## **Highway Traffic Noise** Noise Studies and How Highway Traffic Impacts the Noise

Kathryn McKelvey Environmental Planner II Environmental Policy and Development Section Pennsylvania Department of Transportation



## ► Outline

- What is noise?
- How is it measured?
- How does a noise barrier work?
- When is a noise analysis done?
- Importance of accurate traffic modeling



### ► What is Noise?

- Any sound that is undesired or interferes with one's hearing
- Negative affects
  - Quality of life
  - Productivity
  - Education
- Characteristics
  - Magnitude
  - Frequency
  - Time



https://www.sciencesquared.eu/sites/default/files/ featured-images/sketch1\_1.jpg



#### How is Noise Measured - Land Use Activity Categories

Hou	urly Weighted Sou	Table 1 and Levels dB(A) For Various Land Use Activity Categories*	
Land Use Activity Category	$Leq(h)^1$	Description of Land Use Activity Category	
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.	
B2	67 (exterior)	Residential	
C2	67 (exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.	
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.	
E2	72 (exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A, B or C.	
F		Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.	
G		Undeveloped lands that are not permitted.	

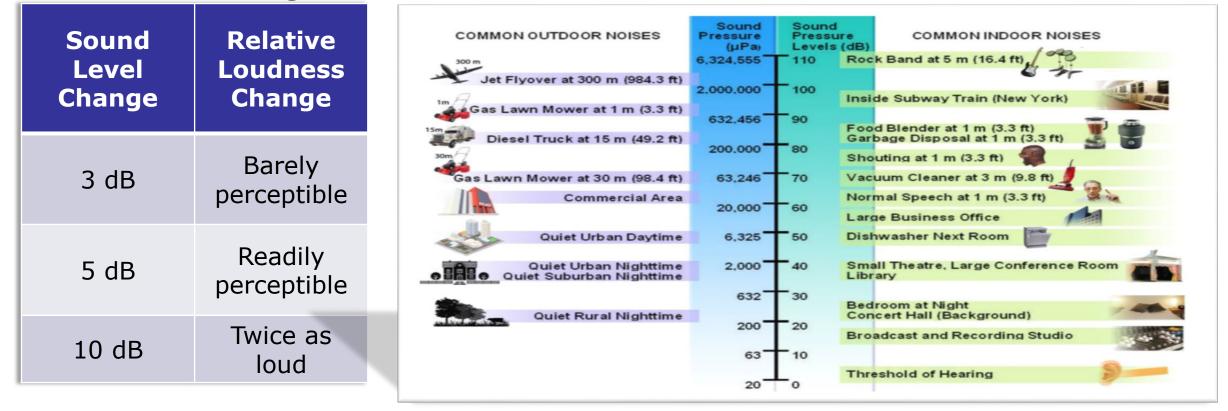
<sup>1</sup> Impact thresholds should not be used as design standards for noise abatement purposes.

<sup>2</sup> Includes undeveloped lands permitted for this activity category



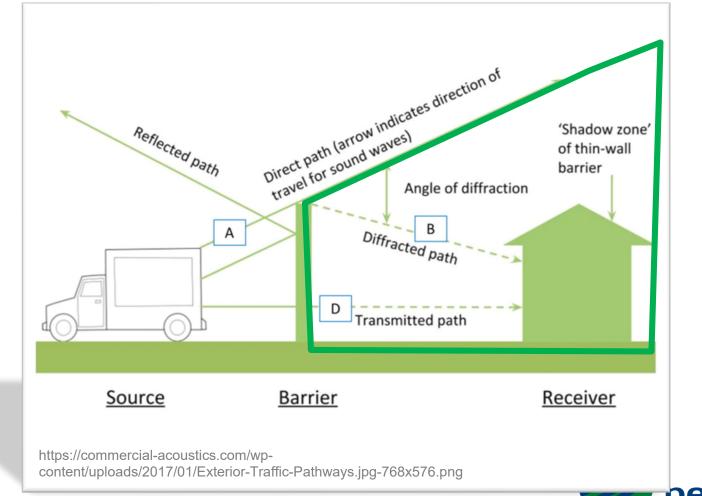
### How is noise measured - continued

### Relative changes in "loudness"





#### How a Noise Barrier Works



pennsylvania DEPARTMENT OF TRANSPORTATION

### When is a noise analysis done?

### • Type I

- Construction of highway on new location
- Substantial horizontal or vertical alteration
- Addition of through traffic lanes
- Addition of auxiliary lanes if > 2500ft
- Addition or relocation of interchange lanes or ramps
- Type II
  - Retrofit projects
- Type III
  - Non-capacity improvements
  - Turning lanes

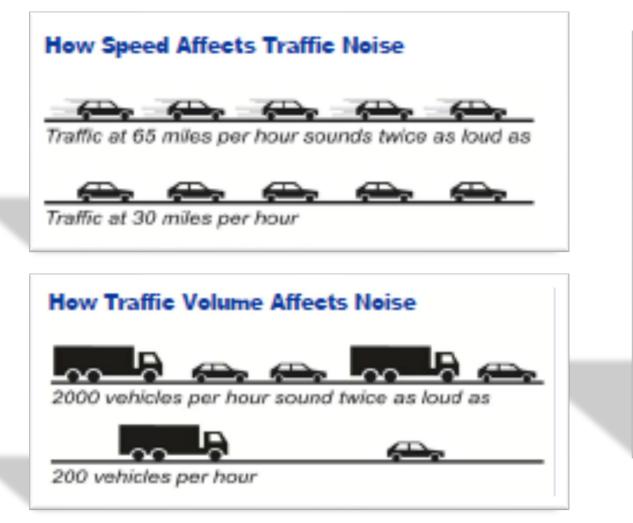


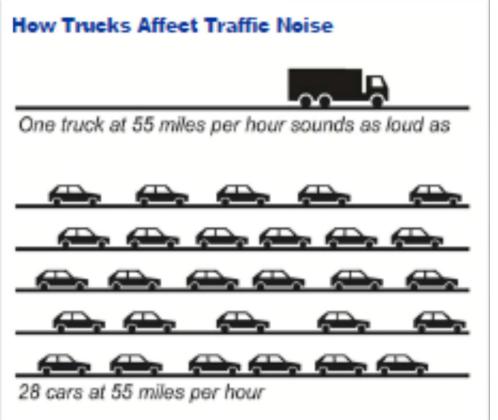
### When does PennDOT Build a Barrier?

- Warranted
  - Approaches or exceeds noise abatement criteria
- Feasibility
  - Can a reduction of 5 dB(A) be achieved at the majority of impacted receptors?
  - Can the barrier actually be built safely?
- Reasonableness
  - Does at least one benefitted receptor experience a reduction of 7 dB(A)?
  - Does the barrier meet the 2,000 Max SF/BR?
  - Did the majority of benefited receptors vote yes for the wall?



### How Traffic Affects Noise

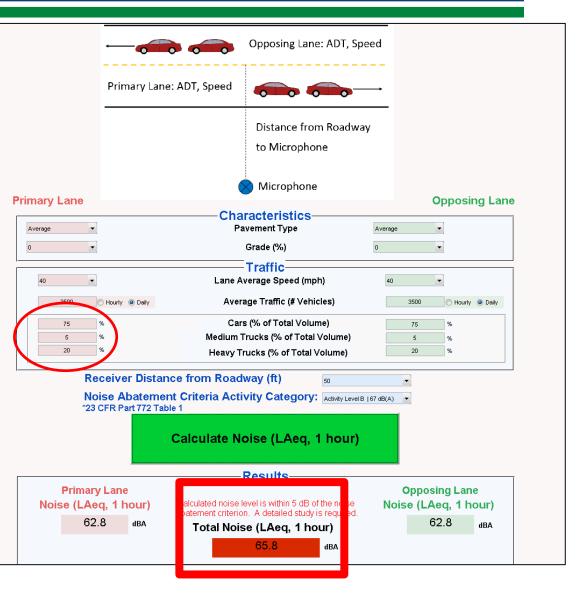






### Truck Traffic Example

			Opposing Lane: ADT, S	Speed			
	Primary Lane: A	ADT, Speed	<del>@@</del>	<u> </u>			
			Distance from Roady	way			
Primary Lane			Microphone		Opposing Lane		
			racteristics				
Average 💌			vement Type	Average	•		
0			Grade (%)	0			
40 💌			Traffic verage Speed (mph)	40	40 💌		
3500	Hourly   Daily	Avera	age Traffic (# Vehicles)	3	500 O Hourly O Daily		
75	%	Cars	s (% of Total Volume)		75 %		
	%		rucks (% of Total Volume)		10 %		
15 5	*	Heavy Tr	ucks (% of Total Volume)		15 %		
Ree	ceiver Distance	from Road	way (ft) 50	•			
	se Abatement ( CFR Part 772 Table 1		vity Category: Activity Lev	vel B   67 dB(A) 💌			
	с	alculate No	bise (LAeq, 1 hour	)			
			Results				
Primary					pposing Lane		
Noise (LAe	i a	tement criterior	n. A detailed study is requir	Noise	e (LAeq, 1 hour)		
62.	4 dBA	Total Nois	e (LAeq, 1 hour)		62.4 <sub>dBA</sub>		
			65.4 dBA				
4							



# ADT Example

Opposing Lane: ADT, Speed         Primary Lane: ADT, Speed         Distance from Roadway         to Microphone         Opposing Lane         Microphone         Opposing Composition         Opposing Lane         Opposing Composition         Opposing Lane         Noise Abatement Criteria Activity Category:         Medium Tucks (% of Total Volume)         10         %         Calculate Noise (LAeq, 1 hour)         20 CFR Part T72 Table 1         Calculate noise level is within 5 dB of the pisse         Noise (LAeq, 1 hour) </th <th></th> <th></th> <th></th> <th></th>				
Distance from Roadway to Microphone imary Lane Characteristics Pavement Type Grade (%) Grade (%) Grade (%) Characteristics Pavement Type Favement T			Opposing Lane: ADT,	Speed
to Microphone imary Lane Characteristics Pavement Type Grade (%) Grade (%) Grade (%) Traffic Lane Average Speed (mph) 40 Traffic Lane Average Speed (mph) 40 Traffic Cars (% of Total Volume) 75 % Medium Trucks (% of Total Volume) 15 % Noise Abatement Criteria Activity Category: Activity Category: Activity Levels 167 cB(A) 23 CFR Part 772 Table 1 Calculate Noise (LAeq, 1 hour) 61.9 dBA Calculated noise level is within 5 dB of the orse batement criterion. A detailed study is re ured. Total Noise (LAeq, 1 hour) 61.9 dBA		Primary Lane: ADT, Speed	d 🙃 🙃	<b>→</b>
Immary Lane     Opposing Lane       Immary Lane     Pavement Type     Immary Lane       Immary Lane     Grade (%)     Immary Lane       Immary Lane     Grade (%)     Immary Lane       Immary Lane     Average Traffic (# Vehicles)     Immary Lane       Immary Lane     Average Traffic (# Vehicles)     Immary Lane       Immary Lane     Medium Trucks (% of Total Volume)     Immary Lane       Immary Lane     Noise (LAeq, 1 hour)     Immary Lane       Noise (LAeq, 1 hour)     Galuate Noise (LAeq, 1 hour)     Opposing Lane       Immary Lane     Calculated noise level is within 5 dB of the noise leatement criterion. A detailed study is required. Total Noise (LAeq, 1 hour)     Galuate Noise (LAeq, 1 hour)       Immary Lane     Calculated noise level is within 5 dB of the noise leatement criterion. A detailed study is required. Total Noise (LAeq, 1 hour)     Galuate Noise (LAeq, 1 hour)       Immary Lane     Immary Lane     Opposing Lane       Noise (LAeq, 1 hour)     Immary Lane     Opposing Lane       Noise (LAeq, 1 hour)     Immary Lane     Immary Lane       Immary Lane     Immary Lane     Immary Lane       Noise (LAeq, 1 hour) <th></th> <th></th> <th></th> <th>way</th>				way
Average       Pavement Type       Average         0       Grade (%)       0         0       Grade (%)       0         0       Grade (%)       0         0       Traffic         10       Lane Average Speed (mph)         0       Cars (% of Total Volume)         75       %         10       %         10       %         Noise Abatement Criteria Activity Category:         23 CFR Part 772 Table 1         Calculate Noise (LAeq, 1 hour)         Opposing Lane         Noise (LAeq, 1 hour)         61.9       dBA	imary Lane		🚫 Microphone	Opposing Lane
Primary Lane: ADT, Speed       Distance from Roadway         Distance from Roadway       to Microphone         Primary Lane       Opposing Lane         Primary Lane       Characteristics         Pavement Type       Image: Characteristics         Stance       Traffic         Lane Average Traffic (# Vehicles)       Image: Characteristics         Image: Characteristics       Image: Characteristics         Stance       Carculate Noise (Total Volume)       Image: Characteristics         Stance       Medium Trucks (% of Total Volume)       Image: Characteristics         Noise Abatement Criteria Activity Category:       Image: Characteristics       Characteristics         Calculate Noise (LAeq, 1 hour)       Characteristics				
Traffic         10       Lane Average Speed (mph)       40         3500       Hourly       Daily         75       %       Average Traffic (# Vehicles)       3500         75       %       Medium Trucks (% of Total Volume)       75         10       %       Heavy Trucks (% of Total Volume)       15         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         10       %       Heavy Trucks (% of Total Volume)       10         *23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)       *         Calculated noise level is within 5 dB of the oise abeterment criterion. A detailed study is reduired.       Opposing Lane Noise (LAeq, 1 hour)         61.9       dBA       61.9       dBA	Average 💌			Average
40       Lane Average Speed (mph)       40       •         3500       Hourly © Daily       Average Traffic (# Vehicles)       3500       Hourly © Daily         75       Cars (% of Total Volume)       75       %         10       %       Medium Trucks (% of Total Volume)       15       %         10       %       Medium Trucks (% of Total Volume)       15       %         10       %       Heavy Trucks (% of Total Volume)       10       %         Noise Abatement Criteria Activity Category:       Activity Level B [67 dB(A)       •         *23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)       •       •         Results         Primary Lane       Calculated noise level is within 5 dB of the oise ataement criterion. A detailed study is re uired.       Opposing Lane         Noise (LAeq, 1 hour)       61.9       dBA       61.9       dBA	0 💌		Grade (%)	0
40       Lane Average Speed (mph)       40       •         3500       Hourly © Daily       Average Traffic (# Vehicles)       3500       Hourly © Daily         75       Cars (% of Total Volume)       75       %         10       %       Medium Trucks (% of Total Volume)       15       %         10       %       Medium Trucks (% of Total Volume)       15       %         10       %       Heavy Trucks (% of Total Volume)       10       %         Noise Abatement Criteria Activity Category:       Activity Level B [67 dB(A)       •         *23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)       •       •         Results         Primary Lane       Calculated noise level is within 5 dB of the oise ataement criterion. A detailed study is re uired.       Opposing Lane         Noise (LAeq, 1 hour)       61.9       dBA       61.9       dBA			-Traffic	
75       %       Cars (% of Total Volume)       75       %         10       %       Medium Trucks (% of Total Volume)       15       %         10       %       Heavy Trucks (% of Total Volume)       15       %         10       %       Heavy Trucks (% of Total Volume)       10       %         Noise Abatement Criteria Activity Category: Active Level B 167 dB(A)         You was a structure of the total Volume         Calculate Noise (LAeq, 1 hour)         Opposing Lane         Noise (LAeq, 1 hour)         61.9       dBA       Calculated noise level is within 5 dB of the toise abatement criterion. A detailed study is required. Total Noise (LAeq, 1 hour)       61.9       dBA	40	Lar		40
10       %       Medium Trucks (% of Total Volume)       15       %         10       %       Heavy Trucks (% of Total Volume)       10       %         Receiver Distance from Roadway (ft)         Noise Abatement Criteria Activity Category:       10       %         '23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)       *         Calculate Noise (LAeq, 1 hour)         Primary Lane       Calculated noise level is within 5 dB of the oise abatement criterion. A detailed study is re uired.       Opposing Lane         Noise (LAeq, 1 hour)       61.9       dBA       Total Noise (LAeq, 1 hour)       61.9       dBA	3500	Hourly  O Daily	verage Traffic (# Vehicles)	3500 O Hourly O Daily
10       %       Heavy Trucks (% of Total Volume)       10       %         Receiver Distance from Roadway (ft)         Noise Abatement Criteria Activity Category:       \$       •         *23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)       •         Calculate Noise (LAeq, 1 hour)         Opposing Lane         Noise (LAeq, 1 hour)       61.9       dBA	75	9	Cars (% of Total Volume)	75 %
Receiver Distance from Roadway (ft)       S0         Noise Abatement Criteria Activity Category:       Activity Level B (67 dB(A) •         "23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)         Calculate Noise (LAeq, 1 hour)       Opposing Lane         Noise (LAeq, 1 hour)       61.9         61.9       dBA				
Noise Abatement Criteria Activity Category: Activity Level B 167 dB(A)         *23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)         Calculate Noise (LAeq, 1 hour)         Primary Lane         Noise (LAeq, 1 hour)       Opposing Lane         61.9       dBA       Calculated noise (LAeq, 1 hour)         61.9       dBA       Total Noise (LAeq, 1 hour)	10	* Heav	y Trucks (% of Total Volume)	10 %
Noise Abatement Criteria Activity Category: Activity Level B 167 dB(A)         *23 CFR Part 772 Table 1       Calculate Noise (LAeq, 1 hour)         Calculate Noise (LAeq, 1 hour)         Primary Lane         Noise (LAeq, 1 hour)       Calculated noise level is within 5 dB of the oise abatement criterion. A detailed study is re uired.       Opposing Lane         61.9       dBA       Total Noise (LAeq, 1 hour)       61.9       dBA	Re	ceiver Distance from Ro	adway (ft) 50	•
Primary Lane Noise (LAeq, 1 hour) 61.9 dBA Calculated noise level is within 5 dB of the poise abatement criterion. A detailed study is re uired. Total Noise (LAeq, 1 hour) 61.9 dBA				
Results         Primary Lane       Opposing Lane         Noise (LAeq, 1 hour)       Calculated noise level is within 5 dB of the oise abatement criterion. A detailed study is required.       Opposing Lane         61.9       dBA       Total Noise (LAeq, 1 hour)       61.9				
Primary Lane       Opposing Lane         Noise (LAeq, 1 hour)       Calculated noise level is within 5 dB of the oise abatement criterion. A detailed study is required.       Noise (LAeq, 1 hour)         61.9       dBA       Total Noise (LAeq, 1 hour)       61.9		Calculate	Noise (LAeq, 1 hou	r)
Primary Lane       Opposing Lane         Noise (LAeq, 1 hour)       Calculated noise level is within 5 dB of the oise abatement criterion. A detailed study is reuired.       Noise (LAeq, 1 hour)         61.9       dBA       Total Noise (LAeq, 1 hour)       61.9			-Results	
61.9     dBA     abatement criterion. A detailed study is required.     61.9     dBA	Primary			Opposing Lane
61.9 dBA Total Noise (LAeq, 1 hour) 61.9 dBA	Noise (LAe			e Noise (LAeq, 1 hour)
	61.	0 104	· · · · · · · · · · · · · · · · · · ·	01.0

			<b>~</b>	Opposing Lane: ADT	, Speed		
		Primary Lane: A	ADT, Speed	<del>~~~</del> ~~	<u> </u>		
				Distance from Road to Microphone	dway		
D	rimary Lane			Microphone		Opposing L	ana
г Г	innary Lane		Cha	racteristics		opposing L	
	Average 💌		Pa	wement Type	Average	<b>-</b>	
	0 💌			Grade (%)	0		
	40			Traffic verage Speed (mph)	40	•	
	4000	Hourly 🔘 Daily	Aver	age Traffic (# Vehicles)		4000 O Hourly O Dail	У
		8 % %	Medium 1	s (% of Total Volume) Frucks (% of Total Volume rucks (% of Total Volume)	·	75 % 15 % 10 %	
L	Noi	ceiver Distance ise Abatement CFR Part 772 Table 1	Criteria Acti	way (ft) 50 vity Category: Activity D	.evel B   67 dB(A)	•	
		с	alculate N	oise (LAeq, 1 hou	ır)		
ſ				Results			
	Primary Noise (LAe					Opposing Lane se (LAeq, 1 hour)	
	62.	<u> </u>		n. A detailed study is requise (LAeq, 1 hour)	əd.	62.5 dBA	
				65.5 dBA			
-							

# Questions?

