Program Progress Performance Report for University Transportation Centers

Submitted to: Office of the Assistant Secretary for Research and Technology U.S. Department of Transportation 1200 New Jersey Avenue, SE Washington, DC 20590

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Project Title: Tier 1 University Transportation Center for Environmentally Sustainable Transportation in Cold Climates (CESTiCC)

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Report Term: Semi-annual PPPR #4

Signature: [Signature]
Abbreviations

- ALTAP – Alaska Local Technical Assistance Program
- ASCE – American Society of Civil Engineers
- ATTAP – Alaska Tribal Technical Assistance Program
- CESTiCC – Center for Environmentally Sustainable Transportation in Cold Climates
- ICOET – International Conference on Ecology and Transportation
- ISSAEST – International Symposium on Systematic Approaches to Environmentally Sustainable Transportation
- LCA – Life Cycle Assessment
- MSU – Montana State University
- NSPE – National Society of Professional Engineers
- STI – Summer Transportation Institute
- TRB – Transportation Research Board
- WSU – Washington State University
- UAF – University of Alaska Fairbanks
- USDOT – United States Department of Transportation
- UTC – University Transportation Center
1. Accomplishments

**What are the major goals and objectives of the program?**

The major goals and objectives of the CESTiCC program are to systematically engineer environmentally sustainable transportation infrastructures in cold climates, considering the entire life cycle of transportation planning, design, materials selection, construction, maintenance and operations, preservation, and recycling through the collaboration of academia, industry and other stakeholders by cross-disciplinary research, education, and technology transfer activities.

**What was accomplished under these goals?**

During the past six months of the project:

- **International Symposium on Systematic Approaches to Environmental Sustainability in Transportation (ISSAEST)**
  Nearly 100 people from all over the world gathered in Fairbanks, Alaska from August 2-5, 2015 to attend ISSAEST. The symposium provided a forum for professionals to discuss environmental challenges associated with design, construction, and maintenance of multimode transportation systems and showcase recent development, practices and advances to maximize environmental sustainability. The four-day symposium consisted of two pre-conference workshops, five keynote speeches, 45 lectern presentations, 11 poster presentations and three technical field tours. A total of 37 peer-reviewed papers on innovations and advances in sustainable pavement materials and 22 peer-reviewed papers on environmental sustainability in transportation were selected and published in ASCE special publications as two E-books.

- **Summer Transportation Institute (STI)**
  More than 30 participants from various communities, representing the federal highway administration, state transportation agencies, local village councils, tribal councils, and universities gathered for a five-day training workshop hosted by CESTiCC, the ATTAP and the ALTAP from June 8-12, 2015 in Fairbanks, Alaska. Lectures, lab tours, and field trips with various topics on transportation infrastructure in a rural and cold environment were provided free of charge to participants. Typical transportation challenges found in rural areas of Alaska and how to address these challenges were discussed such as innovative materials and design to mitigate permafrost heave, pavement preservation treatments in cold regions, gravel road design and dust control practice. Many of the participants came from rural Alaska Native villages.

- **Regular email announcements and website updates**
  A CESTiCC emailing contact list has been regularly updated. The Center announcements have been distributed through emails and then forwarded to professionals in the transportation and engineering communities by CESTiCC
partners. Activities have been posted to the website in a timely fashion as reflected by News, Webinars, and other links on the CESTiCC website.

- **Monthly webinar series**
  Starting in September 2014, CESTiCC has hosted a monthly webinar series that invites internationally recognized researchers to discuss *Environmentally Sustainable Transportation in Cold Climates*. The seminar series is free and open to all transportation professionals and engineering communities. Since the last reporting period, CESTiCC has hosted three webinars: *High Content Recycled Asphalt Pavement up to 100% Recycling; Animal Detection Systems: Reliability, Effectiveness and other Considerations for Design, Implementation and Maintenance;* and *Sustainable Construction in Remote Cold Regions: Methods and Knowledge Transfer*. Additionally, all webinars have been recorded and posted on our website.

- **E-newsletters**
  Starting in December 2014, CESTiCC has sent out E-newsletters. The newsletters give our subscribers the opportunity to see what we have been up to and any upcoming events. We have published two newsletters during the reporting period, one of which was a special issue that detailed the international symposium and summer events. Pdf files of each newsletter can be found on the CESTiCC website under Publications.

- **Research projects**
  
  **14 ongoing research projects**
  Detailed project information is available on our website at cem.uaf.edu/cesticc/research. The research progress during this reporting period is summarized as follows.

  - CESTiCC held project progress update meetings for all 14 ongoing projects in June. During the meetings, PIs presented to the CESTiCC Directors and staff, Advisory Board and other funding agencies the work completed, ongoing work, work to be completed and express any concerns or issues. All presentations were uploaded on the CESTiCC website to make it available to the public.
  - Quarterly reports have been collected and reviewed in a timely fashion to keep track of progress, accomplishments, and future goals.
  - PIs continue to conduct and disseminate research through professional meetings and other venues, and details can be found in the *products section on pages 8 -17* of the PPPR.
  - There are currently 12 modules available in the *Environmental Life Cycle Assessment learning Module Series*. The modules are in PowerPoint format with narration and will automatically play the audio and advance slides when put in presentation mode. Each module is approximately twenty minutes long. They are intended to be used for personal education, short background workshops or as components for more detailed classes.
• The Evaluation of Effectiveness and Cost-Benefits of Woolen Roadside Reclamation Products project is seeking a patent through MSU.

13 new projects to be set up
During this reporting period, CESTiCC has gone through a peer-review process to select 13 new projects. The projects will be launched in October.

• Effective communication and exchange
Meetings with state agencies, industry experts, private sectors, and other institutions were held to discuss ideas and collaborate on research, education, workforce development, and outreach activities. For two weeks in June, CESTiCC held project progress update meetings for all ongoing research projects.

• Sponsorship
CESTiCC sponsored a number of events during this reporting period to promote the UTC program. The center sponsored the eighth annual Imagine Tomorrow problem-solving energy competition for grades 9-12, which encourages high school students to seek new ways to support the transition to alternative energy sources. CESTiCC sponsored the International Conference on Ecology and Transportation, which seeks to address an array of ecological issues related to transportation systems. CESTiCC sponsored the Transportation Research Congress (TRC) Inaugural Meeting, which serves as a global platform for researchers, educators, practicing engineers, investors, entrepreneurs, and governmental officials in China. Lastly, CESTiCC is sponsoring the 2016 International Conference on Transportation Infrastructure and Material in Xian, China.

• Outreach and technology transfer
CESTiCC has actively participated in various outreach activities and technology transfer to promote environmental sustainability in transportation. Please see details in what opportunities for training and professional development on page 5, how have the results been disseminated section on pages 6 – 8 and the impact section on pages 18-20.

What opportunities for training and professional development has the program provided?

• CESTiCC is hosting three visiting professors (Drs. Rongtao Yan, Zhibing Wang, and Zhaotian Zeng) from Guilin University of Technology, Guilin, China. They are working with Dr. Xiong Zhang’s group on research topics on modeling and monitoring soil behavior for environmental considerations.
• International Symposium on Systematic Approaches to Environmentally Sustainability in Transportation, Hosted by CESTiCC, August 1 – 5, 2015.
• Summer Transportation Institute for high school students, Montana State University, June 15-26, 2015.
• Summer Transportation Institute, Hosted by CESTiCC, the ATTAP, and the ALTAP, June 8 – 12, 2015.
• M. Zaumanis, and N. Sefidmazgi, High Content Recycled Asphalt Pavement up to 100% Recycling, CESTiCC webinar series, April 7, 2015.

How have the results been disseminated? If so, in what way? (Please provide links or examples for website use.)

CESTiCC staff and researchers have been actively involved in various professional meetings and outreach activities to promote the UTC program, enhance public understanding, and increase interest in learning and transportation careers.

Research
• CESTiCC Program Progress Update Meeting, June 16 – 26, 2015
For two weeks in June, CESTiCC held project progress update meetings for all ongoing projects. This gave the PI a chance to update everyone on the status of his/her project. Each PI created a PowerPoint presentation showing work completed (progress so far with some results/products), ongoing work, work to be completed, and any concerns/issues. CESTiCC Directors, the Advisory Board, and other funding agencies also joined the program progress update meetings. To make this information widely available to the public, we uploaded each PowerPoint presentation to our website and the PowerPoint presentation with audio.

• USDOT UTC Spotlight Newsletter, April 2015
CESTiCC’s research on bio-based renewable additives for sustainable roadway snow and ice control operations was featured in the USDOT UTC Spotlight newsletter. The USDOT wrote an extensive article that highlighted Dr. Xianming Shi’s innovative research on environmentally friendly available anti-icing formulations for snow and ice control on highways as one of CESTiCC’s accomplishments as a UTC.

• Research information through RiP, website, quarterly reports, and Gotomeetings
Research project information was available at the TRB’s Research in Progress (RiP) database and the Center’s website. Research progress was updated to funding agencies through quarterly reports and Gotomeetings.

Professional Meetings
During this reporting period CESTiCC members have given numerous presentations and invited talks at various professional venues all over world such as:
2. Council of University Transportation Centers Summer Meeting. New Brunswick, New Jersey
3. TRB Committee ADC60 Summer Workshop: Sustainability in a Time of Resource Scarcity. Los Angeles, California
4. Wuhan Polytechnic University; Institute of Rock and Soil Mechanics; Chinese Academy of Sciences; Beijing Jiaotong University; Chinese Academy of Railway Sciences; Beihang University; and National Center for Materials Service Safety
6. Wuhan Polytechnic University, Wuhan; and Chinese Academy of Transportation Sciences. Beijing, China
8. Zhejiang University. Hangzhou, China
9. Northwest International Air Quality Environmental Science and Technology Consortium. Portland, Oregon
12. Harbin Institute of Technology. Harbin, China
13. Harris County Flood Control District. Houston, Texas

For more details please review the product section found on page 8 – 17.

Outreach

- **Tanana Valley (Fairbanks) State Fair, August 11, 2015**
  CESTiCC participated in the Tanana Valley State Fair’s first UAF day. Different units from the university brought hands-on demonstrations, and interactive activities to showcase their work. CESTiCC’s table included a hot wheels exhibit to demonstrate the fundamentals of geometric and road design transportation engineering. Additionally, participants were able to see the ingredients that make up a road and asphalt concrete specimens brought in from the lab.

- **Alaska Native Student Wisdom Enrichment Retreat (ANSWER) Camp Students visit CESTiCC, June 19, 2015**
  Forty-five 7th graders visited CESTiCC to learn about transportation engineering. The ANSWER Camp participants came from nearly 25 different villages around Alaska. ANSWER Camp is funded by a U.S. Department of Education grant and provides intensive science, math, and cultural experiences to students. Students first listened to a presentation given by CESTiCC director Dr. Jenny Liu that addressed common transportation challenges found in cold climates. The students then had the chance to explore a real asphalt lab and continue their discussion on Alaska transportation issues.
• **Imagine Tomorrow, May 29-31, 2015**  
Imagine Tomorrow challenges 9th through 12th graders to seek new ways to support the transition to alternative energy sources. The students research complex topics related to renewable energy, innovate technologies, designs, or plans to mobilize behavior. CESTiCC Associate Director Liv Haselbach planned and oversaw all judging activities for the May 2015 competition. Additionally, CESTiCC sponsored this outreach event.

• **Kids2College, April 15th, 2015**  
Elementary school students from Fairbanks, Salcha, Delta, and Tok area came to UAF to experience a day in the life of a college student. CESTiCC Research Associate Dr. Sheng Zhao presented on what transportation engineers do and CESTiCC undergraduate student Paul Eckman gave a lab tour to all 23 students. It was a great opportunity to share with students the many positive impacts civil engineers can have in the world.

**What do you plan to do during the next reporting period to accomplish the goals and objectives?**

We will follow the implementation plan to ensure that all the CESTiCC funded research, education, and outreach activities move forward as scheduled.

- CESTiCC will be wrapping up most of year 1 projects, which will result in final reports and project close-up meetings.
- CESTiCC will complete year 2 project selection and all year 2 projects will be set up at the beginning of the next reporting period.
- CESTiCC will initiate meetings with interested parties to solicit proposals for year 3 research projects and begin the peer-review process.
- CESTiCC researchers will continue to get students involved in research and disseminate results timely.
- CESTiCC will continue monthly webinar series by working with various partners. The seminar series will be open to all transportation professionals and presentations will be posted on the Center’s website after the seminar.
- CESTiCC will continue to participate in various activities on outreach, technology transfer and other activities to publicize the Center.
- The website will continue to be updated with news, products and research. We will also continue producing our E-newsletter, which will then be posted on our website in pdf format.

2. **Products**

*Publications, conference papers, presentations, websites, lectures, seminars, workshops, invited talks*

*Publications*
• Books

• Journal Publications


• **Reports**


• **Special Publications**


N. Xie, A. Muthumani, Y. Dang, and X. Shi, *Deicer Impacts on Concrete Bridge Decks: A Comparative Study of Field Cores from Potassium Acetate and Sodium Chloride Environments*, ASCE Construction Institute Special Publication on Innovative Materials and Design for Sustainable Transportation Infrastructure, Edited by S. Zhao et al., 42-57, 2015.


• L. Li, and X. Zhang, *Accuracy and Sensitivity Analyses on the Photogrammetry-Based Deformation Measurement Method*, ASCE Construction Institute Special Publication on Innovative Materials and Design for Sustainable Transportation Infrastructure, Edited by S. Zhao et al., 222-228, 2015.


• Conference papers


Presentations


- L. Li, Use of an Oedometer Equipped with High Suction Tensiometer to Characterize Unsaturated Soils, ISSAEST, August 3, 2015.


- A. Muthumani, and X. Shi, Corrosion of Bare Metals Affected by Exposure to 25% Magnesium Chloride Solution and Tensile Stress: Field and Lab Studies. Poster Presentation, ISSAEST, August 3, 215.

• N. Cui, and X. Shi, Improved user Experience and Scientific Understanding of Anti-icing and Pre-wetting for Winter Roadway Maintenance in North America, Poster Presentation, ISSAEST, August 3, 2015.
• N. Cui, L. Fay, and X. Shi, Review of Toxicological Effects of Chloride Based Deicers: Impacted Environments and Assessment Methods, Poster Presentation, ISSAEST, August 3, 2015.
• N. Xie, and X. Shi, Life-cycle Performance Determination of Concrete Bridge Decks with Exposure to Aggressive Environment via a New Risk Rating Method, ISSAEST, August 4, 2015.
• L. Li, A Photogrammetry-Based Method to Measure Unsaturated Soil Deformation during Triaxial Testing, ISSAEST, August 4, 2015.
• L. Haselbach, Modified Media Filter Drain Mix with Alternate Aggregate Grading, ISSAEST, August 5, 2015.
• N. Xie, A. Muthumani, Y. Dang, and X. Shi, Deicer Impacts on Concrete Bridge Decks: a Comparative Study of Field Cores from Potassium Acetate and Sodium Chloride Environments, ISSAEST, August 5, 2015.
• X. Zhang, Use of Wicking Fabric to Dehydrate Road Embankment under Unsaturated Conditions, Chinese Academy of Sciences, Beijing Jiaotong University, China, June 2015.
• X. Zhang, Limitations of Suction Controlled Triaxial Tests in the Characterization of Unsaturated Soils, National Center for Materials Service Safety, China, June 2015.
• L. Fay, Best Practices for Winter Road Maintenance, TRB ADC60 Summer Workshop, Los Angeles, California, June 2015.
• X. Zhang, Modeling Residential Buildings on Expansive Soils in Response to Climatic Conditions, Wuhan Polytechnic University, Institute of Rock and Soil Mechanics, China, June 2015.
• S. Chung, *Cold Start Emissions from Vehicles*, International Air Quality Environmental Science and Technology Consortium, June 24-26, 2015.


• L. Haselbach, *Introduction to Low Impact Development and Pervious Concrete*, Environmental Engineering Undergraduate Class at University of Sao Paulo, June 19, 2015.

• L. Haselbach, *Pervious Concrete Design and Testing*, University of Sao Paulo, June 16, 2015.


• L. Haselbach, *Advances in Pervious Concrete*, Federal University of Santa Maria, Santa Maria, Brazil, April 17, 2015.


• **Other Products**


  • *Bio-Based Renewable Additives for Sustainable Roadway Snow and Ice Control Operations*, USDOT April Newsletter, Published April 2015.


• Life Cycle Assessment modules on CESTiCC website or drafted
  ▪ Module α6 – Environmental Product Declarations
  ▪ Module τ1 - Functional Units in Transportation LCA
  ▪ Module β1 – Global Warming Potential
  ▪ Module β2 - Acidification
  ▪ Module β3 – Ozone Depletion
  ▪ Module β4 - Smog
- Module β5 - Eutrophication
- Module β6 – Human Toxicity and Ecotoxicity
- Module β7 – Particulates
- Module α3 - Life Cycle Stages (April 2015)
- Module α4 - LCIA Optional Elements: Grouping, Weighing, Normalization (April 2015)
- Module B1 - Introduction to Impact Categories (April 2015)
- Module B3 - Other Common Emissions Impact Categories (March 2015)
- Module G2- General Free LCA Software Tools (March 2015)
- Module G3 - Transportation LCA Software Tools (March 2015)

- Websites
  - CESTiCC Website: http://ine.uaf.edu/cesticc/
  - CESTiCC Facebook Page: https://www.facebook.com/cesticc
  - Summer Transportation Institute: http://tribalmgmt.uaf.edu/akttap/Training/STI-2015
  - International Symposium on Systematic Approaches to Environmental Sustainability in Transportation: http://cem.uaf.edu/cesticc/symposium.aspx

- Lectures/Seminars/Workshops/Invited Talks
  - Workshop. L. Haselbach, Pathways to Entrepreneurship, Spokane, Washington, August 2015.
  - Invited Talk. X. Shi, Materials Research Related to Sustainable Concrete Pavements, 9th International Conference on Road and Airfield Pavement Technology (ICPT), Dalian, Liaoning, China, August 11, 2015.
• **Workshop.** J. Liu, B. McHattie, and A. Mullin, Pavement Preservation in Cold Regions, STI, Fairbanks, Alaska, June 8-12, 2015.


• **Workshop.** L. Haselbach, *Low Impact Development, Pervious Concrete Design, and Environmental Studies on Concrete*, Universidade Estadual de Campinas.

• **Workshop.** Q. Langfitt attended a one month long workshop in India as part of the *Indo-US Excellence Center for Design of Sustainable Products, Services and Manufacturing Systems*, June 2015.

3. **Participants & Collaborating Organizations**

What organizations have been involved as partners?

- Collaborative research and financial support
  Fourteen research projects were selected and funded by CESTiCC and the following agencies:
  - Alaska Department of Transportation and Public Facilities
  - Brookside Woolen Mill
  - Clear Roads Pooled Fund
  - Film Department, University of Alaska Fairbanks
  - Midwest Industrial Supply, Inc., Canton, OH
  - Minnesota Department of Transportation
  - Montana Department of Transportation
  - Nevada Department of Transportation
  - PacTrans
  - Ramy Turf Products, LLC
  - Sugerloaf Wool Mill
  - TenCate Geosynthetics
  - University of Tennessee Knoxville
  - University of Waterloo, Canada
  - Washington State Ferries
  - Washington State Department of Ecology

Have other collaborators or contacts been involved?

- Alaskans for Litter Prevention and Recycling (ALPAR)
- ALTAP
- American Concrete Institute Alaska Chapter
- Apun LLC, Anchorage, AK
- ASCE
- ASCE Construction Institute
- ASCE Fairbanks Chapter
- ATTAP
- Central Environmental Inc.
- Chinese Academy of Engineering
Chinese Society of Civil Engineering
Emulsion Products
Environmental UTCs Network
- CESTiCC
- Electric Vehicle Transportation Center
- National Center for Sustainable Transportation
- Marine Engine Testing and Emissions Laboratory
- Mid-Atlantic Transportation Sustainability (MATS) Center
Fairbanks KIAK 102.5 FM and KFBX AM 970
Frontiers of Structural and Civil Engineering
Infrastructure & Climate Network (ICNet)
Insulfoam
International Association of Chinese Infrastructure Professionals
Louisiana Transportation Research Center
NSPE Alaska Chapter
PacTrans
PDC Inc. Engineers
Shanghai Tongyan Technology of Civil Engineering Co., Ltd
Tongji University
TRB
University of Kansas
University of Tennessee Knoxville
Wuhan Polytechnic University

4. Impact

What is the impact on the development of the principal discipline(s) of the program?

Through our research, CESTiCC has made impacts in the areas of advancing innovative sustainable materials and design, managing stormwater runoff, reducing environmental impacts during construction, operations and preservation, and improving the sustainability and conservation of ecosystems to maximize environmental sustainability in transportation. A few examples are highlighted as follows.

Using reclaimed asphalt pavement (RAP) diverts material from the waste stream and preserves virgin aggregate resources. Cost savings can be achieved if RAP material is incorporated in new or rehabilitation pavement projects provided it is properly designed, produced, and placed. Representative and accurate mix properties will enable pavement designers to perform more reliable value engineering and life-cycle cost analyses. CESTiCC aims to properly characterize these HMA mixes through its research on the Characterization of Alaskan Hot-Mix Asphalt Containing RAP. The outcome and results can be used for pavement performance predictions and comparisons, and mechanistic empirical pavement procedures.

The LCA process is now internationally recognized for cradle to gate/grave/cradle assessment of environmental and resource impacts of a product, process or constructed element. In the project entitled Transportation LCA Synthesis, CESTiCC Associate Director Liv Haselbach and PhD student Quinn Langfitt have been developing
modules in the LCA Learning Module that are intended for personal education, short background workshops or as components for more detailed classes. There are 12 modules in four groups currently available on our website.

Another CESTiCC project, Bio-based Renewable Additives for Anti-Icing Applications, is developing liquid anti-icing formulations for snow and ice control on roadways, using beet sugar refining by-products, glycerol, and other additives available for performance enhancement and corrosion inhibition. Relative to deicing and sanding, anti-icing leads to improved levels of service, reduced needs for chemicals, and associated cost savings and safety mobility benefits. This research has been highlighted all over the nation by prominent news agencies such as NPR, Los Angeles Times, CBS News, Vox, Washington Times, USA Today, Scientific American, Discovery Magazine and TIME.

**Other Disciplines**

In addition to the intellectual merits in the transportation field, CESTiCC research, through several cross-disciplinary projects, is also expected to generate impact on other disciplines. For example, the Optimal Highway Durability in Cold Regions project is conducting economic analysis to the highway durability problem. The quantitative results will be useful for designing optimal highway pavement and winter maintenance strategies.

**What is the impact on the development of transportation workforce development?**

CESTiCC has impacted the development of the transportation workforce through many means, but most notably through ISSAEST and STI. This summer, CESTiCC hosted the International Symposium on Systematic Approaches to Environmental Sustainability. The event drew over 100 attendees from all over the world. The symposium provided a forum for professionals to discuss environmental challenges associated with design, construction, and maintenance of multimode transportation systems and showcase recent development, practices and advances to maximize environmental sustainability. CESTiCC also co-hosted STI, which focused on transportation challenges found in rural Alaska and how to address these challenges. CESTiCC staff have given thirty-nine presentations at professional meetings and hosted numerous workshops during this reporting period.

Additionally, we have continued to contribute to the development of the future transportation workforce through educational events. For example, during this reporting period we hosted ANSWER Camp students from remote villages in Alaska to expose them to the civil engineering field.

**What is the impact on physical, institutional, and information resources at the university or other partner institutions?**

CESTiCC currently has 14 ongoing research projects. While they are not yet completed, the projects have already produced innovative and valuable results, which can be used as physical, institutional, and information resources at universities and our partner institutions. For example, as mentioned earlier, the Transportation LCA Synthesis project has produced 12 modules that can be used for educational purposes and has led to the launch of a three credit graduate course at WSU entitled CE507.
Sustainability: Life Cycle Assessment, in addition to a completed one credit course at Universidade Federal do Rio Grande do Sul in Porto Alegre, Brazil. In addition, CESTiCC researchers have been very active in research disseminations, collaboration, and exchange through numerous professional occasions. For example, CESTiCC is hosting three visiting professors from Guilin University of Technology, Guilin, China. CESTiCC also hosted visitors from China Communications Construction Company (CCCC) LTD. Drs. Xiong Zhang and Xianming Shi were invited to give many talks in various universities in China. All of these institutions or industry companies expressed strong interests in further collaboration with CESTiCC. Through various outreach, technology transfer, and workforce development activities, CESTiCC has provided information and resources on environmental sustainability in transportation to professional societies, K-12 students, and the public community.

- **What is the impact on technology transfer?**
  CESTiCC is actively engaging the public with its research through various modes such as E-books, free monthly webinars, presentations, seminars, workshops, and symposiums as mentioned in earlier sections. For example, during this reporting period, CESTiCC has published five books, 16 journal publications, 20 special publications, nine conference papers, and hosted three webinars. The center also updates the CESTiCC website in a timely manner with news, publications, webinar announcements and current research information.

  CESTiCC strives to make its research accessible to the public. As an example, we held program progress update meetings with all PIs. Each presentation was recorded and uploaded to our website for the advisory board, funding agencies, CESTiCC staff, and interested personnel to review.

- **What is the impact on society beyond science and technology?**
  CESTiCC has made it a center priority to go beyond science and technology by continuously participating in educational outreach opportunities, specifically with K-12 ages. CESTiCC has hosted numerous student groups, camps, and classes to expose them to the positive impacts civil engineers can have in the world. For instance, CESTiCC Associate Director Liv Haselbach has actively participated in the Imagine Tomorrow competition. This event allows 9th through 12th graders to respond to the renewable energy crisis by answering any of the four challenges the competition presents. Students and teacher collaborate to make a difference in the challenge of energy production in the 21st Century. This event exposes high school students to higher education, STEM disciplines, renewable energy issues, and fosters community building.

5. **Changes**
   Nothing to Report