Heavy Truck Contributions to Highway Traffic Sound Pressure Levels

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Environmental Measurement and Modeling

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Motivation

- Effectiveness of noise treatments is different for heavy trucks and autos
- Noise treatment strategies may be different for areas dominated by heavy trucks
- An understanding of when heavy trucks dominate provides guidance in treatment selection
- Interaction of parameters affecting heavy truck dominance are complex

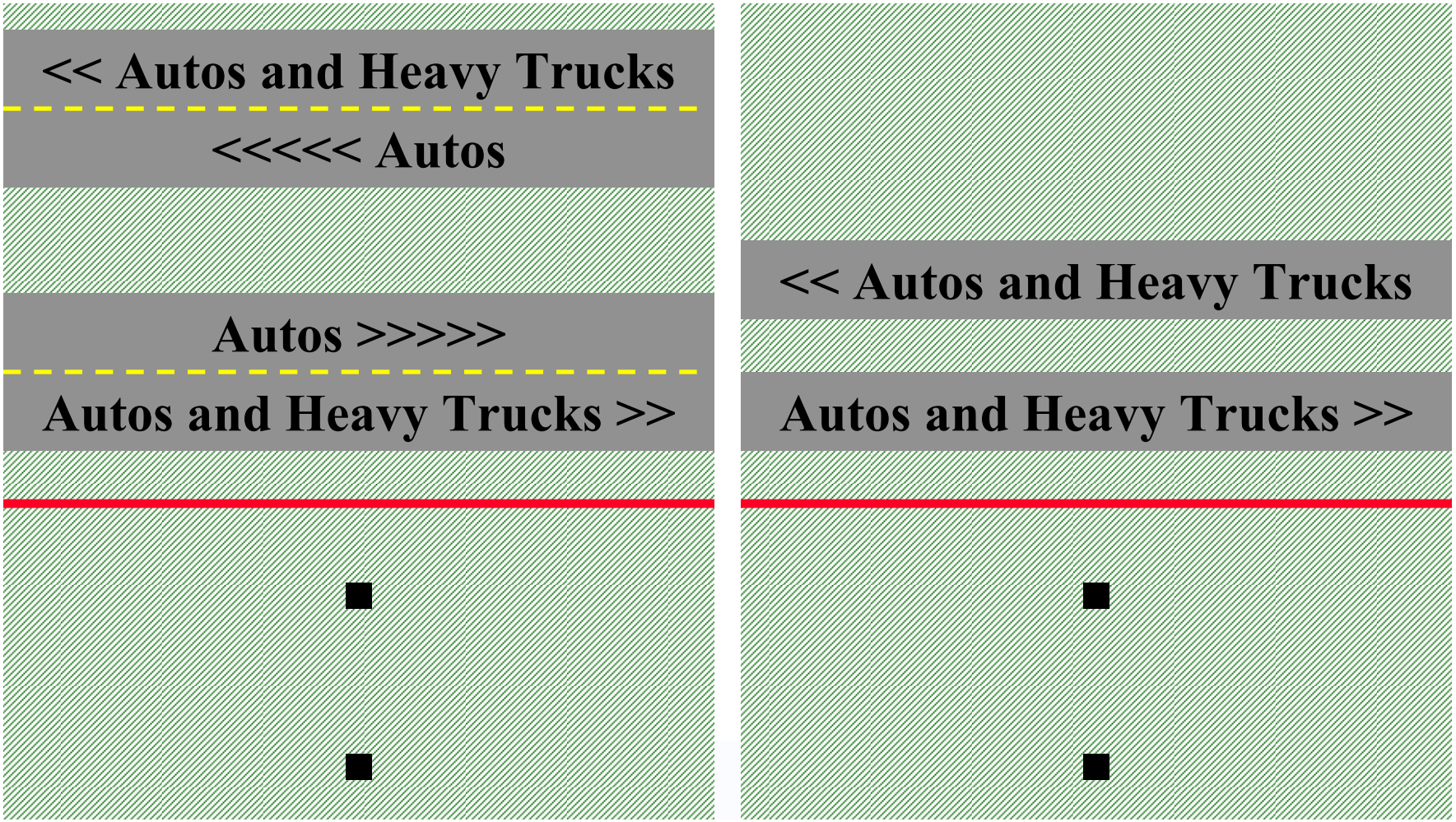
Parameters of Interest

- **Heavy truck percentage**
  - 0, 3, 5, 10, 15, 20, 30, 50, 100%
- **Pavement type**
  - TNM average, OGAC, and PCC
- **Ground type**
  - Hard (20000 Rayls) and soft (300 Rayls)
- **Number of traffic lanes**
  - 2 and 4
- **Distance from the roadway**
  - 50, 100, 200, 300, 500, 1000, and 2000 ft
- **Noise shielding**
  - No barrier, 10, and 20 ft single barrier
- **Vehicle speed**
  - 30 and 60 mph
- **Site geometry**
  - Level and raised roadways

Assumptions for Each Run

- Constant traffic (volume, speed, distribution)
- Vehicles travel at same speed
- Only autos and heavy trucks
- Passing lanes - only autos
- Met. conditions - TNM defaults
- Terrain is flat
  - Barriers (exception)
  - Raised roads (exception)
- Receivers - 5 ft above ground

Sample Site Geometry



Four - Lanes

Two - Lanes

Site Modeling

- **Traffic volumes based on Pennsylvania sites previously studied.**
  - **Two morning and two afternoon time blocks averaged**
  - **440 (travel lane) and 160 (passing lane) vehicles per hour.**
  - **Adjusted to 500 (travel lane) and 200 (passing lane) to simplify fractional distributions.**
- **Roadway widths based on Pennsylvania sites**
  - **Two-lanes: road = 12 feet (each lane), median = 10 feet.**
  - **Four-lanes: road = 12 feet (each lane), median = 20 feet.**
- **All ground except for roadways modeled as either acoustically soft or hard.**

Analysis by Percent of Sound Energy

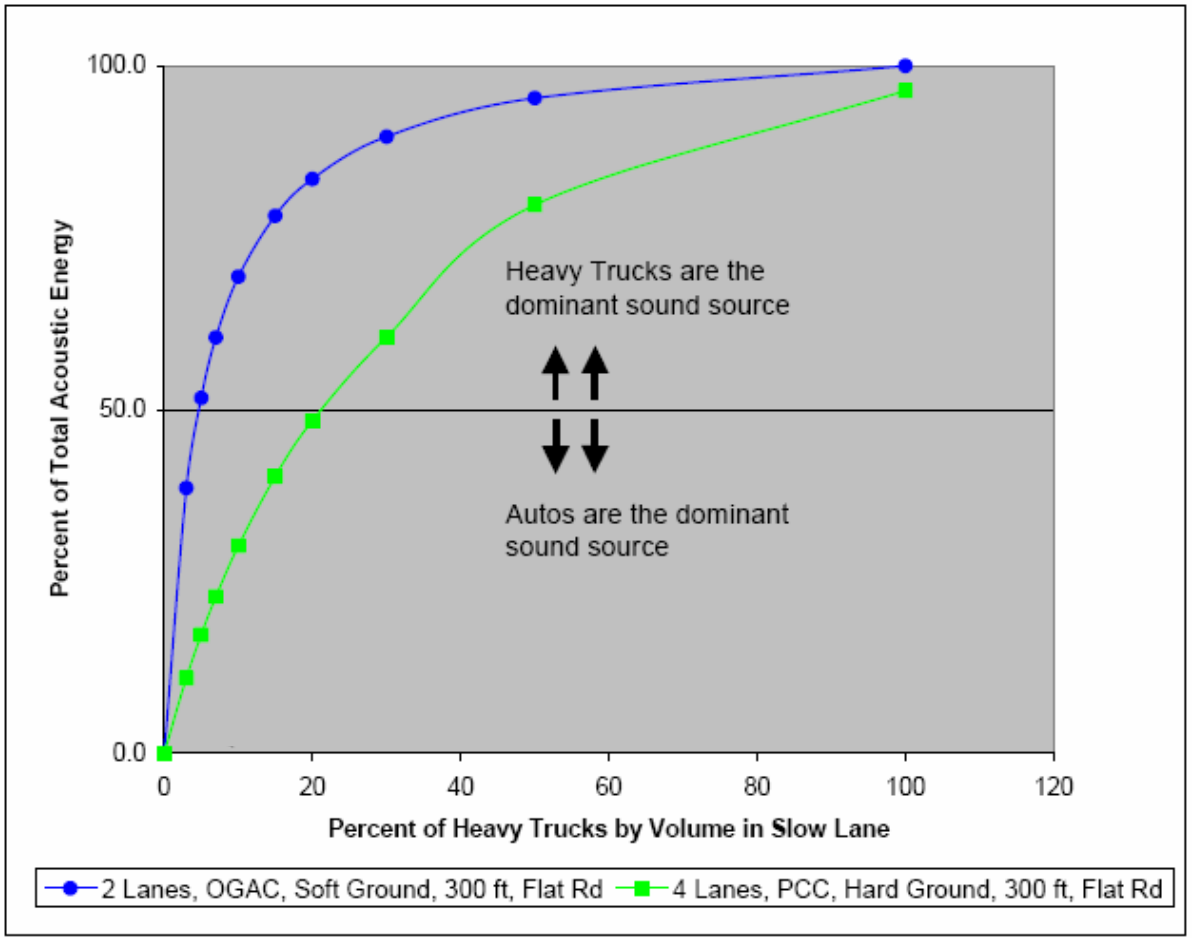
$$\%SE_{HeavyTruck} = 100 \cdot \frac{P^2_{HeavyTruck}}{P^2_{HeavyTruck} + P^2_{Auto}}$$

Example:

$SPL_{Autos} = 60$ dB

$SPL_{HT} = 65$ dB

$\%SE_{HT} = 76\%$



Analysis by Percent of Sound Energy

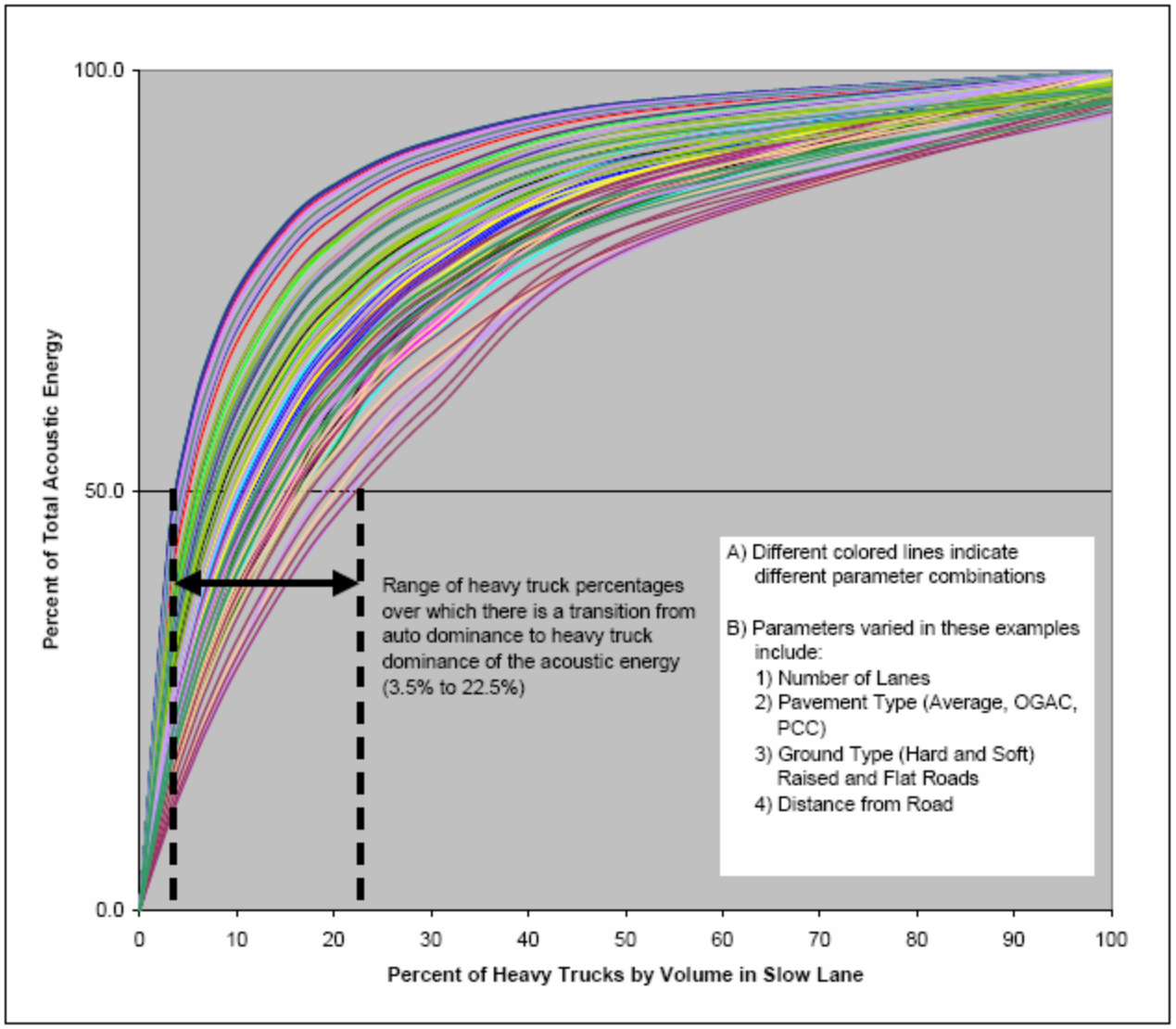


Table 3: Percent of Total Acoustic Energy for Heavy Trucks (Flat Road, 60 mph, No Barrier)

				2 Lanes									4 Lanes								
				% Heavy Trucks									% Heavy Trucks								
				3	5	7	10	15	20	30	50	100	3	5	7	10	15	20	30	50	100
Avg. Pavement	Soft	Rec Distance, ft	50	19.4	29.0	36.9	46.4	57.8	66.0	76.9	88.6	100.0	16.3	24.9	32.0	40.8	51.9	62.3	73.4	85.5	100.0
			100	21.8	32.2	40.4	50.0	61.4	69.2	79.4	90.0	100.0	19.2	28.6	36.3	45.4	56.3	64.1	74.3	85.2	98.1
			200	30.1	42.3	51.2	60.7	71.1	77.7	85.6	93.3	100.0	22.8	33.3	41.5	50.8	61.6	68.9	78.2	87.6	99.0
			300	36.8	49.8	58.6	67.7	76.9	82.5	89.0	95.0	100.0	23.9	34.6	42.9	52.3	63.0	70.2	79.3	88.4	96.7
			500	42.9	56.2	64.7	73.0	81.1	85.9	91.3	96.1	100.0	28.0	39.6	48.3	57.7	68.0	74.7	82.8	90.7	97.7
			1000	39.1	52.2	61.0	69.8	78.6	83.9	89.9	95.4	100.0	28.1	39.8	48.4	57.9	68.2	74.8	83.0	90.8	97.8
			2000	33.4	46.0	55.0	64.3	74.1	80.2	87.4	94.2	100.0	25.6	36.8	45.3	54.7	65.3	72.4	81.1	89.7	97.5
Avg. Pavement	Hard	Rec Distance, ft	50	20.2	30.1	38.1	47.7	59.1	67.2	77.8	89.1	100.0	15.5	23.7	30.6	42.2	53.4	61.6	72.7	85.0	100.0
			100	19.3	28.9	36.8	46.2	57.7	65.9	76.8	88.5	100.0	14.5	22.3	29.0	37.4	48.3	60.2	71.5	84.3	100.0
			200	19.1	28.7	36.5	45.9	57.4	65.6	76.6	88.4	100.0	14.5	22.2	28.9	37.3	48.1	56.3	71.6	84.3	100.0
			300	20.0	29.8	37.8	47.3	58.7	66.9	77.6	89.0	100.0	15.1	23.2	30.0	38.5	49.4	57.6	72.8	85.1	100.0
			500	21.2	31.4	39.6	49.2	60.6	68.5	78.9	89.7	100.0	16.1	24.5	31.5	40.2	51.2	59.3	70.5	86.1	100.0
			1000	22.7	33.3	41.6	51.3	62.6	70.3	80.2	90.5	100.0	17.2	26.0	33.3	42.2	53.3	61.3	72.1	87.1	97.9
			2000	24.1	35.1	43.6	53.3	64.5	72.0	81.5	91.1	100.0	18.4	27.6	35.1	44.2	55.3	63.2	73.7	85.1	98.1
OGAC Pavement	Soft	Rec Distance, ft	50	21.4	31.7	39.9	49.5	60.9	68.8	79.1	89.8	100.0	17.9	27.0	34.4	43.5	54.6	65.0	75.6	86.9	100.0
			100	23.8	34.7	43.2	52.9	64.1	71.6	81.2	91.0	100.0	20.8	30.7	38.6	47.9	58.8	66.4	76.2	86.4	98.4
			200	32.3	44.8	53.7	63.2	73.1	79.4	86.9	93.9	100.0	24.2	35.0	43.4	52.7	63.4	70.5	79.4	88.4	96.6
			300	38.6	51.7	60.5	69.3	78.2	83.6	89.7	95.3	100.0	24.5	35.4	43.7	53.1	63.8	70.9	79.8	88.7	96.8
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PCC Pavement	Soft	Rec Distance, ft	50	13.4	20.8	27.3	35.7	46.9	55.5	68.2	83.3	100.0	11.2	17.7	23.4	30.9	41.2	49.4	64.1	79.2	96.3
			100	15.4	23.6	30.6	39.5	50.9	59.5	71.6	85.4	100.0	13.7	21.2	27.6	35.7	46.3	54.4	65.9	79.3	97.2
			200	22.7	33.3	41.6	51.3	62.6	70.3	80.3	90.5	100.0	16.9	25.6	32.8	41.5	52.4	60.4	71.1	82.9	94.7
			300	29.8	41.9	50.8	60.4	70.7	77.4	85.5	93.2	100.0	18.2	27.3	34.8	43.7	54.7	62.5	73.0	84.3	95.3
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			2000	19.4	29.1	37.0	46.4	57.9	66.1	77.0	88.6	100.0	14.6	22.4	29.1	37.5	48.4	56.6	68.1	81.3	95.1

Trends for Heavy Truck Dominance

Heavy Truck Sound at Receiver associated with	
Dominance at Lower Heavy Truck Percentages	Dominance at Higher Heavy Truck Percentages
Two-Lane Roads	Four-Lane Roads
Soft Ground	Hard Ground
Far Receivers	Near Receivers
10 ft Barrier	No Barrier
20 ft Barrier	
Raised Road	Flat Road
30 mph	60 mph

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Thank You

Questions