Civil Engineering in a Changing Climate:
Key CACC Goals and Actions for 2021 and Beyond

Purpose and Approach

The purpose of the ASCE Committee on Adaptation to a Changing Climate (CACC) is to identify and communicate the technical requirements and civil engineering challenges for adaptation to climate change. (NOTE: CACC emphasizes that adaptation to climate change must occur in tandem with activities to reduce and remove greenhouse gases, but the focus of its activities is on adaptation to the unavoidable changes that we are already beginning to observe.) This report lays out the overall goals of CACC for the next three years, as well as key milestones and approaches that CACC should follow to achieve them. This work draws heavily on the ASCE report *Adapting Infrastructure and Civil Engineering Practice to a Changing Climate*, and ASCE *Manual of Practice 140: Climate Resilient Infrastructure Adaptive Design and Risk Management*, which were conceived and authored by CACC members**.** This strategic plan focuses on two time-horizons, FY2024 (three years in the future) and FY2021 (the current ASCE fiscal year). This structure reflects the view that the major needs of the civil engineering community will best be addressed through thoughtful and coordinated action over at least three years, and that 2021 will be a period during which CACC can establish and further build important relationships with key entities both internal and external to ASCE, who share a common desire to address the challenge of adaptation to climate change.

This strategy continues to draw on ASCE Policy 360, which recognizes that many facilities are exposed to and are often are vulnerable to the effects of extreme climate and weather events and states that “Engineering practices and standards associated with these facilities must be revised and enhanced to address climate change to ensure they continue to provide acceptably low risks of failures and to reduce vulnerability to failure in functionality, durability and safety over their service lives.” CACC also recognizes the updated ASCE Code of Ethics with the guiding principle that "engineers create safe, resilient and sustainable infrastructure "and stakeholder responsibilities closely related to climate change including "Engineers: A. adhere to the principles of sustainable development; . . . and, C. mitigate adverse societal, environmental, and economic effects." It also recognizes that ASCE has a number of policies that address infrastructure resilience and sustainability, and this calls for an integrated approach.

Over the last five years, the United Nations has implemented the 17 Sustainable Development Goals (SDG) and ASCE has played a lead role in implementation through its participation in the World Federation of Engineering Organizations (WFEO). ASCE is now (2021) leading U.S. participation in WFEO and leading the WFEO participation at the UN. A focus of the WFEO UN work is implementation of the SDGs. Of particular relevance to CACC is SDG 13—Climate Action and its adaptation targets. ASCE Policy 517 supports implementation of the civil engineering aspects of the SDG and the UN believes quality infrastructure affects 92 percent of the SDG targets.

The long-lived nature of infrastructure and associated rights-of-way demands that the climate of the future should be taken into account when planning and designing new

infrastructure or modified natural systems (e.g., environmental restoration). The requirement that engineered systems meet future needs, and the uncertainty of future climate at the scale of the majority of engineering projects, leads to a dilemma for practicing engineers. This dilemma is the gap between climate science and engineering practice that must be bridged.

The approach taken by CACC is to focus on coordinating efforts of its members and the broader ASCE membership to achieve greatest possible progress toward a series of commonly held goals. CACC developed its first strategic plan in 2016 to leverage the variety of related ongoing ASCE activities. Today, with a renewed sense of the growing challenge climate change represents to both society in general, and the civil engineering profession specifically, there is considerable interest in expanding the impact that CACC could have on engineering practice nationally and globally. As this updated plan builds upon the 2016 version, the priorities of that plan, and their impact, are reviewed below.

The priorities put forward in 2016 addressed recommendations put forward in *Adapting Infrastructure and Civil Engineering Practice to a Changing Climate*, including:

- Engineers should engage in cooperative research involving scientists from across many disciplines to gain an adequate, probabilistic understanding of the magnitudes of future extremes and their consequences.
- Practicing engineers, project stakeholders, policy makers and decision makers should be informed about the uncertainty in projecting future climate and the reasons for the uncertainty, as elucidated by the climate science community.
- Engineers should develop a new paradigm for engineering practice in a world in which climate is changing but cannot be projected with a high degree of certainty.
- Critical infrastructure that is most threatened by changing climate in a given region should be identified, and decision makers and the public should be made aware of this assessment.

As these recommendations made clear, achieving many of the goals identified by CACC required actions beyond the committee's remit. In fact, CACC could not achieve any reasonable component of this vision without the active cooperation of many other entities. Given the limited time and manpower available to CACC, the 2016 plan was organized to place equal weight on both internal (within ASCE) and external collaboration.

Recent Progress and Lessons Learned

Considerable effort has been expended by CACC volunteers over the last 5 years yielding tangible products and benefits (A more complete discussion of CACC activities, and their implications relevance to CACC Goals, appears in Appendices A and B; respectively). While not an exhaustive list some significant outcomes include:

- 2016 CACC coordinated the second ASCE-wide review of the National Climate Assessment
- 2017 CACC's Task Committee on Hydroclimatology and Engineering Adaptation

(HYDEA) held a workshop on precipitation under a changing climate which led to the ASCE publication of *Engineering Methods for Precipitation under a Changing Climate* in 2020.

- 2018 CACC completed, and ASCE published the development of ASCE *Manual of Practice 140: Climate Resilient Infrastructure Adaptive Design and Risk Management*. This report also marked the second successful collaboration with the American Meteorological Society (AMS), which provided technical review comments.
- 2018 CACC established the Task Committee on Future Weather and Climate Extremes
- 2019 CACC established the Task Committee on Climate Intelligence for Codes and Standards
- 2020 CACC's Task Committee on Hydroclimatology and Engineering Adaptation (HYDEA) held a series of workshops on compound flooding which is expected to lead to an ASCE publication in 2021
- 2020 CACC's Task Committee on Future Weather and Climate Extremes completed, and 2021 ASCE to publish, *The Impacts of Future Weather and Climate Extremes on United States' Infrastructure: Assessing and Prioritizing Adaptation Actions*.

Internal discussions among CACC members suggests that while the current membership has grown, loss of some senior members of CACC does limit our understanding and experience with senior ASCE leadership**. CACC, with the help of the ASCE Committee on Technical Advancement (CTA) should undertake a coordinated effort to build a deeper network of communication across various ASCE Committees and Institutes as well as with various professional organizations and Federal agencies with interest in developing climate-resilient engineering practice. In addition, greater attention needs to be placed on cataloging and coordinating activities of CACC committees and individual members, so a clearer picture of CACC's progress may be gauged each year.**

Moving Forward

The success of past CACC activities coupled with the ever-growing interest in responding to changes in weather and climate extremes through improved engineering practices has led to both an increased demand for CACC participation in a variety of ASCE activities, as well as an increased interest by ASCE members in joining CACC.

Aligning the experience and expertise of current and future CACC members with the growing demand for CACC engagement in the development of civil engineering practice will always be an important component of CACC planning. Self-evaluation is an important component of strategic planning. To facilitate annual progress evaluation, clearer understanding of CACC goals and associated milestones, and membership expertise is needed. Once clarified, goals and actions should facilitate development of annual implementation plans, including enhancing membership to fill knowledge gaps if necessary. **CACC should clarify the roles of its various subcommittees, improve understanding of how each subcommittee supports the collective goals of CACC, and**

catalogue the expertise of its members to facilitate alignment of that expertise across the subcommittees and effectively deploy CACC expertise to foster and maintain external relationships. CACC should re-evaluate goals, actions and knowledge need on an annual basis.

2024 Goals

Consistent with ASCE Strategic Goal #3 ("All infrastructure is safe, resilient, and sustainable"), best practice in the field of civil engineering considers likely changes in conditions (e.g., population growth, urban expansion) over the lifespan of new and existing infrastructure and managed environmental systems. Incorporating the potential impacts from future weather and climate extremes should be an integral part of the design process. ASCE can be a key enabling organization for this vision, providing trusted information, best practice recommendations, inputs to standard setting, and implementation case studies. ASCE is also uniquely qualified to speak on behalf of the civil engineering community, as the national and international dialogue on incorporating climate change into infrastructure design continues to grow. Finally, **CACC and ASCE should support the work of engineers through climate-informed codes and standards, and where appropriate and necessary, empower engineers to exercise professional judgment as they address the challenges presented by future weather and climate extremes while managing project costs and timelines.**

Key internal ASCE partners for CACC include entities those that set standards of practice, educate members, or advocate for government programs that provide information civil engineers use. Collaboration with ASCE entities to achieve the following goals would seem to be of particular value:

- **Goal 1.** ASCE's Strategic Plan and its various codes and standards acknowledge and address the implications of changes in weather and climate extremes as appropriate for their use in engineering design and practice
- **Goal 2.** Active use of risk-based decision making as a method for treating uncertainty due to changing climate conditions in engineering practice and education
- **Goal 3.** Low-regret, robust decision making, dynamic adaptive planning (DAP), and the observational method are widely incorporated in appropriate ASCE and infrastructure community standard
- **Goal 4.** Risk-based, low-regret design thinking is well represented in various education and certification programs (potentially interface with Institute for Sustainable Infrastructure (Envision), US Green Building Council (LEED) etc.)
- **Goal 5.** Research-based improvements in the understanding the range of tradeoffs across costs and benefits of practices and standards are well established

Key external (non-ASCE) partners for CACC include entities that help establish standards of practice or collect, maintain, and disseminate information needed by civil engineers. Collaboration with non-ASCE entities to achieve the following goals would seem to be of particular value:

- **Goal 6.** Review of climate and weather research programs and studies to improve civil engineering education, practice, and standards is ongoing

Goal 7. Research-based improvements in the bounds and characterization of future climate and weather extremes are more available

Goal 8. Investigations of extreme climate and weather events and their implications for the improvement of engineering practice and standards are underway

Goal 9. Civil engineering practice is well represented in efforts directed toward incorporating climate adaptation into Federal facilities

Goal 10. The scope and accessibility of relevant climate information for civil engineers reflects the input of practitioners.

2021 Actions

Given the recent change in Administrations, ASCE fiscal year 2021 is an important opportunity for CACC to position ASCE to realize many of the goals listed above. Again, as CACC has limited resources, 2021 actions should be explicit and high impact, and include the formation of key strategic partnerships both internal and external to ASCE. Furthermore, the planning and execution of key engagement activities (i.e., meetings, symposia, or summits) undertaken in 2021 should clearly advance the work of CACC. Of particular importance are the following efforts:

Action 1. With the help of ASCE Committee on Technical Advancement, engage with the ASCE Board of Direction, the Industry Leaders Council, the Government Relations Office, and the Committee on Codes and Standards [Goals 1, 2, 3, 4, and 5]

Action 2. Co-plan and support relative activities or summits that may be organized by key ASCE partners (e.g., Infrastructure Resilience Division [IRD], Committee on Sustainability [COS], Environment and Water Resources Institute [EWRI], and Coasts, Oceans, Ports, and Rivers Institute [COPRI]) to ensure they include significant discussion of approaches and development of objectives for addressing uncertainties due to changing climate conditions in engineering practice [Goals 1, 2, 3, 4, and 5],

Action 3. Develop and promote a session on Climate Resiliency at ASCE National Convention October 2023 [Goals 1, 2, 3, 4, and 5]

Action 4. Propose and participate in one or more pilot efforts for incorporating low-regret decision making and observational method in ASCE standards [Goals 1, 3 and 4]

Action 5. Plan and propose Federal agency support of research to address the public policy, financial and legal issues, as well as the scientific and technical issues, involved in incorporating low-regret adaptive strategies and the observational method in regulations and in the standards upon which the regulations are based [Goals 1, 2, 3, 4, 5, and 9]

Action 6. Plan and propose, in cooperation with the American Meteorological Society or similar entities, Federal agency support of multi-disciplinary research to gain an adequate, probabilistic understanding of the magnitudes of future extremes, their effects on infrastructure systems and their economic, environmental, and social consequences [Goals 1, 6, 7, 8, 9 and 10]

Action 7. Recommend relevant entities within the National Academies complex take steps to educate both the scientific and engineering communities to the

challenges practicing engineers face due to changing climatic conditions, and as needed, propose integrated actions to facilitate infrastructure adaptation as well as GHG mitigation. [Goals 6, 7, 8, 9 and 10]

Action 8. Discuss with selected ASCE journal editors the possibility of a special issue in each of their journals addressing CACC topics in their subfield [All 10 Goals]

Immediate Next Steps — CACC (via its subcommittees) should take steps during the balance of this fiscal year to position CACC to reach its stated goals for 2021. To achieve this, CACC should:

- Systematically catalogue the expertise and relevant activities of its members and sub-committees
- Clarify and advertise the function of its various subcommittees, so as to improve internal coordination and recruit needed expertise,
- Ensure that annual CACC strategic planning efforts produce actionable recommendations in time to inform annual financial planning for the forthcoming fiscal year (NOTE: ASCE committee fiscal years begin on October 1, and budget discussions take place between November and January of the previous year. For example, the FY22 CACC budget was submitted in February 2021),
- Aggressively engage with the following ASCE entities:
    - ASCE Board of Direction
    - ASCE Government Relations and Infrastructure Initiatives
    - ASCE Committee on Codes and Standards
    - ASCE Region 10 (ASCE international members covering all countries outside of North America)
    - Infrastructure Resilience Division [IRD]
    - Committee on Sustainability [COS],
    - ASCE Technical Region Board of Governors (institutes and CTA leaders)
    - Environmental and Water Resources Institute (EWRI)
- Formally propose to present *Manual of Practice 140* and other recent and forthcoming CACC publications to:
    - National Institute for Building Safety (NIBS)
    - International Code Council (ICC)
    - National Climate Assessment Network
    - Interagency Forum on Climate Change Impacts and Adaptations
    - NOAA's Climate Program Office
    - NIST Engineering Laboratory.

Conclusion

The actions outlined above are critical to achieving the vision outlined in *Adapting Infrastructure and Civil Engineering Practice to a Changing Climate* and reaffirmed in subsequent CACC products. Those actions also constitute an ambitious body of work for a volunteer organization such as CACC**. CACC should focus its limited resources on actions that increase the likelihood that the overall vision for engineering practice is more likely achieved.** The likelihood of success is increased when CACC actions are carried out in cooperation with entities that can advance our work in meaningful ways.

Date	Title	Description	Categorization	Task Committee	Goals and Actions
2012	Discussion on Weather Models and Relationship to Climate Models with NOAA Climate Prediction Center	CACC held early outreach with contacts	Coordination		N2
2012	Review of the report by the National Climate Assessment Network Affinity Group on Built Environment	CACC members reviewed the report (10/12/12 Minutes)	Coordination		N2
2013	Bridging the Gap between Climate Change Science and Engineering Practice and its presentation at the Carbon Management Technology Conference	Dick Wright-organized Webinar	Presentation		
6/12/2014	Workshop on Measurement Science for Sustainable Construction and Manufacturing	6/12-13/2014 workshop jointly hosted by NIST, ASCE, ASME, and the University of Maryland, Dick Wright and Bilal Ayub attended	Workshop		A4
11/6/2014	ASCE International Conference on Sustainable Infrastructure	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Conference		A2
2015	EWRI Conference	(12/3/2014 Minutes)	Conference		
2015	ASCE News Article, eLearning Webinar September 1, 2015, and circulation to ASCE staff	Initial promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (5/28/2015 minutes, FY16 Work Plan Status)	Presentation		A2
2015	COS Summit	CACC representatives attended (5/28/2015 Minutes)	Summit		A1
2015	ASCE Policy 488 on Greenhouse Gas Emissions;	CACC followed these initiatives	Legislation		
2/11/2015	NASA's Special Training Session on Climate Adaptation and Infrastructure Engineering	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Presentation		A2
5/20/2015	ASCE EWRI Conference	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (12/3/2014 Minutes, FY16 Work Plan Status)	Conference		A2
5/26/2015	Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper	http://dx.doi.org/10.1061/9780784479193	Publication		A2
6/5/2015	National Academies' Roundtable on Science and Technology for Sustainability	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Presentation		A2
6/9/2015	Sustained National Climate Assessment	ASCE provided input	Coordination		N2
7/19/2015	International Conference on Cold Regions Engineering	7/19-22/2015, (12/3/2014 Minutes)	Conference		
7/19/2015	International Conference on Cold Regions Engineering	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper"; Three out of four CACC papers involved members promoting this White Paper (12/3/2014 Minutes)	Conference		A2

Date	Title	Description	Categorization	Task Committee	Goals and Actions
7/27/2015	National Climate Assessment Network of the US Global Change Research Program	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Presentation		A2
9/23/2015	Virginia Engineers Conference	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Conference		A2
9/26/2015	ASCE Technical Region Board of Governors (TRBG)	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (5/28/2015 Minutes, FY16 Work Plan Status)	Presentation		A2
9/30/2015	Interagency Forum on Climate Change Impacts and Adaptations	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Conference		A2
10/5/2015	Civil Engineering Section of the National Academy of Engineering	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Presentation		A2
10/12/2015	ASCE National Convention	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Conference		A2
12/9/2015	ASCE-CSCE-ICE Triennial Congress	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" 12/9-10/2015 (5/28/2015 Minutes, FY16 Work Plan Status)	Conference		A2
2016	ASCE Convention	Session proposed on Forecasting Climate and Weather Extremes (FY16 Work Plan Status)	Conference		
2016	ASCE Technical Congress	Plenary session on “Grand Challenge of Designing for Adaptation to a Changing Climate: Applying the Observational Method” (building on the ASCE convention session) with an open forum for discussion with other CTA committees and divisions; Three 1.5-hour sessions on HYDEA, Energy Adaptation, and Standards Study (4/28/2016 Minutes)	Conference		
2016	U.S. Climate Resilience Toolkit	CACC agreed to provide ASCE representation in the Urban Topic Area for the U.S. Climate Resilience Toolkit (FY16 Work Plan Status)	Coordination		N2
1/7/2016	ASCE Sustainability Summit	CACC representative attended January 7-9, 2016 to ensure they include significant discussion of approaches and development of objectives for addressing uncertainties due to changing climate conditions in engineering practice (FY16 Work Plan Status)	Summit		A1
1/26/2016	Discussion on a workshop to review standards with GAO	(FY16 Work Plan Status)	Coordination		A4
2/2/2016	Discussion on a workshop to review standards with GAO	(FY16 Work Plan Status)	Coordination		A4

Date	Title	Description	Categorization	Task Committee	Goals and Actions
4/12/2016	Washington Forum of the American Meteorological Association	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper" (FY16 Work Plan Status)	Presentation		A2
6/15/2016	IRD Summit	CACC representatives attended, 6/15-16/2015 (5/28/2015 Minutes)	Summit		A1
2017	ASCE Convention	Promotion of "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper"; Three presentations on: (1) overview of white paper and observational method, (2) plan for standards study, (3) guide to available resources for climate/weather extremes. (4/28/2016 Minutes)	Conference		A2
5/30/2017	Workshop for Precipitation Under a Changing Climate	Industry and academia experts invited for presentations and discussions	Workshop	HYDEA	A1
10/26/2017	International Conference on Sustainable Infrastructure	October 26–28, 2017 COS Conference, members published Adaptive Risk Management for Future Climate/Weather Extremes proceeding.	Conference		A1
2018	Climate-Resilient Infrastructure: Adaptive Design and Risk Management MOP 140	As of Feb 2021, 582 copies sold (Hardcover/Downloads) per Jay Snyder 2/5/2021 email; ASCE publications records say 412 copies sold 1/1/2016-3/10/2021	Publication		
2018	CACC Workshop with Proceedings	Held at ASCE Headquarters	Workshop		A1
2019	ASCE	Promotion of "The Impacts of Future Weather and Climate Extremes on United States' Infrastructure: Assessing and Prioritizing Adaptation Actions Report on Future Weather and Climate Extremes"	Conference	FWCX	
2019	AGU	Promotion of "The Impacts of Future Weather and Climate Extremes on United States' Infrastructure: Assessing and Prioritizing Adaptation Actions Report on Future Weather and Climate Extremes"	Conference	FWCX	
2019	AMS	Promotion of "The Impacts of Future Weather and Climate Extremes on United States' Infrastructure: Assessing and Prioritizing Adaptation Actions Report on Future Weather and Climate Extremes"	Conference	FWCX	
2019	CACC Workshop with Proceedings	Held at ASCE Headquarters	Workshop		A1
11/22/2019	Several calls for special collections of Journal Articles	Calls included the Natural Hazard Review, the ASCE-ASME J. of Risk and Uncertainty in Engineering Systems, and a specific call for a special issue on compound floods, including the stressors (including non-stationarity) and the stressed or impacted built-human systems for Frontiers in Water	Coordination	HYDEA	A7
2020	Engineering Methods for Precipitation under a Changing Climate		Publication	HYDEA	
5/28/2020	Virtual Workshop on Compound Flooding	Industry and academia experts invited for presentations and discussions	Workshop	HYDEA	A1

Date	Title	Description	Categorization	Task Committee	Goals and Actions
2021	The Impacts of Future Weather and Climate Extremes on United States' Infrastructure: Assessing and Prioritizing Adaptation Actions Report on Future Weather and Climate Extremes	Forthcoming	Publication	FWCX	
2021	MOP on Compound Flooding	Forthcoming	Publication	HYDEA	

Civil Engineering in a Changing Climate: Level 1 Internal Audit of CACC Goals and Milestones

Introduction

This document evaluates CACC activities related to 2016/2018 committee goals and milestones. The audit is intended to provide a reference for internal assessment of CACC based on a "Level 1" first pass review of documentation for 2021 strategic planning. A more detailed chronology of CACC accomplishments is included in the associated CACC Timeline spreadsheet. Neither this document nor the CACC Timeline form an exhaustive record of CACC and CACC member achievements. Collected information is based on correspondence with Dan Walker and Jay Snyder, CACC's FY16 Work Plan Status, and select CACC meeting minutes (5/17/2011, 10/12/2012, 10/20/2013, 12/3/2014, 5/28/2015, 4/28/2016, 10/30/2019 (HYDEA)).

2016/2018 Actions — The forthcoming ASCE fiscal year will be an important opportunity for CACC to position ASCE to realize many of the goals listed above. Again, as CACC has limited resources, 2016 actions should be explicit and high impact, and include the formation of key strategic partnerships both internal and external to ASCE. Furthermore, the planning and execution of key engagement activities (i.e., meetings, symposia, or summits) undertaken in 2016 should clearly advance the work of CACC. Of particular importance are the following efforts:

A1. Co---plan and support sustainability and various summits being organized key ASCE partners (e.g., Infrastructure Resilience Division [IRD], Committee on Sustainability [COS]) to ensure they include significant discussion of approaches and development of objectives for addressing uncertainties due to changing climate conditions in engineering practice [Items 1, 2, 3, and 4]

CACC was the lead committee for the Summit on Innovative Civil Engineering Practice Addressing Climate Change, Sustainability and Resilience (12/3/2014 Minutes). This summit was intended to be a partnership of CACC with COS, ILC, and IRD, but FY2016 funding was withdrawn and FY2017 funding was adapted from the roadmap from the Sustainability Summit (FY16 Work Plan Status). The lack of additional comments in minutes or discussion implies that this summit did not occur. CACC additionally sent representatives to 2015 and 2016 COS and IRD summits and to the 2017 COS International Conference on Sustainable Infrastructure.

Independent of key ASCE Partners, CACC held workshops with proceedings at ASCE headquarters in 2018 and 2019 and the CACC HYDEA task committee held 2017 and 2020 workshops. No more recent CACC actions were noted in the minutes or identified in discussion.

A2. Develop and promote a session on White Paper at ASCE National Convention October 2015 [Items 1, 2, and 3]

Complete. The Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper is available as a free e-book on the ASCE website. The link to the book is http://dx.doi.org/10.1061/9780784479193. The e-book was released on May 26, 2015. CACC members performed significant promotion, including ASCE staff circulation, conference sessions at the 2015 ASCE National Convention and many other conferences, and presentations to various agencies.

A3. Propose and participate in one or more pilot efforts for incorporating low--- regret decision making and observational method in ASCE standards [Items 2 and 3]

This initiative was identified as an aspect of the ongoing standards study discussed with the following goal (FY16 Work Plan Status). No additional CACC actions were noted in the minutes or identified in discussion.

A4. Plan and propose Federal agency support of research to address the public policy, financial and legal issues, as well as the scientific and technical issues, involved in incorporating low---regret adaptive strategies and the observational method in regulations and in the standards upon which the regulations are based [Items 1, 2, 3, and 4]

CACC sought NSF funding for a workshop to review standards in an apparent next step measure from a 6/12-13/2014 Workshop on Measurement Science for Sustainable Construction and Manufacturing, jointly hosted by NIST, ASCE, ASME, and the University of Maryland and attended by Dick Wright and Bilal Ayub (12/3/2014 Minutes). The workshop was discussed with GAO and USGCRP in 2016, but does not seem to have occurred. Bilal remains a contact for NIST activities. No subsequent Federal agency research support planning or proposals were noted in the minutes or identified in discussion.

A5. Plan and propose, in cooperation with the American Meteorological Society or similar entities, Federal agency support of multi---disciplinary research to gain an adequate, probabilistic understanding of the magnitudes of future extremes, their effects on infrastructure systems and their economic, environmental and social consequences [Items 4, 5, 6, 7, 8 and 9]

AMS and other federal agency engagement is primarily accomplished by overlapping membership. CACC has some overlapping membership with AMS, including Rolf Olsen and others. Additional federal-level engagement includes outreach to USGCRP, National Climate Assessment Network (pre-2016), Interagency Forum on Climate Impacts and Adaptation, Transportation Research Board, and NOAA Climate Program. No specific multi-disciplinary research initiatives with these groups were noted in the minutes or identified in discussion.

A6. Recommend relevant entities within the National Academies complex take steps to educate both the scientific and engineering communities to the challenges practicing engineers face due to changing climatic conditions, and as needed, propose integrated actions to facilitate infrastructure adaptation as well as GHG mitigation. [Items 4, 5, 6, 7, 8, and 9]

National Academies representation is currently reduced (Dick Wright, etc.). National Academy funding for climate change reports were depleted without significant outcome.

A7. Discuss with selected ASCE journal editors the possibility of a special issue in each of their journals addressing CACC topics in their subfield [Items 1, 2, 3, 4, and 9]

No ASCE journal special issues were noted in the minutes or identified in discussion. CACC has generally provided encouragement and support of conference presentations and several ASCE publications without special journal issues and the HYDEA technical committee sent out several calls for special collections of journal articles in 2019.

Next Steps — CACC or its subcommittees should take steps during the balance of this fiscal year to position CACC to reach its stated goals for 2016. To achieve this, CACC members should:

N1. Aggressively engage with the following ASCE entities:

- Infrastructure Resilience Division [IRD]
- Committee on Sustainability [COS]

This step is primarily accomplished by overlapping membership. Engagement by way of overlapping membership has been fairly effective but hinges on a few key individuals. IRD engagement is currently reduced (Dick Wright, etc.). There are a few CACC members active in COS (Bilal Ayub, Bill Wallace).

N2. Formally propose to present Adapting Infrastructure and Civil Engineering Practice to a Changing Climate to the following entities:

- Technical Region Board of Governors (institutes and CTA leaders)
- U.S. Global Change Research Program [USGCRP]

ASCE provided input to the Sustained National Climate Assessment on June 9, 2015. USGCRP purchased 25 copies of MOP 140.

- National Climate Assessment Network
- Interagency Forum on Climate Change Impacts and Adaptations

Dick planned to join a workshop with the Interagency Forum on Climate Change Impacts and Adaptations and hoped to use some of their information to develop an online course for CACC (12/3/2014 Minutes).

- Transportation Research Board's First International Conference on Surface Transportation System Resilience to Climate Change and Extreme Weather Events
- NOAA's Climate Program Office

CACC held early outreach with contacts at the NOAA Climate Prediction Center to discuss Weather Models and Relationship to Climate Models (10/12/2012 Minutes). Current CACC involvement on this initiative is unknown, with no subsequent CACC actions noted in the minutes or identified in discussion.

Additional federal engagement includes 2016 involvement with the U.S. Climate Resilience Toolkit (FY16 Work Plan Status) and 2012 CACC member review of the report by the National Climate Assessment Network Affinity Group on Built Environment (10/12/12 Minutes).

Additional Efforts

Publications

CACC has now issued several notable publications. Following the 2015 Adapting Infrastructure and Civil Engineering Practice to a Changing Climate White Paper, CACC developed the 2018 Climate-Resilient Infrastructure: Adaptive Design and Risk Management MOP 140 (MOP 140). Subsequent publications were issued in 2017 (Engineering Methods for Precipitation under a Changing Climate) and are expected in 2021 (The Impacts of Future Weather and Climate Extremes on United States' Infrastructure: Assessing and Prioritizing Adaptation Actions Report on Future Weather and Climate Extremes; MOP on Compound Flooding) through HYDEA and FWCX Task Committee initiatives. As a measure of impact,

there were 456 copies of MOP 140 and the Engineering Methods for Precipitation under a Changing Climate sold between January 1, 2016 and March 10, 2021.

Publications can provide a communication platform for CACC messaging. Developing publications is one way to engage CACC members and external parties. Publications also take significant member effort. More CACC attention was directed at publications in the past several years than initially conceived in the 2016/2018 committee goals and milestones. Recent publication successes are the result.

Legislation

In 2015, CACC followed ASCE Policy 488 on Greenhouse Gas Emissions and work through Government Relations (5/28/2015 Minutes). Current relevant legislation on the Hill includes the Built to Last Act. There are current initiatives in the House and Senate to ensure that extreme weather information is available and to set standards. There may be initiative through NOAA and NIST and through FY2021 appropriations.

Conference Representation

CACC has had good representation at various ASCE and non-ASCE conferences (see CACC Timeline), attributed in part to committee meetings held at ASCE events and promotion of CACC publications.