

**EXAMINING THE EFFECTS OF EXTREME HEAT
AND WEATHER ON TRANSPORTATION**

HEARING

BEFORE THE

**COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS**

UNITED STATES SENATE

ONE HUNDRED EIGHTEENTH CONGRESS

FIRST SESSION

SEPTEMBER 13, 2023

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COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED EIGHTEENTH CONGRESS

FIRST SESSION

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EXAMINING THE EFFECTS OF EXTREME HEAT AND WEATHER ON TRANSPORTATION

WEDNESDAY, SEPTEMBER 13, 2023

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The Committee met, pursuant to notice, at 10:03 a.m. in room 406, Dirksen Senate Office Building, Hon. Thomas R. Carper (Chairman of the Committee) presiding.

Present: Senators Carper, Capito, Fetterman, and Mullin.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Good morning, everybody. I welcome our witnesses.

I was just joking with the Ranking Member, she starts her morning with a distinguished panel, and I understand she has dinner tonight, maybe, with Lady Gaga. So you are the opening act, how is that? We will see how that goes.

[Laughter.]

Senator CARPER. One of my all time favorite pictures is the picture of Tony Bennett, who died not long ago, there was a great shot of him a couple of years with Lady Gaga. And I thought, I want to grow up and be just like Tony Bennett. You have that chance.

All right. Good morning, everybody. I call this hearing to order.

Today's hearing comes at a time when the topic of extreme heat is top of mind for literally millions of Americans. Just last week, Washington, DC, our Nation's capital, where we gather today, experienced its hottest day on record. Temperatures reached 99 degrees with a heat index between 100 and 105 degrees.

That record followed a summer of sweltering heat waves across large parts of our country. For example, Phoenix, Arizona, home to one of our witnesses today, saw temperatures of 110 degrees or hotter every day from June 30th to July 30th. I am going to say that again. When I read it, I didn't believe it. But Phoenix, Arizona, home to one of our witnesses today, saw temperatures of 110 degrees or hotter every day from June 30th to July 30th, and even hotter days in August.

In fact, this summer was our planet's hottest on record, according to data from the European Union Climate Change Service.

Extreme heat contributes to dry conditions that make areas more susceptible to wildfires that burn out of control. Just last month, our Nation witnessed the heartbreaking loss of lives, homes, and businesses due to the unprecedented wildfires in Hawaii. For years

we have seen the same thing happen across western States including California and Oregon and others.

Wildfires can have wide ranging impacts on transportation, from road closures and travel disruptions due to excessive smoke, to the weakening of highways and bridge structures from the heat generated by those fires.

These are not unrelated or isolated events. Extreme heat also means warmer oceans, which lead to stronger and more destructive hurricanes. Currently, we are in the middle of an active hurricane season that has already resulted in damaging storms that have unleashed wind, rain, and storm surges in Florida, in the Southeast, and on the West Coast.

In my own State of Delaware, coastal storms and flooding have resulted in the closure of parts of State Route 1, the major north-south highway in our State, which links communities along our East Coast.

The frequency, intensity, and duration of more intense heat waves, wildfires, and extreme weather across the United States have only gotten worse in recent years due in large part to human caused climate change. In turn, this has put our Nation's transportation infrastructure, our work force, and our travelers at a greater risk of harm.

Extreme heat can impact our transportation infrastructure in many ways. For example, when temperatures reach triple digits, roadways can buckle, resulting in costly damage that disrupts travel and leads to unsafe road conditions. In fact, it is estimated that the additional road maintenance and replacement costs caused by extreme heat could reach a total cost of \$26 billion nationwide by 2040.

And it is not just roads and highway infrastructure that experience the effects of extreme heat. High temperatures can cause rail tracks to shift, delaying or slowing rail service, something that as a frequent rider on Amtrak between DC and Delaware I have experienced just in the last week. Last summer, a commuter train in the San Francisco Bay area derailed when the temperature of the tracks exceeded 140 degrees.

When talking about extreme heat, we can't forget that heat's effect on transportation infrastructure directly impacts the people who use it as well as those who build and maintain it.

We know that rising temperatures have serious implications for our health. Thousands of people in the United States are hospitalized each year due to heat. Many of these hospitalizations are workers who are exposed to dangerously high temperatures on the job.

Today, we will hear about the impacts that urban heat islands have on the people who live in cities, including many who live in low income and disadvantaged communities. We will also hear about the hazards faced by our transportation construction work force, whose jobs require them to be outside, building and repairing our roads, highways, and our bridges even when temperatures soar to record highs.

In the years ahead, extreme heat will continue to threaten our infrastructure and our public health, even as we work to transition toward a clean energy future. Fortunately, solutions are available

to help transportation agencies better address the effects of extreme heat. Cities like Phoenix, Arizona, and Los Angeles, California, are turning to innovative materials, including cooler pavements, which give off less heat than traditional pavement.

Communities are also deploying strategies to reduce the urban heat island effect by planting more tree cover to help cool sidewalks and transit stops and reduce the overall heat intensity in dense, highly paved places. In Delaware, we have already planted 80,000 trees since the launching of a program initiative called the Tree for Every Delawarean Initiative. We launched that, I think, in 2020.

I am proud that our Committee has taken a leadership role in implementing policies to address extreme heat and weather at the Federal level. In the Bipartisan Infrastructure Law and the Inflation Reduction Act, we created new programs including the Healthy Streets Program, the PROTECT program, and the Neighborhood Access and Equity Program to help States and local governments better address this challenge.

With that, my hope is that today's hearing will help to further our Committee's understanding of the nexus between extreme heat and transportation. I also hope that our hearing today will bring greater awareness to the work that is being done across our country to address this increasingly urgent problem.

Today, we are privileged to be joined by a panel of three witnesses who will testify about the many ways in which cities, the labor force, and the private sector are working, and in many ways working together, to make our communities more resilient to extreme heat and weather events.

I would say, just before introducing our Ranking Member, Senator Capito, when we talk about issues like these, extreme weather and extreme weather events, I am a guy who always looks for opportunity in adversity. That opportunity would include the creation of jobs, good paying jobs. That would be part of, as we address these issues today, I am always looking for that: How do we create a more nurturing environment for job creation, and then in all this adversity, and there is a lot of it now around the planet, how do we somehow grasp and create some economic opportunity for people to work?

With that, I am delighted to be sitting next to Senator Capito, as I do often, and to turn this over to her.

Senator Capito.

**OPENING STATEMENT OF HON. SHELLEY MOORE CAPITO,
U.S. SENATOR FROM THE STATE OF WEST VIRGINIA**

Senator CAPITO. Thank you, Mr. Chairman. Thank you for calling today's hearing and for your ongoing commitment to bipartisanship in the Committee's business.

I also want to give a warm welcome to our Committee witnesses, and I understand one of my fellow native West Virginians, Mr. Parsons, who is from Fort Ashby, West Virginia. Thank you for taking the time to share your expertise with us today.

If we look back at the first 8 months of 2023 our country has confronted several types of disasters. We have seen catastrophic floods in California and Vermont, tornadoes in Arkansas and Mississippi,

violent hailstorms in Texas, a hurricane that made landfall in Florida, flash floods in my home State of West Virginia, and those horrible, massive fires in Hawaii.

The consequences of extreme weather are felt in both urban and rural communities year round. With the many challenges that our States face in improving their transportation infrastructure, I am very proud of this Committee's bipartisan work to provide them with the funding they need to address these challenges in the IIJA. And as with varied extreme weather events show, there is not a one size fits all approach to addressing infrastructure and resiliency.

As my colleagues have heard me say many times, maintaining flexibility within the Federal Aid Highway Program is absolutely crucial to ensuring that States can tackle their own unique transportation needs head on. I am pleased that the programs and policies we established in the IIJA have adhered to this principle. So, as we continue with the oversight of the implementation of the IIJA, I will work to ensure that States retain that flexibility provided to them within the law.

One of the IIJA's new programs that is especially relevant to today's hearing is the Promoting Resilient Operations for Transformative, Efficient, and Cost Saving Transportation, or the PROTECT program. As the acronym suggests, this program provides a renewed focus on improving the resiliency of our transportation infrastructure to withstand extreme weather.

Specifically, it gives formula funding to all States and directs the Secretary of Transportation to also award competitive grants to eligible entities. The funding can be used to carry out planning activities, build evacuation routes, and reinforce existing highways and bridges, among other eligible uses.

The program is important because it is a new tool we have to ensure we are preparing for the future, and not just responding to the aftermath of extreme weather. To do otherwise would be a failure in our stewardship of Federal taxpayer dollars, and could delay timely disaster response and recovery efforts.

I noted earlier that the PROTECT program places a renewed focus on resiliency. That is because resiliency is not a new consideration for States and other non-Federal partners as they design and construct highways and bridges to best serve our citizens. Infrastructure owners were already incorporating resiliency into asset management strategies, planning documents, and project development. I am glad to see that the work that we did in the IIJA is furthering these efforts.

As we were developing the IIJA, one of my other policy priorities was improving the environmental review and permitting process. I am pleased that we were successful in this area. The IIJA included a robust set of provisions to make this process more efficient, without sacrificing environmental protections, and included codifying the One Federal Decision policy for surface transportation projects.

Our ability to prepare for, respond to, and recover from extreme weather is directly related to whether States can get their projects through the morass of the Federal environmental review process, and secure the necessary permitting approvals. Faced with challenges like extreme weather, we cannot afford to have a process

that adds years to project timelines, and drives up costs, especially given the current inflationary environment. This issue continues to be an area of focus for me.

I was pleased to see that further improvements to the project delivery process were included in the Fiscal Responsibility Act. However, I am troubled that the Administration is not faithfully implementing that law, and instead seems intent on adding more hurdles to infrastructure permitting.

Recently, the CEQ proposed phase two of its NEPA implementing regulations, which they advertise as implementing the Fiscal Responsibility Act provisions. But additional changes in that proposal, which have no textual basis in the Fiscal Responsibility Act, seek to transform environmental reviews from information gathering processes into tools that slow projects that the Administration does not support, and many times they don't support because of political reasons.

The Administration is proposing to layer on political bias and favor certain types of projects at the expense of others. I hope that the Administration corrects course on these issues based on stakeholder feedback, and adheres to the FRA's plain text.

I look forward to hearing from our witnesses today about the on the ground efforts to address the effects of extreme weather on our transportation infrastructure.

I thank the Chairman again, and I yield back my time.

Senator CARPER. Thank you, Senator Capito.

I think next I am going to take a minute to introduce each of our witnesses, then we will lead off with David Hondula.

Has anybody ever mispronounced your name, Mr. Hondula? Never?

[Laughter.]

Senator CARPER. All right, we will try not to do that today.

Our lead off witness today is Dr. David Hondula, who is the Director of the Office of Heat Response and Mitigation for the city of Phoenix, Arizona.

Have you always lived in Arizona?

Mr. HONDULA. Ten years, Senator.

Senator CARPER. OK.

In his current role, Dr. Hondula helps coordinate and implement programs to protect people from dangerous summer heat and improve their quality of life. He is a member of the American Meteorological Society of Board of Environment and Health, a faculty member at ASU.

My wife is a graduate of ASU, Appalachian State University.

[Laughter.]

Senator CARPER. The other ASU. But anyway, Dr. Hondula is a member of the American Meteorological Society's Board of Environment and Health, and faculty member of ASU School of Geographical Sciences and Urban Planning. Dr. Hondula also has authored more than 90 peer reviewed articles, book chapters, and technical reports related to extreme heat and public health and urban climatology. He earned a Ph.D. in environmental sciences from the University of Virginia in 2013.

Where did you grow up?

Mr. HONDULA. In New Jersey, Senator.

Senator CARPER. All right.

Next, we are going to hear from Travis Parsons, who is the Director of Occupational Safety and Health for the Laborers' Health and Safety Fund of North America. Mr. Parsons has over 25 years of experience working in safety, and has worked at the Laborers' Health and Safety Fund of North American since 2002, is that right?

Mr. PARSONS. Yes, sir.

Senator CARPER. All right.

In addition to his work for the Laborers, he is Vice President for the Labor Division of the National Safety Council, where he sits on the board of directors among other leadership positions. Mr. Parsons is a native of West Virginia.

Tell us where you were born.

Mr. PARSONS. A little small town called Fort Ashby, West Virginia, over in the eastern panhandle.

Senator CARPER. All right. I know you have heard of that, more than a few times, probably been there more than a few times.

Senator CAPITO. Yes.

Senator CARPER. A native of West Virginia, graduate of West Virginia University, who played Penn State in football a week or two ago, right?

Mr. PARSONS. Ouch.

[Laughter.]

Senator CARPER. And the next week, Penn State played the University of Delaware. Really big ouch.

Mr. PARSON. Yes, and we actually played three Pennsylvania teams in a row. We played Duquesne last week, and we play Pitt this coming weekend.

Senator CARPER. We have Duquesne coming to Delaware for a match in a week or so. As I told the President of the University of Delaware, don't schedule Penn State. Once is enough.

[Laughter.]

Senator CARPER. Mr. Parsons, football aside, we are delighted that you are here today.

Last but not least, we will hear from Dr. Aimee Flannery, who is Global Principal for Transportation Risk and Resilience, at Jacobs, Solutions and Technologies. Dr. Flannery has an extensive background in researching, developing, and implementing projects and policies to improve the resilience of our Nation's transportation infrastructure. Previously, she has held positions at the U.S. Department of Transportation, the Applied Engineering Management Corporation, and for a time was an associate professor at George Mason University, not too far from here.

Dr. Flannery earned her Ph.D. in civil engineering from Penn State.

[Laughter.]

Ms. FLANNERY. Apparently, the infamous Penn State.

[Laughter.]

Senator CARPER. We are glad to see her. I understand she is the mother of at least one daughter, who is sitting over her left shoulder.

We are watching your daughter to see if her lips move when you speak.

We welcome all of you. We thank each of you for your willingness to testify before our Committee today. We are now pleased to hear your testimony, starting with Dr. Hondula.

Dr. Hondula, you are recognized for 5 minutes. Take it away.

STATEMENT OF DAVID HONDULA, PH.D., DIRECTOR, OFFICE OF HEAT RESPONSE AND MITIGATION, CITY OF PHOENIX, PHOENIX, ARIZONA

Mr. HONDULA. Thank you, Mr. Chairman, and good morning, Senators.

Thank you, Mr. Chairman and Ranking Member Capito and Senator Kelly for the invitation to join you today. It is an honor to be here with my fellow witnesses to share what we are learning about how to manage and mitigate heat in the hottest large city in the country, Phoenix, Arizona.

As the Chairman noted, this summer has been an especially challenging one for us. We set a new record with 55 days total of those temperatures of 110 degrees or higher.

All across the country, local governments like ours have begun to recognize that there are serious deficiencies in planning for, mitigating, and managing extreme heat. In an effort to address this gap, the city of Phoenix launched the Nation's first publicly funded local government office focused on heat, the Office of Heat Response and Mitigation that I am proud to lead.

Our new office works with many local partners to coordinate and improve programs that help protect people from the dangers of heat and ensure that our cities and communities are cooler, safer, and more comfortable. Improving our cities' resilience to extreme heat requires that we engage across all levels of government and across all sectors of society, and it requires us to significantly invest in communities that have been historically underserved. These are communities that have older transportation assets that are more likely to be strained by the heat, communities where people have fewer transportation options, and often must walk in the heat. And these are communities that simply have fewer trees and less shade, places we might call shade deserts.

I would like to share some examples from Phoenix that highlight how we are working to address heat challenges in the transportation sector. You might be aware, Senators, that the transportation sector contributes to making our cities hotter for several reasons. One of those reasons is that the transportation sector uses a lot of land. Pavement accounts for more than 30 percent of the land area of Phoenix, and pavement is a significant contributor to urban heat, due to its low reflectivity of solar energy.

The city of Phoenix is a national leader in the testing and implementation of technologies that alter that reflectivity, the reflectivity of the road surfaces, through our Cool Pavement Program. This program has now reached more than 100 miles of city streets that have received a light gray solar reflective coating.

The city and Arizona State University have been collaborating to produce an independent, rigorous, and open evaluation of the Cool Pavement Program. We have found that the coating is highly effective at reducing the road surface temperature, the temperature you

would feel if you put your hand directly on it. That temperature has been reduced by up to 12 degrees Fahrenheit.

With this reduction, the underlying asphalt itself experiences less thermal strain. So the coating may reduce long term asphalt maintenance needs and costs.

We also need to think critically about how heat impacts the experience of our transportation users. Residents tell us all the time that heat impacts decisions they make about where they will go and how they will get there. And these decisions of course in turn impact commerce, labor, education, health care access, and so much more.

Phoenix is accelerating its investments to make more shade available for transportation users. One investment is called our Cool Corridors Initiative, through which we are striving to achieve 200 miles in the city with at least 60 percent shade coverage for pedestrians.

Phoenix is continuing to closely monitor all Federal funding opportunities to scale up and accelerate our ability to address heat through the transportation sector. And we are so appreciative of Federal resources included in the IRA and Bipartisan Infrastructure Law to help us do so.

The city worked with Senator Kelly to help create the Healthy Streets Program in the BIL, which could fund, for example, Cool Pavement projects. Phoenix has also applied to the EPA's Government to Government Environmental Justice grant program that was created in the IRA. Our proposal there is to create a model cool corridor in a shade desert in south Phoenix. This cool corridor would integrate a wide range of cooling features, including shade and freely accessible chilled drinking water that would more fully support neighborhood mobility and connectivity.

Shade and heat mitigation elements are also included in Phoenix's 2022 RAISE award, and our recent proposal to the PROTECT grant program.

We respectfully ask that the Federal agencies and Congress continue to work to ensure that formula and discretionary programs include heat response and heat mitigation initiatives as project eligibilities. What is especially important to us is that the notices of funding opportunities and project evaluation criteria clearly and appropriately acknowledge how heat related initiatives can be competitive for funding.

Moving forward, continued work to integrate heat planning and thinking across all scales of government sectors and agencies will be critical to help pursue community health and prosperity. Our experience in Phoenix is that our transportation infrastructure and systems are very important focal points as we work to build a more weather ready and heat ready Nation.

Thank you.

[The prepared statement of Mr. Hondula follows:]



David M. Hondula

Director of Heat Response and Mitigation, City of Phoenix, Arizona

Testimony Before the

U.S. Senate Committee on Environment and Public Works

Examining the Effects of Extreme Heat and Weather on Transportation

September 13, 2023

Introduction

Phoenix, Arizona is the hottest large city in the United States. Located in the Sonoran Desert, the City and its more than 1,600,000 residents experience long and hot summers with temperatures routinely exceeding 100°F for four months of the year. This unique position along the climatic gradient of the country's major cities provides Phoenix the opportunity, and arguably the necessity, to be leading the national dialogue about how communities can become more resilient to the risks posed by extreme heat. Summer 2023 has been especially challenging, as Phoenix set a new record with 55 days of temperatures reaching 110°F, including a stretch of 28 in a row that covered nearly the entire month of July. This unprecedented heat—both with respect to its intensity and duration—has made even clearer the significant challenges facing our City, as well as many others across the country, in ensuring that the public is safe, our infrastructure is resilient, and that our communities are thriving, even in the face of high and health-threatening temperatures.

Addressing the Heat Governance Gap

Over the past decade, local governments and the federal government have begun to recognize that there are serious deficiencies in planning for, mitigating, and managing extreme heat. In an analysis of 175 municipal plans from the 50 most populous cities in the United States, researchers found that 'few (plans) include strategies to address (heat), and even fewer cite sources of information' (Turner et al. 2022). Similarly, a 2021 survey of planning professionals

in American cities found that barriers related to human and capital resources were constraining the effectiveness of heat planning (Meerow and Keith 2022). Scholars have called for the creation of more explicit and dedicated staff roles and processes regarding heat across multiple scales and sectors of government, recognizing what has largely been an uncoordinated, ambiguous, and underdeveloped governance framework to date (Keith et al. 2021). This governance gap is especially concerning given that heat ranks among the nation’s most impactful weather hazards with respect to public health; heat typically accounts for more fatalities each year in the United States than most other weather hazards combined (Berko et al. 2014).

In an effort to address this governance gap at the local scale, in 2021, the City of Phoenix launched the nation’s first publicly funded office focused on heat—the Office of Heat Response and Mitigation (OHRM)—embedded in the structure of local government. This new office works with all of the City departments and additional partners to coordinate and improve programs that help protect people from the dangers of heat and ensure that our city’s communities are cooler, safer, and more comfortable for their residents. The local mission of OHRM aligns with that of the National Integrated Heat Health Information System (NIHHIS). NIHHIS is a cross-federal agency collaboration originally developed by the National Oceanic and Atmospheric Administration (NOAA) and the Centers for Disease Control and Prevention (CDC), with a mission to “build societal understanding of heat risks, develop science-based solutions, and improve capacity, communication, and decision-making to reduce heat-related illness and death.”

The creation of OHRM in the City of Phoenix and NIHHIS at the federal level acknowledges that extreme heat is very much an intersectional challenge that requires cross-sectoral collaborative thinking and cross-agency engagement. These new initiatives and others also reflect the fact that the challenges posed by extreme heat have not yet been adequately met. Success in building a nation that is more resilient to extreme heat will require engagement across all levels of government and across all sectors of society. The City is honored to submit this testimony to address how we are working to address heat challenges within and through one critical sector: transportation. Effective management and mitigation of extreme heat must incorporate the transportation sector. New innovations and ideas are needed to not only protect transportation users, assets, and workforce from risks posed by extreme heat, but also to leverage our transportation infrastructure and systems as part of the portfolio of solutions that can cool American cities.

Mitigating Heat via the Transportation Sector

A significant body of literature demonstrates that urbanization has a significant effect on local and regional climate (e.g., Krayenhoff et al. 2021). Temperatures in cities are typically higher than those in surrounding areas—especially overnight—because of several different physical processes. Compared to natural landscapes, cities are: (1) constructed of materials that are better absorbers of heat; (2) have more heat-emitting machines including air conditioners and vehicles; and (3) have more complex geometry that can trap heat between buildings rather than it being emitted to space. The transportation sector has a particularly influential role regarding the first two processes: land cover and waste heat emissions.

Pavement, which accounts for 30–40 percent of the total land cover of the Phoenix metropolitan area, is a significant contributor to urban heat. Pavement is a significant contributor to urban heat because of its low reflectivity of solar energy. As such, one strategy that could reduce the impact of pavement on urban heat is to apply materials that increase its reflectivity.

The City is a national leader in the testing and implementation of technologies that alter the reflectivity of road surfaces through our Cool Pavement Program. This program began with pilot tests in 2020 and has now expanded to more than 100 miles of city streets, or approximately 20.5 million square feet. These streets have been coated with a water-based asphalt treatment on top of existing asphalt pavement. The coating is a lighter color to the eye and appears light gray, similar to concrete. More importantly, the coating makes the road more reflective to solar energy. At initial installation, the coating that Phoenix has applied increases road surface solar reflectivity from 12 percent to 33 to 38 percent. Ten months after application, the reflectivity was measured between 19 and 30 percent.

The City of Phoenix has collaborated with Arizona State University to produce an independent, rigorous, and open evaluation of the Cool Pavement Program to further drive innovation and support good decision-making. Key findings from the evaluation study include:

- The surface temperature of streets coated with cool pavement were lower at all times of the day compared to traditional asphalt. This difference was more than 10°F at noon and during the afternoon hours and approximately 2°F at sunrise.
- Nighttime air temperature measured six feet above the cool pavement surface was on average 0.5°F lower than above traditional asphalt.
- The thermal comfort of a pedestrian walking on the sidewalk adjacent to a street coated with cool pavement was not significantly influenced by the treatment. However, a person walking directly on the treated street would experience a reduction in thermal comfort (an increase in mean radiant temperature of 5.5°F) that is approximately equivalent to the difference between walking on asphalt and concrete.
- Sub-surface temperatures measured in the asphalt below the cool pavement coating averaged 4.8°F lower than sub-surface temperatures in untreated streets.

The fourth finding, related to sub-surface temperatures, is particularly important with respect to protection of infrastructure from adverse effects of extreme heat. Because the underlying asphalt itself experiences less thermal strain, the cool pavement coating may ultimately reduce long-term maintenance needs and costs, which could yield substantive economic and environmental benefits. Continued evaluation of cool pavement technologies is needed to fully understand their long-term performance with respect to infrastructure protection and urban heat mitigation. Phoenix's decision to invest in cool pavement program evaluation has already paid significant dividends. The evaluation motivated changes to the products that we are applying, which is catalyzing innovation in the manufacturing sector, supporting well-paying jobs. Phoenix also worked with industry to pioneer a spray application technique for cool pavement that increases efficiency and reduces traffic disruption. The City regularly receives requests from communities all across the country interested to learn more about our experience with cool pavement, and we

are proud to be in a position to help inform and advance the national dialogue about how the transportation sector can lead urban heat mitigation efforts.

The City worked with Senator Kelly and this committee to create the Healthy Streets Program in the Bipartisan Infrastructure Law (BIL) to assist with funding cool pavement projects. The goals of this program include mitigating urban heat islands; improving air quality; and reducing the extent of impervious surfaces, stormwater runoff, and flood risks, and heat impacts to infrastructure and road users. Unfortunately, this program is subject to the annual appropriations process. As such, the City of Phoenix encourages the committee to consider mandatory spending for this program in the next surface transportation bill.

Regarding waste heat, it is estimated that more than 40% of extra heat added to urban environments from energy consumption is related to vehicle use (Sailor and Lu 2004). Phoenix is at the national forefront of vehicle electrification, and the adoption of more electric vehicles will help offset the contribution of the transportation sector to urban heat. Our effort to lead by example as a local government includes conversion of the City's vehicle fleet to alternative fuel. We are already making good progress converting light-duty vehicles and are in the early stages of transitioning heavy-duty vehicles, including our bus fleet. Our bus fleet transition plan includes plug-in battery electric busses and hydrogen fuel cell electric busses, and we anticipate a complete transition to 100 percent zero emission busses by 2040. Our overall fleet transition efforts were recently recognized with the Top Green Fleet Award for 2023 by the National Association of Fleet Administrators.

The City of Phoenix recently received more than \$16 million in Federal Transit Administration (FTA) Lo-No grant funding from the Bipartisan Infrastructure Law. This program is essential for supporting our transportation fleet transition. This recent award will support acquisition of battery and fuel cell electric buses, installation of charging and maintenance infrastructure, and maintenance training for personnel. The funding will offset the higher cost of zero-emission buses for planned fleet replacements for up to 12 hydrogen fuel cell buses (FCEB) and up to six battery electric buses (BEB)s, support workforce development, and construct fueling infrastructure and install charging equipment.

We also appreciate the new Charging and Fueling Infrastructure Grant program created in the Bipartisan Infrastructure Law that will help expand the deployment of electric vehicle charging and hydrogen/propane/natural gas fueling infrastructure along designated alternative fuel corridors.

Managing Heat for Transportation Users, Assets, and Workers

The ability of the transportation sector to fully support the mobility needs of communities depends, in part, on how environmental factors including the weather are addressed in transportation system design and operation. For warm weather cities like Phoenix, heat influences the experience of transportation users, especially people who walk, bicycle, or use public transportation (e.g., Dzyuban et al. 2021). Residents tell us that heat impacts the decisions they make about where they will go and how they will get there, which impacts commerce, labor, education, healthcare access, and more. Furthermore, Phoenix has ambitious goals to

increase the proportion of the population that chooses active and/or public transportation modes; to achieve those goals, people must perceive their active or public transportation options to provide sufficient thermal comfort and thermal safety.

The most influential determinant of thermal comfort and safety for active and public transportation users is shade coverage. Shade significantly reduces mean radiant temperature, which is one measure of the cumulative heat load on the human body that accounts for shortwave and longwave radiation (Turner et al. 2023). The City's metropolitan planning organization (MPO), Maricopa Association of Governments (MAG) has created the Active Transportation Plan Toolbox that defines 20 percent as the minimum acceptable shade coverage for pedestrian walking routes based on the climatology of Phoenix. 30 percent is considered to be good shade coverage and 60 percent is excellent. At the 30 percent shade threshold, a typical 20-minute walk is considered safe for an average person on all but the hottest 5 percent of summer days (MAG n.d.). Accordingly, natural and engineered resources that can provide shade, like trees, shade sails, and ramadas, are all critical components of our transportation and public health infrastructure.

The City of Phoenix is accelerating its investments to make more shade available for transportation users. One investment is the City's Cool Corridors initiative, through which we are striving to achieve 200 linear miles with at least 30 percent shade coverage for pedestrians by 2030. The City has also recently launched tree and shade grant programs for community and neighborhood groups, schools, youth centers, and local non-profits. As directed by our Mayor and City Council, we are striving to over-invest in communities that have been historically underserved and where shade is simply lacking places that have been coined "shade deserts" (Turner et al. 2023). Our commitment to address disparities in tree and shade coverage is formalized in the Tree Equity Pledge the City made to the non-profit American Forests in 2021. A further indication of our commitment to address the inequitable burden of heat across our communities is our participation with NOAA as one of four cities in a Heat and Equity Pilot Program.

Phoenix is appreciative of federal resources included in the Inflation Reduction Act and Bipartisan Infrastructure Bill that will help us provide shade for transportation users in the communities where it is most needed. For example, the U.S. Forest Services Urban and Community Forestry Program created through the Inflation Reduction Act aligns well with the City's tree and shade equity goals. The City and our partners have submitted two grant applications: one that will implement a series of tree planting programs in places where shade and cooling are most urgently needed, and a second that would support workforce development to maintain the trees we do have and to grow new ones. Phoenix has also applied to the Environmental Protection Agency (EPA)'s Government to Government Environmental Justice grant program that was created in the Inflation Reduction Act. Our proposal is to create a model Cool Corridor in a neighborhood in South Phoenix that integrate a wide range of features including shade and free publicly accessible chilled drinking water systems that would more fully support neighborhood mobility and connectivity. Shade and heat mitigation elements are also included in Phoenix's 2022 Rebuilding American Infrastructure with Sustainability and

Equity (RAISE) award from the Department of Transportation and our recent proposal to the Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) grant program. We encourage Congress to continue programs like these in the next surface transportation authorization bill.

The Phoenix Public Transit Department is also working hard to ensure that there is robust shade coverage at our transit stops. More than 70 percent of Phoenix's 4,000 public bus stops have shade structures today, and the department is adding 80 to 100 more each year using local funding sources.

With respect to the City's transportation assets, heat is a stressor that increases failure rates and diminishes lifetimes of several critical components. It is critical for Phoenix to consider and use products that operate well in extreme summer heat just as cold weather cities need to have confidence in their systems during winter weather and freezing conditions. In Phoenix, sidewalk buckling can occur because of high temperatures, which causes the potential for trip and fall incidents. The City is also concerned about the impact of heat on electronic systems in the field that operate traffic signals and streetlights, including diminished lifetimes expected from LED lights. Our traffic signal controller cabinets have fans that provide some cooling, but if the fans were to fail, it would be more likely that traffic signals switch to flash mode due to the equipment's heat sensitivity.

In the public transportation domain, high summer temperatures add strain to the air condition systems, engines, and on-board equipment for city buses, including automated doors, wheelchair ramps and lifts, and electronic components. These are challenges that we recognize and integrate into our procurement processes and into seasonal planning. For example, the air conditioning systems we require on our bus fleet have higher capacity components and quicker cool-down periods after engine start-up and between passenger pick-ups, among other updates that improve their performance in hot weather. Each winter and spring, the City works closely with contractors to ramp up preventative maintenance campaigns in anticipation of the higher failure rates that occur during hot weather.

The City of Phoenix places the utmost importance on the safety of its entire workforce, including those who work outdoors in the summer heat to operate and maintain our transportation infrastructure. Phoenix has recently completed a comprehensive review and update of departmental heat safety plans and protocol following formalized guidance provided by the Arizona Division of Occupational Safety and Health through a new State Emphasis Program aimed to reduce heat-related illness and injury in the workplace.

Recommendations and Conclusions

Phoenix is continuing to closely monitor all federal funding opportunities from the Bipartisan Infrastructure Law and the Inflation Reduction Act to scale up and accelerate our ability to comprehensively address heat through the transportation sector and beyond. We have worked hard to identify opportunities to integrate heat-related elements into a diverse suite of federal funding applications and are confident that significant benefits are being delivered to the community from the support that we have received. We do remain concerned, however, that

communities are constrained in their ability to bring forward the best and most comprehensive heat mitigation and heat response programs for federal support. Our experience is that heat-related projects are not yet fully compatible with legacy language in notices of funding opportunities (NOFOs), as well as in proposal evaluation criteria. Heat is one of our nation's most consequential natural hazards, but its impacts manifest in markedly different ways than the other hazards that have more historical and sustained funding streams. We respectfully ask that the federal agencies and Congress to continue to work to ensure that formula and discretionary programs include heat mitigation and heat response initiatives as project eligibilities, and that the NOFOs and project evaluation criteria more clearly and appropriately acknowledge how heat-related initiatives can be competitive.

Moving forward, continued work to integrate heat planning and thinking across all scales of government, sectors, and agencies will be critical to help pursue community health and prosperity. In Phoenix, we are benefitting from federal engagement and financial support in our efforts to do so, and we look forward for more opportunities for Phoenix and others to achieve even greater impact.

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Senate Committee on Environment and Public Works
Hearing Entitled “*Examining the Effects of Extreme Heat and Weather on Transportation*”
September 13, 2023
Questions for the Record for Dr. Hondula

Senator Markey:

1. **You touched on the role of the National Integrated Heat Health Information System (NIHHIS) in studying and addressing extreme heat. I introduced a bill with some of my Senate colleagues called the *Preventing HEAT Illness and Deaths Act* that would formally authorize NIHHIS, strengthen federal collaboration on heat resilience, and create a new program to directly support communities struggling with extreme heat. Would more effective federal-level collaboration on heat help to address gaps or barriers in data, planning, or implementation that you're facing on the ground in Phoenix?**

REPLY: Thank you, Senator Markey, for the question. We have had a very positive experience in the City of Phoenix engaging with federal agencies that are part of the National Integrated Heat-Health Information System, including NOAA, EPA, and CDC. In particular, we have appreciated the opportunity to be one of four cities participating in a Heat and Equity Pilot Program with NOAA, a highlight of which was a tabletop planning exercise that NOAA led in Phoenix this past February. We do believe that more effective and sustained federal-level collaboration on heat would help address several different gaps and barriers as related to data, planning, and implementation of urban heat resilience strategies. From our perspective, one of the most important outcomes of increased federal-level collaboration on heat would be improved clarity in individual notices of funding opportunity (NOFOs) regarding the eligibility and evaluation criteria for heat-focused projects and initiatives. Federal agencies could work together, and with local partners, to convene a workshop to discuss challenges that applicants have experienced when preparing funding proposals and co-develop strategies to overcome those challenges to support greater investment in local heat resilience.

2. **In your testimony, you said that agencies and Congress need to improve how heat is considered in formula and discretionary programs.**
 - a. **Would it be helpful to have more federal funding that is authorized specifically for monitoring and managing extreme heat?**

REPLY: Thank you, Senator Markey, for the question. Yes, we do believe that it would be helpful to have more federal funding that is authorized specifically for monitoring and managing extreme heat. One of the reasons that it would be helpful to have a specific funding stream for extreme heat is that the societal consequences of heat are manifest in different ways than other hazards with more historical and sustained funding streams; the public health impacts of extreme and chronic heat are often much more acute than damages to physical infrastructure (although significant infrastructure damages are also possible).

Should such a funding stream be developed, our recommendation is to provide as much flexibility as possible for local jurisdictions to meet their individual needs based on their own

local climate, demographics, and infrastructure. We also recommend that community-based organizations be centered in those efforts, either as entities directly eligible for funding or as required partners for funding proposals. Allowances and/or requirements for project evaluation will help build a much-needed evidence base regarding the efficacy of urban heat solutions; the CDC Building Resilience Against Climate Effects (BRACE) program has been advancing methods for evaluation of climate-health intervention strategies and could be used as a model in developing future funding opportunities.

b. What are some of the barriers to demonstrating the competitiveness of heat-related interventions?

REPLY: Thank you, Senator Markey, for the question. As we noted in our reply to your first question, we think that it would be productive to convene a workshop with local jurisdictions and federal agencies to discuss challenges that applicants have experienced when preparing funding proposals and co-develop strategies to overcome those challenges to support greater investment in local heat resilience. Challenges that we believe that applicants currently face when attempting to demonstrate the competitiveness of heat-related interventions:

- Funding opportunities tend to have narrower definitions of “infrastructure” than the complete solution set that would be helpful for building heat resilience and are often more oriented toward investment in and preservation of physical assets rather than human resources (e.g., outreach teams, educational programs, health and social services).
- Inconsistent availability of data concerning the health impacts of extreme heat and the economic consequences of those impacts, which inhibits applicants’ ability to use benefit-cost analysis and calculators.
- The lack of economic valuation of many of the harms that people and communities experience from extreme heat, including disrupted daily schedules, reduced overall physical well-being, increased stress and anxiety, and undesirable tradeoffs between utility costs and other essential needs. The absence of this information also inhibits applicants’ ability to use benefit-cost analysis and calculators.
- The nature of extreme heat as both an acute and chronic hazard; the public health impacts of extreme heat are not exclusively defined to specific “events” or periods with formal warnings or advisories in place, particularly in communities across the southern tier of the United States. In Phoenix, there are more heat-associated deaths most years on days *without* a National Weather Services Excessive Heat Warning in effect than those that do have warnings. While the daily rate of heat-associated deaths peaks on warning days, there are many days with temperatures below warning thresholds on which it would be impractical to issue warnings, but the public health risks remain relatively high.
- A limited evidence base regarding the effectiveness of heat response and heat mitigation strategies, and challenges observing or understanding counterfactuals if interventions were not in place. Consequently, there are not yet well-established and widely understood metrics or criteria for evaluating heat-related proposals.

3. From your written testimony, Phoenix set a new record with 55 days of temperatures reaching 110°F, including a stretch of 28 days in a row that nearly spanned the entire month of July. We know that heat is not even given distributed throughout cities and towns, given the built environment and racist redlining practices. What solutions have you seen prove successful in mitigating urban heat island effect?

REPLY: Thank you, Senator Markey, for the question. The record-setting conditions that Phoenix and so many other communities in the United States experienced this summer highlight the urgent need to accelerate the implementation of strategies that will keep people safe from the dangers associated with extreme heat. In Phoenix, we recognize that the urban heat island effect is a component of, but not the entirety of, the challenge that confronts us related to high temperatures. The urban heat island effect—the contrast between temperatures in city centers and surrounding areas—is typically strongest in the overnight and early morning hours. In many cities, the effect is much smaller, and can even be zero or negative, during the daytime hours. While we are certainly trying to implement strategies that will limit how much hotter city centers are than the surrounding areas, we are also trying to implement strategies that will provide more thermal safety for residents during our hot days and afternoons as well. Engineered shade structures at public transit stops, for example, are an important investment to promote public transportation and ensure residents can be safe, out of the sun, waiting for a bus to arrive, but these investments do not have a measurable effect on urban temperatures or the overall urban heat island effect. More generally, we understand shade provisioning (which does not always mitigate the urban heat island effect, but does help mitigate harms from heat) to be an essential component of our heat response and mitigation portfolio (see Turner et al. 2023).

The Phoenix area is one of the most well-studied with respect to the unequal distribution of heat and heat burdens in cities. Researchers and practitioners here have been, and remain, at the forefront of efforts to understand and resolve those inequities and the overall public health burden of heat. Foundational literature on this topic emerged from Arizona State University in the mid-2000s (e.g., Harlan et al. 2006), work that was supported by research grants through the National Science Foundation. One of the key themes that has emerged from this research is the inequitable distribution of tree canopy and shade coverage across urban neighborhoods.

At the City of Phoenix Office of Heat Response and Mitigation, we are working to leverage the growing pool of research about urban heat impacts to help our city implement a comprehensive portfolio that will address community needs with a focus on communities that are disproportionately impacted by extreme heat and have fewer resources to cope with heat-related stressors. We know that a number of different strategies are helping to cool our city and residents, protect infrastructure, and keep people safe. It is important to recognize that not all urban heat solutions offer the same types of benefits, and that a broad portfolio is needed to address the many different types of challenges that heat presents for American cities. Among the strategies currently being implemented in the Phoenix area and understand to be successful:

- Increasing the tree canopy cover, to provide more shade for pedestrians, promote outdoor physical activity and active transportation, reduce urban air temperatures, conserve energy, and create habitat

- Adding engineered shade structures, to provide more shade for pedestrians and promote outdoor physical activity and active transportation, particularly in locations where infrastructure conflicts prohibit implementation of natural shade
- Applying cool pavement, to reduce urban street surface temperatures, decrease asphalt maintenance and replacement costs, and reduce urban air temperatures
- Applying cool roofs, to reduce urban roof temperatures, decrease energy demand for buildings, reduce emissions of waste heat, and reduce urban air temperatures

Many other strategies are also being implemented to help residents cope with challenges associated with extreme heat, including home weatherization, operation of cooling centers, provision of shelter for people experiencing homelessness, and utility assistance, but the impacts of those programs are not as directly related to reducing urban temperatures or increasing outdoor thermal safety.

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Senator Kelly:

1. **As we all know, this summer we saw countless record-breaking extreme heat events. Phoenix had a record 31 straight days of 110+ degree temperatures in July, and just this past weekend hit 110 for the 54th day this year. We've never had that many days above 110 degrees in the history of Phoenix. To address these increasingly frequent extreme weather events, in 2021, the City of Phoenix created the country's first publicly-funded municipal office focused on the management of extreme heat. Since then, the Office of Heat Response and Mitigation has spearheaded policies to improve public safety when hot weather occurs and deploy strategies to cool the city and make it more comfortable in the long term, including by combatting the urban heat island effect. How does transportation infrastructure contribute to this phenomenon?**

REPLY: Thank you, Senator Kelly, for the question. As you note, part of the Office of Heat Response and Mitigation's charge is to accelerate the implementation of strategies that can reduce urban temperatures and increase thermal safety and comfort for our residents. We do understand the transportation sector to be a contributing factor to elevated urban temperatures.

Temperatures in cities are typically higher than those in surrounding areas—especially overnight—because of several different physical processes. Compared to natural landscapes, cities are: (1) constructed of materials that are better absorbers of heat; (2) have more heat-emitting machines including air conditioners and vehicles; and (3) have more complex geometry that can trap heat between buildings rather than it being emitted to space. The transportation sector has a particularly influential role regarding the first two processes: land cover and waste heat emissions. With respect to land cover, pavement is a significant contributor to urban heat because of its low reflectivity of solar energy. Pavement is one of the most widely deployed materials in our transportation infrastructure and is estimated to account for 30–40 percent of the total land cover of the Phoenix metropolitan area. Regarding waste heat, it is estimated that more than 40% of extra heat added to urban environments from energy consumption is related to vehicle use (Sailor and Lu 2004).

a. What types of resilient transportation infrastructure investments should we be making to combat this effect and its impact?

REPLY: Thank you, Senator Kelly, for the question. The City of Phoenix is proud to be working to implement urban heat solutions in the transportation sector. Many city departments are contributing to these efforts, including Street Transportation, Public Transit, Water, Public Works, and Sustainability. We recommend that resilient transportation infrastructure investments be made in three different domains:

- Investments that reduce the contribution of the transportation sector to urban heat, especially through mitigating the impacts of land cover and waste heat emissions. Relevant strategies include, but are not limited to, deployment of natural and engineered shade, adoption of cool/reflective pavement (of which Phoenix is a national leader, with more than 100 miles deployed to date), reduction of the overall prevalence of impervious surfaces, adoption of alternative fuel vehicles, increased use of active and public

transportation modes (which would reduce waste heat generated from the transportation sector).

- Investments that protect transportation system users from adverse impacts of extreme heat. Residents tell us that heat impacts the decisions they make about where they will go and how they will get there, which impacts commerce, labor, education, healthcare access, and more. Relevant strategies include, but are not limited to, deployment of natural and engineered shade, provision of publicly accessible chilled drinking water, ensuring reliable air conditioning on public transportation assets, and real-time tracking of bus and rail assets to enable riders to minimize outdoor exposure.
 - Investments that protect transportation system assets from harmful effects of extreme heat, increase their life span, and/or improve their reliability. Relevant strategies include, but are not limited to, adoption of materials less subject to thermal strain and failure in high temperatures, increasing preventative maintenance schedules ahead of the summer months, providing additional cooling equipment for critical assets (e.g., fans to cool electronic systems in traffic signals), adopting higher capacity components and/or quicker cool-down systems on transit vehicles.
2. **The City of Phoenix’s Office of Heat Response and Mitigation is tasked with two primary objectives: not only addressing extreme heat events as they occur, but also building resiliency over the long term to ensure the City of Phoenix is better prepared for future record-breaking heat. How is the increasing frequency of extreme heat events impacting the safety and longevity of Phoenix’s transportation infrastructure?**

REPLY: Thank you, Senator Kelly, for the question. The Office of Heat Response and Mitigation is coordinating with all City departments to understand how the increasing frequency of extreme heat events may impact the safety and longevity of Phoenix’s transportation infrastructure and how we can minimize or eliminate adverse impacts. There are wide-ranging potential consequences of extreme heat on our transportation infrastructure. While the City has been proactive in making investments that can withstand our challenging environment, we know that there will be continued opportunities and needs to do so. Examples of transportation infrastructure impacts of extreme heat in Phoenix include:

- Sidewalk buckling because of high temperatures, which causes the potential for trip and fall incidents.
- Diminished lifetime and performance of electronic systems that operate traffic signals and streetlights, including LED lights.
- Added strain to the air conditioning systems, engines, and on-board equipment for city buses, including automated doors, wheelchair ramps and lifts, and electronic components.

a. What are the long-term strategies you are working towards, in collaboration with other city departments, to ensure Phoenix's transportation systems will be able to operate safely under future extreme heat events?

REPLY: Thank you, Senator Kelly, for the question. We are working with other city departments to make investments in the three broad domains outlined in our answer to the previous question: investments that reduce the impact of the transportation sector to urban heat (reducing the severity of future extreme heat conditions), investments that protect transportation users from adverse impacts of extreme heat (as we interpret transportation users as critical components of the overall transportation system), and investments that protect transportation system assets from the harmful effects of extreme heat. City departments are making investments across all three domains and will continue to explore opportunities to strengthen our transportation system resilience to extreme heat. Examples of City-lead initiatives to ensure reliable performance of the transportation system under extreme heat conditions include:

- The integration of fans into traffic signal controller cabinets to help cool critical electronic components.
- Requiring air conditioning systems on the city bus fleet to have higher capacity components and quicker cool-down periods after engine start-up and between passenger pick-ups, among other updates that improve their performance in hot weather.
- Enhanced preventative maintenance campaigns in the winter and spring in anticipation of higher failure rates that can occur during hot weather.
- Ensuring that departments that support transportation have comprehensive and up-to-date heat safety plans for employees that align with state guidelines.

b. Should transportation infrastructure fail or become unusable as a result of extreme heat, what would be the immediate and long-term impacts on Phoenix residents?

REPLY: Thank you, Senator Kelly, for the question. The reliability of our transportation systems is essential for the overall health, well-being, and economic vitality of the City of Phoenix and its residents. Failure or disruption of transportation systems as a result of extreme heat would produce significant undesirable consequences for our residents and businesses. We are not aware of any academic studies that specifically model the consequences of transportation system disruption on residents in the context of extreme heat, but we would anticipate that impacts could include:

- Increased absenteeism from workplaces and schools
- Increased traffic and travel times, which may extend to emergency services
- Increased costs to residents for vehicle repairs (e.g., from driving on damaged roads)
- Reduced economic activity in certain sectors
- Lower perception of quality of life
- Lower perception of property values and investment desirability

We also understand that one of the most serious hazards that would face the Phoenix area is a concurrent heat wave and prolonged, widespread power failure. The transportation system would be a critical lifeline for residents in those conditions to ensure the movement of essential goods, services, and emergency personnel, and potentially to support voluntary or mandatory evacuation. As such, it is essential that our transportation system has the necessary backups and redundancies to ensure its reliable performance even under the most extreme heat conditions.

3. Another challenge in preparing for and addressing the challenges posed by extreme heat is the so-called “governance gap”. Given the significant danger that extreme heat poses to our communities, this lack of ownership over whose responsibility it is to manage extreme heat seems to be a hazard itself. What are the benefits of having a single department focusing on extreme heat?

REPLY: Thank you, Senator Kelly, for the question. We agree that ambiguity in the responsibility for managing extreme heat is a contributing factor to cities nationwide not being as fully prepared as possible for the challenges associated with one of our nation’s most consequential hazards. The City of Phoenix’s experience is that an office that is singularly focused on heat response and mitigation within the structure of local government can lead to many positive outcomes. We recognize that not all communities may be able to exactly replicate the model of the City of Phoenix in having a new office created that focuses on extreme heat, and/or that model may not be the most appropriate to meet local needs in different communities. What we do understand to be achievable, though, is the designation of a heat leader or leadership group within the structure of local government. The designation of heat leadership can help ensure that heat is included in as many relevant decision-making processes as possible. These processes include allocations of internal funding, pursuit of external funding, designation of staffing assignments, development of city protocol and policy, implementation and evaluation of programs, and partnerships with community groups and other institutions. The impacts of extreme heat are experienced across many different sectors of society and across many different city departments, and improving our ability to respond to and mitigate extreme heat requires that we widely integrate heat planning and preparedness into city operations and policy. In the absence of designated heat leadership, opportunities to achieve cooler and safer communities are likely to be missed or underdeveloped.

a. How do you work in collaboration with transportation departments at the local level?

REPLY: Thank you, Senator Kelly, for the question. The Office of Heat Response and Mitigation works collaboratively with the city’s streets and transit departments. We have regular working group meetings with transportation department staff members on several projects and initiatives related to extreme heat, including the City’s Cool Corridors Program, which is focused on increasing tree and shade coverage for pedestrians. We are also fortunate to have consistent transportation sector participation in the Arizona Heat Resilience Work Group, which is a voluntary coalition of more than 50 partners that meet at least monthly throughout the year to share best practices and address mutual challenges in pursuit of more heat resilient communities. This year, we benefitted from engagement with the regional transportation authority and our local transportation departments to improve public messaging and education around heat safety at public transit stops and platforms.

b. Do you feel it would be beneficial to national efforts to address extreme heat to scale this model to a federal level?

REPLY: Thank you, Senator Kelly, for the question. Yes, we do feel that it would be beneficial for increased coordination around efforts to address extreme heat at the federal level. We have had a very positive experience in the City of Phoenix engaging with federal agencies that are part of the National Integrated Heat-Health Information System, including NOAA, EPA, and CDC. In particular, we have appreciated the opportunity to be one of four cities participating in a Heat and Equity Pilot Program with NOAA, a highlight of which was a tabletop planning exercise that NOAA led in Phoenix this past February. We do believe that more effective and sustained federal-level collaboration on heat would help address several different gaps and barriers as related to data, planning, and implementation of urban heat resilience strategies. From our perspective, one of the most important outcomes of increased federal-level collaboration on heat would be improved clarity in individual notices of funding opportunity (NOFOs) regarding the eligibility and evaluation criteria for heat-focused projects and initiatives. Federal agencies could work together, and with local partners, to convene a workshop to discuss challenges that applicants have experienced when preparing funding proposals and co-develop strategies to overcome those challenges to support greater investment in local heat resilience.

Senator CARPER. Dr. Hondula, thank you so much for leading us off.

Mr. Parsons, you are recognized for 5 minutes. Go right ahead.

STATEMENT OF TRAVIS PARSONS, DIRECTOR, OCCUPATIONAL SAFETY AND HEALTH, LABORERS' INTERNATIONAL UNION OF NORTH AMERICA

Mr. PARSONS. Thank you very much, and thank you for having me here this morning.

Good morning, everybody, good morning, Chairman Carper and Ranking Member Capito, and esteemed members of the Committee.

As pointed out, I proudly serve as the Director of Occupational Safety and Health for the Laborers' Health and Safety Fund of North America. From here on I will just say Laborers, because that is a mouthful. We serve LIUNA and its memberships, which is the Laborers' International Union of North America, their signatory employers, and affiliates.

I am also a proud member of LIUNA Local 11, which is DC, Maryland, and Virginia, or some people refer to it as the DMV, having nothing to do with motor vehicles.

My primary areas of expertise and focus are industrial hygiene, hazard awareness and correction, ergonomics, infection control, and overall job site safety. As was pointed out by Senator Capito, I am from a small town in West Virginia originally, in the eastern panhandle, although I have lived here for 21 years in DC, and I am raising my family here.

Being from that small town in West Virginia, that instills in me a deep concern for the well being of blue collar workers, especially for their safety and health on the job, at the workplace. I am very grateful for the opportunity to address this vital issue of heat that affects our country's work force and the health and safety of its laborers.

I will start with a little description around the problem, as Senator Carper did a very good job of framing this, so I will try to be brief. Nationwide, we face a sobering reality that far too many workers lose their lives every year due to extreme heat, and many more are suffering from heat related illnesses and injuries, some chronic. The urgency of this issue cannot be overstated. Extreme heat is on the rise, with record breaking heat waves affecting millions of Americans every year.

It is an alarming trend: Every 1 degree Celsius increase in temperature leads to a 1 percent rise in workplace injuries. One percent doesn't sound like much, but that is a very significant concern when we have over 160 million workers in this country. That is a lot of people affected by heat.

Just last month, as the Chairman pointed out, we witnessed Hawaii grappling with heat, devastating wildfires, Louisiana declaring a heat emergency and tropical storms reaching unprecedented locations such as California, Texas, and Puerto Rico. It is evident that extreme weather and heat are becoming an unfortunate and enduring reality.

Despite the alarming images of hurricanes, tornadoes and floods, it is essential to note that extreme heat claims more lives than any other weather related phenomenon. The symptoms of heat stress

can strike suddenly, often unnoticed, and it is too late to intervene. Prevention is the strongest defense.

Prolonged exposure to elevated temperatures strains the heart, the lungs, the kidneys, and may lead to chronic health conditions. I just read recently in my research it is also being tied to respiratory problems, that go along with the environmental problems that the wildfire causes, with the heat.

Survivors of severe heat related illnesses bear long term health burdens including muscle and organ damage, chronic kidney disease, and exacerbation of preexisting conditions, such as diabetes and cardiac disease.

Now let's talk a little bit about the cost. The economic impact of extreme heat is profound. Employers failing to implement basic heat safety measures cost our economy hundreds of billions of dollars every year. That is both in direct and indirect costs. These costs encompass absenteeism, reduce productivity, worker turnover, overtime costs, and creates workers' compensation premiums, liability expenses, and equipment damage due to a rise in workplace incidents.

Some may argue that providing additional rest breaks increases payroll expenses for employers. However, safer working conditions means fewer injuries and illnesses, resulting in lower health care costs, reduced workers' compensation claims, and less lost time from work. The old adage of "an ounce of prevention is worth a pound of cure" rings true to me when I think of these numbers. Investing in heat related illness prevention outweighs the cost of neglecting it. Increased breaks not only protect workers from heat stress but also enhances productivity, saving employers money in the long run.

The notion of a conflict between worker safety and business profitability is a false dichotomy. Ensuring that heat hazard safety measures are in place in the workplace is in everyone's best interest.

Who faces the burden when you think about heat and a lot of these weather related incidents? I think of the workers out there, especially blue collar workers. Some of the most affected workers include those in construction, landscaping, and roadwork, members of LIUNA. It is imperative that we improve the tracking of injuries of heat related illness and the impact on our work force.

Tragically, low income workers and workers of color bear the brunt of these consequences. In construction alone, African American workers experience heat related deaths at a rate 51 percent higher than average, and a death rate for Mexican born workers is a staggering 91 percent higher.

Workers' physical and mental capacities decline significantly as heat and humidity rise. Research reveals that worker productivity drops 3 percent for every degree Celsius when it is above 75 degrees Fahrenheit. In the end, it is not about the temperature scales, it is about protecting workers.

Now I want to talk about some solutions. We possess the knowledge, the science, and background to mitigate heat related illness in this country. While many employers adopt these strategies, regrettably, not all do. Embracing the mantra of water, rest, shade is a strong place to start.

These measures, which are well documented and easy to implement, reduce the risk of heat related incidents. Workers require access to cool drinking water and adequate cool down breaks in shaded, air conditioned areas. If you want to ask what temperature, 80 degrees and below in these areas of breaks.

Moreover, the implementation of work acclimatization protocols such as a comprehensive written program, training for supervisors and front line workers, emergency response procedures, and diligent recordkeeping are all vital components of a comprehensive heat related illness prevention program.

The right to a safe workplace is a fundamental human right, and exposure to excessive heat is one of the most pressing hazards facing workers today. Tens of thousands of workers suffer from heat illness, injuries, and fatalities yearly in the United States. Employers bear the responsibility to protect those workers. The people who build this Nation, provide our food, and deliver essential goods deserve every safeguard available.

In conclusion, it is past time to protect workers from heat related illness, injury, and death. We must act decisively. The burden of occupational health related illness on our economy is substantial and growing. Neglecting these hazards of excessive heat for workers carries significant financial consequences for employers.

Thank you for your attention and commitment to addressing this pressing issue. I am open to any questions and discussion you may have on this critical matter.

[The prepared statement of Mr. Parsons follows:]

Senate Environment and Public Works Committee
Examining the Effects of Extreme Heat and Weather on
Transportation
September 13, 2023

Testimony of Travis Parsons
Director of Occupational Safety and Health
Laborers' Health and Safety Fund of North America

Introduction

Good morning, Chairman Carper, Ranking Member Capito, and esteemed members of the Committee. My name is Travis Parsons, and I proudly serve as the Director of Occupational Safety and Health at the Laborers' Health & Safety Fund of North America, representing the common interests of the Laborers' International Union of North America (LIUNA), their members, signatory employers, and affiliates. I am also a proud member of LIUNA Local 11. I have been at the Fund since 2002, and my primary areas of expertise are industrial hygiene, hazard awareness and correction, ergonomics, infection control, and overall jobsite safety. While I currently reside and work here in the Washington, D.C. area, I hail from a small town in the eastern panhandle of West Virginia, and I am a graduate of West Virginia University. This background instilled in me a deep concern for the well-being of blue-collar workers, especially for their safety and health in the workplace.

I am grateful for the opportunity to address this vital issue that affects our country's workforce and the health and safety of its laborers.

The Problem

Nationwide, we face a sobering reality that far too many workers lose their lives each year due to extreme heat, and many more are suffering from heat-related injuries and illnesses.^[1] The urgency of this issue cannot be overstated. Extreme heat is on the rise, with record-breaking heat waves affecting millions of Americans every year. It is an alarming trend—each 1-degree Celsius increase in temperature leads to a 1% rise in workplace injuries^[2], a significant concern when we consider the 162 million workers in our nation.^[3]

Just last month, we witnessed Hawaii grappling with devastating wildfires, Louisiana declaring a heat emergency, and tropical storms reaching unprecedented locations such as California, Texas, and Puerto Rico. It is evident that extreme weather and heat are becoming an unfortunate and enduring reality.

Despite the alarming images of hurricanes, tornadoes, and floods, it is essential to note that extreme heat claims more lives than any other weather-related phenomenon.^[4] The symptoms of heat stress can strike suddenly, often when it's too late to intervene. Prevention is our strongest defense. Prolonged exposure to elevated temperatures strains the heart, lungs, and kidneys, leading to chronic health conditions. Survivors of severe heat-related illnesses bear long-term health burdens, including muscle and organ damage, chronic kidney disease, and exacerbation of pre-existing conditions such as diabetes and cardiac disease.

The Cost

The economic impact of extreme heat is profound. Employers' failure to implement basic heat safety measures costs our economy billions of dollars annually.^[5] These costs encompass absenteeism, reduced productivity, worker turnover, overtime, increased workers' compensation premiums, liability expenses, and equipment damage due to workplace incidents. Some may argue that providing additional rest breaks increases payroll expenses for employers. However, safer working conditions mean fewer injuries and illnesses, resulting in lower healthcare costs, reduced workers' compensation claims, and less time lost from work. The adage "An ounce of prevention is worth a pound of cure" rings especially true. Investing in heat-related illness prevention outweighs the costs of neglecting it. Increased breaks not only protect workers from heat stress but also enhance productivity, saving employers money.

The notion of a conflict between worker safety and business profitability is a false dichotomy. Ensuring heat hazard safety measures in the workplace is in everyone's best interest.

The Burden on Workers

Some of the most affected workers include those in construction, landscaping, and roadwork—members of LIUNA. It is imperative that we improve the tracking of heat-related illnesses and their impact on workers. Tragically, low-income workers and workers of color bear the brunt of these consequences. In construction, African-American workers experience heat-related deaths at a rate that's 51% higher than the average, and the death rate for Mexican-born workers is a

staggering 91% higher. ^[6] Workers' physical and mental capacities decline significantly as heat and humidity rise. Research reveals that worker productivity drops nearly 3% per degree Celsius when it is above 75°F. ^[7] In the end, it is not about temperature scales; it is about protecting workers.

A Blueprint for Solutions

We possess the knowledge to mitigate heat-related illnesses. While many employers adopt these strategies, regrettably, not all do. Embracing the mantra of "water/rest/shade" is a strong start. These measures, which are well-documented and easy to implement, reduce the risk of heat-related incidents. Workers require access to cool drinking water and adequate "cool down" breaks in shaded or air-conditioned areas. Moreover, the implementation of worker acclimatization protocols, a comprehensive written program, training for supervisors and frontline workers, emergency response procedures, and diligent record-keeping are all vital components of a comprehensive heat-related illness prevention program.

The right to a safe workplace is a fundamental human right, ^[8] exposure to excessive heat is one of the most pressing hazards facing workers today. Tens of thousands of workers suffer from heat illnesses, injuries, and fatalities yearly in the United States. Employers bear the responsibility to protect their workers. The people who build this nation, provide our food, and deliver essential goods deserve every safeguard available.

In conclusion, it is past time that we protect workers from heat-related illness, injury, and death. We must act decisively. The burden of occupational heat-related illness on the economy is substantial and growing. Neglecting the hazards of excessive heat for workers carries significant financial consequences for employers. However, we have manageable and cost-effective solutions at our disposal—solutions that safeguard workers and benefit employers alike. The choice is clear: invest in worker safety, protect lives, and secure a brighter future for all.

Thank you for your attention and commitment to addressing this pressing issue. I am open to any questions or discussions you may have on this critical matter.

Citations

[1] Fulcher, Boiling Point: OSHA Must Act Immediately to Protect Workers from Deadly Temperatures, Public Citizen (June 2022), <https://www.citizen.org/article/boiling-point/> [herein after Fulcher, Boiling Point (June, 2022)].

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[3] Bureau of Labor Statistics. United States; August 2021 to August 2023; 16 years and older; full-time and part-time employees.
<https://www.statista.com/statistics/209123/seasonally-adjusted-monthly-number-of-employees-in-the-us/#:~:text=In%20August%202023%2C%20about%20161.48,employed%20in%20the%20United%20States>.

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[7] Foster et al., Quantifying Impact of Heat on Work Capacity (2021).

[8] All about OSHA, Occupational Safety and Health Administration, U.S. Department of Labor, OSHA 3302–02R 2023, https://www.osha.gov/sites/default/files/publications/all_about_OSHA.pdf.

Senate Committee on Environment and Public Works
Hearing Entitled “Examining the Effects of Extreme Heat and Weather on Transportation”
September 13, 2023
Questions for the Record for Mr. Parsons

Senator Markey:

1. From melting runways in London to last year’s meltdown at Southwest Airlines, climate change is stressing our runways, tarmacs, and planes. As a Brookings report declared earlier this year, “America’s airports aren’t ready for climate change.”
 - a. How do you see the climate crisis affecting all forms of transportation, particularly aviation?

Answer:

My background and expertise are in occupational safety and health focusing on the construction and heavy highway industries. I am not a climate change expert, nor do I specialize in aviation, but I do know that the climate crisis is expected to have significant impacts on all forms of transportation, due to our reliance on fossil fuels and their contribution to greenhouse gas emissions and that our planet continues to get hotter and hotter each year.

- b. Would you agree that airports need additional investment in order to be made more resilient in the face of more extreme storms and extreme heat?

Answer:

Yes, I would agree that airports need additional investment to be made more resilient in the face of more extreme storms and extreme heat. Airports are critical transportation hubs, and they rely on a range of infrastructure, including runways, terminals, hangars and control towers. These facilities need to be protected against the impacts of extreme weather events such as hurricanes, flooding and heat waves. Investing in stronger and more resilient infrastructure can minimize disruptions and downtime caused by extreme conditions.

2. When extreme storms hit our airports and other infrastructure, transportation workers are on the frontlines, risking their health and safety, working to get our systems back on track. What risks have you seen extreme weather pose to transportation workers?

Answer:

Extreme weather events can pose significant risks to workers who are on the frontlines trying to keep our infrastructure and systems operational. In my experience, the risks they may face include, but are not limited to:

Physical Hazards: Transportation workers often have to work outdoors, and extreme weather conditions can expose them to various physical hazards. For

example, in extreme heat, workers may be at risk of heat illness like exhaustion or heat stroke. In extreme cold, they may face frostbite and hypothermia risks. Windstorms and hurricanes can lead to struck-by incidents from flying debris or falling objects, causing injuries.

Electrical Hazards: Extreme weather, such as lightning storms, can increase the risk of electrical hazards for workers who maintain and repair transportation infrastructure. Downed power lines and lightning strikes can damage electrical equipment, create dangerous working conditions or create dangerous electrical surges.

Flooding: Heavy rainfall or storm surges can lead to flooding. This can make it extremely hazardous for workers, as they may have to navigate through deep water with many unknown hazards and deal with submerged electrical systems.

Slippery Surfaces: Ice, snow and heavy rain can create slippery surfaces, increasing the risk of slips, trips and falls for workers.

Visibility Issues: Fog, heavy rain and snow can severely reduce visibility, making it challenging for workers to perform their duties safely.

Transportation Disruptions: Extreme weather can disrupt transportation services, stranding workers at their workplaces and making it difficult for them to commute to and from work, especially if they rely on public transportation. This can pose additional challenges and risks to their safety and well-being.

Mental Health Stressors: Working in extreme weather conditions for extended periods can also take a toll on the mental health of transportation workers. Stress, anxiety and fatigue may increase due to the demands of responding to weather-related disruptions.

To mitigate all of the risks above, it's crucial for all employers to have comprehensive safety protocols and training in place. This includes providing workers with appropriate preventative methods utilizing the hierarchy of controls, personal protective equipment (PPE), ensuring they are well-trained to handle extreme weather conditions and having contingency plans for responding to weather-related emergencies. Involving workers in this process is also crucial. Worker input to hazardous and emergency situations is invaluable and creates an avenue for buy-in to safety protocols from workers. Additionally, having a proactive approach to weather-related risks can help protect the health and safety of workers on the frontlines.

3. Transportation workers engaged in heavy outdoor labor are among the most vulnerable to heat-related illnesses and deaths. But far too many workers are left unprotected and exposed to dangerous workplace practices.
 - a. How would you respond to an employer that fails to provide employees with water, rest, and shade?

Answer:

Assuming they are in a state that does not have an existing state OSHA rule (i.e., California, Oregon or Washington state), I would first ask the employer why they are not providing these essential elements for worker protection, comfort and satisfaction. I would then walk through potential solutions. If they are in one of the three states above, I would point out that they are in direct violation of state OSHA law.

Next, I would point out their duty to provide a safe and healthful workplace and summarize OSHA's General Duty Clause 5(a)(1) of the OSH Act: *"Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."* It is important for employers to understand their obligations under the General Duty Clause and take proactive measures to identify and address workplace hazards, even in the absence of specific OSHA standards. Employees also have the right to bring concerns about unsafe conditions to their employer's attention or to report them to OSHA if necessary.

Then I would refer them to OSHA's current Guidance and National Emphasis Program and see if they are willing to follow those proven protocols and best practices. I would also offer assistance to them for the implementation of any of these steps or programs along the way.

- b. How can the government more effectively protect workers from extreme weather-related risks on the job?

Answer:

A Federal Regulation for Heat Illness Prevention at work: Frankly, this is way overdue, and it is time to protect workers from extreme heat.

Mandatory Breaks and Rest: Enforce mandatory break and rest periods for workers during extreme weather conditions to allow them to cool down, hydrate and recuperate. Follow the National Institute for Occupational Safety and Health's work/rest schedules.

<https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2017-127.pdf>

Provide Guidance: Develop comprehensive guidelines and best practices for employers to follow in order to protect workers from extreme weather risks. These guidelines can be tailored to specific industries and weather conditions.

Follow the Hierarchy of Controls: We should always follow the hierarchy of controls to mitigate hazards in the workplace. The hierarchy of controls is a method of identifying and ranking safeguards to protect workers from hazards. They are arranged from the most to least effective and include elimination, substitution, engineering controls, administrative controls and personal protective

equipment. Often, you'll need to combine control methods to best protect workers. <https://www.osha.gov/heat-exposure/controls>

Access to PPE: Ensure that employees have access to appropriate PPE, such as heat-resistant clothing, cooling vests, cooling neck wraps and cold-weather gear, depending on the weather conditions.

Worker Participation: Promote worker involvement in safety decision-making by establishing safety committees or councils where employees can provide input on safety measures and report concerns without fear of reprisal.

Collaboration with Employers: Encourage collaboration between government agencies and employers to jointly address extreme weather-related risks and develop effective safety measures.

Incentives and Penalties: Offer incentives for employers who proactively implement weather-related safety measures and impose penalties for non-compliance or negligence.

Worker Advocacy: Support worker advocacy organizations that can raise awareness, provide resources and advocate for the rights and safety of workers in extreme weather conditions.

Ultimately, a combination of stringent regulations, effective enforcement, education and collaboration between government, employers and workers is necessary to protect workers from extreme weather-related risks on the job. Continual assessment and adaptation of policies and practices are key to ensuring the effectiveness of these measures in the face of changing climate patterns and extreme temperatures.

Senator CARPER. Mr. Parsons, thanks very much for that testimony.

Before we introduce Dr. Flannery, my maternal grandmother and her husband, my grandfather, lived right outside of Beckley, in a little town called Beaver, also known as Daniels, right by Shady Springs High School. I remember when we were little kids, we would go back and visit in the summer. One of my grandmother's favorite sayings was, an ounce of prevention is worth a pound of cure. As little kids, we were just wondering what she was talking about. But it has finally become clear to me, the wisdom of my grandmother and her husband as well.

I just had to give her a shout out for introducing me to that phrase a long, long time ago. A lot of wisdom there.

All right, Dr. Flannery, you are on. Your daughter is here watching over your shoulder. So do your best.

STATEMENT OF AIMEE FLANNERY, PH.D., P.E., GLOBAL PRINCIPAL, TRANSPORTATION RISK AND RESILIENCE, JACOBS, SOLUTIONS AND TECHNOLOGIES

Ms. FLANNERY. Good morning, Chair Carper and Ranking Member Capito, and members of the Senate Committee on Environment and Public Works. My name is Aimee Flannery, I am the Global Principal of Transportation Risk and Resilience for Jacobs Solutions.

I want to thank you for the opportunity to testify today as you examine the effects of extreme heat and weather on transportation systems, and how the private industry are helping our community partners. I would also like to thank the American Council of Engineering Companies for their leadership in making my testimony possible.

As mentioned, my career to date has provided me the opportunity to serve as an educator of tomorrow's civil engineers at George Mason University where I was a tenured member of the faculty. I have also worked for a small woman owned business, have been a business owner myself, and have had the privilege of working at the U.S. Department of Transportation Office of Research in the Office of the Secretary prior to joining Jacobs.

As America's largest engineering firm, Jacobs is investing in people and technology to address resilience challenges alongside communities across the Nation. My experience incorporating climate resilience began a decade ago this week while working for the Colorado Department of Transportation.

In September 2013, a stalled cold front clashed with a warm, monsoonal air mass from the south and dropped 20 inches of rain on northern Colorado. The extensive rainfall and duration resulted in flow surges, damaging and destroying major sections of roadway, along with access bridges and retaining walls. Many residents were cut off with no access out of the Big Thompson River Canyon.

The operational response involved over 19,000 evacuations and 2,000 air rescues. The event resulted in nine deaths and caused nearly \$4 billion in damages to public and private infrastructure, including damages to 50 major bridges and 485 miles of roadway.

Changes to the FHWA Emergency Relief Program in May 2013, just prior to the September floods, allowed the Colorado Depart-

ment of Transportation to pursue more resilient designs to address major damage to some of their facilities. One specific area known as Horseshoe Curve on the U.S. 34 corridor was destroyed by flooding in 2013, and had been previously destroyed by flash flooding in 1976. These changes to the emergency relief program allowed for a final design that provides for a more resilient corridor, with access for first responders during emergency events. And it is anticipated to minimize damage from similar future events.

In 2013, addressing extreme weather events and climate stressors were just emerging as a new area of concern within the highway industry. Today, nearly 2 years since the passage of IIJA, the transportation industry has for the first time dedicated funding to address resilience from natural hazards.

The PROTECT program alone provides over \$8 billion in formula and grant funding opportunities for proactive management of system vulnerabilities. State agencies and their partners have been working diligently to develop resilience improvement plans and prioritize lists of projects for their highway systems.

We at Jacobs are pleased to be working with several States represented here on the Committee, including Delaware, West Virginia, and Maryland, on their resilience improvement plans.

A few challenges that I have heard from professionals that I work with include the need to increase training for their staff to understand awareness of resilience strategies, to better understand economic assessment methodologies for resilient design alternatives, to better understand best practices for incorporating resilience into design, and to better understand Federal aid requirements of new programs.

Incorporating climate resilience into our standard practice has yet to be fully integrated, but change is happening. To that end, the future transportation reauthorization efforts from this Committee to spur the incorporation of resilience into practice could include supporting the industry to better understand risk tolerance and what is an acceptable level of resilience for the range of facilities that our industry maintains. These criteria may support potential changes to design standards and material specifications to address climate resilience in the future.

As a former educator, the need to integrate infrastructure resilience into our undergraduate and graduate degree programs is also necessary to ensure that the next generation of transportation engineers and planners are well versed in these concepts.

I thank you for your time, and I look forward to your questions.
[The prepared statement of Ms. Flannery follows:]



**Testimony of Aimee Flannery, Ph.D., PE
Global Principal - Transportation Risk & Resilience
Jacobs**

**Before the
Senate Committee on Environment and Public Works**

**Hearing on
*"Examining the Effects of Extreme Heat and Weather on Transportation"***

Wednesday, September 13, 2023

Good morning, Chair Carper, Ranking Member Capito and Members of the Senate Committee on Environment and Public Works.

My name is Aimee Flannery, and I am a Global Principal for Transportation Risk and Resilience for Jacobs Solutions.

I want to thank you for this opportunity to testify today as you examine the effects of extreme heat and weather on transportation systems and how private industry is helping our communities prepare. I would also like to thank the American Council of Engineering Companies (ACEC) for their leadership and for helping to make my testimony possible.

My career to date has provided me the opportunity to serve as an educator of tomorrow's Civil Engineers at George Mason University where I was a tenured member of the faculty. I have also worked for a small woman-owned business, have been a business owner myself, and have had the privilege of working with U.S. Department of Transportation in the Office of the Secretary, Office of Research and Technology prior to joining Jacobs.

We like to say at Jacobs that we're "*challenging today to reinvent tomorrow by solving the world's most critical problems,*" and there may be no better example than infrastructure resilience. As America's largest engineering firm, Jacobs is investing in people and technology to address resilience challenges alongside communities across the nation.

My experience incorporating climate resilience into highway decision-making began a decade ago while working with the Colorado Department of Transportation. In September 2013, a stalled cold front clashed with a warm, monsoonal air mass from the south that dropped 20 inches of rain on Northern Colorado. The extensive rainfall and duration resulted in flow surges damaging or destroying major sections of roadway, along with access bridges and retaining walls. Numerous residents were isolated and cut off with no access out of the Big Thompson River Canyon. The operational response involved over 19,000 evacuations including over 2,000 air rescues. The event resulted in 9 deaths and caused nearly \$4 billion in damages to public and private infrastructure, including damage to 50 major bridges and 485 miles of roadways.

Changes in Federal Highway Administration's (FHWA) Emergency Relief Program policy in May of that year (2013) allowed Colorado DOT to pursue more resilient designs to address major damage to some of their facilities. Changes in the policy suggested that agencies consider the long-term resilience of damaged facilities and allowed for the consideration of resilient design to reduce probable losses from future similar events¹. FHWA's ER Program underwent further revision within the *Infrastructure Investment and Jobs Act* (IIJA) to expand the consideration of resilience when building back post-disaster on Federal-Aid highways. The revisions allow for the use of ER funding to make improvements to infrastructure that will mitigate the risk of recurring damage from extreme weather, flooding, and other natural disasters (§11106(3)(A) of P.L. 117-58; 23 U.S.C 125(d)(2)(A)).

¹ [Emergency Relief Manual, Update May 31, 2013 \(fhwa.dot.gov\)](#)



(Above, photo of "Horseshoe Curve" days after the peak of the 2013 floods)
(Below, photo of "Horseshoe Curve" after project completion)



One specific area was the "Horseshoe Curve" of the US-34 corridor which was destroyed by flash flooding in 2013 and previously in 1976. Thankfully, changes to FHWA's ER Program

allowed for innovative designs and methods including soil cement mixing, installing matrix riprap, moving the roadway onto bedrock, swapping the alignment of the road and the river, and a unique approach to traffic control to achieve maximum resiliency within the project budget. This led to a more resilient US-34 corridor that allows access to first responder vehicles during emergency events and will minimize damages in future events. As the lead design firm and prime consultant, the Jacobs' Project Team was recognized alongside the Colorado DOT by Engineering News-Record when the US-34 Permanent Repairs Project won National Project of the Year in 2018².

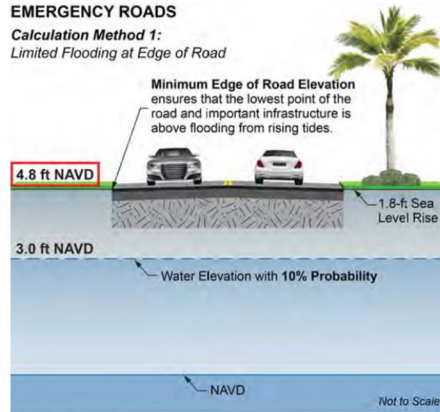
In 2013, addressing extreme weather events and climate stressors, such as increased and extended periods of heat, were emerging as new areas of concern within the highway industry. Today, nearly two years since the passage of the bipartisan *Infrastructure Investment and Jobs Act* in 2021, the transportation industry has, for the first time, dedicated funding to address resilience from natural hazards. The *Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT)* Formula Program includes over \$7 billion in funding along with \$1.4 billion in the *PROTECT* discretionary grant program. Jacobs and the industry applaud this Committee for their work in passing these dedicated funding sources, along with other new programs that address system resilience, as they provide much-needed funding to begin addressing the vulnerabilities of our transportation system, while allowing states and communities to address their own unique resilience needs. These programs

² [Engineering News-Record, Best of the Best Projects 2018 \(enr.com\)](https://www.enr.com/news/best-projects-2018)

proactively address system vulnerabilities prior to major natural hazards and will reduce costs to taxpayers down the road.

State agencies and their partners such as Metropolitan Planning Organizations, cities, and counties have been working diligently to develop Resilience Improvement Plans and prioritized lists of projects for their highway systems to reduce risk from natural hazards and improve system resilience. We at Jacobs are pleased to be working with several states represented here on this Committee, including Delaware and Maryland, on their resilience improvement plans. We are also working with multiple agencies on resilient designs and emergency evacuation corridor planning activities including the Wyoming 22 Corridor in which preliminary design addresses multiple natural hazards including flooding, landslides, avalanches, and wildfires. Jacobs is also providing final design services to the City of Elk Grove, California for the Kammerer Road Extension project, which will provide an evacuation route within the Sacramento Valley floodplain.

Some agencies are also beginning to develop methods to increase the design criteria for critical and vulnerable assets in the absence of broader national changes to design standards. Jacobs is assisting agencies with revisions to their design standards to address the recurrence of stressors and shocks to roadway systems including the cities of Miami Beach and Key West.



For Emergency Roads, Method 1 results in higher Minimum Elevation at the Edge of Road for projects built in 2020.

These two figures include information on the types of functional classification agencies are considering when revising their design standards. In this case, the City of Miami Beach has established higher minimum elevations for three classifications of roadways ranging from emergency routes to local neighborhood streets.

Level of Service by Road Type	Sea Level Rise for 2020 Start Year ^a	Freeboard/Clearance	Preliminary Design Road Elevation	Final Minimum Design Road Elevation
CALCULATION METHOD 1: Limited Flooding at Edge of Road				
Emergency Roads 10% (1 per 10-year): 3.0 ft NAVD	2020 Start: 1.8 ft	Edge of Road: Freeboard 0 ft	Edge of Road: 4.8 ft	Emergency Roads EOR ≥ 4.8 ft BORB ≥ 2.9 ft
Major Roads 20% (1 per 5-year): 2.3 ft NAVD	2020 Start: 1.3 ft	Edge of Road: Freeboard 0 ft	Edge of Road: 3.6 ft	Major Roads EOR ≥ 3.9 ft BORB ≥ 2.9 ft
Local Roads 50% (1 per 2-year): 1.7 ft NAVD	2020 Start: 1.3 ft	Edge of Road: Freeboard 0 ft	Edge of Road: 3.0 ft	Local Roads EOR ≥ 3.9 ft BORB ≥ 2.9 ft
CALCULATION METHOD 2: Limited Groundwater/Tidal Wetting at Base of Road				
All Roads Mean Higher High Water (MHHW): 0.6 ft NAVD	2020 Start: 1.3 ft	Typ. Road Thickness (Base & Pavement): 1 ft Bottom of Road Base: Clearance 1 ft	Edge of Road: 3.9 ft minimum Bottom of Road Base: 2.9 ft	
METHOD 3: Roadway Harmonization with Adjacent Property				

^a See Landed Flood Assessment with Projections for 2020 and 2050

While we are beginning to see movement, in particular at the local level, to address climate resilience in design standards, there is still room for improvement to support transportation professionals. The transportation industry has continued to make investments in research, training, and guidance to support transportation engineering and planning professionals. Agencies and organizations like the Transportation Research Board (TRB), Federal Highway Administration (FHWA), and the American Association of State Highway and Transportation Officials (AASHTO) have published guidance on a range of topics related to climate resilience. For example, research is underway to develop resilience metrics (National Cooperative Highway Research Program (NCHRP) Report 23-26)³, standardize methods of assessing system risk and resilience from natural hazards (NCHRP 23-32)⁴, and estimate the level of effort required to update national design standards (NCHRP 15-80)⁵.

Additionally, while research, policy, and pilot programs have been underway for several decades, moving research into practice does not happen quickly or easily. Prior to the passage of IIJA, agencies did not have a dedicated source of funding to address climate resilience. The state agency professionals I work with note that this is a game changer and allows them to begin to establish programs and processes to integrate resilience into their day-to-day practice, while ensuring that their solutions meet the needs of their individual resilience challenges. States also appreciate the flexibility of existing and new programs such as PROTECT to allow them to combine funding streams to accomplish greater returns on investments made. A few

³ Measuring Impacts and Performance of State DOT Resilience Efforts, [NCHRP 23-26](#)

⁴ Transportation Asset Risk and Resilience, [NCHRP 23-32](#)

⁵ Design Guide and Standards for Infrastructure Resilience, [NCHRP 15-80](#)

challenges noted by professionals include the need to increase training for their staff to improve workforce awareness of resilience strategies, including Nature-Based Solutions; economic assessment methods for resilient design alternatives; best practices for incorporating resilience into design; and federal aid requirements of new programs.

Incorporating climate resilience into our standard practice has yet to be fully integrated but change is happening. To that end, future transportation reauthorization efforts from this Committee to spur the incorporation of resilience into practice could include supporting the industry to better understand risk tolerance and what is the acceptable level of resilience for the range of facilities that serve our surface transportation needs. Establishing such criteria would help to better understand what potential changes to design standards and material specifications may be needed to address climate resilience.

Fundamental research to understand asset performance under extreme weather events and climate stressors is also needed. For example, how do asset condition, age, and design standards play into asset failure curves? Utilizing our University Transportation Centers, and academic and federal laboratories to model such performance would improve our ability to estimate asset performance under a range of conditions and asset deterioration scenarios.

As a former educator, I will also note the need to integrate infrastructure resilience into our undergraduate degree programs to ensure the next generations of transportation engineers, planners, and professionals are well-versed in these concepts.

Thank you again Chair Carper, Ranking Member Capito and Members of the Committee for the opportunity to testify.

I look forward to your questions.

Senate Committee on Environment and Public Works
Hearing Entitled “*Examining the Effects of Extreme Heat and Weather on Transportation*”
September 13, 2023
Questions for the Record for Dr. Flannery

Senator Markey:

Question: Heat does not get the same level of attention as the other more obviously destructive climate extremes. However, high temperatures have caused major transportation delays, including in Massachusetts, with the potential for serious safety incidents.

What are some of the unanswered fundamental research questions on extreme heat?

I appreciate the opportunity to answer your questions, Senator Markey, and I hope you will reach out with any additional questions or needs as they relate to resilience infrastructure.

There is no question that fundamental research is needed to understand the effect of extreme heat and prolonged heat waves on infrastructure and travelers. Examples of effects of extreme heat and heat waves on infrastructure include:

- Less efficient transmission of energy which can affect transit rail operations, Intelligent Transportation Systems, and traffic management systems.
- Concrete expansion accelerating degradation.
- Earlier snowpack melt leading to potential cascading threats such as early intense spring rainfall events on snowpack versus slower snowpack melt.¹
- Roadways and airport runways can buckle due to extreme heat.
- Train tracks and steel bridges warping.

With these impacts in mind, below are some primary fundamental research areas that require more thorough examination:

1. Guidance and design standards are needed that incorporate risk tolerance associated with climate resilience into practice. Current design standards for transportation facilities are based on each facility’s functional classification (e.g., Interstate freeways versus local facilities) and the required minimum level of performance. These industry standards need to be revised to incorporate expected changes in rainfall intensity, increases in temperature, etc., to ensure consistent design across systems.
2. Transportation infrastructure is a long-term investment that includes several materials (concrete, asphalt, steel, earthen materials, etc.). Fundamental research to understand and identify construction materials that reduce embodied carbon is needed. This research should address not only the reduction in carbon these materials can offer, but also the performance of these materials as compared to more traditional materials. Research is needed to support the assessment of whole-life return on investment (ROI). For example, how do these materials perform under the changing climate and the increasing demand on

¹ [Extreme Heat | CISA](#)

our transportation system? Just as important is moving these types of materials from research into practice through revisions of design standards when pilot studies support broader adoption and use.

3. Information and education on the impacts of changes to material selection, mix design, and design standards on performance (not only asset performance over time but also service performance to travelers) is needed. This type of education and training is needed by practitioners already in the field as well as the next generation of transportation practitioners, engineers, and planners to ensure we are incorporating climate impacts in our day-to-day decision-making in investments that often have long service lives.

Question: How can the federal government best support a research agenda that will quickly get answers into the hands of state and local transportation professionals?

Congress has made major strides in this area already - the *Transportation Resilience and Adaptation Centers of Excellence (TRACE)* were established in IJA to include 10 regional Centers of Excellence and one national Center of Excellence for Resilience and Adaptation. To date, the anticipated \$55 million in annual funding for these centers has not been fully allocated. This program will lay the groundwork for critical research as regional centers are ideal for supporting the specific needs of practitioners and professionals in Transportation. Regional centers will allow varying regional climate resilience issues (heat, cold, permafrost thaw, earthquakes, landslides, avalanches, increased rainfall, sea-level rise, drought, etc.) to be addressed locally and shared ideally through the national center.

Additionally, U.S. DOT has recently announced a funding opportunity for a climate change and transportation research initiative that will support decarbonization of the transportation sector, build resilience of transportation infrastructure networks, and address adverse climate and environmental impacts related to transportation.

Congress took the critical first step in creating and funding these initiatives. This research will need to extend beyond the 5-year lifespan of the IJA, however, and should be reauthorized in the next surface transportation reauthorization in Fiscal Year 2026. These programs will allow Congress to advance the goals of disseminating critical information, to increase training and education, and to further critical research efforts.

Senator CARPER. Thank you for your testimony.

I will start it off, then yield to Senator Capito.

I think it was a 2021 study that found that taking a proactive approach to adapting U.S. roads and roadways to climate change could save the economy up to \$470 billion, billion with a B, annually by the year 2100. As I have said more than a few times in this room, climate change is an issue we can no longer afford to ignore. I think most people have bought into that.

That means investing in our transportation infrastructure and making upgrades to protect against extreme heat and weather before infrastructure is damaged, rather than just continuing to make the same repairs over and over again.

I will start off with a question for Dr. Hondula. Would you please describe for us how Phoenix is taking a proactive rather than a reactive approach to extreme heat?

Mr. HONDULA. Thank you for the question, Chairman Carper.

I think it is critical to be proactive in our efforts to prepare, and that preparation really shows up at the minutiae of operating local government in the procurement processes, in our negotiations, in our engagement with industry, thinking about how products work, what the product design specifications are.

Just to give you one example from Phoenix, in our city we are concerned about the impact of heat on the electronic systems in the field that operate our traffic systems and streetlights. That might include diminished lifetimes from LED bulbs. Our traffic signal controller cabinets have fans in them that provide some cooling. When we are shopping for products on the market, building procurement processes, we need to be sure that heat is a factor in that process.

Senator CARPER. As a follow up, are there any key lessons learned for other cities about the benefits and challenges to proactive adaptation?

Mr. HONDULA. Chairman Carper, thank you, it is an excellent question.

Unfortunately, I think we are still very much in the early stages of learning what it means to build heat resilient communities. Phoenix, as I noted, is at the forefront of deploying Cool Pavement technology. We are learning as we go, as we deployed 100 miles where it is most—

Senator CARPER. A hundred miles out of how many miles?

Mr. HONDULA. Many thousands. So just a small fraction.

Senator CARPER. So it is a start.

Mr. HONDULA. It absolutely is a start.

Learning which products bond correctly to the road material, what any trade offs might be in terms of pedestrian thermal comfort or safety. I think all of our communities across the country are still learning how to become more heat resilient.

I think an important role the Federal Government is beginning to play and can continue to play is convening cities together to share what we are learning and ensure we are applying best practices as quickly as possible. As you noted, there is a strong sense of urgency to ensure we are ahead of the game here.

Senator CARPER. All right. Good, thank you.

Mr. Parsons, as you described in your own testimony just a few minutes ago, transportation worker productivity decreases significantly as heat levels increase. Transportation agencies, transportation contractors, and labor organizations all have a stake in finding solutions to ensure the construction work force can continue to safely and efficiently do their jobs building and maintaining our Nation's roads, our highways, and our bridges.

Would you please elaborate on what your union is doing to work collaboratively with the private sector, with government agencies, and other stakeholders, to respond to the effects of extreme heat on construction workers?

Mr. PARSONS. Yes, thank you for that question, Mr. Chairman.

Yes, we work collectively, we are a labor management cooperation fund, so we work with our signatory contractors for worker training, we visit job sites, help contractors write programs, especially small and medium size contractors. That is one way we help, is by assisting our signatory employers.

We also work on a Federal level nationwide on worker advocacies for better protections for workers with every agency that plays in the worker safety and health space. Whatever agency affects workers, whether it is Federal Highway, Federal OSHA, EPA, we work hand in hand with them to increase protection for workers on our jobs.

Senator CARPER. OK, thank you.

A question now for, it could be for Dr. Hondula or Dr. Flannery. Dr. Flannery, why don't you take the first shot at it.

I am proud that our Committee has played a leading role in the enactment of the Bipartisan Infrastructure Law and the Inflation Reduction Act, both of which include new authorities to help make our transportation system more resilient to extreme heat and extreme weather.

Would you, Dr. Flannery, please take a moment to discuss how programs like the Bipartisan Infrastructure Law and the Healthy Streets Program and so forth, the RAISE grant program, describe how these programs and others will help States, will help transportation agencies and local government take more proactive action to make their transportation infrastructure more resilient to hazards like extreme heat and flooding?

Ms. FLANNERY. The one thing that the PROTECT program does provide is for the first time dedicated funding to address things like extreme heat and extreme weather events. For years we have known as an industry that we have needed to address these things. But we have a very vague system that is aging, and so there is lots of need and potentially not a lot of dedicated funding.

So the PROTECT program does provide for the first time dedicated funding, and has spurred within the agencies a need to begin to address resilience, understanding where the vulnerabilities are, and beginning to address those with prioritized lists of projects.

Senator CARPER. I am going to yield now to Senator Capito and Senator Mullin as well. I think we have one of our Senators from the Commonwealth of Pennsylvania who is on his way here. We look forward to his arrival and others as well.

When we come back, Dr. Hondula, I am going to ask the same question Dr. Flannery has answered, I am going to turn to you and ask that question.

For now, Senator Capito.

Senator CAPITO. Thank you, Mr. Chairman.

Dr. Flannery, I mentioned in my opening statement how important I think to not have a one size fits all regulatory environment coming down from Federal Highways. You mentioned in your opening statement that a variety of States, one of which is my home State, that you have seen action on. How important is it to reject that one size fits all and give the flexibility that each State—obviously, West Virginia’s needs are not the same as Arizona, as he tells the story. How important is that?

Ms. FLANNERY. Sure, happy to answer.

One of the challenges with a one size fits all is it limits our understanding of the range of threats that do affect highway assets. For example, we talked about things that happened in Colorado with extreme rainfall and monsoonal air masses. Those aren’t quite the same threats that would affect the State of Florida, for example, where you have a lot of hurricanes and sea level rise.

So understanding the range of threats that affect assets is really important, and they vary greatly across the country. But also understanding the maturity of data systems within agencies. Some agencies are a little bit further ahead of the curve, some are a little bit behind. So having sort of a very rigid program might be challenging for those who aren’t quite ready to jump into the boat fully to embrace the programs. Flexibility is very important.

Senator CAPITO. As you are seeing now, the PROTECT program is rolling out. Are you finding that the flexibility is in that program?

Ms. FLANNERY. Yes, I think so.

Senator CAPITO. Good.

Let me ask this question. You just mentioned this, that State DOTs are tackling this in different ways and at different rates of speed. How could they focus on to get their efforts to move forward more quickly, and how can the Federal Highways Administration help them with that?

Ms. FLANNERY. The one thing we do benefit from as an industry is Federal Highways and the Transportation Research Board and AASHTO have been aware of this challenge that we have to our system and have been developing guidance and research over the past several years on the topic. Now we are into the dedicated funding sources to actual implementation. We are seeing the hiring of new staff, we are seeing the expanded duties of staff to begin to address resilience. And I think that is helping tremendously for States to begin to accelerate implementation.

So they are looking for opportunities, in particular, in West Virginia for example we are looking at opportunities throughout the life cycle of projects and throughout the agency to actually engage staff with these resilience concepts. So whether it be maintenance and operations all the way through to design, there is an opportunity to engage and to include resilience in the decisionmaking.

Senator CAPITO. Thank you.

Dr. Hondula, let me ask you, I was interested to hear about the Cool Pavement. You described that in your opening statement. Just curious, how do you think they are going to be reapplied? It is a new concept, I guess, are you just it experimentally, or are you planning to expand that?

Mr. HONDULA. Thanks, Senator Capito. As I noted, we have been very proud of our work to evaluate the Cool Pavement Program with university researchers. But as you note, we still are in the early stages. Our street transportation department would say that we have moved beyond the pilot stage, we have seen sufficient success in terms of how the material is bonding to the road surface, how residents are perceiving, how it is performing in real world conditions, which we can't learn from a laboratory.

So we have upgraded it into a full scale program. But we are continuing to learn about how well it will perform over time. One concern, for example, is that the reflectivity will degrade as cars drive on the surface, as it weathers.

Senator CAPITO. You mean it wears down?

Mr. HONDULA. It will become less reflective as it become dirty. The same as if we put a piece of paper on the road it would become dirty as well.

So we need to understand how the long term performance evolves to know what the right scale of investment is, at what pace, and see if we are achieving those cost savings that are possible with the reduced thermal wear and tear of the asphalt.

Senator CAPITO. Keep us up on that. That is very interesting.

Mr. Parsons, you did a good job describing the challenges of the heat on our workers. I think we want to make sure we have as many laborers working as possible in safe and healthy conditions. One of the ways we can do that, I think, is to get permitting reform, which I mentioned in my opening statement. I know you all as an organization have been supportive of permitting reform. I didn't know if you wanted to make a statement on that in terms of how it impacts the number of workers and how many workers are actually engaged since we have these permit delays. Is this an area of concern for you?

Mr. PARSONS. Yes, thank you for the question, Senator Capito.

Absolutely, permitting, while important, should never get in the way of progress. We are all about workers going to work safely, and also workers going to work as soon as they can, shovels in the ground, rubber on the road. So we never want to see permitting get in the way of progress or active work.

As a matter of fact, I have actually seen permitting get in the way of some safety interventions on roadways. I will give you a prime example. Everybody knows what a Jersey barrier is, a concrete barrier on the road that protects workers from the traveling public. That will be specced in, it will be paid for, even in a low bid environment in the Federal highway system. And then permitting will come through and take it out, and there are workers out there exposed to hazards because of that permitting.

Senator CAPITO. Wow.

Mr. PARSONS. So absolutely, anything we can do to streamline permitting, although sometimes important, especially for safety, as

long as it is safe out there and we can streamline it and not hold things up, absolutely, I agree with you.

Senator CAPITO. Thank you.

Senator CARPER. Thanks, Senator.

We have been joined by Senator Fetterman, our neighbor to the north of Delaware. Delaware and Pennsylvania used to be the same State, and we gave them their independence about 200 years ago. They seem to have done pretty well since then, too well when it comes to playing football.

Senator Fetterman, you are recognized. Welcome aboard.

Senator FETTERMAN. Mr. Chairman, thank you.

I am deeply concerned for the welfare of our transportation work force in Pennsylvania, of course. Mr. Parsons, these workers are forced to work in an extreme heat without Federal safety standards. What lessons can we take from the States that have set heat standards, or those that have eliminated worker protections?

Mr. PARSONS. Thank you for that question, Senator. What I will say to that is, we need codified heat protections across the country. There is only, in this whole country, I think there are 44 States that do not have a Federal OSHA rule. There are six States that have somewhat of a version of it, and there are three that have a permanent rule.

So without mentioning all those States and messing that up, California kind of set the way a long time ago, and Oregon and Washington State jumped on board last year after the extreme weather and heat related conditions.

We like those rules in place. We like them codified, best practices. In the construction world, unfortunately, there is a lot of good actors out there that do the right thing, fortunately, but unfortunately sometimes smaller contractors either don't have the means or the ways to implement programs unless they absolutely have to.

So we have to set the standard straight across the board, have codified rules for everyone, and have minimum criteria to base our worker protections on.

Senator FETTERMAN. Thank you.

Of course, extreme weather events, particularly flooding for our transportation infrastructure in Pennsylvania, are really wreaking havoc. Dr. Flannery, can you walk us through why it is so important that States and agencies have a consistent source of Federal emergency relief funding that they know will be there into the future?

Ms. FLANNERY. Thank you, Senator.

One of the things that agencies need in terms of the emergency relief program and some of the changes I mentioned earlier in my opening have allowed for the use of resilient designs post-disaster. We have seen changes within the ER program that have been very beneficial. And I think States are doing the best that they can with the limited dollars they have to address the needs of their systems, of their asset management programs. Sometimes they just don't have the ability to get to those needs before these major events occur.

So continual funding of the FHWA Emergency Relief Program is essential to maintain system operations.

Senator FETTERMAN. Thank you very much.

Mr. Chairman, I cede my remaining time. Thank you.

Senator CAPITO [presiding]. Thank you.

Senator MULLIN.

Senator MULLIN. Thank you, and thank you everybody for being here.

Dr. Flannery, first of all, thank you for being here. I sure appreciate your expertise on this. In your testimony, you mentioned the importance of State DOTs maintaining flexibility to accomplish greater returns on infrastructure investments that cater to unique transportation needs. As we know, one size doesn't fit all, right? What is good for New York maybe isn't actually the best idea for States like Oklahoma.

Can you give us a few examples of projects that you have worked on to improve resiliency, and as a result have withstood the extreme weather for specific designs?

Ms. FLANNERY. Sure. I will tell you a little bit about a project that we did in Colorado. We had a major rockfall, rockslide event that occurred on the I-70 corridor that shut down the corridor for nearly 2 weeks. One of the things we did, working with the Federal Highway Administration and the Colorado Department of Transportation, was to look for resilient alternatives, how could we avoid this type of shutdown of a major interstate, east-west corridor in the State of Colorado in the future.

We researched and investigated. There was some new technology in terms of rockfall netting that was available. There were some other things that we could do in terms of monitoring and making the public aware if these events occurred in the future, in terms of warning devices.

Working with FHWA and the division office in Colorado, as well as the Colorado Department of Transportation, we worked to ensure that in the future events are hopefully avoided, and if they do occur, that we can clear them quickly and reopen the facility.

Senator MULLIN. What year was that rockslide on I-70?

Ms. FLANNERY. The I-70 in the Glenwood Springs area?

Senator MULLIN. Yes, what year was that?

Ms. FLANNERY. That would have been 2016, if I remember correctly.

Senator MULLIN. I think you are correct, because I got stuck in that. We got rerouted and had to go way around through the canyon. Then we had to go through a game refuge or a national park. It was an absolute mess. I was pulling a trailer, too, so that even made it worse.

Ms. FLANNERY. Not fun.

Senator MULLIN. I appreciate you getting that fixed for us.

[Laughter.]

Senator MULLIN. Streamlining infrastructure projects is obviously, it is a must, it is not a need, it is a must. And if we want to integrate infrastructure resiliency into our Nation's transportation sector, to do this there is obviously some imperative for the State DOTs to provide information that is required for them. If I understand it correctly from our State DOT, that information isn't always easy to access. Would you agree with that?

Ms. FLANNERY. As I mentioned in my opening, I was a professor at George Mason University. One of the things I think our industry

desperately needs is the continual training of staff. For example, I went to school nearly 30 years ago. I was not taught about climate resilience. I did not teach climate resilience when I taught at George Mason University. So we have a whole bunch of practitioners that are 10, 20, 30 years out of school who never heard these concepts.

Working with organizations like ASCE, for example, the American Society of Civil Engineers, the Transportation Research Board, FHWA, and training outlets is really important. They hear the term; they recognize the need for it. But what does that mean when you put it into practice, I think is still a little bit of a gap. We are working on that, and there is lots of training available. But it is going to take a bit for it to kind of make its way down through the layers of staff and those that can actually impact resilience.

Senator MULLIN. Well, this is me being a politician, you don't look like you were in school that long ago. Your daughter is way too young for that. That is me being a good politician.

[Laughter.]

Senator MULLIN. Going back to that, is there something that Congress needs to do to maybe enact, is there legislation, is there an understanding we need to put into a bill, is there something we can do to help with that?

Ms. FLANNERY. I fall back on this term that I use, models, metrics, and methods. I often say to people, if I say to you, make something more safe, what does that mean? In our world, that means fewer crashes. If I say to you, make something more resilient, you kind of know what I mean, like don't fail and recover quickly. But what does that mean in terms of design or in terms of operations or in terms of maintenance practices?

So we don't yet have standard methods to sort of address resilience or fold it into design. We don't quite fully understand what resilience investments do in terms of return on investment. So things like fundamental research to understand how assets perform under a range of threats would be really ideal. The development of understanding of risk tolerance and what is the acceptable level of resilience on the range of systems that we operate is also something that I think could be helpful for the industry.

Senator MULLIN. Great. Thank you so much.

Senator CARPER [presiding]. Dr. Flannery, in my last question, I directed a question to Dr. Hondula. I said when it was my turn again, I was going to ask the same question of you.

Both of you mentioned the PROTECT Program that we created in Congress in the Bipartisan Infrastructure Law.

I think Dr. Hondula, you also mentioned the Healthy Street Program and the RAISE grant program as well.

My question, Dr. Flannery, is would you take a moment as well to discuss how these programs and others will help States, transportation agencies, and local governments take more proactive action to make the transportation infrastructure more resilient to hazards like extreme heat and flooding?

Ms. FLANNERY. For the past several years, State departments of transportation have been implementing asset management programs and performance management programs. They have begun to look at climate resilience along those lines of how long can as-

sets last, are they deteriorating more quickly, do we need to repair them after extreme events and things like that.

The PROTECT Program, the thing that it does is provide a dedicated stream of funding, so States are now a little bit more comfortable thinking about how I might address resilience from soup to nuts, from planning all the way through design. They see that there is an opening in terms of continual funding, there is an opportunity to make the investments that they have known about, but maybe didn't necessarily have the funding to actually dedicate at the time.

So they are very excited about it. I actually just left a conference of 25 State DOT representatives on the topic of resilience in Wilmington, Delaware.

Senator CARPER. When was that? When were you in Wilmington?

Ms. FLANNERY. Last night, and I am heading back tonight.

Senator CARPER. Me too.

[Laughter.]

Ms. FLANNERY. They are very excited, and the enthusiasm within the industry is very palpable, and very fun to actually be a part of the industry right now.

Senator CARPER. That is great, thank you.

Let me turn to Mr. Parsons again. In your testimony you talked about the burden of extreme heat on transportation workers, and the fact that many of the folks that you and others represent come from low income and in some cases disadvantaged communities. These construction workers are on the front lines of adapting our transportation system to extreme heat events, yet in doing so they are also bearing the burden of extreme heat on their own health and well being.

What type of health impacts from extreme heat are you seeing on our transportation construction work force? What are some of the effective strategies for addressing these negative impacts?

Mr. PARSONS. Some I mentioned lead to chronic diseases. But the more immediate effect is what is called heat stroke, we have all heard of heat exhaustion, and we have all experienced dehydration. But if a worker gets heat stroke, it is usually too late. Oftentimes, the symptoms aren't there.

So we need to put in place requirements to have something as simple as water, rest, and shade. What I mean by that is so much water per hour, a place to take a break, mandatory breaks, at least 15 minutes every 2 hours. And that break area should be shaded, and it should also have some kind of cooling mechanism, whether inside or outside. It doesn't do any good if it is not cold air.

So the types of injuries you experience are exacerbation of people who already have existing conditions, like diabetes, it affects your heart, it affects your kidneys because of dehydration. That answers the first part of your question.

You would think it is human rights on the job, but in today's world, we just don't have that for our workers. And when it comes to the low income workers or other workers of color, oftentimes they are also placed in the most dangerous jobs, and they don't speak up for themselves. They may or not be documented workers, they may be lower paid.

So they are worried about losing their jobs more than anybody, so they don't speak up for safety on the jobs, another reason why they are more vulnerable.

Senator CARPER. All right. Thank you for that.

Dr. Hondula, I want to come back to you for my next question. Based on your experience in running the first municipal office in the country, I believe, dedicated to addressing heat, what advice would you have for other cities that are struggling with extreme heat and are looking for solutions?

Mr. HONDULA. Thank you for the question, Chairman Carper.

I think our experience is that it is critical within the structure of local government and arguably other scales to clearly articulate where the leadership is in the organization for heat, which department and which people there are responsible for ensuring heat is a consideration in every relevant policy or program.

There are tens of thousands of large and small cities, large and small towns across the United States, not everyone is going to be positioned or have the right model to have an entire office in local government. But I still think it is possible in every city to designate a heat leader in the organization, so when people have questions, whether it is residents or people from within the organization, they know where to go. That has been very helpful for our experience in the city of Phoenix.

Senator CARPER. Good.

Anybody else, any other panelist want to comment on that? What advice would you have for other cities that are struggling with heat and are looking for solutions? Any thoughts? If you don't that is fine, but if you do, you are welcome to respond. No? OK.

Follow up question for Dr. Hondula. How can the Federal Government better assist States in their efforts to stand up these offices?

As a recovering Governor, I used to be Governor of Delaware for 8 years. I loved being Governor. There are 14 of us here in the Senate who are former Governors. We were all part of the National Governors Association in those years, and part of the National Governors Association is a center for best practices that Tommy Thompson and I were active in standing up when he was Governor of Wisconsin.

The idea is for States to have a forum, a vehicle, to share ideas that work. So I always hold that out there as a way for States to help one another, including transportation issues.

Dr. Hondula, how can the Federal Government better assist States in their efforts to stand up these offices? Any more thoughts that you have, please proceed.

Mr. HONDULA. Thank you, Chairman Carper.

I would like to echo a sentiment we hear from Dr. Flannery that education is a really important role that the Federal Government can play in supporting resilience efforts at the local scale for heat or other hazards. We have been really proud to work with the National Oceanic and Atmospheric Administration as part of their efforts to coordinate cross-Federal agency engagement on heat through the National Integrated Heat Health Information System.

Phoenix has been proud to be one of four cities participating in a heat and equity pilot program. We are in dialogue on a regular

basis with Las Vegas, Charleston, and Miami, learning about our experiences. We all have a different approach to heat, heat manifests differently in our four different cities, and we have a different governance model as well.

I think agencies like NOAA, like the CDC and others can be very helpful in building heat literacy at the local level, understanding the design vocabulary, the specifications. What is the difference between air temperature and surface temperature, for example? These are critical concepts that our local leaders need to have to ensure that our hazard mitigation plans are thoughtful and comprehensive in addressing heat, and that heat shows up in other planning processes and in the budget processes in a meaningful way to help our residents.

Senator CARPER. Good, thank you.

Another question, I don't mean to be picking on you, Dr. Hondula, but we will give Mr. Parsons and Dr. Flannery a few more shots as well. This summer's widespread extreme heat has been really staggering, including a month, as we talked to earlier, of temperatures over 110 degrees in your own city of Phoenix. Academic scientists affiliated with world weather attribution found that the maximum heat experienced in July in the western United States would have been virtually impossible, virtually impossible, without human caused climate change.

A question of you, Dr. Hondula, would you talk with us a bit about how climate change is affecting the work that you do in Phoenix to address extreme heat?

Mr. HONDULA. Thank you, Chairman Carper, for the question.

In part, I think it created this job. I think one of the motivating factors for our mayor and city council to create the country's first local office focused on heat was our observation that temperatures have been rising in the Southwest and indeed all across the country, and that they are expected to continue to rise.

Other motivating factors were the recognition that heat does have serious public health consequences, as my fellow witnesses have provided testimony regarding, and that there is this governance gap for heat. There has been too much ambiguity regarding where in the organization responsibility falls for managing heat.

In the city of Phoenix, we see climate change and extreme heat as closely coupled topics. We hear from our residents all the time that they are concerned about how it has been getting warmer and what that means for the future. We hear stories about going outside, playing in the evenings in bare feet from residents who have been in Phoenix for multiple generations. But they say they don't see the same happening with their children today, and they are concerned about what the future looks like.

So I think the projections of a warmer future are motivating our work very strongly every day. I would argue that the work is already important. Even if projections were for a cooler future, we still are not doing a good enough job meeting the heat challenge today. But the fact that the projections are for a warmer future adds more motivation and a sense of urgency to our work.

Senator CARPER. All right. Thank you.

Dr. Flannery, another question of you. What more should the Federal Government do to help States prioritize the resiliency of our transportation infrastructure?

Ms. FLANNERY. As I mentioned earlier, we still have a need for some fundamental research. And what I mean by that is understanding asset performance under a range of threats and a range of magnitude. For example, how might a culvert perform under a rainfall event of some particular magnitude versus another.

Also taking into consideration the age of the asset. As we know, our infrastructure can be upwards of decades years old. Understanding how they may deteriorate or fail under different conditions is something that we still have a lot of need to better understand.

Also listening to some of the testimony about heat, some of the emerging research, understanding the deterioration of pavements under these increases in temperature is something that we still have yet to incorporate into our pavement management programs. It could be something, again, fundamental research that places like Turner Fairbank and some of our university transportation centers would be very valuable.

Senator CARPER. All right, good.

I am going to be talking about football here. I don't want to mention baseball, but they have a term in baseball that is called, when a pitcher is holding a ball, releases the ball, there is a certain way of throwing a pitch. The pitcher can telegraph the pitch. I am going to telegraph a pitch. I have a couple of questions to ask of you. I am going to give you the chance of, maybe a question you were not asked, which you would like to have been asked. Just tell us what that question would be, and then answer it. That is how we will wrap up right at the end.

We have a lot of competition going on with hearings in the Senate today. There is a large forum that is going on in the building next door, right here in the Capitol, on AI, a major forum on AI. So we were maybe hoping that a couple other colleagues could join us, but there is a lot going on. That does not diminish at all the importance of this hearing, so we are deeply grateful for your participation.

Dr. Hondula, your written testimony mentions the effect of electric vehicles on reducing heat intensity. I am told that something like 30 percent of the greenhouse gas emissions that we are creating in this country comes from the cars, trucks, and vans that we drive. Maybe another 25 percent comes from our power plants that produce the electricity that we use, and maybe another 20 percent comes from the manufacturing operations of asphalt, steel mills, and stuff like that.

Would you talk with us a little bit about the effect of electric vehicles on reducing heat intensity, please?

Mr. HONDULA. Thank you, Chairman Carper.

Phoenix is very proud to be leading national efforts toward vehicle electrification. In fact, the term Electric Valley circulates in our local conversation in Phoenix because of the progress we have made.

Separate from the greenhouse gas emissions that you noted, Chairman Carper, vehicles are also a very important part of the

urban heat story, because they directly emit waste heat into the environment. We have all had that experience of standing next to a car and feeling the heat radiating off of it. It is estimated that vehicles add up to 40 percent of all heat added to the urban environment from energy consumption. Other sources might include air conditioners, for example.

So vehicles are a really important part of the story of why our cities are hotter than their surrounding areas. If we can have vehicles that emit less waste heat, which electric vehicles would, we could potentially be achieving cooler cities in the future.

We are certainly trying to make an effort to lead by examples as a local government, converting our city's vehicle fleet to alternative fuel sources. We are making good progress doing so with our light duty vehicles, and we are in the early stages of transitioning heavy duty vehicles, including the bus fleet. When we talk about resilience to extreme heat, having electric and other alternative fuel source heavy duty vehicles that work well in the heat is still an area where we are looking for more market innovation.

Our bus fleet transition plan includes plug in battery electric buses and hydrogen fuel cell electric buses. We are pursuing a complete transition to 100 percent zero emission buses by 2040. We have been using Federal funding to help with this transition, including more than \$16 million in FTA low and no emission grant funding as part of the BIL. We are also appreciative of the new Charging and Fueling Infrastructure Grant program created in the BIL that will continue to expand the deployment of EV charging and other types of alternative fuel stations.

The transition to alternative fuels can be a transition toward vehicles emitting less heat into our already hot cities.

Thank you, Chairman.

Senator CARPER. Thank you.

Maybe one more for you, and then we will get each of you to ask your own questions.

Dr. Hondula, what has been the biggest challenge you face in trying to reduce shade deserts across the city of Phoenix?

Mr. HONDULA. Thank you, Chairman Carper.

Eliminating and reducing these shade deserts is certainly a priority for our office. Of course, one of the challenges is simply the availability of resources to do so. Eliminating a shade desert requires more than just handing a tree to a person and hope that it will survive. We need to be very comprehensive in thinking about the complete basket of strategies and solutions that can allow for more shade.

We are certainly appreciative of additional resources. The new Urban and Community Forestry Program we hope will help us get there. We have a couple of large proposals in there.

But I think the biggest challenge that we experience, and other cities would experience, is that there are locked in legacy effects of previous infrastructure design that constrain where and how we can move forward. There are only so many places in the city that are easy to modify right now to add more shade. But the places where we really need shade require more significant overhaul of the streetscape, of our infrastructure systems. And of course, that becomes more expensive.

We need to break those patterns that we have been locked into and be strategic and thoughtful how we do so. And we know that we will be needing the Federal Government's assistance to get there in all of our underserved communities.

Senator CARPER. All right.

Either of the other witnesses want to comment on that question? All right.

Before we close, this is a chance for you to ask maybe a question you wish you had been asked but were not, then respond to that question.

Dr. Flannery, would you lead this off?

Ms. FLANNERY. Sure.

One of the things I think that as an industry we are still struggling to understand is the rightsizing of assets. What I mean by that is, does it make sense to build your way out of some areas. In some ways, there may be areas in your system that might not make sense to re-invest in. It may make more sense to move the facility or abandon the facility.

I think there is still a lot of research to be done in that area, and a lot of support to State agencies as they struggle with some of these areas that are challenging within their system that experience repeat damage. Understanding risk tolerance is also something that we as an industry could use help with.

Those are things that I think FHWA and AASHTO, the Transportation Research Board, could help with.

Senator CARPER. All right. Thanks very much.

Mr. Parsons, please. A question, if we were sitting in different seats, and I was out there, and you were asking a question, what question would you have asked?

Mr. PARSONS. Maybe two quick ones. I would address something that has already been mentioned but maybe expand on it. One of them is from my esteemed fellow witnesses here. I wrote a couple of notes down for myself.

We really need to work on interagency cooperation between all of our Federal programs, Federal Highway, EPA, OSHA. A lot of times there is a punting back and forth on whose jurisdiction is what. We really need to work on better cooperation between those agencies for worker protection. So I think you brought up inter-agency cooperation.

Along those same lines, another thing I wrote down was understanding of Federal aid programs, especially in the era of IIJA, BIL, whatever you want to call it nowadays. We have an opportunity right now as a country to improve our roads, to improve our resiliency, and to improve our worker protections like no other. There is a lot of money out there. We need to educate people on how to use that money, how to access that money, and how to level the playing field for employers alike.

Then the one last thing I would like to say, this whole one size fits all, I agree, one size does not fit all across the country, especially when it pertains to heat. When it comes to heat, you are talking about relative humidities that are different, different temperatures, wind, personal protective equipment, type of work you do. But you need to have a fundamental ground that you start with when it comes to worker protection, such as water, rest, shade.

So while it is not one size fits all, we have to do exposure assessments on our jobs, it is actually a requirement for the employer to do that across the country. They have to do exposure assessments for every hazard, including heat. So it is not one size fits all, it is an exposure assessment with fundamental core values and protocols to start with.

Senator CARPER. All right, thank you for that.

Dr. Hondula.

Mr. HONDULA. Thank you, Chairman Carper.

Perhaps two questions that might have been asked, or that I would be interested to ask somebody sitting in this seat. In the Phoenix area there has been some mixed messaging in the media coverage of the Cool Pavement Program, including a headline that Cool Pavement makes people hotter.

So a question might be, why are these conflicting messages in the media about the Cool Pavement Program? If I may take a moment just to explain the state of our understanding thus far about Cool Pavement.

Senator CARPER. Yes, please do.

Mr. HONDULA. The reason that cities are pursuing or might consider pursuing Cool Pavement is that pavement is hot, and if we can make a hot surface less hot, that should produce a benefit in terms of cooling the city.

But like every heat mitigation strategy, there is the potential for unintended consequences. If we plant a tree, for example, in the wrong place, it could disrupt above or below ground utilities, which could have unintended disruption of service.

With respect to Cool Pavement, what our experience in Phoenix has been is that because we are reflecting more solar energy away from the surface, a person who is standing directly above it, on the road surface when the sun is out, might experience more heat stress than over traditional coating. The sunlight has to go somewhere, and if it is reflected into the human body, that could be adverse for the person standing on that street.

This does not mean we shouldn't deploy Cool Pavement, but it means we need to be very strategic in where we are putting Cool Pavement, avoiding places like playgrounds or plazas where pedestrians tend to congregate. In our cities, there are thousands and thousands of miles of pavement where people are not congregating. Those are the places that make the most sense for more reflective surface, rather than these settings of congregation.

That is how we have had this mixed messaging emerge in our media coverage of Cool Pavement in Phoenix. That was one question.

And if I may entertain a second, Chairman Carper.

Senator CARPER. Yes, you may.

Mr. HONDULA. I think it could be argued that our cities and Federal Government are behind where we would like to be in managing heat. The question might be, why is that the case. I don't think we have adequately framed heat as a hazard like others. As you and my fellow colleagues here have noted, heat is a very consequential hazard for Americans in terms of the public health impacts, accounting by most metrics for more deaths every year than most other hazards combined.

Yet when we look at lists in notices of funding opportunities, here are the hazards and disasters you can apply for money for, heat does not always appear on that list. In fact, heat is not yet included in the Stafford Act that shapes how FEMA can issue its response and hazard mitigation money to communities.

I don't think it is just a matter of getting the word heat in the acts. We need to think about the mechanisms, the evaluation, the processes that will provide the right resources to communities. But it would be a terrific first start if we could see extreme heat start to appear on lists along with all the other hazards that are so consequential for Americans. We know that heat is consequential as well.

Senator CARPER. Good.

I saw a couple of our witnesses nodding their head as you spoke. Do any of you want to add anything to what Dr. Hondula just said?

Ms. FLANNERY. I was just going to say, this is something that we definitely need to study further in highway infrastructure, understanding material performance, understanding asset performance under those stressors of extreme heat. It is an area that we haven't researched very extensively to date, and certainly something that we need to invest in.

Senator CARPER. Thank you.

Mr. Parsons.

Mr. PARSONS. I will just say I concur with that last statement, that we need more funding, available funding for heat as a hazard, for all of the above, for occupational and public health resiliency. And I forgot to mention that I loved your "heat leader." In the construction world, we call that a competent person on a job site. But it is a heat leader, I wrote that down from your statements. Thank you.

Senator CARPER. Good. Thank you all.

Before I do a little bit of housekeeping, let me just say, I have had the privilege of representing Delaware, which is about 90 minutes away by train from Wilmington to Washington. It is not all that hard, the trains start early in the morning and run into the night. I have been able to represent Delaware and serve Delaware and live in Delaware and work here and go back and forth.

Usually when I am driving to the train station in the morning, I have an electric vehicle, it is really great, a lot of fun to drive. It also has a great music system. It is one of those deals where you can play radio stations or whatever, you can also make requests. I asked my music system to play an appropriate song for today's hearing, we kicked off the hearing this morning that Senator Capito may well be in a forum later today with Lady Gaga, who is quite a star in her own right.

I asked the music system in my car to play a song called "The Heat is On," by Glenn Frye, who was one of the original Eagles. The heat is on, it has been on for a while, and it is likely to be on for a long while. The question is, what do we do about it? What do we do about it?

As it turns out, here in the Congress, with the support of the Administration, we have done a lot about it.

I announced a couple of months ago that I am not going to run for re-election next year. But I remind my colleagues and the con-

stituents at home that I will continue to serve in the Senate until high noon on January 3rd, 2025. So I am going to be running through the tape on a lot of things that I still want to get done. One of those is to fully implement the provisions in the Bipartisan Infrastructure Law, not just those that deal with roads, highways, bridges, ports, and rail and so forth, but also climate provisions. I want to make sure that we have fully implemented provisions in the Inflation Reduction Act that pertain to climate change.

I mentioned earlier that if we can address climate change, including heat, in our State and all the States across the country, including Arizona, we can do it in a way that can create a lot of jobs, a lot of economic opportunity. If we are smart, we will do both.

I am not that smart, but I have really smart people around me, and a lot of smart people who serve on this Committee. Our staffs, both on the majority and minority side, have looked across the country to find witnesses that are well suited to address this issue of heat, and they have come up with all of you, each of you. We are grateful that you have joined us. Thank you for the work that you do, thank you for imparting your wisdom and your thoughts to us today.

Before we adjourn, a little bit of housekeeping. Senator Kelly has been trying to get here, he is in another hearing, and I think Senator Markey is in another hearing, and there is this big forum that is going on in AI, artificial intelligence, that a lot of people are participating in this morning. But that does not mean there is not strong interest in continuing to address the heat and the things that are causing the heat.

Before we adjourn, a little bit of housekeeping. Senators may submit questions for the record until the close of business on Wednesday, September 27th. We will compile those questions, send them to each of you, our witnesses, and we will ask you to reply to us by Wednesday, October 11th.

I am going to look over my shoulder and see from majority staff, minority staff, if there is anything else we are forgetting.

All right. In our business, at this point in time, we say it is a wrap. We are grateful for the work you do, and for your sharing your wisdom with all of us today.

With that, this hearing is adjourned. Thanks so much.

[Whereupon, at 11:29 a.m., the hearing was adjourned.]

