

Passing Lane/Climbing Lane

The Traffic Operations Technical Memorandum from Patriot Transportation Engineering, PLLC completed October 16, 2019 provides the traffic forecast for STIP Project No. A-0009C. This forecast predicts a 2045 Annual Average Daily Traffic (AADT) of 12,900 vehicles per day (vpd) on US 129 and 8,800 vpd on NC 143 at the western terminus of the project. AADT near the eastern terminus of the project are 4,600 vpd on NC 143 and 5,200 vpd on NC 28. Truck percentages reflect five percent (5%) duals and two percent (2%) truck-tractor semi-trailers (TTSTs) on NC 28 and NC 143. Truck percentages on US 129 declined to four percent (4%) duals and one percent (1%) TTSTs. US 129, NC 143 and NC 28 serve as the sole east/west route for Robbinsville for recreational, commuter travel as well as access to medical and commercial facilities outside Graham County.

NCDOT planning level of service (LOS) guidance indicates capacity for 2-lane rural major thoroughfares with a 45 miles per hour (mph) design speed is 14,600 AADT and 15,100 AADT for a 55-mph design speed. Therefore, a two-lane typical section is appropriate for the proposed project. Though appropriate, based on the traffic forecast, the current two-lane routes present numerous challenges which comprise the basis for the A-0009C project and its purpose to improve mobility and reliability. Without improvements, it is expected that the 2045 AADT for the project will further reduce the mobility from 35% to 88%.

In addition to being two lane routes, NC 143 and NC 28 have steep grades and sharp curves. Grades exceed 8% in Stecoah Gap on NC 28 and 6% along NC 143. NC 143 has several sharp curves; most notably near the Appalachian Trail (AT). Sight distance is restricted by rolling grades along existing NC 143 in Sweetwater Valley. There are several side streets and driveways along this portion of NC 143 that restrict mobility and the use of "skip" lanes (two lane section with a dotted yellow line) allow minimal to no passing on this two-lane roadway.

Highways are designed to encourage a uniform operation. Steep grades, narrow lane widths, the lack of paved shoulders, and sharp curves on US 129, NC 143, and NC 28 affect travel speeds and limit opportunities to pass slower vehicles and thus the uniform operation of the facilities. According to the 2015 Graham County Comprehensive Transportation Plan (CTP), all paved roads into and out of Graham County ; except for a small section where US129 and NC143 in Robbinsville; are primarily two-lane and with the inability to pass slower vehicles over substantial distances ("up to 19 miles" as noted in the project needs). When reduced speeds from excessive grades are considered, the mobility and ability to pass vehicles significantly declines. Slow moving heavy trucks on two-lane roads create operational problems in terms of delay, reduced level of service, increase in passing attempts, aborted passes, and driver frustration. If a large portion of a road consists of no-passing zones, some motorists violate the established passing restrictions, thereby increasing the probability of an accident. In these situations, the use of passing lanes increase the passing opportunities and improve safety and operational problems (*TRB 1991, 1303-009*). The draft Crash Analysis by Patriot Transportation Engineering indicates 26% of the crashes along NC 143 and 43% along NC 28 in the study area are rear-end crashes. Improving the mobility and ability to pass stopped, slow, or turning vehicles along the corridor would address this type of crash.

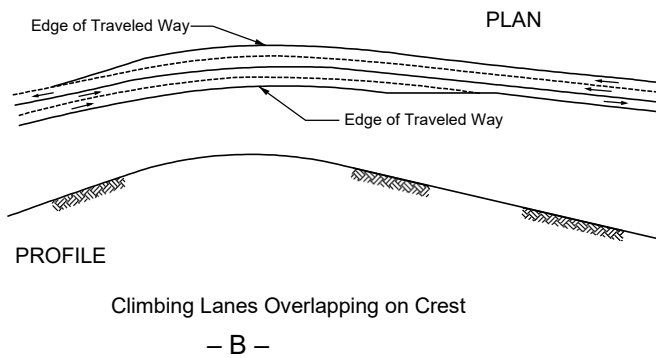
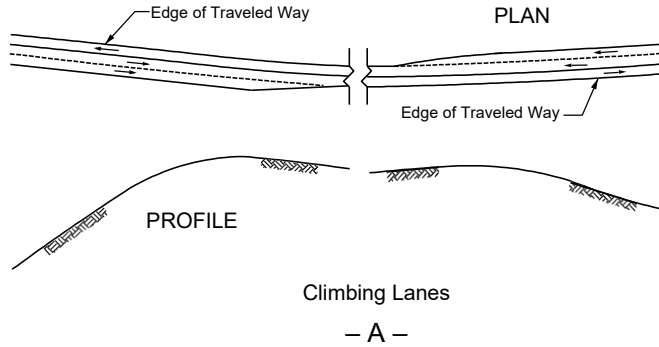
When examining how to address these challenges, NCDOT considered the information in the Traffic Operations Technical Memorandum January 2020 update which relays that the two-lane alternatives *with passing/climbing lanes* would not only provide increased travel time reliability but would also increase the overall mobility. Further, AASHTO guidance indicates roadways with the 2+1 alignment generally increased mobility more than a conventional two-lane highway with the same traffic volumes (AASHTO, 2018). Climbing lanes, coupled with passing lanes address limited mobility by providing opportunities to pass in a safe manner in tangent sections, along steep grades, and in areas with a high number of side streets and driveway connections, fulfilling the purpose and need of STIP Project No. A-0009C. According to AASHTO guidance, a two-lane road in rolling and hilly topography may not provide an adequate passing zone length between crests of vertical curves. AASHTO recommends an optimal distance of 0.5 mile to 2.0 miles for each passing lane. NCDOT has provided five areas of passing within the project limits along with six climbing lane sections.

NCDOT decided to incorporate a 2+1 design for multiple reasons. As noted in AASHTO guidance, a 2+1 design configuration may be a suitable treatment for roadways with traffic volumes higher than can be served by isolated passing lanes, but not high enough to justify a four-lane roadway. Additionally, the 2+1 configuration is applicable for use at locations where environmental or fiscal constraints, or both, make provision of a four-lane facility impractical. The passing opportunities for STIP Project No. A-0009C in the 2+1 design can be divided into three sections. Section 1 is on NC 143 from the municipal limits of Robbinsville to SR 1213 (Tatham Road). This section is bound by the existing three lane section in Robbinsville and a proposed climbing lane on the east and is 0.65 miles in length. Rear-end crashes account for 35% of the accidents in this section. Section 2 is on NC 143 from Sweeten Creek Road to SR 1222 (Orr Branch Road). This section is bound by a climbing lane on either end, and the section length is 2.16 miles. Note, passing in Section 2 includes a switch from a westbound passing opportunity to an eastbound passing opportunity. Rear-end crashes account for 27% of the collisions in this section. Section 3 is on NC 28 from SR 1226 (Stecoah Road) to the proposed climbing lane near Poplar Hill Road. This section is 1.3 miles in length. Rear-end crashes account for 33% of the accidents in this section.

When considering climbing and passing lanes, NCDOT utilizes design criteria outlined in the AASHTO publication *A Policy on Geometric Design of Highways and Streets (2018)*, Chapter 3 as well as research from the Transportation Research Board. Climbing lanes are used where the grade of the roadway causes a 10-mph reduction in vehicle operation speed. Passing lanes are used to improve overall traffic operations and maintain mobility. Passing lanes should be provided systematically at regular intervals (AASHTO, 2018). Passing lane sections “are particularly advantageous in rolling terrain, especially where the alignment is winding or the profile includes critical lengths of grade” (AASHTO, 2018).

The criteria used for the placement of climbing lanes on A-0009C was a 10-mph or greater speed reduction by determining the critical length of grade for the profile. The critical length of grade was found using the Truck Speed Profile Model outlined in the National Cooperative Highway Research Program Report 505: Review of Truck Characteristics as Factors in Roadway Design. (Harwood, Torbic, & Richard, 2003) Each side of the design alignments were evaluated independently using a typical truck to determine the effect of the grade on speed. Climbing Lanes were then placed using those calculations starting where the speed was reduced 10-mph or greater and ending where the truck returned to within 10-mph. Alignment and profile conditions determine whether the climbing lanes will overlap. When

there is a long grade on both sides leading up to a crest vertical curve, as is the case in Stecoah Gap, the climbing lanes will overlap. If the grade is steep on one side of the vertical crest and mild on the other, then the climbing lanes did not overlap. Both examples are represented by the figures below:



In conclusion, NCDOT recommends a 2+1 typical section for STIP Project A-0009C from the municipal limits of Robbinsville on NC 143 to the end of the four-lane section in Stecoah on NC 28 to address the mobility component of the project's purpose and need. A 2+1 typical section provides passing opportunities for slow, stopped and turning vehicles while minimizing the potential environmental impacts of a four-lane divided typical section. Climbing lanes as a hybrid of the 2+1 design, addresses mobility issues on steep grades.

References

AASHTO, A. A. (2018). *A Policy on Geometric Design of Highways and Streets*.

Harwood, D., Torbic, D. J., & Richard, K. R. (2003). *Review of Truck Characteristics as Factors in Roadway Design*. Kansas City: Transportation Research Board. Retrieved from Transportation Research Board: <http://onlinepubs.trb.org/Onlinepubs/trr/1988/1195/1195-008.pdf>