NCHRP PROJECT 25-34: SUPPLEMENTAL GUIDANCE FOR MODELING AREA SOURCES

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Presentation overview

- What are area sources?
- Issues when modeling with TNM
- Development of methodology/validation
- Guidance for:
  - Stationary sources
  - Accelerating and decelerating vehicles
  - Stop-and-go traffic

What are area sources?

Area sources include:

- toll facilities
- weigh stations
- service plazas
- park and ride lots

What characterizes area sources?

- Typical noise sources:
  - Low-speed traffic
  - Stop-and-go traffic
  - Accelerating vehicles
  - Decelerating vehicles
  - Idling vehicles (trucks, buses)

- Often no louder than mainline traffic, but may annoy nearby residents, particularly if closer than mainline

Issues when modeling with TNM

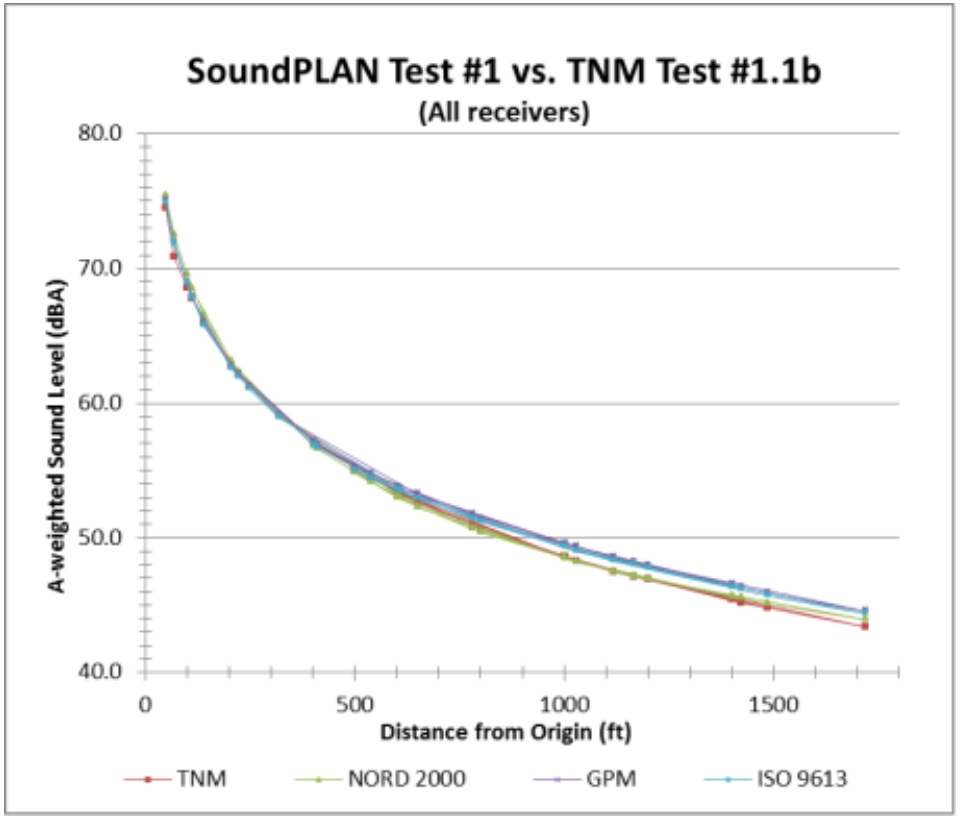
- TNM treats all sources as line sources
- TNM has no provision for modeling:
  - Stationary sources (e.g., idling trucks or buses)
  - Decelerating traffic
  - Stop-and go traffic (queues)

Modeling stationary sources

- Idling vehicles: service plazas, park-and-ride, weigh stations
- Typically quieter than moving traffic (no tire-pavement noise)
- When adjacent to noise-sensitive receptors and/or between receptors and the main roadway, modeling may be appropriate
- When adjacent to highways, mainline roadway may dominate noise levels, modeling may not be necessary

Stationary sources: development/validation

- No new source level measurements: used TNM REMELs; also “Advanced Approach” with user source measurements available as an option
- Used SoundPLAN to validate procedure with 3 different models for various geometries
- Excellent agreement with NORD 2000, ISO 9613, and General Prediction Method



Stationary sources: two options

- **“Standard Approach” uses TNM Reference Energy Mean Emission Levels (REMELs) for standard TNM vehicle types**

- **“Advanced Approach” provides procedure for creating user-defined vehicle type within TNM based upon emission level measurements conducted by the practitioner**

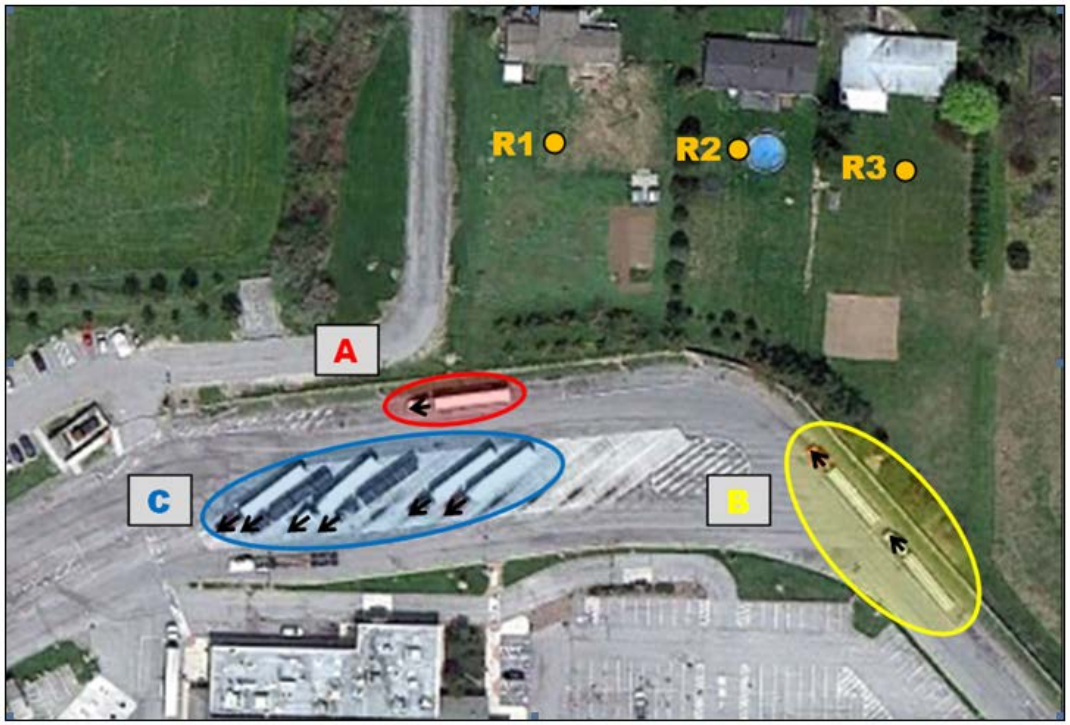
Stationary sources: Standard Approach

- Straight-forward, requires no special measurements or TNM modifications
- Appropriate for most situations involving standard TNM vehicle types
- Expected to be used mainly for idling heavy trucks, buses, etc.

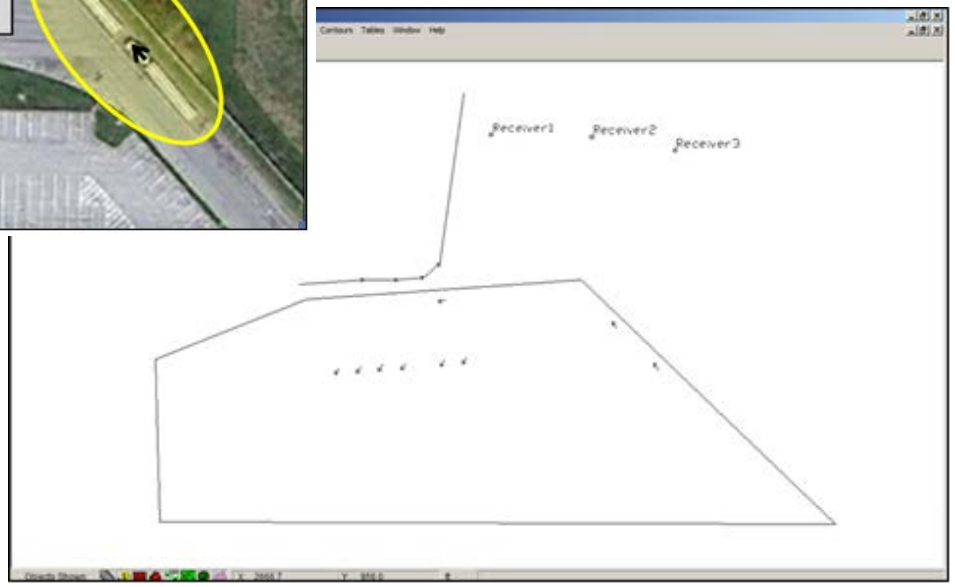
Roadway segments

- Segment(s) model geometric distribution of stationary sources
- Length varies depending upon the size and/or distribution of the modeled source(s):
  - Model a single heavy truck as a 10-foot long roadway segment
  - Model a line of idling heavy trucks or buses as a longer roadway segment
  - Model a large truck parking area as several roadway segments arranged in appropriate geometry

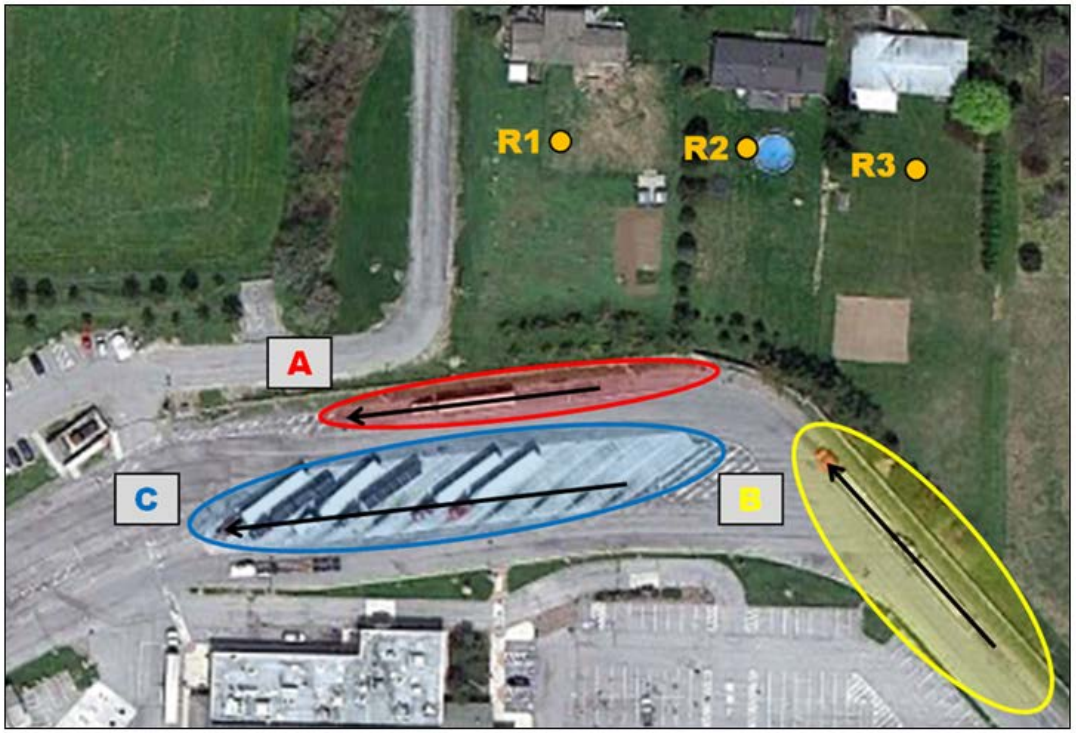
Modeling stationary sources (Example 1)



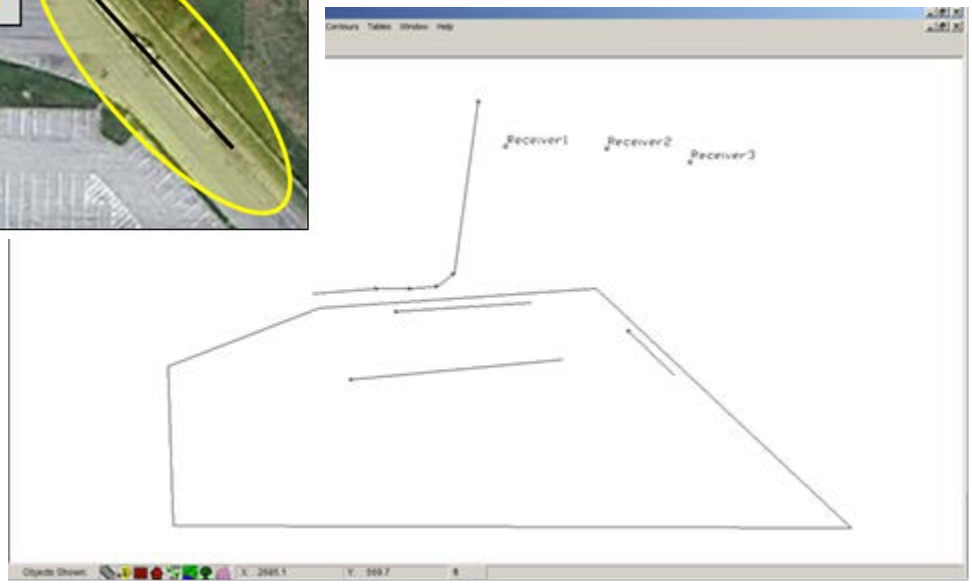
- Each truck modeled as an individual source
- Roadway segment length = 10 ft.



Modeling stationary sources (Example 2)



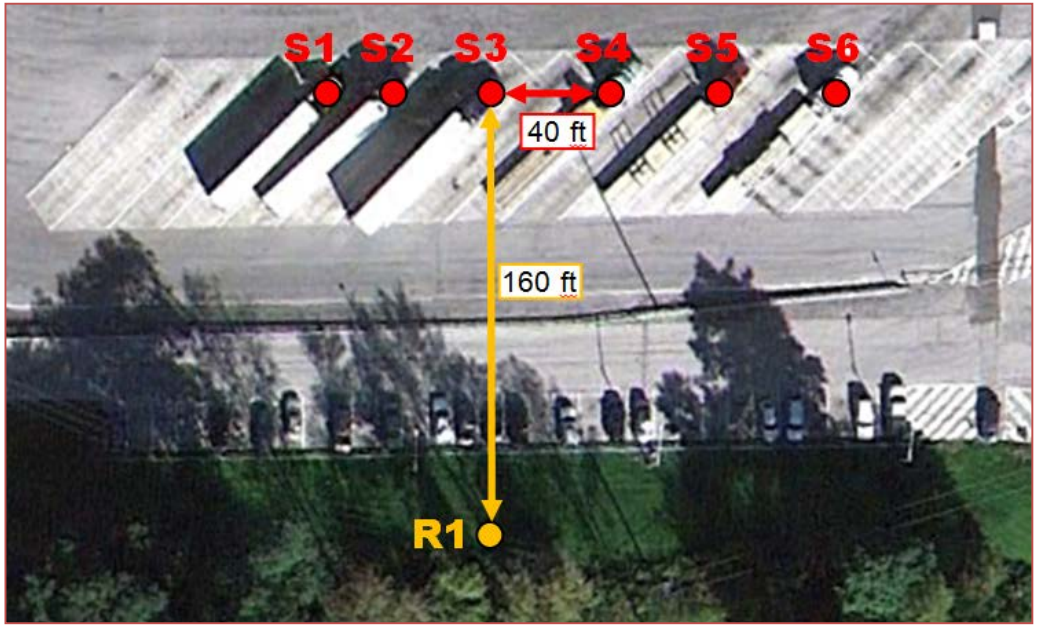
- Each truck parking area modeled as a line source
- Roadway segment lengths determined by actual geometry of parking areas



Array of single sources or line source?

- If distance from closest receiver to nearest noise source ≥ spacing between individual noise sources, line source may be substituted for array of individual sources

- Typically limits discrepancy between line source and corresponding array of individual sources to less than 1 dBA



Volume factors (VF)

- TNM does not accept input speeds of 0 mph. Instead, use 1 mph to provide 0 mph emission level
- VF = number of vehicles each moving at 1 mph, required to traverse roadway one at a time with one vehicle always present throughout 1-hour period
- VF depends only on length of modeled segment
- Input traffic = VF x actual number of vehicles represented by segment

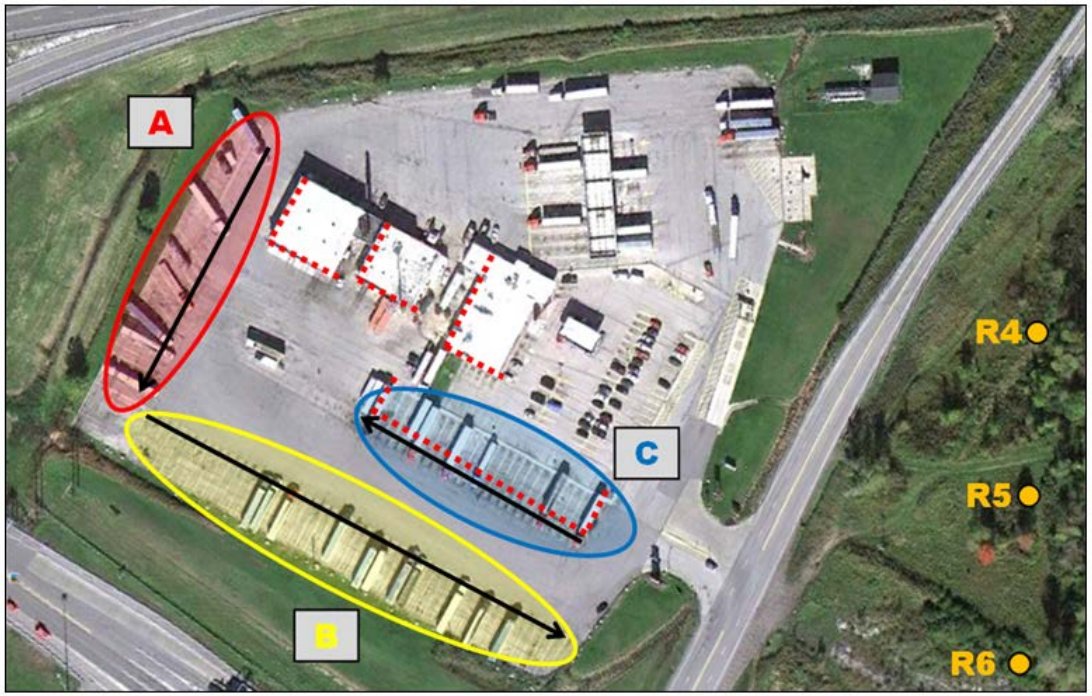
Roadway Length (feet)	Modeled Speed (mph)	Volume Factor
10	1	528.0
100	1	52.8
500	1	10.6

Calculate VF for any roadway length as:

VF = (10/L) * 528

where L = Roadway Length in feet

Modeling stationary sources (Example 3)



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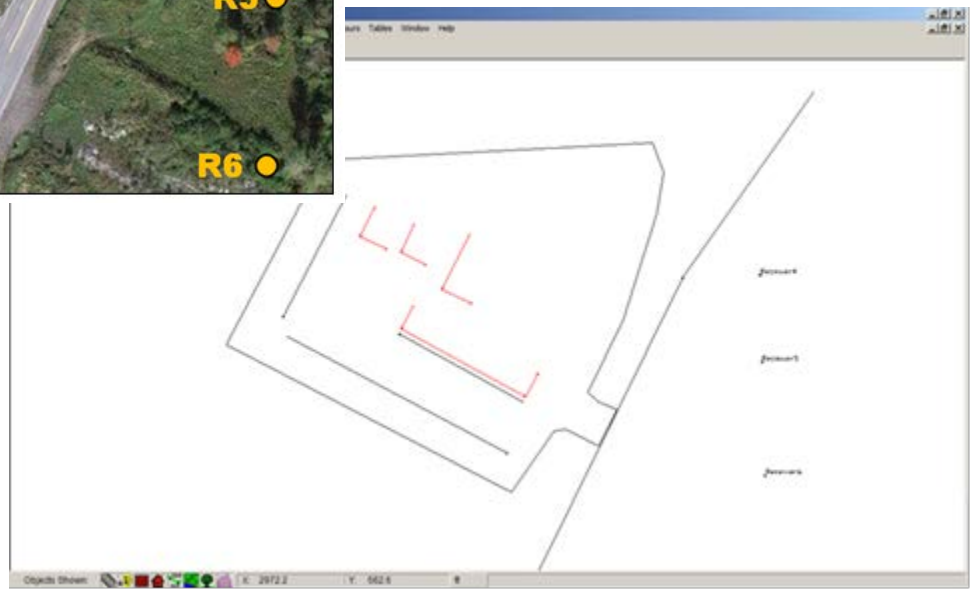


- VFs determined by segment lengths
- Input traffic = VF x number of trucks per area

Stationary sources: Advanced Approach

- Use to model a stationary source other than standard TNM vehicle type
- Conduct emission level measurements (*Measurements of Highway-Related Noise*, Report No. FHWA-PD-96-046 and DOT-VNTSC-FHWA-96-5, May 1996) and then create user-defined vehicle type within TNM
- TNM requires three coefficients (A, B, and C) to define emission level curve. For a stationary vehicle, A=B=0 and C is the measured emission level at 50 feet
- Once user-defined vehicle has been created, proceed using the standard approach

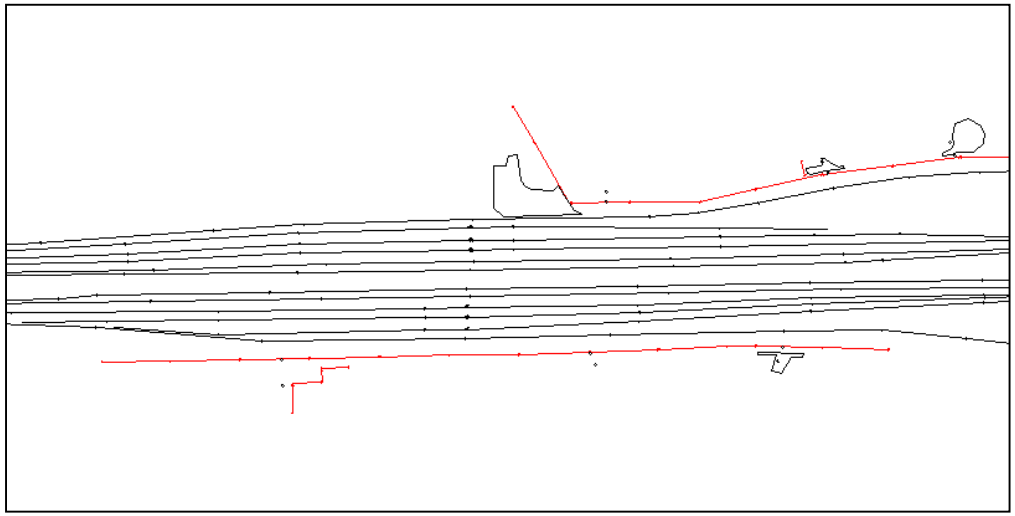
Modeling accel. and decel. traffic

- **Weigh stations, park and ride lots, and service plazas: vehicles entering and departing the facility**
  - **Entrance/exit ramp to a limited-access roadway**
  - **Vehicles within facility, e.g., buses at park-and-ride lot**
- **Toll plazas: vehicles decelerating from/accelerating to cruise before/after passing through the toll barrier**
  - **Toll tickets: all vehicles to/from 0 mph**
  - **Electronic tolling: some reduced speed >0 mph**

Additional guidance for modeling accelerating/decelerating vehicles included in NCHRP Report 791: Signalized Interchanges; Intersections; and Roundabouts

Accel./decel. vehicles: development/validation

- Uses existing elements: TNM for accel., NCHRP 311 *(Predicting Stop-and-Go Traffic Noise Levels)* for decel. and stop-and-go
- Coordination with other topic areas
- Toll plaza validation with existing data



Accelerating traffic

- Use TNM's "flow control" feature
- Entrance ramps to limited-access roadways (traffic departing weigh stations, park and ride lots, service plazas, etc.):
  - Control Device: Onramp
  - Vehicles Affected (%): 100
  - Speed Constraint: 10 mph
- Traffic accelerating away from toll plazas:
  - Control Device: Toll
  - Vehicles Affected (%): 100
  - Speed Constraint: 0 mph if toll-ticket lane; average speed through barrier if electronic toll lane

Decelerating traffic – exit ramps

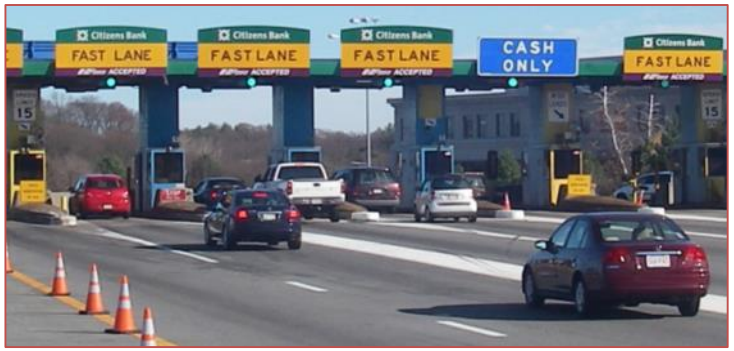
- Based on NCHRP 311 and other sections of NCHRP 791
- Under free-flow conditions, traffic entering weigh stations, park and ride lots, service plazas, etc.:
  - Divide ramp into two decel. "Zones of Influence" (ZOI)
  - Use table to determine modeled speed for each ZOI

Decel. Range (mph)		Length (ft)		Speed ZOI(1) (mph)			Speed ZOI(2) (mph)		
$S_{initial}$	S_{final}	ZOI(1)*	ZOI(2)**	Autos	MT	HT	Autos	MT	HT
60	0	500	100	50	40	35	20	20	20
60	30	500	none	50	40	35	n/a	n/a	n/a

*Starting from end of ZOI(2)
**Starting from point of S_{final} and proceeding upstream

Decelerating traffic – toll plazas

- **Under free-flow conditions, decelerating traffic approaching toll plazas:**
  - **Divide affected roadways into deceleration ZOIs working backwards from point where final speed is reached**
  - **When a queue forms at a toll plaza, endpoint of ZOI(2) is located at average end of the queue**
  - **Using table, determine appropriate modeled speed for each ZOI roadway**



Mixed tolls: electronic and ticket lanes

- Due to higher speeds, electronic toll lanes may dominate overall sound level near combined electronic/ticket toll plazas
- Relative contribution to overall sound level depends on many factors including:
  - Traffic volume in each type of lane
  - Traffic mix in each type of lane, especially HT percentage
  - Average speed of vehicles in electronic lanes
  - Distance to toll plaza
  - Relative distance to different types of lanes

Rules of thumb: electronic and ticket lanes

- **Ticket lanes and reduced-speed electronic lanes:**
  - **Minimum speed in electronic lanes ≤ 30 mph and volume in electronic lane(s) ≥ volume in ticket lane(s), model all vehicles as if in electronic lanes**
- **Ticket lanes and high-speed open road tolling lanes:**
  - **Volume of vehicles in electronic lane(s) at least 2x volume in ticket lane(s), model all vehicles as if in electronic lanes**
- **Typical error < 1 dBA**
- **If in doubt, model traffic in different types of lanes separately**

(Assumptions: HT percentages ranging from 4% to 10%, same vehicle mix in both electronic and ticket lanes, both types of lanes equidistant from prediction points. Substantial deviations from these parameters may provide different outcomes.)

Stop-and-Go Traffic (Queues)

- NCHRP 311: stop-and-go traffic increases heavy truck emission levels by ~ 3 dBA (vs. free-flow decel. or idling)

- Emission levels for other stop-and-go vehicle types significantly lower than HTs, typically not necessary to model other vehicles in queues
  - In general, if HTs at least 1% of total traffic volume, HTs will dominate Leq of vehicles in the queue
  - Exception: queues in facilities, such as parkways, with no HTs; may use similar methodology for autos

Stop-and-Go Traffic (Queues)

- **Follow "Stationary Sources, Standard Approach" with 3-dBA adjustment for higher emission level of stop-and-go traffic:**
  - **Determine average queue length**
  - **Determine volume factor (compute or use table)**
  - **Determine average number of vehicles in queue**
  - **Compute modeled volume (VF x Average Number in Queue)**
  - **Include 3-dBA stop-and-go adjustment: multiply computed volume by 2 (doubling traffic volume increases modeled Leq by 3 dBA)**

Modeled Volume = VF x Average Number in Queue x 2

Summary

- Modeling area sources with TNM requires special techniques
- NCHRP Report 791 provides guidance for toll plazas, service plazas, park-and-ride lots, weigh stations, etc.
  - Stationary sources: standard and advanced approaches
  - Accelerating vehicles: use TNM features
  - Decelerating vehicles: use NCHRP 311 Zone of Influence (ZOI) approach
  - Stop-and-go traffic (queues): combine stationary source methodology with NCHRP 311 adjustment
- In some cases, detailed modeling may not be necessary

Questions?

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