APPENDIX G

MODELING GUIDANCE FOR INTERCHANGES, INTERSECTIONS, AND ROUNDABOUTS

Modeling Guidance for Interchanges, Intersections and Roundabouts			
Interchange/Intersection/ Roundabout Type	**TNM Element**	**General Guidance from NCHRP Report 791©**	**For More Detailed Guidance, Refer to the Following Section of NCHRP Report 791©**
Normal Signalized Diamond Interchange	Entrance Ramp	The ramp should be modeled as a flow control acceleration roadway that starts at the beginning of the ramp, with 100% Vehicles Affected. The Speed Constraint should be 10 mph, based on *NCHRP Report 311*. If the ramp carries more than 3% heavy trucks, the Speed Constraint could be increased to 15 or 20 mph because automobiles can make the turn onto the ramp at a higher speed before beginning the acceleration along the ramp.	3.4.1.1
	Exit Ramp	The need to model deceleration along the ramp in detail is moderated by several factors. First, while 100% of traffic will either have to stop at the signal or decelerate down to about 10 to 20 mph to make a turn at the end of the ramp, the traffic may then be modeled as accelerating away from the end of the ramp. If there is a queue on the ramp for the signal, that acceleration will occur along the ramp. Acceleration from the end of ramp or the queue will affect levels at upstream receivers; as a result, precise modeling of end of deceleration is not needed. Second, the mainline noise may be the dominant contributor to the total sound level for receivers along the ramp; the effect is a function of the receiver offset distance from the ramp, the distance upstream along the ramp, and the amount of traffic on the ramp compared to the main-line traffic.	3.4.1.2
Folded Diamond Signalized Interchange	Entrance Loop Ramp	The FHWA TNM roadway would start at the beginning of the ramp, just past the traffic signal. It would be designated as a flow control roadway with 100% Vehicles Affected and a Speed Constraint of 10 mph (based on *NCHRP Report 311* for heavy trucks) until the loop curve is reached. Then, a new roadway of cruise segments would be used to model the loop at the posted ramp speed. Then, an acceleration road-way would be modeled with 100% Vehicles Affected and a Speed Constraint equal to the ramp loop speed up to final mainline speed. The FHWA TNM roadway segment lengths should not exceed 50 ft if the final cruise speed is 30 mph, 100 ft for 45 mph, and 500 ft for speeds of 60 mph or higher.	3.4.2.1
	Entrance Diamond Ramp	This ramp would be modeled in the same manner as described for the regular diamond interchange.	3.4.2.2
	Exit Loop Ramp	The FHWA TNM roadway would start at the beginning of the ramp. It would be modeled by a series of segments along the loop at the posted speed. A final 100-ft segment could be modeled at a speed of 20 mph, ending at the stop line. The immediately adjacent entrance ramp with accelerating traffic and the local crossing road would dominate the levels for any nearby receivers.	3.4.2.3
	Exit Diamond Ramp	This ramp would be modeled in the same manner as described for the regular diamond interchange. The immediately adjacent entrance ramp with accelerating traffic and the local crossing road would dominate the levels for any nearby receivers; precise modeling of the deceleration is much less important.	3.4.2.4

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Single-Point Signalized Urban Interchange (SPUI) - Full Modeling	Exit Ramp Entrance Ramp Crossing Road	SPUIs present potentially complex modeling scenarios. The mainline can be designed to pass over or under the turn-ing movements. When passing under, the mainline traffic is largely shielded from the receivers by the ramp embankments or retaining walls. When the mainline traffic passes over the crossing road, mainline noise will dominate the exit ramp traffic's deceleration noise even more than at diamond inter-changes because the SPUI ramp is closer to the mainline due to geometry of the interchange design. Also, in this configuration, the interchange movements are under the mainline deck and are shielded from the receivers. Due to the complexity of modeling this type of interchange, the TNM modeler is directed to the instruction and descriptive graphics contained in the NCHRP Report 791.	3.4.3.1
Single-Point Signalized Urban Interchange (SPUI) - Partial Modeling	Exit Ramp Entrance Ramp Crossing Road	Partial modeling of the interchange turning movements has the advantages of avoiding micro-modeling of all segments of all turning movements and avoiding modeling of 12 roadway segment intersecting points in the center deck area. A disadvantage is that partial modeling may slightly underestimate sound levels for receivers very close to the end of the exit ramp because the acceleration away from the signal for the left leg of the ramp is not modeled.While partial modeling is somewhat less complex than full modeling, suffiecient guidance cannot be provided here, and the TNM modeler is directed to the instruction and descriptive graphics contained in the NCHRP Report 791.	3.4.3.2

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Unsignalized Intersection	Two-Way Stop	This situation would involve a more heavily traveled main road and a lower volume cross street. The main road should be modeled by FHWA TNM roadways in each direction at cruise speed with no acceleration or deceleration. The cross street probably does not need to be modeled because if even a four-way stop is not warranted to control traffic on the main road, then intersecting road volumes and speed are both likely to be low. However, the cross street could be modeled if there are adjacent receivers by a flow control acceleration roadway starting just past the mainline roadways using 100% Vehicles Affected and a Speed Constraint of 20 mph to represent speed as the vehicle exits the inter-section. The local road approach leg should be modeled at the posted speed for that road; no modeling of reduced speeds for deceleration is needed if the approach speeds are 40 mph or less.	3.4.4.1
	Four-Way Stop	The four-way stop may require more complete modeling if there are receivers adjacent to each road. One would model the acceleration away from the stop line in each of the four directions.Total modeling would require many intersecting points for the crossing roadways because FHWA TNM does not allow two roadways to cross without sharing a point with the same x, y, and z coordinates and may not be needed: If the scenario is modeled with one FHWA TNM roadway in each direction, there would be four points of intersection. If the scenario is modeled as two FHWA TNM roadways per direction of travel on one road and one FHWA TNM roadway per direction of travel on the other road, there would be eight intersecting points. If the scenario is modeled as two FHWA TNM roadways in each direction for each road, there would be 16 intersecting points. In all cases, the flow control roadway would start at the stop line with 100% Vehicles Affected and a Speed Constraint of 0 mph. As illustrated in the SPUI discussion, the approach¬ing traffic could be modeled as the posted speed. If the posted speed were as high as 60 mph, there would be over-prediction by 1–3 dB by not modeling the deceleration. A simpler approach is to partially model the movements of one of the roads and avoid all of the intersecting FHWA TNM points. In this case, model the road with the most traffic (or perhaps the most adjacent receivers) as continuous, with an FHWA TNM cruise speed roadway on the upstream side connected at the stop line to a flow control acceleration roadway that crosses through the intersection and proceeds downstream on the departing leg. The flow control roadway would have a Speed Constraint of 0 mph and 100% Vehicles Affected. The lesser road would be modeled as described above for the two-way stop: (1) on the departing leg, by a flow control acceleration roadway starting just past the main roadways using 100% Vehicles Affected and a Speed Constraint of 20 mph to represent speed as the vehicles exit the intersection, (2) on the approach leg, by a constant-speed roadway at the posted speed for that road. No modeling of reduced speeds for deceleration is needed unless the posted speed is high and the simpler modeling did not result in levels within a couple of dB of causing noise impacts.	3,4,4,2

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Signalized Intersection	One-Way Roadway	Model the departing leg as a flow control acceleration roadway starting halfway back along the upstream queue. Use 50% Vehicles Affected, a Speed Constraint of 0 mph, and a final speed of the operating or posted speed. Model the approaching leg as a constant-speed roadway at the operating or posted speed to halfway back in the queue. The low-speed deceleration does need to be modeled unless the posted speed is high because of the dominance of noise from the percentage of traffic cruising through the signal and the per-centage of traffic accelerating from a stopped condition on the upstream side of the intersection.	3.4.5.1
	Two-Way Roadway	The degree to which a signalized intersection with two-way traffic on all legs needs to be modeled depends on the proximity of the receivers. As described for the four-way stop, total modeling would require many intersecting points for the crossing roadways because FHWA TNM does not allow two roadways to cross without sharing a point with the same x, y, and z coordinates and may not be needed. A simpler approach is similar to what was described for the four-way stop—partially model the movements of one of the roads and avoid all of the intersecting FHWA TNM points. The road with the most traffic (or perhaps the most adjacent receivers) would be modeled as continuous in each direction. A constant speed FHWA TNM roadway (or multiple roadways for multiple lanes) would be modeled on the approach, connected to a flow control acceleration roadway (or roadways) that crosses through the intersection and proceeds downstream on the departing leg. The joining point would be halfway up the expected queue, which could be several hundred feet from the stop line. The flow control roadway would have a Speed Constraint of 0 mph and 50% Vehicles Affected. The intersecting road would be modeled as not crossing through the intersection. On the departing leg, a flow control acceleration roadway would start just past the main roadways to avoid the intersecting points. This flow control roadway would have 50% Vehicles Affected and a Speed Constraint of 20 mph to represent the speed as the vehicles exit the intersection. On the approach leg, a constant-speed roadway would be modeled at the posted speed for that road; no modeling of reduced speeds for deceleration is needed. Unlike the one-way road case illustrated above, even at higher approach speeds, the difference between modeling a combination of deceleration and cruise and all cruise is small.	3.4.5.2

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Roundabout	General Considerations	Roundabout design is largely governed by guidance in *NCHRP Report 672.* Key design factors are the entry, circulation, and exit speeds, which are determined by the radii of the curves leading into, going around, and leaving the round-about. For a single-lane roundabout with a center radius on the order of 90 ft or less, the typical entry and circulation speed is 20 mph. For a multilane roundabout with a larger radius, the typical entry and circulation speed is approximately 25 mph. This research showed that detailed noise modeling of all of the roundabout movements is generally not needed. However, if a modeler chooses to model all of the movements, he/she is dircted to the methodology illustrated in Section 3.4.6 of NCHRP Report 791.	3.4.6
	One-Lane Circulatory Roadway	Approach Leg. The approach to the roundabout may be modeled by a constant speed equal to the posted speed up to the beginning of the splitter island/crosswalk. Then, one 25-mph segment would be used to represent the entry leg, ending at the entry point to the circulatory road. Inner Circulatory Road. The traffic on the inner circula-tory road does not need to be modeled. The noise from the accelerating traffic departing the roundabout will dominate the overall sound levels. Departure Leg. For the departure leg, a one-segment constant-speed roadway would be modeled at a speed of 25 mph. It would start at the exit point from the inner circulatory road and end at the end of the reverse curve typically at the end of the splitter island/crosswalk. Then, a flow control acceleration roadway would be modeled from the point downstream to the end of the modeled site. The roadway would have a Speed Constraint of 25 mph and 100% Vehicles Affected with the posted or operating speed as the final desired speed.	3.4.6.1
	Two-Lane Circulatory Roadway	A roundabout with a two-lane inner circulatory road may be modeled in essentially the same way as a one-lane inner circulatory road.Because of the slightly higher speed typical of the two-lane case (20 to 25 mph instead of 15 to 20 mph on the smaller diameter one-lane road and the greater circumference), there might be a desire to model the inner circulatory road, especially if receivers are immediately adjacent. However, if the inner road’s entry and approach legs are each modeled, then it is unlikely that the inner road itself needs to be modeled, especially because of the noise of vehicles accelerating away from the roundabout.	3.4.6.3