

NATIONAL  
ACADEMIES *Sciences*  
*Engineering*  
*Medicine*

**TRB** TRANSPORTATION RESEARCH BOARD

NCHRP *National Cooperative*  
*Highway Research*  
*Program*

# IMPACT REPORT 2021

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. John L. Anderson is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the **National Academies of Sciences, Engineering, and Medicine** to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the National Academies of Sciences, Engineering, and Medicine at [www.national-academies.org](http://www.national-academies.org).

The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to provide leadership in transportation improvements and innovation through trusted, timely, impartial, and evidence-based information exchange, research, and advice regarding all modes of transportation.

The Board's varied activities annually engage about 8,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

Learn more about the Transportation Research Board at [www.TRB.org](http://www.TRB.org).

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## National Cooperative Highway Research Program

Systematic, well-designed, and implementable research is the most effective way to solve many problems facing state departments of transportation (DOTs) administrators and engineers. Often, highway problems are of local or regional interest and can best be studied by state DOTs individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation results in increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

Recognizing this need, the leadership of the American Association of State Highway and Transportation Officials (AASHTO) in 1962 initiated an objective national highway research program using modern scientific techniques—the National Cooperative Highway Research Program (NCHRP). NCHRP is supported on a continuing basis by funds from participating member states of AASHTO and receives the full cooperation and support of the Federal Highway Administration (FHWA), United States Department of Transportation, under Agreement No. 693JJ31950003.

The Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine was requested by AASHTO to administer the research program because of TRB's recognized objectivity and understanding of modern research practices. TRB is uniquely suited for this purpose for many reasons: TRB maintains an extensive

committee structure from which authorities on any highway transportation subject may be drawn; TRB possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; TRB's relationship to the National Academies is an assurance of objectivity; and TRB maintains a full-time staff of specialists in highway transportation matters to bring the findings of research directly to those in a position to use them.

The program is developed on the basis of research needs identified by chief administrators and other staff of the highway and transportation departments, by committees of AASHTO, and by the FHWA. Topics of the highest merit are selected by the AASHTO Special Committee on Research and Innovation (R&I), and each year R&I's recommendations are proposed to the AASHTO Board of Directors and the National Academies. Research projects to address these topics are defined by NCHRP, and qualified research agencies are selected from submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Academies and TRB.

The needs for highway research are many, and NCHRP can make significant contributions to solving highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement, rather than to substitute for or duplicate, other highway research programs.

## Introduction

Each year, NCHRP produces dozens of research products that offer guidance on topics that are important to state DOTs as well as others within the highway industry. In some instances, the benefits of applying NCHRP research products are evident immediately, whereas the impact of applying other research products may not be understood or achieved for several years. Although there are no easy predictors or uniform measures of outcomes and impacts, the use of NCHRP research products has consistently and repeatedly generated value to practitioners, researchers, and decisionmakers from state DOTs and other transportation agencies and, consequently, to the general public.

The NCHRP Impact Report 2021 is fourth in a series that began in 2019 and attempts to document and present that value, in the form of outcomes and impacts, of the application of NCHRP research products.

Containing data and anecdotes compiled from various sources, this report presents an overview of recent NCHRP research products, how the products are disseminated, and the impacts of product application.

Despite the COVID-related challenges that affected many, NCHRP continued to produce high-quality research products, engaged thousands of practitioners in our webinars, and provided value and benefits to all of our stakeholders at state DOTs, governmental agencies, educational institutions, the private sector, and other organizations.

This report reflects the three distinct goals of NCHRP's approach—Generating Knowledge, Disseminating Knowledge, and Producing Impacts—and examines how state DOTs and other stakeholders benefit from each goal.

**GENERATING  
KNOWLEDGE**

# Our research products cover a range of research areas

Each year, NCHRP produces dozens of research products that offer guidance on topics that are important to state DOTs as well as others within the highway industry. The subject matter of NCHRP research products extends across the full spectrum of concerns within the state DOTs and demonstrates AASHTO's interest in acquiring answers to the many acute problems facing state DOT administrators and engineers. In 2021, NCHRP produced 65 research products across different series, covering 15 different subject areas, and extending across all facets of a state DOT's operations.

Exhibit 1: Number of NCHRP research products produced in 2021 by series.

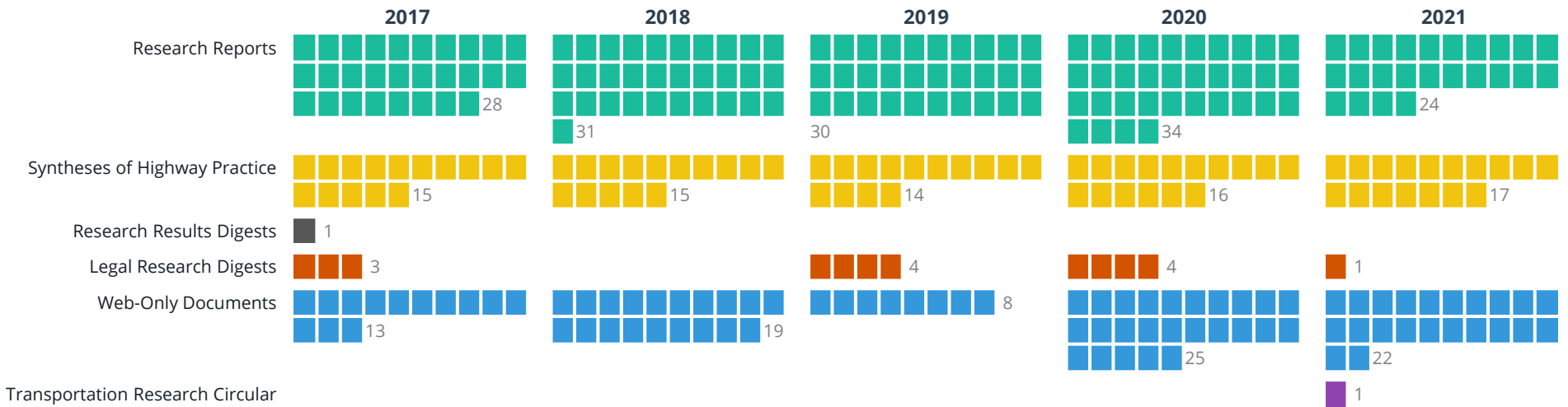
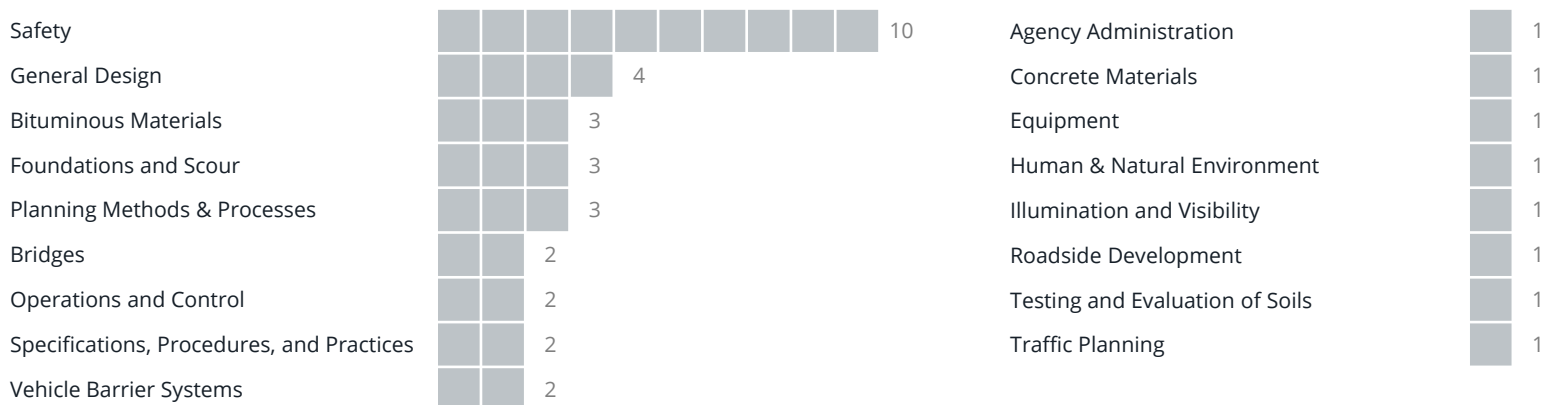


Exhibit 2: Number of NCHRP research products produced in 2021 by research area.\*



\* Does not include 26 research products produced under Special Projects.

# Our project panels are diverse, which results in better NCHRP research products

NCHRP project panel members assume key responsibilities for (1) helping ensure the quality of NCHRP research and (2) to help develop the best products possible—products that are objective and credible and significantly advance the state of knowledge or practice. Experience has shown that NCHRP gets the best results when receiving guidance from panels of subject matter experts, who bring diverse perspectives and experiences to bear on any given topic and can gauge the effectiveness of proposed research approaches and successfully monitor the research. The quality of our research reflects the growing diversity of NCHRP panel compositions in terms of gender, ethnicity, and professional affiliations.

Exhibit 3: Break up by state of NCHRP panel members on NCHRP projects initiated in 2021.

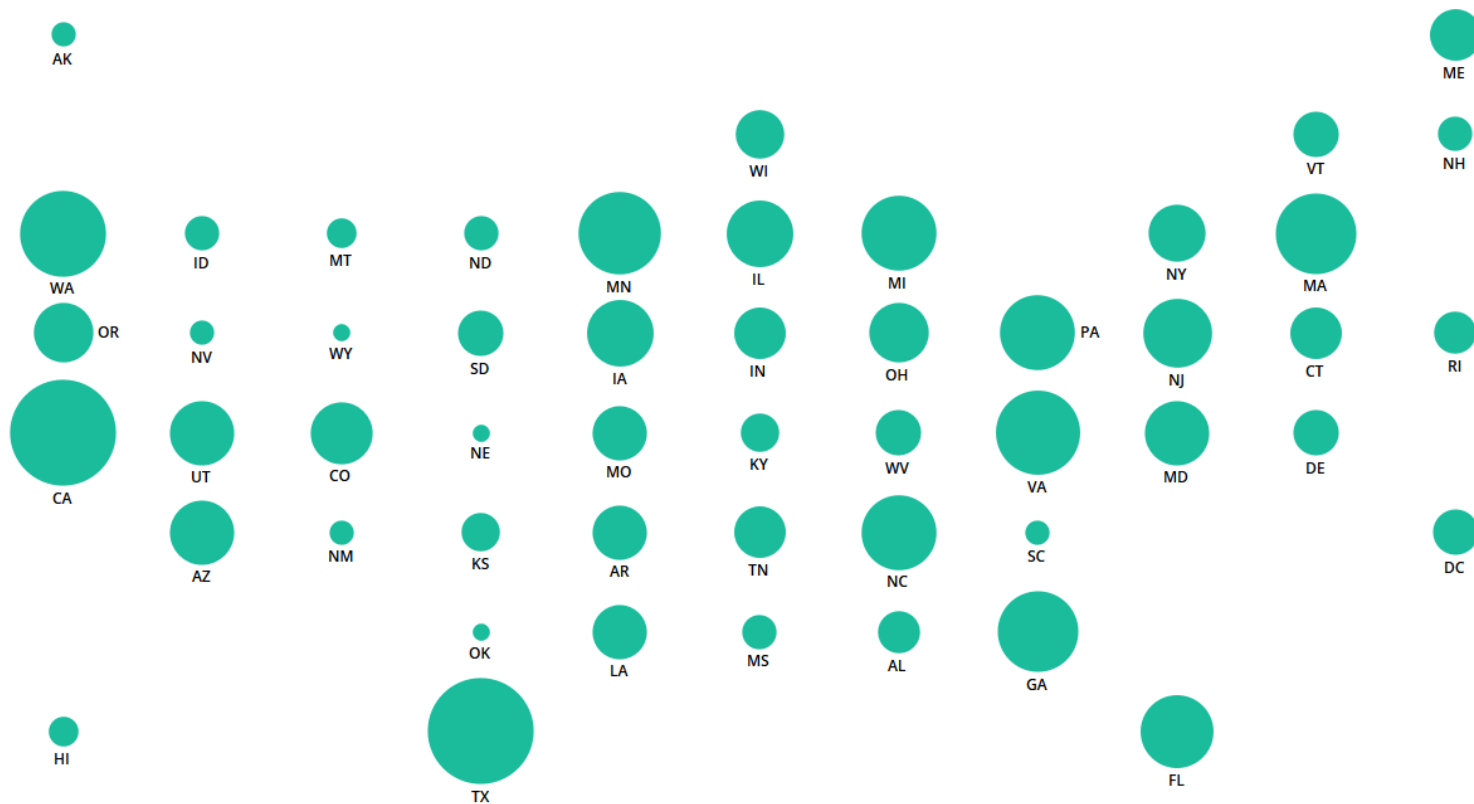
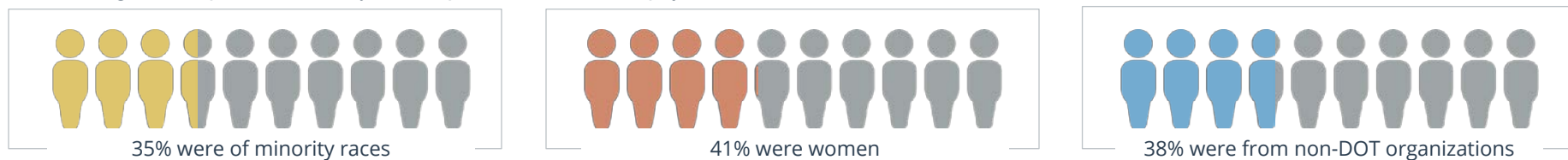


Exhibit 4: Ethnic, gender, and professional diversity of NCHRP panel members on NCHRP projects initiated in 2021.



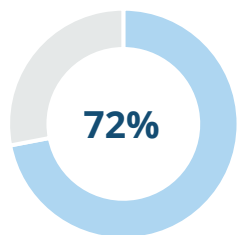
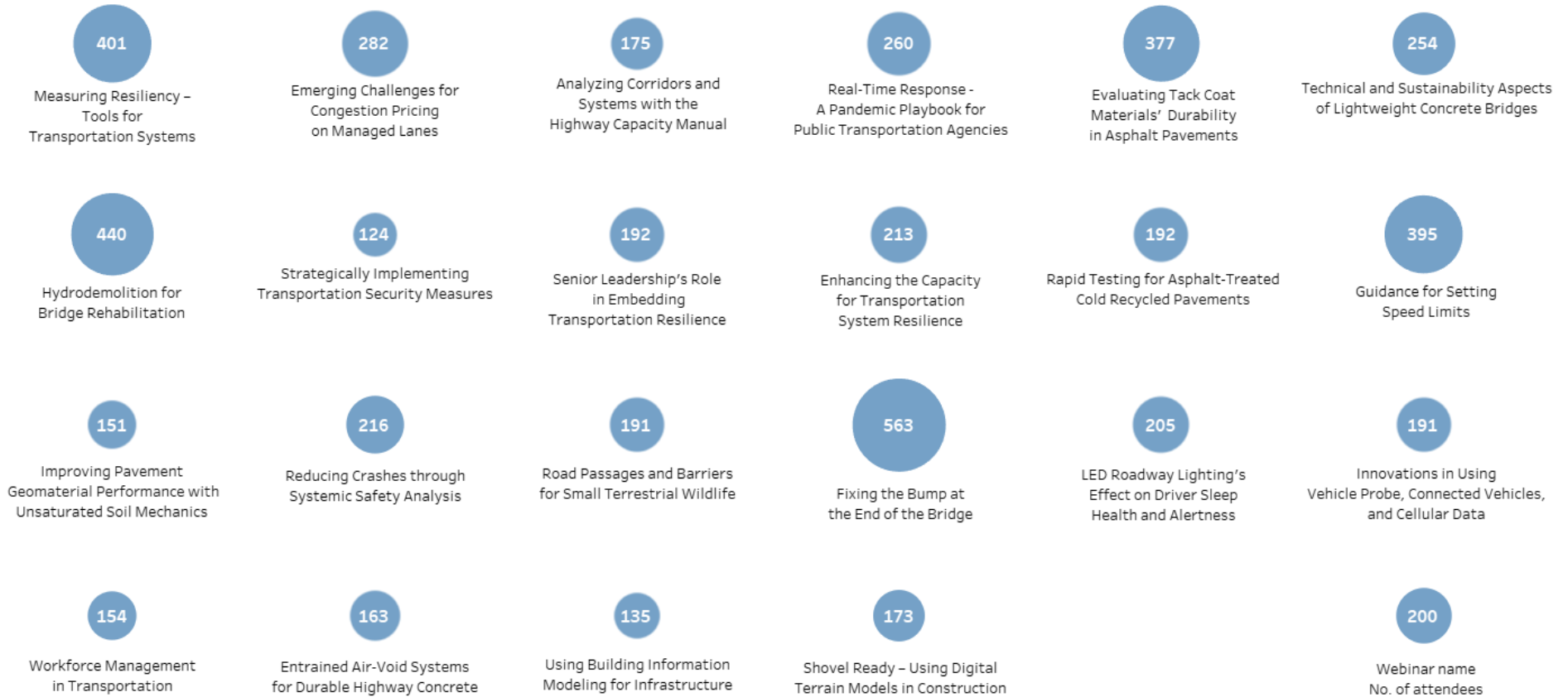


# **DISSEMINATING KNOWLEDGE**

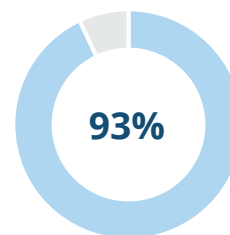
# NCHRP webinars are reaching more practitioners

Webinars are an effective way of informing and educating practitioners about relevant new research. Often, the information acquired through these webinars lead to implementation of the research. In 2021, NCHRP research products were the focus of 22 webinars attended by over 5,400 participants, including over 360 first-time participants. These webinars covered a wide range of topics as shown below.

Exhibit 5: Webinars on NCHRP research products held in 2021, with their attendees.



The proportion of participants who were from state DOTs.

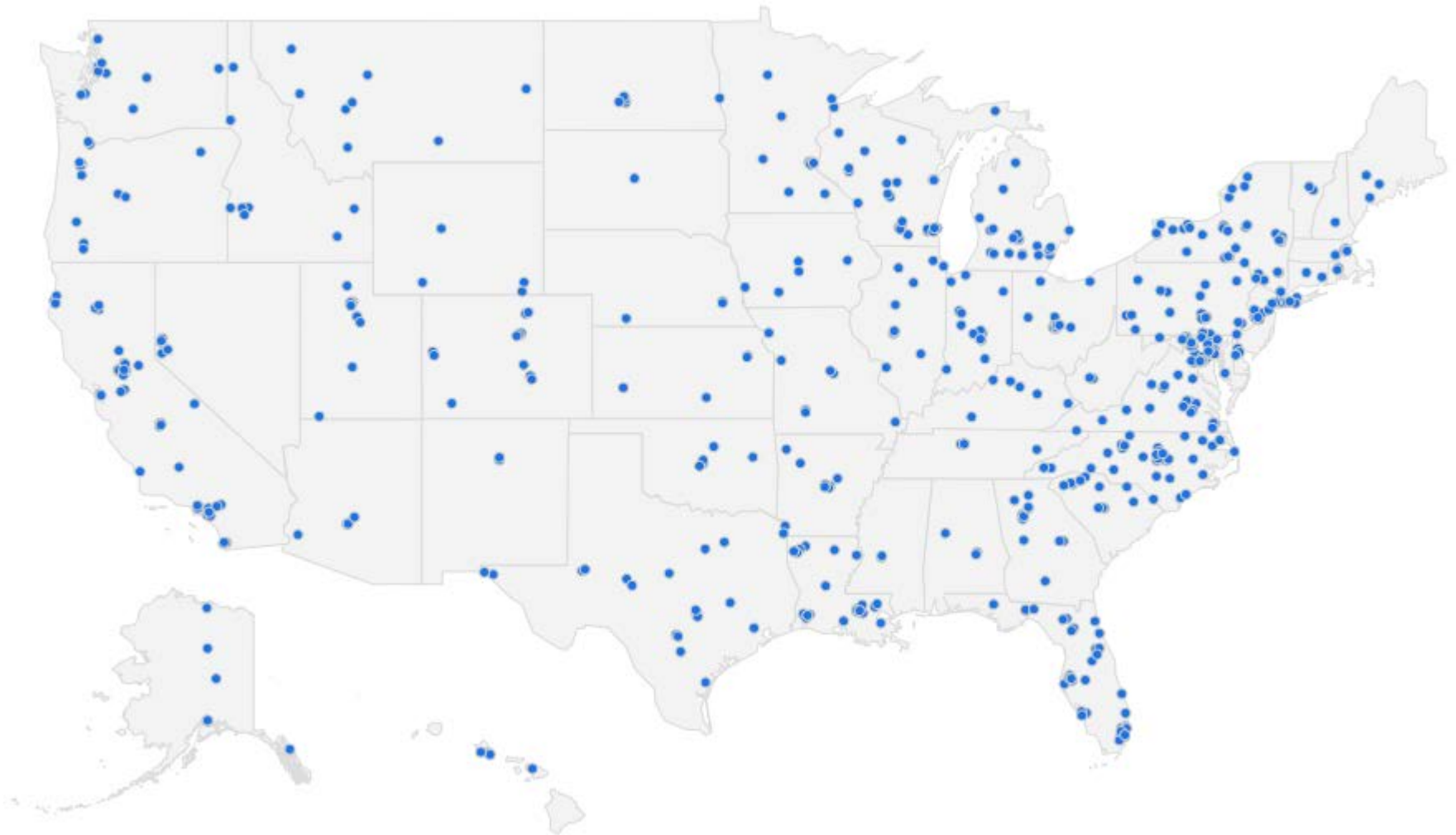


The average satisfaction rate across 22 webinars — a good indicator of the high quality of our webinar offerings.

# NCHRP webinars are reaching more practitioners

Our webinar participants cover a wide range of organizational affiliations, professional expertise, and interests. Moreover, they attended NCHRP webinars from all 50 states and the District of Columbia, as well as 27 other countries from around the world.

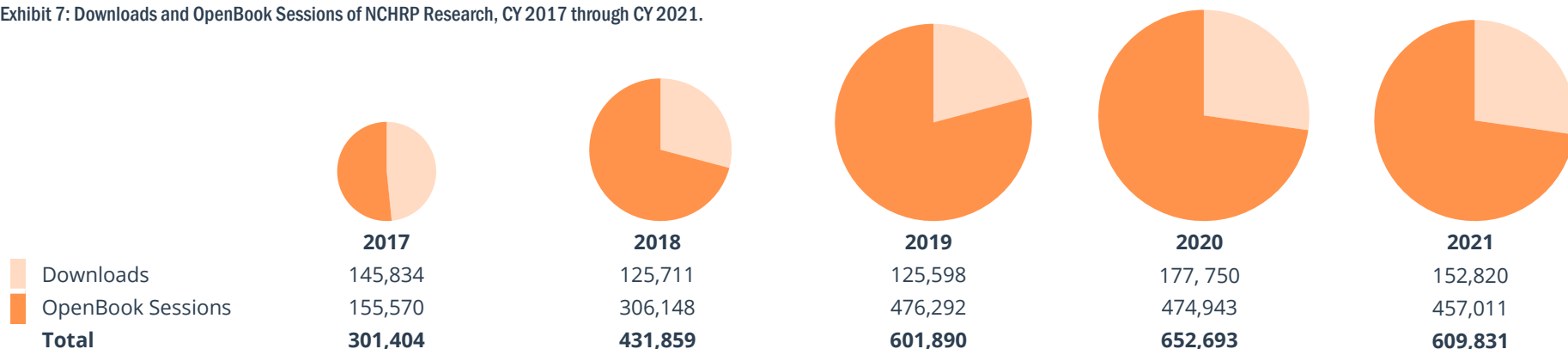
Exhibit 6: Location, within the 50 states and Washington D.C., of the attendees of NCHRP research products webinars held in 2021.



# Downloads and OpenBook Sessions of NCHRP Research

Downloads and OpenBook Sessions\* are key indicators of who is using what NCHRP research products and how. NCHRP research products were accessed nearly 610,000 times in 2021.

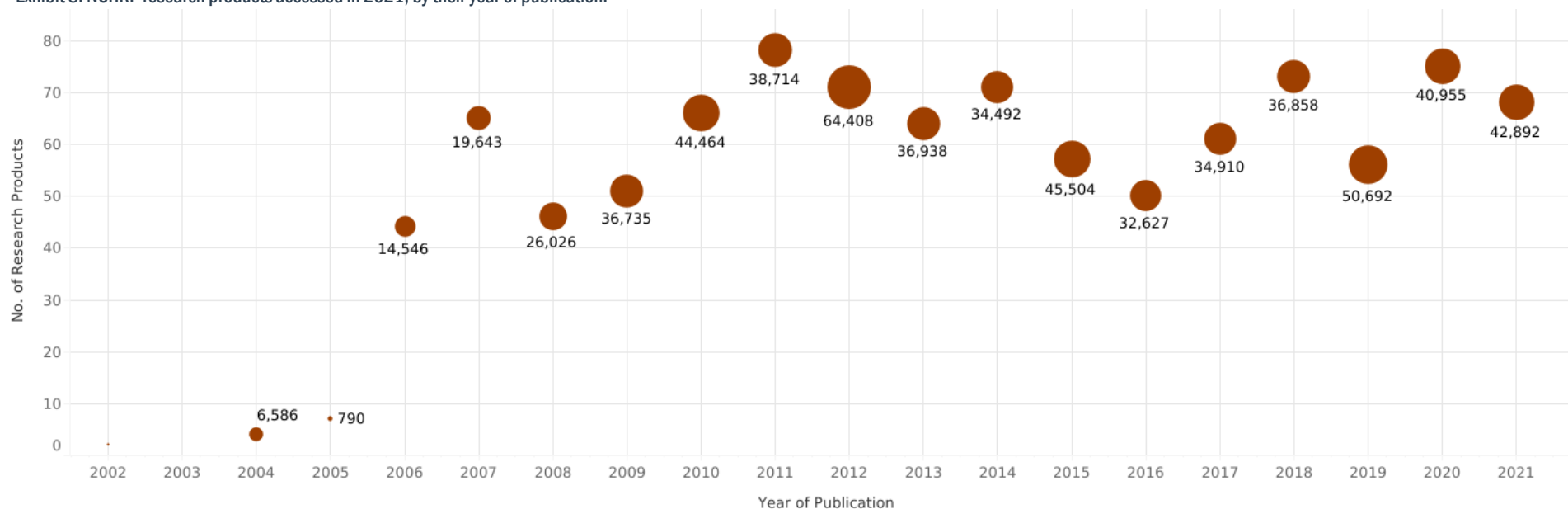
Exhibit 7: Downloads and OpenBook Sessions of NCHRP Research, CY 2017 through CY 2021.



\*OpenBook sessions are the number of times a report has been read online.

NCHRP research products have value well beyond their immediate publication. Our Downloads and OpenBook data showed NCHRP research products published in 2002 through 2021 were accessed in 2021.

Exhibit 8: NCHRP research products accessed in 2021, by their year of publication.



# **PRODUCING IMPACTS**

# NCHRP research products contribute to formulating national guides, handbooks, and manuals

NCHRP research forms the basis for AASHTO publications that are widely used by transportation agencies. The publications design serve as industry standards and are often the result of continuous cycles of research conducted under the NCHRP. Below are some of those publications from the last 15 years that were developed from NCHRP research.

Exhibit 9: AASHTO publications developed from NCHRP research since 2006.



**THE 2021  
NCHRP PUBLICATIONS  
SURVEY RESULTS**

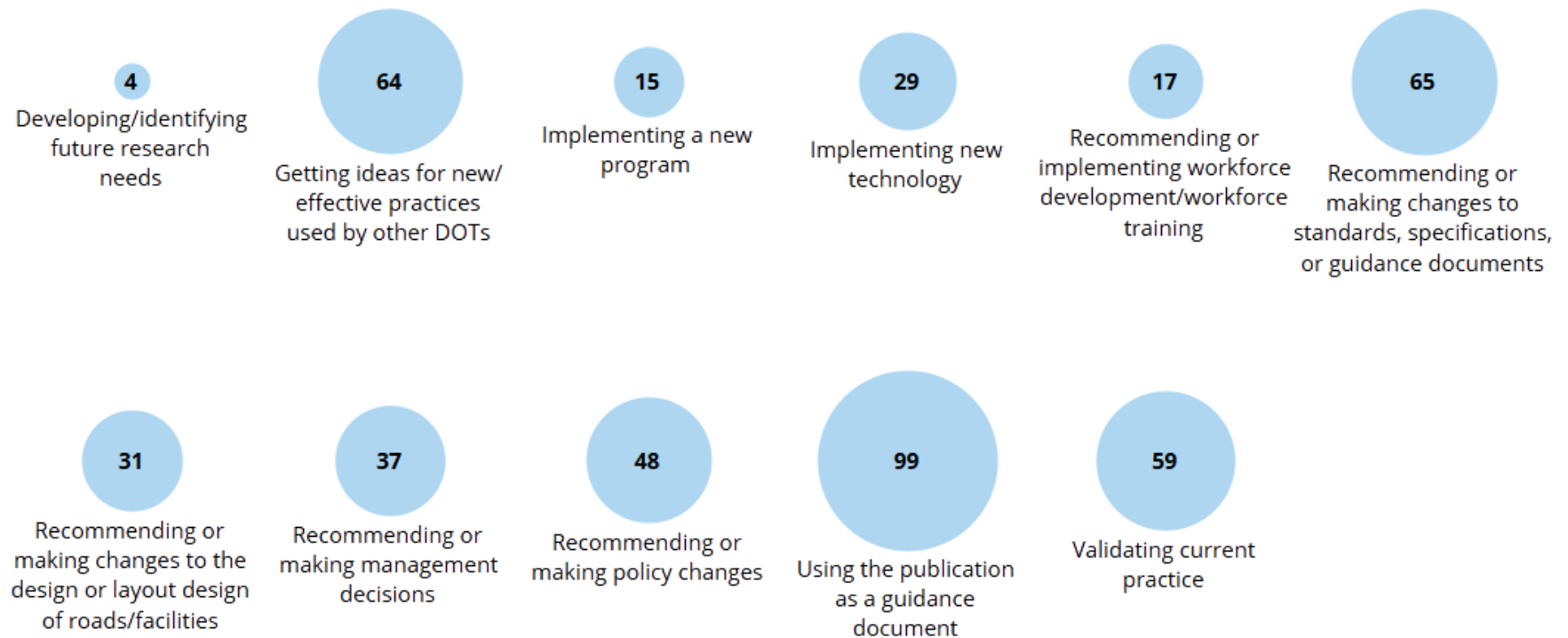
In late 2021, NCHRP surveyed practitioners, researchers, and decisionmakers within state DOTs and the larger transportation community to determine what NCHRP research products were used, how they were used, and what benefits they produced. Covering 61 NCHRP publications published in the year 2017, over 550 surveys were completed, providing valuable insights. The full list of publications is provided as Appendix A.

The next few pages highlight what our respondents told us about where and how those publications were used and the benefits the publications produced within the respective organizations.

## How NCHRP research products were applied

The same NCHRP research product can often be applied differently by different users. Below are some of the major ways NCHRP research product were applied, according to our 2021 NCHRP Publications Survey.

Exhibit 10: How organizations applied NCHRP research products.



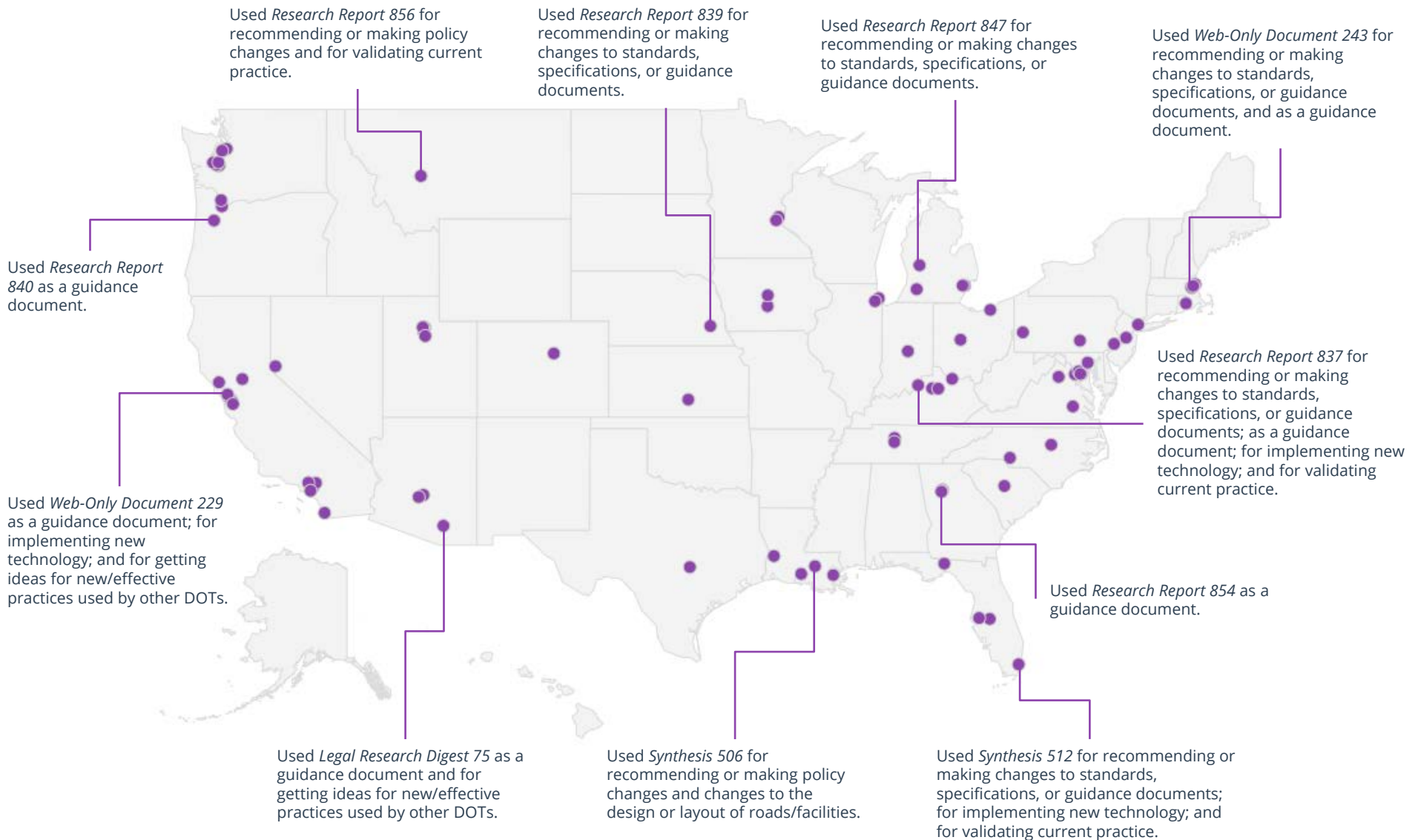
The size of the circles and the numbers in them denote the number of responses for that application.



# Where NCHRP research products were applied

In 2021, 152 respondents indicated that their organization had successfully applied NCHRP research products. Each dot on the map below denotes a location where the respondents' organization applied NCHRP research products.

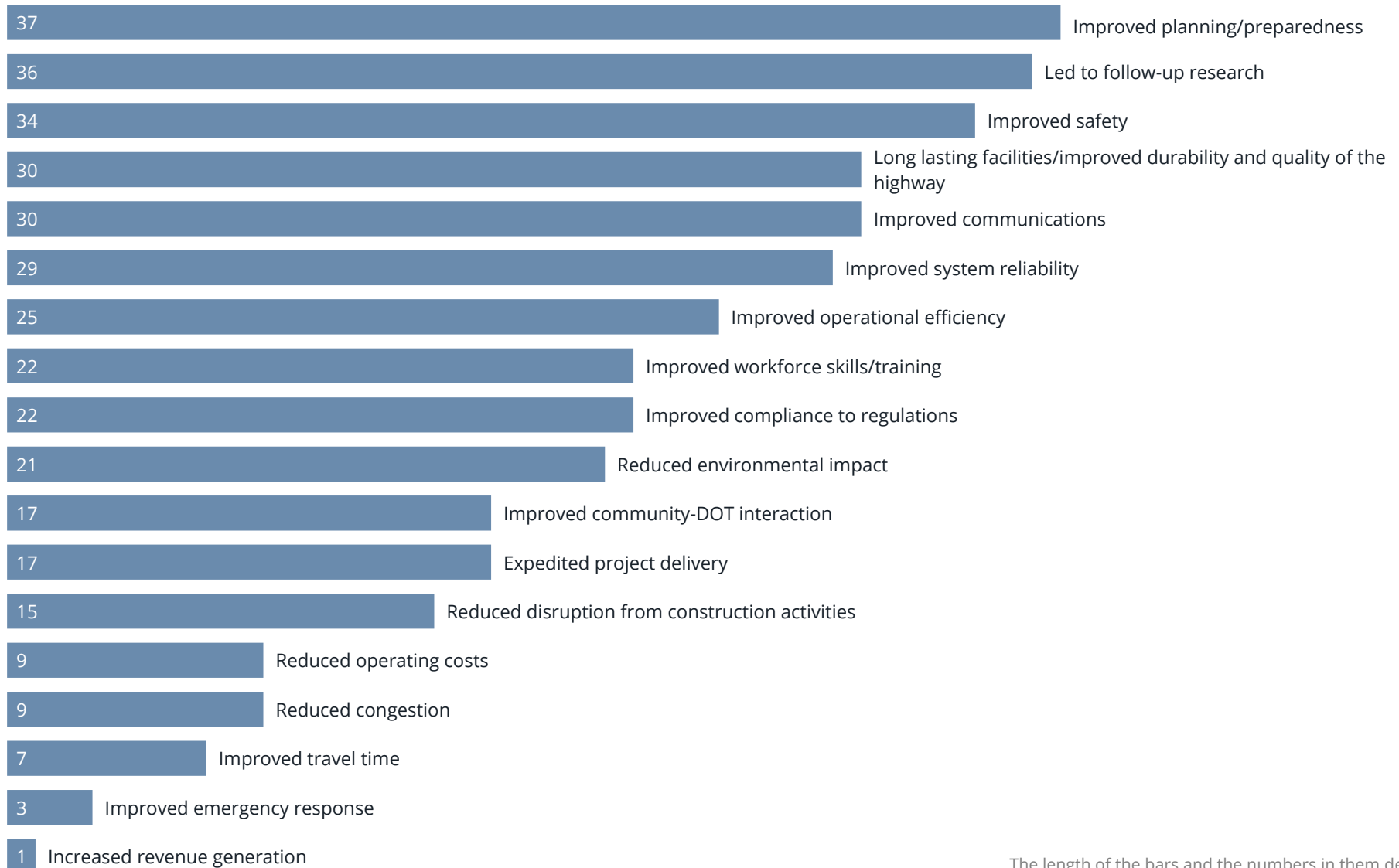
Exhibit 11: Where organizations used NCHRP research products, with selected examples.



# What the benefits of applying NCHRP research products were

The application of NCHRP research often provides several benefits to the transportation system. The following are the major benefits indicated by our 2021 NCHRP publications survey respondents.

Exhibit 12: How implementation of NCHRP research products benefitted the transportation systems.



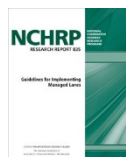
The length of the bars and the numbers in them denote the number of responses for that benefit.

# How NCHRP research products were used

## Developing a managed lane assistance plan

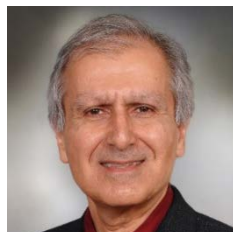
Maria 'Sole' Aranguiz, the Chief of Forecasting and Traffic Analysis at the California Department of Transportation and her team working in District 8 used *NCHRP Research Report 835: Guidelines for Implementing Managed Lanes* to develop a managed lane assistance plan. In order to identify deficiencies and complete the managed lane network system with an emphasis on congestion, safety, and revenue generation, her team at Caltrans referenced and used figures from the document and built upon what they had learned from past experience. *Research Report 835* helped clarify whether the team were up to date, understood concepts, gave pros and cons in moving in a certain direction, helped with developing a framework, and demonstrated important performance metrics to capture.

Aranguiz explains, "Sometimes you develop an idea in your mind, but it's difficult to determine whether the performance measures are achievable and what it would take to compile and analyze them." This managed lane assistance plan was created for the district as new policy is coming from Caltrans headquarters, which is expected to create a master plan for the development of managed lanes with a greater emphasis on equity and a multimodal aspect with Greenhouse Gas and Transportation Demand Management (TDM).



*NCHRP Research Report 835: Guidelines for Implementing Managed Lanes* provides guidance for transportation agencies interested in designing, implementing, operating, and maintaining managed lanes.

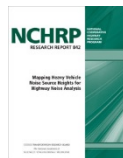
## Formulating revisions to bridge design code



Bahram M. Shahrooz is a Professor of Structural Engineering at the University of Cincinnati and he was the principal investigator for *NCHRP Research Report 842: Mapping Heavy Vehicle Noise Source Heights for Highway Noise Analysis*. He explains how he used the research in his own work; "One of the main objectives of my research has been to formulate revisions to the bridge design code."

This report, as well as other reports (*NCHRP Research Report 679: Design of Concrete Structures Using High-Strength Steel Reinforcement*, and soon to be published *NCHRP Research Report 994: Use of 0.7-in. Diameter Strands in Precast Pretensioned Girders*) were used by AASHTO T-10 Concrete Design Committee to revise AASHTO LFRD Bridge Design Specifications. "Although AASHTO is a U.S. design code, it has been adapted by other countries and/or has been used as the basis of bridge code in a number of other countries. Therefore, the research findings culminated in NCHRP reports have wide reaching impacts."

Shahrooz has been the principal investigator of three NCHRP projects and co-principal investigator of two projects. He says that each of these projects has provided a unique collaborative platform for university faculty and researchers, practicing engineers and consultants, and graduate and undergraduate students to develop new knowledge for better and safer design of bridges. Among many other benefits, these interactions have helped him to teach students the latest research that will form the basis of upcoming revisions of bridge design code, enabled him to publish journal articles for disseminating seminal information and knowledge to the engineering community, given him an incentive to develop design and computational tools that he can use in other research projects and in his classes, helped students learn a variety of different skills and better prepare them for their future careers, and allowed students to interact with and learn from leading experts in the field.



*NCHRP Research Report 842: Mapping Heavy Vehicle Noise Source Heights for Highway Noise Analysis* provides an analysis to determine height distributions and spectral content for heavy vehicle noise sources.

## How NCHRP research products were used (continued)

### Setting posted speed limits



Brian Chandler is the National Director for Transportation Safety at DKS Associates and has used *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide* extensively in his work. He explains that in Washington State, cities and counties are able to set their own speed limit policies without state DOT oversight. “There are still some state guidelines and rules about establishing speed maximums and minimums, but within the broad policy there is room to set local speed limits.”

The first agency he worked with was Island County, where they have county roads, state routes, and appropriated areas. Brian worked on the country roads system with the county to develop their policy based off *NCHRP Research Report 966* guidelines, which is meant to be used as a template and modified based on user needs. “Island County doesn’t have any 4, 5, 6 lane roadways so there are aspects of the NCHRP study that weren’t applicable and the county also doesn’t have any urban areas, so these areas were modified.” Chandler said they also developed a customized Excel tool using the same matrix and processes that the NCHRP project research team used but tailored it to the county’s needs. Now his firm is supporting a follow-up project reviewing every mile of road in the county using the policy and tool he developed, to make all the changes they determined were needed with the tool. By the end of this year, Island County’s roads will be assigned based on NCHRP guidance, modified for their jurisdiction.

Chandler and his team used *NCHRP Research Report 966* and direct application of its tool in two additional locations in Washington: Shoreline and Walawala. In Shoreline, the city examined several arterials through the city. The two locations added bike lanes and improved sidewalks but have not reassessed their speed limit with those additions in mind. There Chandler applied the NCHRP tool directly, ensuring the client understood, and then made recommendations based on the suggested speed limit that came with the tool. These ideas were taken to the City Council to have justification for some of the changes desired. In Walawala, Chandler was able to pass the project on to a midlevel project manager, which he says, is a testament that this research is well done, easy to use, and easy to describe to a client, or even for a client to use on their own and set appropriate speed limits without hiring outside consultants. Brian has already presented on this twice at the ITE Conference and at the 2022 ASCE International Conference on Transportation and Development.



*NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide* provides and explains a speed limit setting procedure (SLS-Procedure) that considers factors beyond the 85th percentile speed, including both driver speed choice and safety associated with the roadway. This report also provides instructions for using an automated version of the SLS-Procedure via a spreadsheet-based Speed Limit Setting Tool (SLS-Tool).

### Understanding legal requirements

Chris Cardillo, an attorney with C. S. Cardillo, P.C. used *NCHRP Legal Research Digest 74: Liability of State Departments of Transportation for Design Errors*.

Cardillo explains, “We used the publication for a wrongful death lawsuit, and it was very helpful. NCHRP does a great job, I love serious people who care. I am an attorney and had a MVA case where the person was killed. I used the information I obtained from the research digest to better understand how traffic intersections are designed and what the requirements are.”



*NCHRP Legal Research Digest 74: Liability of State Departments of Transportation for Design Errors* covers liability insurance for design errors and omissions. It also examines public construction law, professional liability, and product warranties.

## How NCHRP research products were used (continued)

### Ensuring the use of appropriate asphalts



Joseph Kerstetter of the Materials and Tests Division at the Tennessee Department of Transportation used *NCHRP Synthesis 511: Relationship Between Chemical Makeup of Binders and Engineering Performance* to ensure his contractors were using the appropriate asphalts.

In combination with another resource, *NCHRP Synthesis 511* led him to use Fourier transform infrared spectroscopy (FTIR), one of the more important methods for fingerprinting asphalt materials. Kerstetter says, “At the time, we were having an issue with one of our contactors not using the appropriate asphalts. Our asphalts have to have polymer in them and in this case we were led to believe the contractor used a non-polymer. We ended up taking core samples back to the lab, running an extraction on them, putting them through FTIR, and finding lack of a specific wave length that should be there for this type of polymer, which I learned through the NCHRP publication. We ended up finding the contractor had been paving with the non-polymer the day before for a different job and did not take appropriate actions to clean out the line.”

Kerstetter notes that *NCHRP Synthesis 511* is particularly helpful for those like him, a civil engineer with more knowledge and background in chemistry and asphalt. He has referenced the synthesis several times in presentations over the last few years.



*NCHRP Synthesis 511: Relationship Between Chemical Makeup of Binders and Engineering Performance* documents the current practices of departments of transportation (DOTs) in the selection of the chemical composition of a binder used in pavement applications.

### Educating on the use of concrete pavements



Nathan Forrest is the Technical Director of the California Nevada Cement Association, a nonprofit trade association in California and Nevada that represents pouring cement producers and does a great deal of education on the topic of concrete pavements.

Forrest has used *NCHRP Synthesis 499: Alternate Design/Alternate Bid Process for Pavement-Type Selection* for a couple of reasons. His organization often encourages the use of Life Cycle Assessments (LCA) and Life Cycle Cost Analysis (LCCA) to see which concrete pavements fair better with a long-term outlook, and the AD/AB process is one way to do this. He was looking for success stories of AD/AB being used as a reference in presentations and this report supported him in doing so.

Forrest also uses NCHRP publications like this one because it is helpful to have a high-level, impartial analysis on these topics. He explains, “It is like an agency being approached with an idea by a contractor or trade association, like ours. They are much more receptive to entities that do not have a business interest in the outcome. NCHRP is an even further step or two removed from the contract outcome. It’s helpful for us to have that unbiased research in an accessible and applicable form.”



*NCHRP Synthesis 499: Alternate Design/Alternate Bid Process for Pavement-Type Selection* documents the state of the practice in alternate design/alternate bid (ADAB) for pavement-type selection by highway agencies.

## How NCHRP research products were used (continued)

### Informing national and local design criteria and policy

Jim Rosenow is a Design Flexibility Engineer with the Minnesota Department of Transportation and is also actively involved with AASHTO. When he gives presentations on his work, he says there are three legs of the stool serving as the research foundation and direction for the national and local design criteria and policy. Those include *NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets*, *NCHRP Research Report 839: A Performance-Based Highway Geometric Design Process* which explains more of the “meat and potatoes” of the topic and proposes next-generation technology, and *NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets*.

These publications served as the direction and foundation for the AASHTO Green Book as well as for the design handbook that is being redone in Minnesota. Rosenow says, “Today is the second Golden Age for road design research and development. The first in the 1930s and 40s and the second in the last twenty years. Half of that is the design community asking interesting questions and producing provocative research needs and problem statements. The other half is NCHRP stepping up and fulfilling those research needs and presenting the findings. It has been a great team effort, especially over the last twenty years, and that is why we are experiencing this second Golden Age right now.”



*NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets* presents an approach for understanding the desired outcomes of a project, selecting performance measures that align with those outcomes, evaluating the impact of alternative geometric design decisions on those performance measures, and arriving at solutions that achieve the overall desired project outcomes.

### Developing quality technical specifications



Ali Makarachi is the Director of Transportation, Planning, & Engineering at the Northeast Ohio Areawide Coordinating Agency (NOACA) and has been in the transportation field for 30 years. He is now managing a division but he continues to develop models and simulations as well.

Makarachi used *NCHRP Research Report 845: Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies* as a guide for a project that required quality technical specifications. Makarachi said, “We were looking for resources to help guide us through our work, and this ended up becoming the best publication for the job. NCHRP publications are really helpful for technical support, and I use them to see whether certain ideas are recommended or not. I also look at their publications for staffing recommendations.” He finds NCHRP publications through Google, or is referred to them by colleagues, and he often keeps them as reference material for future projects.



*NCHRP Research Report 845: Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies* assesses policy and planning strategies at the state, regional, and local levels that could influence private-sector automated vehicle (AV) and connected vehicle (CV) choices to positively affect societal goals.

# Voices from the field: The benefits of using NCHRP research products

## **Legal Research Digest 74: Liability of State Departments of Transportation for Design Errors**

The publication was used to better understand policies and procedures to be applied to legal matters including consultations and litigation.

Chris Cardillo  
C. S. Cardillo, P.C.

## **Research Report 835: Guidelines for Implementing Managed Lanes**

Through 2026, this will be used for congestion relief, minimizing environmental impacts, right of ways impacts, developing TMC training modules, developing specific sign packages in collaboration with California Traffic Control Devices Committee (CTCDC), FHWA and Caltrans HQ.

Sam  
Caltrans

## **Research Report 837: Performance-Related Specifications for Emulsified Asphaltic Binders Used in Preservation Surface Treatments**

Using as part of follow-up research by adapting findings into an eventual national performance-related specification for asphalt emulsion residue

R Michael Anderson  
Asphalt Institute

## **Research Report 839: A Performance-Based Highway Geometric Design Process**

Used in local Performance-Based Practical Design (PBPD) guidance published in January 2018.

Anonymous  
Minnesota Department of Transportation

Led to reduced construction costs of highway projects.

Jeff Jasper  
KY Transportation Center

## **Research Report 840: A Watershed Approach to Mitigating Stormwater Impacts**

Increased options for providing environmental (stormwater) mitigation.

William Fletcher

## **Research Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments**

We will be proposing policy changes based on this document. We are working with a major city to develop revised crosswalk marking guidance (along with

RRFB and PHB application guidance) and this report is being used as a reference to the recommendations.

Michael Cynecki  
Lee Engineering, LLC

## **Research Report 842: Mapping Heavy Vehicle Noise Source Heights for Highway Noise Analysis**

Will help address equity-related issues. Results and applications of this study and other NCHRP studies are often discussed in the bimonthly AASHTO Noise Working Group meetings and TRB AEP80. Caltrans and Ohio DOT are exploring design changes based on this work as well as NCHRP 635 and NCHRP 630.

Bruce Rymer

## **Research Report 843: Long-Term Field Performance of Warm Mix Asphalt Technologies**

Since the publication's completion, VDOT has continued to allow WMA usage, and the technology has been widely used as a compaction aid, and as such, results in an improved pavement lifespan.

Stacey Diefenderfer  
Virginia Transportation Research Council

## **Research Report 845: Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies**

Led to changes to AV legislation in 2019 and improved transit performance.

Blaine Leonard  
Utah Department of Transportation

Was used in the analysis of widening of I-680 to include technology including TIRTL technology that will be used for the Automated Driving System (ADS) grant.

Randell Iwasaki  
Amazon Web Services (AWS)

Helped students to think about benefits and risks of CVs and AVs, and the infrastructure to realize successful introduction of CVs and IVs on the roads. Conclusion and recommendations were distributed to the class as a topic of discussion in industrial economics and in public economics.

Anonymous  
Hanyang University

# Voices from the field: The benefits of using NCHRP research products (continued)

## **Research Report 845: Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies**

We are currently engaged in a research project examining the influence of consensus science and technology studies on policy making at the state and local levels of government.

Gordon Kingsley  
Georgia Institute of Technology

## **Report 846: Improving Findability and Relevance of Transportation Information -- Volume I: A Guide for State Transportation Agencies, Volume II: Background Research**

The report provided valuable background and a basis for advancing knowledge management at WSDOT.

Anonymous  
Washington State Department of Transportation

## **Research Report 847: Variability of Ignition Furnace Correction Factors**

When the report came out we compared our ignition oven operations with the report as well as notified our HMA suppliers so that they could utilize the information as well.

Anonymous  
Massachusetts Department of Transportation

Aggregate correction factors just came up in relation to RAP so this document is serving as a reference as we work towards adapting our process to adequately and accurately characterize RAP.

Anonymous  
Montana Department of Transportation

## **Research Report 849: Strand Debonding for Pretensioned Girders**

Positive outcomes include confirmation of debonding layouts and confirmation of the effectiveness of bottom tensile reinforcement in shear design.

John Connal  
AECOM

## **Research Report 850: Applying Risk Analysis, Value Engineering, and Other Innovative Solutions for Project Delivery**

This publication was used to guide a taskforce that resulted in new policy and improved practice of risk and value engineering at our agency.

Zach Davis  
Oregon Department of Transportation

Used in 2017 to refine and adapt some of our internal techniques pertaining to the application of Risk Analysis within the application of the Value Methodology (Value Engineering Studies).

Timothy Buckley  
MENG Analysis

## **Research Report 854: Guide for Identifying, Classifying, Evaluating, and Mitigating Truck Freight Bottlenecks**

Several examples: A consultant for the ITTS Pooled Fund Study is currently conducting a multi-state freight bottlenecks analysis; this report is providing a foundational methodology. That same consultant has also recently been contracted by FHWA HQ Freight Office to perform similar analysis at the national level. Another example, but on a smaller-scale is the Chattanooga Tennessee MPO has begun update of their federally-required Metropolitan Transportation Plan; it will include a robust freight component and will heavily utilize the report. Within the GDOT Office of Planning, my fellow staff has led work to address FHWA performance measure requirements in recent years, including freight and national highway system-related issues.

Thomas McQueen  
Georgia Department of Transportation

This research was used to guide our practice in using new data products (truck speed data) in operations modeling.

Trevor Brydon  
Southeast Michigan Council of Governments (SEMCOG)

## **Research Report 859: Consequences of Delayed Maintenance of Highway Assets**

Maintenance used it as supporting information in management and funding discussions to help in reducing the amount of maintenance being delayed. The report provided some justification assistance. The report was also used in follow on Caltrans research on creating a maintenance decision tool. This research is ongoing.

Anonymous  
Caltrans

## **Research Report 861: Best Practices in Rural Regional Mobility**

Improved knowledge operations. I was a new Mobility Manager when I read this document. It gave me more ideas for how rural transit could work in my area.

Kim Lammers  
Maumee Valley Planning Organization



# Voices from the field: The benefits of using NCHRP research products (continued)

## **Research Report 862: Guide to Deploying Clean Truck Freight Strategies**

Federal Highway Administration truck bottleneck and possible mitigation research used this NCHRP effort to select possible mitigation strategies to study.

Victoria Martinez  
Federal Highway Administration

## **Research Report 863: Material Properties of Cold In-Place Recycled and Full-Depth Reclamation Asphalt Concrete**

Was used in documenting practices for future generations.

Anonymous  
QesPavements

As a researcher I used the publications related to Carbon Foot print, energy transition and renewable energy (geothermal energy resources).

Dornadula Chandrasekharam  
Izmir Institute of Technology, Izmir Turkey

## **Synthesis 499: Alternate Design/Alternate Bid Process for Pavement-Type Selection**

Being used to develop an NHI training course on ACMs and a FHWA DBE ACM Handbook.

Daniel D'Angelo  
Applied Research Associates

City of Santa Rosa, CA successfully used AD/AB on a paving project, and other agencies have been taking note

Nathan Forrest  
California Nevada Cement Association

## **Synthesis 502: Practices for Establishing Contract Completion Dates for Highway Projects**

I have applied this knowledge to my work reviewing and managing construction contracts.

Anonymous  
Greenman-Pedersen, Inc. (GPI)

## **Synthesis 505: Current Practices and Guidelines for the Reuse of Bridge Foundations**

The technologies highlighted have been used on a bridge replacement.

Jon Bischoff  
Utah Department of Transportation

## **Synthesis 506: Effective Utility Coordination: Application of Research and Current Practices**

We were inspired to review our own practices and procedures and support research of our own coordination efforts.

Deanne Popp  
Iowa Department of Transportation

Used by statewide utilities staff and utility inspectors internal to VDOT and statewide localities.

Matt Reynolds  
Virginia Department of Transportation

## **Synthesis 507: Traffic Signal Preemption at Intersections Near Highway-Rail Grade Crossings**

UDOT has used this publication to update our own operational guidelines for at-grade RR preemption. They were updated shortly after the document was published. It has been a very useful tool.

Adam Lough  
Utah Department of Transportation

NCHRP work supported the development of training on the topic, "Where Highways Meet Rails" SME Course Review.

Anonymous  
FHWA HOP/Resource Center

## **Synthesis 508: Data Management and Governance Practices**

Currently using the synthesis to guide Data Governance Committee development.

Peggi Knight  
Iowa Department of Transportation

## **Synthesis 509: Highway Worker Safety**

Increased awareness of the importance of work zone safety. The Clemson University Master of Transportation Safety Administration (MTSA) Program used it for teaching students about work zone safety and as a resource.

Terecia Wilson  
Clemson University

# Voices from the field: The benefits of using NCHRP research products (continued)

## **Synthesis 511: Relationship Between Chemical Makeup of Binders and Engineering Performance**

Over the past 3 years to 5 years, it gave a cost-effective way to test for polymers in asphalt binders when DSR testing is inconclusive, including forensic analysis of already placed asphalt.

Joseph Kerstetter  
Tennessee Department of Transportation

## **Synthesis 514: Statewide and Megaregional Travel Forecasting Models: Freight and Passenger**

Was used in an information exchange amongst state DOTs. FHWA is coordinating the peer exchange. Also used by the Statewide Modeling subcommittee of AEP50.

Rebekah Anderson  
Ohio Department of Transportation

## **Web-Only Document 226: Data Visualization Methods for Transportation Agencies**

This document was a valuable source for *NCHRP Synthesis 52-16: Visualization of Highway Performance Measures* that will be published next year.

Frank Broen  
Metro Analytics

## **Web-Only Document 227: Design of Interchange Loop Ramps and Pavement/Shoulder Cross-Slope Breaks**

Used in an in-progress adjustment of design guidance and criteria.

Anonymous  
Minnesota Department of Transportation

Facilitated flexibility in applying previous design guidance and understanding of updated, practical safety impacts.

Anonymous  
Virginia Department of Transportation

## **Web-Only Document 229: Methods and Technologies for Pedestrian and Bicycle Volume Data Collection: Phase 2**

This publication marked the beginning of a number of pivotal studies on pedestrian exposure.

Anonymous  
National Highway Traffic Safety Administration

UNO Transportation Institute has used this document extensively in helping (through the Louisiana Transportation Research Center) LDOTD to initiate multimodal data collection. The program is still in a research/pilot phase but it has been instrumental in setting up the fundamentals. The first phase of research began in 2016 developing a framework for the state, a phase 2 project implementing an initial set of continuous counters began in 2019. Outcomes of the phase 2 project are pending (project completion spring 2022).

Tara M Tolford  
University of New Orleans

## **Web-Only Document 234: Developing a Method Selection Tool for Travel Forecasting**

Used in clarifying needs and resources available for various analyses

Maria Aranguiz  
California Department of Transportation

## **Web-Only Document 243: Recommended Guidelines for Prefabricated Bridge Elements and Systems Tolerances and Recommended Guidelines for Dynamic Effects for Bridge Systems**

Supports the Structures Division ABC Program.

Carmen Swanwick  
Utah Department of Transportation

# Methodology

The NCHRP Impact Report 2021 documents and presents the value, in the form of outcomes and impacts, of the application of NCHRP research results. Containing data and anecdotes compiled from various sources, this report presents an overview of recent NCHRP research results, how the results are disseminated, and the impacts of their application.

NCHRP used various data collection and analysis methods to prepare this report. Unless otherwise noted, all data in this report are current as of December 31, 2021.

## Page 8 **Our project panels are diverse, which leads to better NCHRP research products**

Data on gender, ethnicity, and professional affiliation based on information self-reported by NCHRP panel members.

## Pages 10 and 11 **NCHRP webinars are reaching more practitioners**

Data on participant location and professional affiliation based on information self-reported by webinar attendees. Data on average satisfaction based on the results of post-webinar surveys administered at the conclusion of every NCHRP webinar.

## Page 12 **Downloads and OpenBookSessions of NCHRP Research**

Data from the National Academies Press.

## Page 14 **NCHRP research products contribute to formulating national guides, handbooks, and manuals**

Based on information provided by NCHRP staff and AASHTO staff.

## Pages 16 - 26 **The 2021 NCHRP publications survey results**

NCHRP conducted a survey in late 2021 covering 61 NCHRP publications published in 2017, including Research Reports, Syntheses, Legal Research Digests, and Web-Only Documents. The survey was distributed to three groups of users: (1) publication downloaders — members of state DOTs, private-sector organizations, governmental agencies, and the general public, who had downloaded the publication from the National Academies Press (NAP) site; (2) members of the project panels that had overseen the production of those publications; and (3) RAC members — Members of the AASHTO Research Advisory Committee (RAC). RAC members were encouraged to take the survey themselves and to distribute the survey to as many members of their respective organizations as possible. In total, 555 surveys were completed by 423 distinct respondents.

# Appendix A: List of 2017 NCHRP publications

## **Bituminous Materials**

NCHRP Research Report 837: Performance-Related Specifications for Emulsified Asphaltic Binders Used in Preservation Surface Treatments  
NCHRP Research Report 843: Long-Term Field Performance of Warm Mix Asphalt Technologies  
NCHRP Research Report 847: Variability of Ignition Furnace Correction Factors  
NCHRP Research Report 863: Material Properties of Cold In-Place Recycled and Full-Depth Reclamation Asphalt Concrete

## **Bridges**

NCHRP Research Report 849: Strand Debonding for Pretensioned Girders  
NCHRP Research Report 851: Proposed AASHTO LRFD Bridge Design Specifications for Light Rail Transit Loads  
NCHRP Research Report 864: Seismic Evaluation of Bridge Columns with Energy Dissipating Mechanisms, Volume 1: Research Overview  
NCHRP Research Report 864: Seismic Evaluation of Bridge Columns with Energy Dissipating Mechanisms, Volume 2: Guidelines  
NCHRP Web-Only Document 243: Recommended Guidelines for Prefabricated Bridge Elements and Systems Tolerances and Recommended Guidelines for Dynamic Effects for Bridge Systems

## **Finance**

NCHRP Research Report 850: Applying Risk Analysis, Value Engineering, and Other Innovative Solutions for Project Delivery

## **Foundations and Scour**

NCHRP Research Report 853: Guidance for Design Hydrology for Stream Restoration and Channel Stability

## **General Design**

NCHRP Research Report 835: Guidelines for Implementing Managed Lanes  
NCHRP Research Report 839: A Performance-Based Highway Geometric Design Process

## **Human & Natural Environment**

NCHRP Research Report 840: A Watershed Approach to Mitigating Stormwater Impacts  
NCHRP Research Report 842: Mapping Heavy Vehicle Noise Source Heights for Highway Noise Analysis  
NCHRP Research Report 862: Guide to Deploying Clean Truck Freight Strategies

NCHRP Web-Only Document 225: Appendices to NCHRP Research Report 842

## **Legal Research Digest**

NCHRP Legal Research Digest 73: Primer on Patentability and Use of Ideas Developed by Contractors Performing Work for State and Federal Transportation and Local Planning Agencies  
NCHRP Legal Research Digest 74: Liability of State Departments of Transportation for Design Errors  
NCHRP Legal Research Digest 75: Legal Requirements for State Departments of Transportation Agency Participation in Conservation Plans

## **Maintenance of Way and Structures**

NCHRP Research Report 848: Inspection Guidelines for Bridge Post-Tensioning and Stay Cable Systems Using NDE Methods  
NCHRP Research Report 859: Consequences of Delayed Maintenance of Highway Assets  
Operations and Control  
NCHRP Web-Only Document 227: Design of Interchange Loop Ramps and Pavement/Shoulder Cross-Slope Breaks

## **Pavements**

NCHRP Web-Only Document 235: Quantifying the Influence of Geosynthetics on Pavement Performance  
NCHRP Web-Only Document 236: Incorporating Slab/Underlying Layer Interaction into the Concrete Pavement Analysis Procedures

## **Planning Methods & Processes**

NCHRP Research Report 844: Guide for Integrating Goods and Services Movement by Commercial Vehicles in Smart Growth Environments  
NCHRP Research Report 852: Method Selection for Travel Forecasting, User Guide  
NCHRP Research Report 854: Guide for Identifying, Classifying, Evaluating, and Mitigating Truck Freight Bottlenecks  
NCHRP Web-Only Document 226: Data Visualization Methods for Transportation Agencies  
NCHRP Web-Only Document 234: Developing a Method Selection Tool for Travel Forecasting

## **Research Results Digest**

NCHRP Research Results Digest 401: Continuing Project to Synthesize Information on Highway Problems

## Appendix A: List of 2017 NCHRP publications (continued)

### Safety

NCHRP Research Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments

### Special Projects

NCHRP Research Report 836: Guidelines for Emergency Ventilation Smoke Control in Roadway Tunnels  
NCHRP Research Report 845: Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies  
NCHRP Research Report 846: Improving Findability and Relevance of Transportation Information -- Volume I: A Guide for State Transportation Agencies, Volume II: Background Research  
NCHRP Research Report 856: Specifying and Measuring Asphalt Pavement Density to Ensure Pavement Performance  
NCHRP Research Report 861: Best Practices in Rural Regional Mobility  
NCHRP Research Report 867: Keeping What You Paid For—Retaining Essential Consultant-Developed Knowledge Within DOTs  
NCHRP Web-Only Document 231: Challenges to CV and AV Applications in Truck Freight Operations  
NCHRP Web-Only Document 232: Communications Worker Credentialing Requirements  
NCHRP Web-Only Document 233: Mainstreaming Transportation Hazards and Security Risk Management: CAPTA Update and Implementation  
NCHRP Web-Only Document 238: Developing the Guide to Retaining Essential Consultant-Developed Knowledge Within DOTs  
NCHRP Web-Only Document 239: Impacts of Laws and Regulations on CV and AV Technology Introduction in Transit Operations

### Specifications, Procedures, and Practices

NCHRP Research Report 838: Guidelines for Optimizing the Risk and Cost of Materials QA Programs  
NCHRP Research Report 857: Performance-Related Specifications for Pavement Preservation Treatments

### Synthesis

NCHRP Synthesis of Highway Practice 499: Alternate Design/Alternate Bid Process for Pavement-Type Selection  
NCHRP Synthesis of Highway Practice 501: Pavement Management Systems: Putting Data to Work  
NCHRP Synthesis of Highway Practice 502: Practices for Establishing Contract

### Completion Dates for Highway Projects

NCHRP Synthesis of Highway Practice 503: Leveraging Technology for Transportation Agency Workforce Development and Training  
NCHRP Synthesis of Highway Practice 504: Strategic Program Delivery Methods  
NCHRP Synthesis of Highway Practice 505: Current Practices and Guidelines for the Reuse of Bridge Foundations  
NCHRP Synthesis of Highway Practice 506: Effective Utility Coordination: Application of Research and Current Practices  
NCHRP Synthesis of Highway Practice 507: Traffic Signal Preemption at Intersections Near Highway–Rail Grade Crossings  
NCHRP Synthesis of Highway Practice 508: Data Management and Governance Practices  
NCHRP Synthesis of Highway Practice 509: Highway Worker Safety  
NCHRP Synthesis of Highway Practice 510: Resource Allocation of Available Funding to Programs of Work  
NCHRP Synthesis of Highway Practice 511: Relationship Between Chemical Makeup of Binders and Engineering Performance  
NCHRP Synthesis of Highway Practice 512: Use of Fiber-Reinforced Polymers in Highway Infrastructure  
NCHRP Synthesis of Highway Practice 513: Evolving Debt Finance Practices for Surface Transportation  
NCHRP Synthesis of Highway Practice 514: Statewide and Megaregional Travel Forecasting Models: Freight and Passenger

### Traffic Planning

NCHRP Web-Only Document 229: Methods and Technologies for Pedestrian and Bicycle Volume Data Collection: Phase 2

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Questions about this report should be sent to Sid Mohan at [smohan@nas.edu](mailto:smohan@nas.edu).