinn
Fred Hauchman
Elaine Hubal
Annie Jarabek
Brian Kleinman
David Kryak
Charles Miller
Cindy Roberts
Laurel Schultz
Emily Snyder
Joe Williams

Other Participants:

Natalia Sharova

Contractor Support (ICF International):

Ali Goldstone
Maureen Malloy
Laura Thomas

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Appendix C: Charge Questions

Charge for the Climate Change and Environmental Justice Roadmaps

How effective are the Draft Environmental Justice and Climate Change Research Roadmaps in presenting a problem statement, elucidating key research topics and important scientific gaps appropriate to the mission of the EPA, capturing relevant research in each of the six programs, and identifying areas of integration across the six programs?

Charge to the BOSC ACE Subcommittee

Charge question 1: Given the research objectives articulated in the StRAP, are the topics and project areas planned and organized appropriately to make good progress on these objectives in the 2016-2019 time frame? Issues

Charge question 2: How effective are the approaches for involving the EPA partners in the problem formulation stage of research planning?

Charge Question 3: How well does the program respond to the needs of EPA partners (program office and regional)?

Charge question 4: Please comment on the quality of the products delivered by the program. Are there additional approaches that could be taken by the program to ensure that its products are of high quality?

Charge question 5: How well have we translated research findings and understanding for the end-users? How can we improve our ability to translate research findings and understanding for end-users in the future?

Charge to the BOSC HS Subcommittee

Charge question 1. Given the research objectives articulated in the StRAP, are the topics and project areas planned and organized appropriately to make good progress on these objectives in the 2016-2019 time frame?

Charge question 2. How effective are the approaches for involving the EPA partners in the problem formulation stage of research planning?

Charge question 3. How well does the program respond to the needs of EPA partners (program office and regional)?

Charge question 4. How well has the program transitioned research to the end-user? How can we improve our ability to transition research to the end-user in the future?

Charge question 5. How can we infuse social science into the development of our research products to improve their usability?

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Charge to the BOSC SSWR Subcommittee

General charge question 1. Given the research objectives articulated in the StRAP, are the topics and project areas planned and organized appropriately to make good progress on these objectives in the 2016-2019 time frame?

General charge question 2. How effective are the approaches for involving the EPA partners in the problem formulation stage of research planning?

General charge question 3. How well does the program respond to the needs of EPA partners (program office and regional)?

SSWR-specific charge question 1: How can SSWR streamline model and tool development within the program and across other national programs and partners to improve utility, interoperability, and accessibility, and what are some ways we can measure metrics of success?

SSWR-specific charge question 2: What are the unique aspects of resource recovery and water reuse that SSWR is best able to address? What research products are envisioned to maximize impact?

Charge to the BOSC SHC Subcommittee

Charge question 1: Given the research objectives articulated in the Strategic Research Action Plan (StRAP), are the topics and project areas planned and organized appropriately to make good progress on these objectives in the 2016-2019 time frame?

Charge question 2: How effective are the approaches for involving the EPA partners (program offices and regions) in the problem formulation stage of research planning?

Charge question 3: How well does the program respond to and anticipate the needs of EPA partners (program office and regional)?

Charge question 4: SHC has committed to integrating ecological and human health to better address issues of human and community well-being. Does the research program contain the elements necessary to integrate these two critical elements of EPA's mission?

Charge question 5: SHC's portfolio includes both hypothesis-driven research and the development of decision-support tools to aid Agency, state, and community stakeholders. Is the balance of research and tool development appropriate for this program?

Charge question 6: SHC has a mission to address the short-term needs of EPA's Office of Solid Waste and Emergency Response (OSWER) for research on contaminated sites, oil and fuel spills, and sustainable materials management. How can SHC best leverage these short-term research goals with longer term community sustainability and environmental justice goals?

Charge to the BOSC CSS and HHRA Subcommittee

Charge question 1: Given the research objectives articulated in the StRAP, are the topics and project areas planned and organized appropriately to make good progress on these objectives in the 2016-2019 time frame?

Charge question 2: How effective are the approaches for involving the EPA partners in the problem formulation stage of research planning?

Charge question 3: How well does the program respond to the needs of EPA partners (program office and regional)?

Charge question 4: Please provide input on the scope and implementation for 2016-19 in the following topic areas:

- Complex Systems Science
- Lifecycle Analytics
- Chemical Evaluation

Charge question 5: Please provide input on opportunities and approaches for fit-for-purpose translation and knowledge delivery.

Charge question 6: Please comment on the research dimensions of the HHRA program and, in particular, the proposed approaches for characterization of new data and computational methods to improve confidence and build capacity for their application in the context of risk assessment.