Figures 3-5 through 3-22 provide warrants for left-turn storage lanes on two-lane highways based on 5 to 30 percent left-turn volumes and design speeds of 40, 50, and 60 MPH. Additional storage length is required for 10 to 50 percent truck volumes.

NOTE: There are circumstances where a turn lane may be needed even if the warrants are not met.

For example, intersections and entrances with poor visibility and/or a bad accident record may require the Engineer to use engineering judgment when volume conditions alone do not warrant a storage lane.

Additionally, the functional classification of the highway shall be considered so that the impact of turning movements on highways intended to serve through traffic is minimized.

Lane/Shoulder/Pavement Transitions, Merging Tapers and Speed Change Lengths

Lane/shoulder/pavement transitions typically occur where new or reconstructed roadways tie-in to existing roadways. This also applies to where roadways tie-in to bridges. Lane/pavement transitions, merging tapers and speed change lengths shall meet the minimum length provided by the following equations:

Less than 45 mph	45 mph and greater
$L = S^2W \div 60$	$L = W \times S$

L = length of transition
S = Design Speed
W = Width of offset on each side

Source: *2009 MUTCD*, Section 6.

For Permanent Shoulder and Shifting Tapers see *2009 MUTCD*, Section 6, Table 6C-3 and 6C-4.

NOTE:
A pavement transition length of 1/2L (calculate L by using the applicable formula above) is to be used when establishing project termini for the majority of small bridge replacement and/or major bridge rehabilitation projects when “NO” horizontal or vertical geometric changes are required to tie into the existing approach alignment. For additional information see Volume 5, Part 2, of the *Structure and Bridge Manual*.

Pavement transition is separate from the length of need for guardrail. Length of need and shoulder prep for guardrail shall be in accordance with the VDOT RDM Appendix A and the *Road & Bridge Standards*.