



Free Training? We've got that.

Past issues of the Research Newsletter have discussed free training available through TRB webinars. For more info on those, please go to the TRB Webinar website and sign up for updates while you are there. Most of those will grant PDH or other continuing education credits as long as you sign in as an individual. Those courses typically include excellent technical content.

TRB Webinars are not the only free training available to NCDOT employees: NCDOT R&D funds participation in the AASHTO TC3 Technical Services Program. The Transportation Curriculum Coordination Council provides training on a huge number of topics (several hundred) and 90% of the courses are PDH eligible. That being said, most of these courses are applicable to technicians, inspectors and transportation workers – it's by no means just for engineers. The Materials and Tests (M&T) Unit provides a representative to the advisory board and gives NCDOT a seat at the table for keeping the content relevant and current.

The best thing? These online courses are all free for NCDOT employees due to our annual contribution. Quoting from a recent TC3 Newsletter: "AASHTO member states that financially contribute to TC3 as a technical service program already have unlimited TC3 training available for all employees and do not require a subscription. Create or log in to your free AASHTO e-affiliate account at training.transportation.org to view the available subscription options or see your current hourly rate, which is based on your agency or organization information."

I encourage you to create an e-affiliate account and explore the course and options available to you. Most are online and at your own pace. All participation leverages the NCDOT contribution to the program while also educating our workforce. This is truly an opportunity that is too good to pass-up. If you have any questions, as always, please feel free to contact me at jmastin@ncdot.gov.

Neil Mastin

Research & Development Unit Manager



Knightdale Overpass

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# Recently Completed Research Projects

## [RP2015-12- Cost Analysis on the Reuse of Concrete Residuals](#)

Concrete hydrodemolition and diamond grinding/grooving operations performed for NCDOT generate large amounts of concrete residuals. Currently these residuals can be classified by the North Carolina Department of Environmental Quality (NCDEQ) as Class A Residuals and are treated as “inert debris” thus allowing them to be reused instead of being disposed at Publicly Owned Treatment Works (POTW) and Municipal Solid Waste (MSW) sites. The NCDOT needed to develop a method to compare the potential savings from possible alternatives of disposal such as the use of the concrete residual material as liming amendments on NCDOT right of way highways, Class B residual sites and agricultural applications. Contractors bidding on NCDOT projects needed guidance to assist them in identifying available options for concrete residuals based on project locations. As part of this work, best practices for the disposal/reuse of the concrete residual material both from North Carolina and other states were identified. By surveying DOT personnel and contractors, the attributes contributing to the costs of the various alternatives were identified.

A benefit-cost analysis (BCA) was performed to investigate potential savings from other alternative options to disposal such as the use of the material as liming amendments on NCDOT right of way highways, Class B residual sites and agricultural applications. Using these attributes, a Benefit-Cost Model (BCM) using Multi-Criteria Analysis was developed that enables the estimation of the costs of disposing and/or reusing concrete residual material that is produced by the hydrodemolition and diamond grinding/grooving processes.

In addition to the BCM, a tool was developed that can be used by contractors to better estimate their costs

and allow them to compare alternatives for the disposal/reuse of the concrete residual material.

## [RP 2015-07 - Monetizing Reliability to Evaluate the Impact of Transportation Alternatives](#)

Travel time reliability is considered a viable performance measure for link- or corridor-level analysis and evaluation of transportation alternatives. Travel time reliability is used in transportation planning, project prioritization, and allocation of resources. The use of travel time reliability for evaluation of transportation alternatives depends on identifying an acceptable definition and quantification of reliability.

The value of travel time refers to the monetary value travelers place on their travel time or in reducing their travel time. The value of reliability is the monetary value travelers place on reducing travel time variations. Reliably reaching destination on-time yields different benefits to different motorists. It not only saves time but also their perception towards the transportation system and their planned buffer time for future trips.

Income Group	Value of Buffer Time per Minute
< \$15,000	-
\$15,000 - \$25,000	\$0.16
\$25,000 - \$35,000	\$0.24
\$35,000 - \$50,000	\$0.34
\$50,000 - \$75,000	\$0.50
\$75,000 - \$100,000	\$0.70
\$100,000 - \$150,000	\$1.00
\$150,000 - \$200,000	\$1.40
> \$200,000	\$1.80

**Table: Value of Buffer Time per Minute by Income**

*(Continued on page [3](#))*

## Recently Completed Research Projects (continued)

To address this challenge, data to monetize reliability was collected using surveys. The surveys were conducted at various cities, towns and other areas across the state.

Nine focus group meetings were conducted and data was collected from 93 participants. The focus group survey was to observe participants' trade-off between travel time savings and reliability. The random survey comprised of 357 participants who were asked to choose between a reliable route with longer travel time and an unreliable route with shorter travel time. Results indicated that a higher percentage of participants are willing to opt for routes with lower number of days of unreliability.

The value of buffer time was estimated as \$0.45 per minute. . This value can be used to evaluate the impact of transportation alternatives, in addition to the value of travel time.

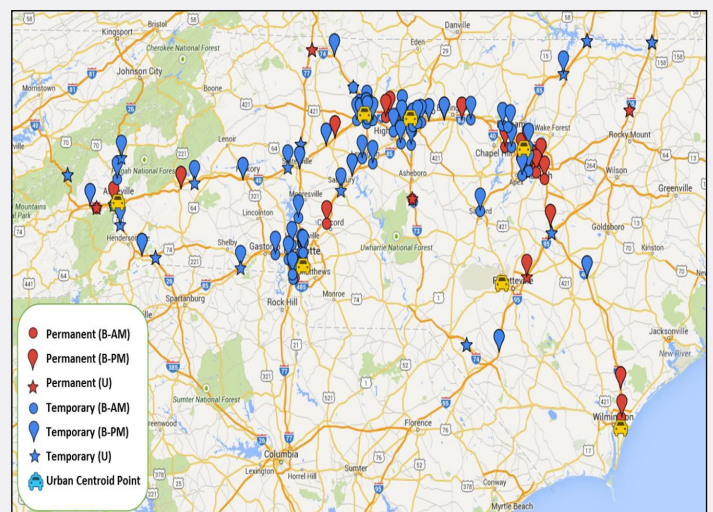
### [RP2015-09 Planning-Level Extensions to NCDOT Freeway Analysis Tools](#)

Conducting a full operational analysis of freeway facilities is a challenging undertaking, as most available methods either lack the necessary detail for specific geometry and demand patterns, or are very data and cost-intensive to implement.

For the past few years, NCDOT has been using a customized software application for conducting in-house analyses of freeway facilities, with a special emphasis on work zones. The analysis methodology and associated software tool, FREEVAL-WZ, were deliverables from a prior NCDOT research effort (2010-08). The methodology is founded on the analytical method for evaluating freeway facilities in the Highway Capacity Manual 2010, but has been enhanced to incorporate

work-zone analysis details, as well as various state-specific default values for application in North Carolina. While that prior research accomplished its objectives and produced a tool that is used by NCDOT analysts today, several critical extension needs to the methodology have been identified by NCDOT staff through the use and application of the tool in day-to-day practice.

This project developed extensions to the freeway work zone analysis methodology and updated the associated software tool. Through the course of this project, necessary data were collected to develop default traffic volume profiles for different freeways across the state. These default demand profiles, along with the proposed methodology to assign them to each analysis, enhance the user's ability to perform work zone evaluations in North Carolina more quickly and accurately. The project team also embedded new methodologies to quantify the impact of work zones based on the recently-completed national NCHRP 03-107 project. The new extensions to the work zone analysis methodology are imple-



**Graphic: Geographical Distribution of Permanent and Temporary Traffic Count Stations**

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## Recently Completed Research Projects (continued)

mented in the new Java based FREEVAL-WZ software tool. FREEVAL-WZ is fully customized to fit the needs of NCDOT to generate standard reports for each work zone analysis. A comprehensive user's guide was also developed and serves as the main reference to guide users through the software tool.

### [RP 2015-11– Preventive Maintenance \(PM\) Criteria](#)

The North Carolina Department of Transportation operates a large and varied fleet of on-road and off-road equipment. Regular oil changes for these machines result in significant costs due to the required labor, replacement oil and filters, and disposal of used oil, as well as downtime for the machine. Provided that oil of sufficient quality can be maintained, PM costs can be reduced by extending oil drain intervals. The purpose of this research was to monitor oil quality throughout extended drain intervals to determine the type, rate, and magnitude of resulting degradation, and to investigate the potential for extending oil drain intervals. The oil analysis program established to analyze and monitor oil quality included selection of the oil analysis equipment, identification of threshold values for oil quality parameters, selection of NCDOT equipment for the program, and establishing oil sampling protocols.

The OSA4 TruckCheck benchtop oil analyzer was used to analyze the physical and chemical properties of fresh and used oil samples of HD Fleet Supreme 15W-40 conventional oil and Rotella T6 5W-40 synthetic oil. Threshold values for measured oil quality parameters were established at conservative levels based on OEM recommendations, review of literature, and expert opinions. A total of 952 samples of used oil were collected and analyzed from 47 machines that consisted of trucks in classes 0209 and 0210, and tractors in classes 0303

and 0311. Trucks in classes 0209 and 0210 were sampled at approximately 1500, 2500, and 5000 miles after the oil drain, while tractors in classes 0303 and 0311 were sampled at approximately 50 hour intervals.

Machines on the extended program were sampled approximately every 1,500 miles or 50 hours beyond the normally scheduled oil drain. Analyses of the used oil sampled from the NCDOT equipment showed that the oils degraded chemically as the oil aged, but the observed viscosity degradation was not related to oil age. Contamination of the oil by water, coolant, dirt, or wear metals was not generally present. The results indicate that the oil drain intervals for most of the studied equipment can be conservatively extended.

The economic and environmental impact of extending oil



**Graphic: OSA4 Truck Check Benchtop Oil Analyzer**

drain intervals for similar machines in the NCDOT fleet were estimated to be annual savings of over \$120,000 and 2,500 gallons of used oil.

### [RP 2016-04 -Public Opinions of Roadway Assets using Roadway Reviews and Focus Groups](#)

Seeking to most effectively allocate limited resources,

*(Continued on page 6)*



Librarian's  
Corner



Lamara Williams-Jones, Research Librarian

## Get To Know Your Scenic Byways

Our last two newsletters featured pictures from some of North Carolina's Scenic Byways which are designated areas that give visitors and residents a chance to experience North Carolina's history, geography and culture. The NC Department of Transportation has designated 51 scenic byways that portray the diverse beauty and culture of the Tar Heel State( and it is beautiful state) as well as bringing awareness to the preservation of these treasures.

N.C. Scenic Byways vary in length from three to 173 miles, and in character from curvy mountain roads to ferry rides across coastal sounds. These byways are intended as a safe alternative to the faster-paced traffic and commercial areas found along our state's major highways and inter-states...Bye-bye I-40 hello Devil's Stompin' Ground Road.

Following the byways, motorists will see some of North Carolina's most breathtaking scenery, from the Blue Ridge Mountains in the west to the fertile plains of the Piedmont to the crystal blue shore of our coast.

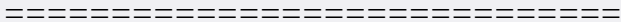


The routes are clearly marked with the N.C. Scenic Byways sign. Visitors are encouraged to follow the maps and route descriptions carefully with the understanding that the maps on each byway page are not to scale and are given as a general guide only. The use of a N.C. State Transportation Map in conjunction with the maps in the book is highly recommended.

A {PDF} version of the latest edition is available for [download](#) as well as information on how to obtain a hard copy.



Download your free copy today



## Library Notes

- Come across a resource you need that's not available in our [Online Catalog](#)? I may be able to get the item for you via Interlibrary Loan at minimal or no cost to you.
- Contact the NCDOT Librarian, [Lamara Williams-Jones](#), for assistance: 919-508-1820, Monday through Friday from 8:30 to 4:30. Since there is only one Librarian, customers should call before visiting the Library.

## Recently Completed Research Projects (conclusion)

the North Carolina Department of Transportation initiated Research Project No. 2016-04: Public Opinions of Roadway Assets using Roadway Reviews and Focus Groups to gain insight into how North Carolina residents assess and prioritize roadway assets. During a three-week period in November 2015, researchers from the North Carolina State University Institute for Transportation Research and Education (ITRE) surveyed more than 350 residents across the state using an innovative methodology termed “Roadway Reviews.” The purpose of the Roadway Reviews was: (1) to determine expectations for the condition of NC roadways and (2) to identify features that NC residents think are the most important on different types of roadways in the areas of overall condition, safety, and appearance.

Unlike traditional methods which separate participants by distance or time, such as web, mail, and phone surveys, this study solicited citizen input face-to-face through surveys that asked residents about state-maintained roadways while they were driven on in real time. Study participants were asked to rate whether the condition of roadway features met their basic expectations, i.e. what they find personally acceptable, and to rank the importance of the features for primary, secondary, and interstate roadway types and for NC roadways overall. Eleven roadway features were examined, including pavement, signs, markings, lighting, and guardrails. In 2011, North Carolina became one of the first states in the country to undertake such an effort.

The present study expands on previous research to incorporate a more robust analysis and the addition

of focus groups which provided further details about how and why citizens value roadway features as they do. To identify how public perceptions of roadways compare to the actual conditions of roadways, expectation ratings provided by survey respondents were compared to the physical condition of individual features on each route as measured by NCDOT and federal standards.



**Picture: Study participant boarding van to assess North Carolina roadways in real-time**



## New Publications from Transportation Research Board

### [Enhanced Performance Zinc Coating for Steel in Concrete: National Cooperative Highway Research Program Innovations Deserving Exploratory Analysis \(IDEA\) Project 174](#)

This report evaluates the performance of a reinforcing bar with a thermal zinc diffusion (TZD) coating to resist corrosion. The long-term performance of bridges and other department of transportation (DOT) structures exposed to deicing or marine salts requires improving the corrosion resistance of embedded steel as well as the performance of the concrete. Several stainless steel alloys are believed to have good performance, but the material costs are several times that of conventional black steel. In addition, though only the outer surface of the steel needs protection, the entire bar is made of alloys using premium raw materials. The product that was the focus of investigation is a reinforcing bar with a thermal zinc diffusion (TZD) coating, with and without a supplemental organic coating.

### [Practices for Establishing Contract Completion Dates for Highway Projects: National Cooperative Highway Research Program \(NCHRP\) Synthesis 502](#)

This synthesis documents current methodologies and procedures used by state transportation agen-

cies to estimate contract time for various highway project delivery methods. Establishing contract time is an important part of the highway project development process because it directly impacts project costs, the public, and risk for contractors.

### [Strategic Program Delivery Methods: National Cooperative Highway Research Program \(NCHRP\) Synthesis 504](#)

This synthesis explores holistic approaches to maximizing the benefits of time and cost savings when delivering transportation programs, rather than delivering individual projects. While a considerable amount of published research has focused on the process of selecting an optimal project delivery method, this report documents how implementing a variety of delivery methods strategically for a program of projects can improve the delivery of the entire program.

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**Please note:** The National Academies Press; publisher of TRB publications now requires an email before downloading some publications to view. An account with [My NAP](#) is encouraged.

Many more publication links can be found on [NCDOT's TRB News Feed](#)

### Calendar of Events 2017

#### April 2017

- NC DOT Board of Transportation Meeting, April 5-6, 2017
- NCAMPO Conference, April 26-28, 2017, New Bern, NC

#### May 2017

- NC DOT Board of Transportation Meeting, April 5-6, 2017



## NCDOT Research and Development Unit General Information

### How to find us:

We are located at 104 Fayetteville Street, Raleigh, in the Transportation Technology Center (formerly The Raney Building).

The Research & Development [web page](#) contains more information about the Unit and what we do.

The Research Library's [catalog](#) is also available on the web.

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### NCDOT RESEARCH AND DEVELOPMENT

The Research & Development Unit oversees transportation-related research that investigates materials, operations, planning, traffic and safety, structures, human environments, natural environments, and more. Please contact one of our engineers listed on this page if you have questions.



## RESEARCH & DEVELOPMENT