

North Carolina Department of Transportation



WORK ZONE SAFETY & MOBILITY PROCESS REVIEW December 2017

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EXECUTIVE SUMMARY

The North Carolina Department of Transportation (NCDOT) is committed to providing safe work zones for all workers and road users while minimizing traffic congestion and adverse impacts on road users and local communities. In response to changes to the Federal Highway Administration's Work Zone Safety and Mobility Rule 23 CFR 630 Subpart J, NCDOT developed its Work Zone Safety and Mobility Policy in 2007. We continue working to fulfill the intent of this policy, which is to support the systematic consideration and management of work zone impacts related to safety, mobility, operations, and training.

This report is an update to the Process Review that was submitted to FHWA in December 2015. Since then, NCDOT has continued to implement those effective strategies and has added additional measures to fulfill all of the goals and intent of the Rulemaking and NCDOT's Safety and Mobility Policy. In addition, NCDOT continues to enhance some pre-existing process elements while still working on improving others such as the collection and usage of work zone data.

PURPOSE AND OBJECTIVE

In 2007, the North Carolina Department of Transportation (NCDOT) committed to systematic consideration and management of work zone impacts related to safety, mobility, operations, and training through the Work Zone Safety & Mobility Policy. The purpose of this review is to assess the effectiveness of the current practices to manage work zone impacts and determine where improvements can be made. In addition, the process review will ensure compliance and adherence to FHWA's Work Zone Safety and Mobility Rule.

APPROACH

A process review meeting was held in November 2017 with various staff members to review the results of the 2015 report and to discuss recent updates and/or improvements.

RESULTS AND RECOMMENDATIONS

The process review meeting reviewed the results of the 2015 report and evaluated whether any improvements and innovations have resulted in safer or better mobility in our work zones. The highlights of the successes along with areas for improvement are described below, along with recommendations to overcome these challenges.

New Practices

Nighttime Work Operations. As the population of North Carolina grows and our roads become more traveled, daily time restrictions for construction activities play a large role in the way we build our roadways and bridges. Working during the night limits the number of motorists exposed to the work zone and limits the number of motorists exposed to the worker. In 2016, in response to a higher demand of nighttime work operations, NCDOT WZTC introduced Sequential Flashing Warning Lights and Work Zone Presence Lighting to our contracts executed mostly by lane closures at night. Digital speed limit signs, though 24 hours per day not just at night, were also added to support the visibility of necessary work zone information.

Sequential Flashing Warning Lights are affixed to the top of the drums in the merging taper at the beginning of the work zone to direct motorists to the desired vehicle path and to reduce the number of late merges. We have received overwhelmingly positive feedback from the construction industry and our regional traffic partners on the Sequential Flashing Warning Lights for being user-friendly, inexpensive, and effective. We will continue to use these devices for all nighttime work zone lane closures.

Work Zone Presence Lighting is a supplement to the Contractor's task and equipment lighting already onsite. The Work Zone Presence Lighting alerts the motorist to the existence of an active work zone and assists in the compliance of the work zone speed limit throughout the length of the work zone. Currently, approved lights have a "balloon-type" light head and the number of lights within the lane closure varies from 4 to 7 lights per mile depending on the light output and light fixture size. These have been in regular use for about 6 months at this time. WZTC is still working to fine tune the positions the lights should be in so as not to conflict with the Contractor's lighting or work operations, but still serve the purpose of lighting the traditionally dark areas of an active work zone. Speed compliance is the ultimate goal we hope to accomplish with the introduction of Work Zone Presence Lighting by making the entire work zone more conspicuous to the motorist. Currently, WZTC has access to several iCone data monitoring devices that will be used to collect speed data in different locations before and within a lane closure using Work Zone Presence Lighting. These tests have yet to be completed using the iCones, but are expected to begin Spring 2018.

Digital Speed Limit Signs (see additional information in 'Work Zone Speed Limit Reductions' section) display the speed limit brightly and clearly to motorists during the night. These signs are regulatory speed limit signs with LED displays for the speed limit numbers. The speed limit is changed remotely and immediately by personnel depending on the operation.

Smart Work Zones. Smart and connected technology has been implemented in several projects around North Carolina recently. Notably, the I-85 corridor between Henderson and the Virginia State Line currently uses a queue warning system complete with speed sensors inside the work zone, stationary detour signs, and 10 smart CMS boards for travel/detour information at the project limits and at the detour points near South Hill, VA and Hillsborough, NC. This project entered a 2-lane, 2-way traffic pattern Summer 2017, and remains in that pattern as of December 2017. Any incident causing a grievous delay (evaluated using captured speed data within the work zone) to the motorist will trigger the CMS boards to begin diverting traffic from the I-85 corridor outside of the project limits before they enter the work zone. The detour includes I-95, US-64, US-264, and I-40. We will continue this practice with project that meet certain criteria and pose the potential for large backups given an incident. A third usage of Smart Work Zones on a project on the I-40 corridor in Davie County. It also uses smart CMS boards in advance of and within the work zone to provide general information about the construction activities and manage incidents during construction. Additional CMS display alternate route information ahead of the detour points on I-40. All CMS have the capability of offsite remote control.

An increased use in WZ ITS will have a significant, positive impact to how motorists navigate our work zones, and road system in general, by enhanced communication of information.

Significant Projects Appearance. Major projects on North Carolina's interstates and freeways have a significant impact on how visiting and residing motorists view the transportation system and the state of North Carolina as a whole. NCDOT WZTC is committed to safe and efficient

work zones, but is also undertaking the task to improve the appearance of significant work zones. As a result, Work Zone Performance Pavement Markings, and Work Zone Pattern Masking and High Visibility Devices have been introduced.

Work Zone Performance Pavement Markings are long life markings (polyurea, epoxy, thermoplastic, polymer, and cold applied plastic - removable tape) to provide a more durable and higher performing work zone pavement marking over traditionally used paint for temporary traffic patterns that will be in place for 12 months or more. The markings are required to last the full duration of a traffic pattern without replacement or reapplication for a period of 12 months. Retroreflective requirements of the Work Zone Performance Pavement Markings will significantly improve dusk and nighttime visibility of the pavement markings to the motorist. Work Zone Performance Pavement Markings will also be essential when autonomous vehicles become common and sensors are used to detect lane and edge lines. These markings were included in few construction projects during 2017, so more use of this practice is necessary to complete a review of it.

Work Zone Pattern Masking is a flat, black, liquid material applied by spray mechanism to conceal the entire existing pavement surface; thus masking/covering the existing markings and allowing revised work zone pavement markings to be placed on a newly black surface. Work Zone Traffic Pattern Masking eliminates grind marks and ghost markings on pavement surfaces to provide clarity to the motorists. This material can accept Work Zone Performance Markings immediately, creating an incomparable contrast between the new black pavement color and new long life pavement markings for work zone patterns. Currently, only one manufacturer has been working with this product and the application process continues to improve. This masking was included in few construction projects during 2017, so more use of this practice is necessary to complete a review of it.

High Visibility Devices are all new drums, stationary work zone signs, and portable work zone signs required for projects on interstates and freeways with durations of 24 months or more. New devices enhance the visibility of them to improve both safety and mobility through a high-speed work zone. Requiring new devices also ensures that they remain in compliance with the required retroreflective properties for the full life of the project and help improve the overall appearance of the work zone. Through a partnership with Texas A&M Transportation Institute, fluorescent drums will be tested on a project along I-40 near NC-150 in Forsyth County to evaluate their effectiveness and visibility during daytime, dusk, and nighttime conditions. The results from this test and feedback from other projects containing this initiative will be reviewed and evaluated at their conclusions.

Improvements to Current Practices

Mobility Measurements using Intelligent Technology. As previously mentioned, WZTC has access to iCone devices to collect and store real time speed data. To date 28 secondary roadwork zones have been evaluated and rated using the data captured from the iCone software. Mobility ratings for flagging times within the work zone range from excellent to needs improvement. More projects are analyzed each year and we hope to establish a stable pattern for flagging wait times depending on the average daily traffic, length of the work zone, and type of work involved. For interstate and freeway work zones, iCones have been used to collect data on two projects in 2016 and iPeMS (Freeway Performance Measurement System) has been used to monitor the mobility on 8 work zones. A weekly work zone mobility report is generated using the iPeMS speed data to

determine the percentage of time and the average number of hours in the week each work zone speed was under 50. Inconsistent data set back this initiative in November 2017, but should be back underway by the beginning of 2018. The goal is to rate the mobility of interstate and freeway work zones similarly to those of secondary roads using speed data as opposed to flagging times.

Work Zone Speed Limit Reductions. The Work Zone Traffic Control Section is continuing to apply speed limit reductions in most cases during lane closures and other traffic control techniques that warrant a lower speed. All speed limit reductions still require an ordinance once the project and/or operation meets certain criteria. The advantage of variable speed limit reductions has been evident on interstate and freeway resurfacing projects, subject to primarily nighttime lane closure operations, with normal traffic patterns existing during the daytime. We have implemented variable speed limit reductions easily with the use of Digital Speed Limit Signs. These signs can be stationary or trailer mounted and make it possible for the appropriate personnel to change the speed limit throughout the work area immediately and simultaneously from a device. As soon as the operation concludes, the speed limit can again be changed immediately to the existing speed limit. Digital Speed Limit Signs have been in operation on various projects across the state with widespread support and effectiveness. We continue to monitor work zones to verify the reduced speed limit is justified for the current conditions. Speed reductions should be removed as soon as the need is no longer required.

Longer term speed limit reductions in work zones have separate criteria and are used when highway geometrics have been altered and/or usable shoulders have been eliminated. When these types of conditions exist, the speed limits are reduced on standard regulatory speed limit signs.

Both variable and long term speed limit reductions signage will include the black on orange “WORK ZONE” G20-5a panels are added to the top of the speed limit signs. Digital Speed Limit Signs will also display the appropriate work zone signage. If a project qualifies for a speed reduction, it automatically qualifies for the “\$250 speeding fine”. In some cases, a \$250 speeding fine is imposed without lowering the existing speed limit to keep the speed limit from seeming artificially low, but encourage speed compliance from the motorist.

\$250 Work Zone Speeding Fine. This practice has been used in North Carolina for over 20 years. The NC general statute for \$250 speeding fine was revised to allow the penalty to be used in sections of a work zone where the actual work is taking place. Previously, the wording of the law required the penalty to be applied for the entire work zone. The public was frustrated that fines were levied in areas where no work is taking place particularly with long Interstate resurfacing projects. To date, we have experienced little concerns from the law enforcement community and frustrated drivers. The lesson learned is to use this technique “judiciously” and the compliance rates will dramatically improve, along with law enforcements willingness to enforce this fine.

Work Zone Training Requirements. Currently, the NCDOT Work Zone Training Requirements include those for Flaggers and Work Zone Supervisors. Work Zone Designer Training remains under development for training requirements for personnel involved in the design of TMPs. However, additional guidelines and design requirements will be available on the work zone website in early 2018. Also new in 2018 is a requirement for Work Zone Installer Training. Work Zone Installers are personnel involved with lane closures and road closures on high speed and/or heavily traveled facilities. Similar to the requirements for Flaggers and Work Zone Supervisor, the Work Zone Installers will be required to be recertified every 4 years.

Review of Ongoing Successful Practices

Safety & Traffic Operations Meetings. Safety & Traffic Operation Meetings continue to be utilized on most of the Category I Significant projects. To date, the I-85 corridor in the Mecklenburg/Cabarrus/Rowan county area and project reconstructing the I-40/I-440 corridor in Raleigh have been using these since project inception. These are held on a biweekly or monthly basis and are planned and executed by the Division Incident Management Engineer. Law Enforcement, emergency services, construction staff, traffic engineering staff, contractor staff, public information officers and the TMP design team meet together to discuss recent traffic issues including WZ crashes, upcoming schedule, traffic shifts, lane and road closures, incident response issues, etc. In addition, they discuss specific solutions to these traffic related issues to improve the congestion and traffic operations in and around the project. Although no WZ crash studies have been performed on projects within the I-85 corridor, preliminary studies on the I-40 corridor have shown a reduction in crash rate on projects regularly holding these Safety & Traffic Operations Meetings. That is a crash rate at or below the pre-work zone crash rate. We expect this technique to continue and expand to all of the upcoming Category I Significant Projects.

IMPACT Let List Meetings. These meetings are held on a quarterly basis and continue to provide valuable information to the public information staff members. The participants of the meeting include WZTC, responsible for the development and/or oversight of the Transportation Management Plans (TMP's) and the Traffic Systems Operations Unit, statewide coordination of incident management and intelligent transportation systems efforts. Each project on the 12 Month Let List, whether it is a traditional design/bid/build or a Design/Build project, is categorized as High, Medium or Low Impact based on either the impact to traffic while the project is under construction and/or upon its completion will have a huge impact on traffic mobility. We also use the results of this meeting to select candidate projects for our "HAWKS" program. This program utilizes off-duty State Highway Patrol Officers to monitor and patrol selected work zones. This is described in more detail below.

HAWKS (Helping All Work Zones Keep Safe). HAWKS is a joint initiative between NCDOT and North Carolina State Highway Patrol (NCSHP) to utilize off-duty law enforcement officers to monitor and patrol work zones. This initiative provides dedicated enforcement in a specific work zone to improve safety and mobility. NCDOT prioritizes the work zones using crash rates, existing congestion, average speeds, and roadway tier classification (statewide, regional, sub regional) as the scored criteria. Projects with the higher scores are selected for the program and notifications are sent to the Resident Engineer and the State Highway Patrol Office for staffing and scheduling assignments.

Work Zone Supervisor. North Carolina requires a Work Zone Supervisor for each company that performs work within our Right of Way. We also require it for each Division within NCDOT. Contractors and NCDOT Divisions are allowed to determine how many Work Zone Supervisors they need based on their work load, but they must have at least one. The requirements are based on years of experience (work zone experience and supervisory experience) as well as the successful completion of an approved Work Zone Supervisor course. Once a person is qualified as a Work Zone Supervisor, they have two major responsibilities: 1) be available to work crews to assist and answer work zone set up questions, 2) they are also responsible for making sure all their employees have adequate work zone training to safely carry out their tasks.

On Category I Significant projects, we require a Work Zone Supervisor to be staffed directly to the project. A project special provision is added to the contract that stipulates the duties and responsibilities of this requirement. The purpose of this position is to provide NCDOT with a point of contact that is responsible for safety and mobility in the work zone. This position is also responsible for ensuring coordination between projects in the same network, monitoring queues, and coordinating with traffic management centers. This practice has provided better communication between the traffic management centers and project personnel.

Work Zone Traffic Analysis Research. WZTC remains under contract with the Institute for Transportation Research and Education (ITRE) at North Carolina State University to develop work zone software to evaluate the impacts of work zones on the highway network. FREEVAL-WZ was used during the summer of 2013 on the I-40/I-440 project in Raleigh. The project is expected to be complete Spring 2018, so the results of the initial FREEVAL-WZ predictions will be compared to actual data collected in the work zone. ITRE has developed an updated version to this software that we anticipate the using the next year. In addition, ITRE is developing software similar to FREEVAL-WZ to evaluate work zone impacts on urban arterials. Artval, mentioned in the previous process review in 2015, remains under development. When completed, the user should be able to analyze work zone impacts at both intersections and midblock areas.

Maintenance / Utility Traffic Control Guidelines (MUTCG). This manual was created and made available online to provide information and guidance to all persons working inside the Highway Right of Way in North Carolina. The manual is intended to blend information contained in the MUTCD with that in the NCDOT Standard Drawings to provide the basic knowledge workers should be familiar with before they perform tasks within our highways. It is expected that all employers provide and discuss this information with each employee on a regular basis. Certification is not required at this knowledge level. To date the manual has been well received by both the industry and internal NCDOT maintenance staff and is available on the NCDOT WZTC website.

Work Zone Review Annual Summary Reports. Data derived from the Work Zone Reviews is compiled and summarized annually indicating the results or findings of field safety audits. These reports help assist us in determining whether NCDOT Standards and Practices are implemented in the field consistently, uniformly, and effectively to provide a satisfactory level of safety, traffic flow and construction efficiency. In addition, they reveal techniques or technologies needed to improve overall safety, traffic flow and construction efficiency or identify current standard practices that may need updating based on observations and/or feedback. These reports are available online in the following location:

<https://connect.ncdot.gov/projects/WZTC/Pages/Manuals-Guidelines.aspx>

Upcoming improvements to Current Practices

Work Zone Traffic Control Design Manual. NCDOT WZTCS is actively updating and reviewing its Traffic Control Design Manual to be distributed for use. The manual will provide a traffic control design resource for Transportation Management Plan designers. Not only should it foster uniformity and consistency in TMP development statewide it will also, be instrumental in the implementation of the Work Zone Designer Training mentioned earlier. This manual will be available on the NCDOT WZTC website in Spring 2018.

Work Zone Reviews. The Work Zone Traffic Control Section implemented procedures and or guidelines for the review of work zones in 2013 (WZ Safety Audits). We also established a work zone “scoring” system that objectively evaluates the work zones by scored categories and an overall score. In 2018, we will begin regular nighttime work zone reviews. Most interstate construction operations happen during the night hours between 9pm and 5am. Reviewing work zones at night will also provide opportunity to evaluate the new nighttime work operations procedures including the use of Sequential Flashing Warning Lights and Work Zone Presence Lighting. Conclusions made from the work zone review is provided to the Contractor, Division personnel and the NCDOT Construction Office. We use this information to determine if there is any correlation between work zone crashes and the type of work, entity performing the work, and the possibility of training requirements.

Areas for Improvement

Work Zone Data. Work zone data collection and usage is still an area where improvements can be made. The availability of speed data is becoming more accessible through the INRIX program and Iteris technology and we are in the beginning stages of evaluating mobility of the work zone through this data. We met our goal set in December 2015 for implementation of mobility evaluation, but will continue to grow as more data is analyzed in 2018-2019.

We are continuing to review work zone crash information. Although allowing us to review these reports and make determinations on whether the work zone may or may not have had an impact in the crash, due to limited staff and time we only concentrate on work zone related crashes involving a fatality at this time. We review other work zone crashes on a project by project basis. As technology improves and government silos are reduced, this information will allow us to be timelier in the assessment of the crash reports, but also may help drive the content and audience of our work zone training.

Process Review. NCDOT is still committed to conduct a bi-annual Process Review to assess performance of existing processes and procedures and make changes that bring about improvements. NCDOT will be using data from the FHWA Work Zone Self-Assessment Program, Safety Audits, and the annual Windshield Review during the process review. Recent organizational changes and budget constraints have had an impact on the needed resources to conduct these reviews. However, NCDOT is working on a recommendation to develop a procedure for conducting process reviews and make it an integral part of the business process.

3. **Work Zone ITS (on all contracting).** We are in the process of developing a statewide “On Call” WZ ITS contract for 2018. This effort will focus on utilizing multiple Traffic Control companies and NCDOT Regional Traffic Engineering Staff to identify and deploy systems in the field.
4. **Work Zone Crashes & Fatal Data.** From reviewing WZ crash data over the past 16 years, NC’s WZ crashes are increasing, but the WZ fatal crash rates per miles driven are decreasing.

5 year avg. (2012-2016) = 4,269 WZ Crashes
5 year avg. (2012-2016) = 19 WZ Fatal Crashes
2016 = 5,831 WZ Crashes

2016 = 24 Fatal WZ Crashes
2017 (as of 12/11/17) = 25 Fatal WZ Crashes

We monitor and analyze this data to determine whether the work zone directly contributed to the occurrence and/or severity of the crash. More often than not, the work zone had no impact on the occurrence and/or severity. Impaired motorists and speeding motorists continue to be a concern in work zones, however if work zone safety is improved for the average motorist it will also improve for the impaired or speeding driver. With an increased presence of WZ ITS, we will be able to analyze and improve these numbers in future years.

CONCLUSION

NCDOT is determined to promote an agency culture committed to the Work Zone Safety and Mobility Policy. Although progress has been made in getting the requirements of the Rulemaking and North Carolina's Mobility and Safety Policy implemented, there are still some areas needing improvement. These areas include: 1) completing the Work Zone Training Program by establishing work zone training requirements for TMP designers, 2) expand the use of feedback for analyzed traffic data back into the training and design processes and procedures project level process and procedures. Although crash and speed data continue to become easier to obtain with improvements in technology, recent cuts in staffing make it increasingly challenging to dedicate personnel to evaluate this data and create a plan of action based on the results of such analysis. To implement the policy completely, we may have to rely more on the private sector and outsource more of this work. We have already privatized most of the work zone training (Flagger and WZ Supervisor training) and may need to do the same for evaluating crash and speed data and even auditing existing work zones. Whether the work is outsourced or remains with existing personnel, the NCDOT is committed to providing safe work zones for all workers and road users while minimizing traffic congestion and adverse impacts on road users and local communities.

It is important to note that the contracting method of project delivery is shifting towards a Design Build Program in lieu of the Design/Bid/Build method. In so doing, the Design Build method brings forth challenges with Lump Sum Pay Items as deficiencies have been seen related to Pavement Markings, Delineation, and Signing associated with those projects. This tendency indicates that we may need to adjust how transportation management is addressed in these type of contracts to ensure strategies, procedures, and standards are not compromised.

REFERENCES

FHWA Work Zone Safety & Mobility Final Rule
Effective October 12, 2007
Available At http://ops.fhwa.dot.gov/wz/resources/final_rule.htm

FHWA Temporary Traffic Control Devices Final Rule
Effective October 4, 2008
Available At <http://ops.fhwa.dot.gov/wz/resources/policy.htm>

NCDOT Work Zone Safety & Mobility Policy
Effective October 12, 2007
Available At https://connect.ncdot.gov/projects/WZTC/Documents/WZSafety_and_Mobility.pdf

NCDOT Maintenance / Utility Traffic Control Guidelines
Available At <https://connect.ncdot.gov/projects/WZTC/Pages/Manuals-Guidelines.aspx>

NCDOT WZTCS – Work Zone Safety Audits Annual Summary Report
Available At: <https://connect.ncdot.gov/projects/WZTC/Pages/Manuals-Guidelines.aspx>