

Construction of Noise Barriers

The actual cost of noise barriers can often be more than \$2 million a mile under normal conditions and can become more than \$3 million a mile if noise walls have to be placed on bridges or involve other special designs, such as retaining walls. The costs to the impacted community for the installation of a noise barrier may include some loss to back yard area due to the need to acquire right-of-way to construct the barrier. If there are trees growing in the area where the noise barrier will be constructed, it is most likely that they will have to be removed to accommodate the construction. However, efforts will be made to save as many trees as possible.

Generally speaking, it is best to locate noise barriers as close as possible to either the highway or the impacted community to be most effective. Either way, the barriers will be built on PENNDOT owned right-of-way and will be the property of the Department.

Maintenance of Noise Barriers

The maintenance of noise barriers is the responsibility of PENNDOT. There may be some restrictions to building permanent structures in the area between the noise barrier and the homeowner property line, so that PENNDOT may gain access to the residential side of the barrier to perform occasional maintenance or re-

place damaged panels. Generally speaking, the Department does not provide landscaping on the residential side; however, if homeowners wish to maintain the area between the barrier and the property line, they are encouraged to discuss their plans with PENNDOT.



The Noise Abatement Process

What Projects Are Eligible?

Only certain highway improvement projects are eligible for noise mitigation in Pennsylvania. These projects have the potential to alter the acoustic environment and are analyzed for noise impacts and abatement is considered. The scope of these types of projects include highways on new locations, substantial alteration of either the vertical and/or horizontal alignment on existing highways, and various other improvement projects, including certain auxiliary lanes, weigh stations, rest areas, etc.

Applying The Process To Eligible Projects

There is a specific process that PennDOT uses to identify communities that will be considered for noise abatement and to determine whether noise abatement measures can be implemented within state or federal guidelines. This process includes the following steps.

The first step in the process is to determine which land-uses in the project could be affected by the project. The Federal Highway Administration (FHWA) has established noise abatement criteria for various land uses which PennDOT uses to determine impacts and where abatement consideration is warranted. Locations such as residences, libraries, houses of worship, hospitals, schools and parks are often the most common land uses that receive abatement consideration.

Monitor Noise Levels

After noise-sensitive locations that may be affected by the proposed highway project have been identified, existing traffic noise levels are monitored at locations that are representative of affected neighborhoods. The results of the monitoring sessions are used to ensure that the noise prediction model will provide accurate results. Many people ask why their house was not monitored and as-

sume that they were not considered if monitoring was not done on their property. The monitoring, however, is used only to set and verify the prediction model and not as a basis for noise abatement decisions.

Noise Modeling

Computer modeling is performed with the FHWA TNM Model to assess future conditions in light of the proposed improvements. Noise projections are made for the worst-case future build condition using forecasted traffic information 20 years in future when the highway is at its maximum capacity. The design details and terrain modifications are in-



cluded in the computer model and additional locations are added to comprehensively delineate the impacted areas.

Noise Abatement Consideration

The next step is where noise mitigation is considered at the noise-impacted locations. If you attend a public meeting for a highway project that includes a discussion of noise issues, you may hear people talking about warranted, feasible and reasonable. The terms describe the three steps PennDOT must take when considering noise abatement for noise-sensitive areas.

To determine whether abatement consideration is warranted, we compare the noise modeling projections to the noise impact criteria for the land use. Using criteria based on FHWA guidelines, abatement is war-

ranted if the future noise levels approach or exceed the noise abatement criteria or are elevated by 10 decibels [dB(A)] above the existing conditions. PennDOT defines an impact for residential areas as 66 dB(A). For communities where noise abatement consideration is warranted, the next step is to consider whether the noise abatement would be feasible for each affected community. Traffic noise abatement is typically provided by using highway noise barriers. Feasible noise barriers are those that provide at least 5 dB(A) of noise reduction to noise sensitive locations and pose no safety, engineering, or access restrictions.

If a noise barrier system is determined to be feasible, the next step is to determine whether or not the barrier is reasonable for construction. For a barrier to be reasonable it must be cost effective and maintenance, constructability, drainage and utility impacts, as well as the desires of the affected residents, must be considered.

Your Role in the Process

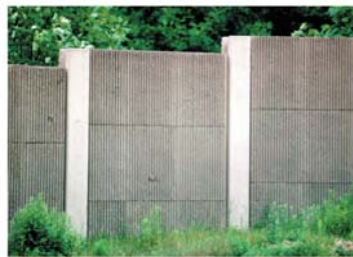
For some highway projects, more than one alternative design is considered. The design of noise barriers begins when a final alignment has been selected for the highway. During noise barrier design process, you will have opportunities to have your concerns addressed through public meetings. To fully participate, try to attend these meetings, fill out all project questionnaires, and voice your concerns and opinions. It is during these meetings that the affected community gets to choose the texture and color of the barrier facing the residents.

When it is determined that noise barrier is warranted, feasible and reasonable, public preferences are considered. If the majority of affected residents do not want the noise wall, the barrier will not be constructed.

OPTIONS FOR NOISE ABATEMENT



SHIP LAP



FRACTURE FIN



EXPOSED AGGREGATE



BRICK



GRAPE STAKE



FUZZY RAKE



ASHLAR STONE



IRREGULAR STONE

Sound Decisions About Highway Noise Abatement

Sound Principles About Traffic Noise

Keep in mind these decisions are final and if a community decides it does not want a barrier, it cannot return at a later time to request a barrier. PennDOT only recommends a noise barrier if determined to be warranted, feasible and reasonable and desired by the affected community.



work the same as most other familiar scales. A sound that increases by 10 decibels is said to double in loudness. Therefore, a source will sound twice as loud if its level increases from 60 to 70 decibels and four times as loud if its level increases from 60 to 80 decibels.

When the number of sound sources is doubled – such as two honking horns instead of one – the noise level increases by 3 decibels. A 3 decibel change is barely noticeable to most people. Since we don't have the same sensitivity to all frequencies or pitches, the A-weighted scale was developed, and is used for highway traffic noise evaluation.

Traffic Noise Generation

When a sound source is stationary, it is called a point source and it radiates sound equally in all directions like a pulsing sphere. When many sound sources are moving in a line, the sound radiates like a pulsing cylinder from the sources. Traffic noise is generated in this fashion. It is important to distinguish point sources from line sources because each has different characteristics.

Noise is rated on a decibel scale. This scale was designed to match our hearing mechanism and does not

Traffic Noise Sources

The principal noise sources of highway vehicles are the exhaust system, engine, and tires. Exhaust noise is typically controlled by mufflers, assuming they are used and are functioning properly. Engine noise can only be controlled by vehicle manufacturers and proper maintenance, factors that PENNDOT has no control over. Tire noise is generated by the interaction of each vehicle's tires with the road surface. Engine and exhaust noise are usually louder than tire noise at vehicular speeds under 30 miles per hour. The reverse is nor-

mally true for vehicular speeds over 30 miles per hour. Highways are typically dominated by tire noise while local streets are typically dominated by engine and exhaust noise. The overall noise level generated by vehicles on a highway depends on the number of vehicles, the speed of the vehicles, and the types of vehicles. The figures below show generally how these factors influence noise levels.



Traffic Noise Propagation

The travel, or propagation, of traffic noise depends mainly on three factors — atmospheric effects, ground effects, and spreading effects. Atmospheric conditions change the direction of sound travel and constantly change. Ground conditions also affect sound travel.

Managing Our Environment: Traffic Noise Abatement

Sound will travel farther over a hard reflective surface than one covered with vegetation. Spreading effects diminish sound at a constant rate as the sound travels away from its source. Sound from a line source – such as a highway – decreases at a rate of approximately 3 dB(A) per doubling of distance from the source.

Principles of Outdoor Sound Control

When trying to solve a noise problem, we look for practical solutions in terms of treating the source of the noise, and the path between the noise source and the listener. Since the source of traffic noise is the combination of vehicles on a highway, the only practical option is to try to reduce the noise along the path between the highway and the listeners.



The most common outdoor noise reduction method is the construction of noise barriers. These barriers can take different forms, as long as they break the line-of-sight between the vehicles on the highway and affected residential communities. Barriers can be in the form of walls or topographical changes. Topographical changes can occur by building earth berms or hills between the highway and the communities or by depressing the highway. To be effective, any noise barrier must be solid. Fences or vegetation have minimal effectiveness as noise barriers. Because noise barriers are open to the air above and around them, sound bends over and around them – just as light bends around obstructions – through the principle of diffraction. Diffraction limits the effectiveness of any barrier to a maximum noise re-

duction of 10 to 15 decibels, independent of the material used. Typical reductions usually range from 5 to 10 decibels.

Highway Design Options

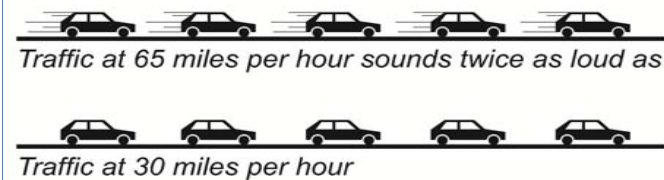
Highway design options to minimize traffic noise include building roadways as far as possible from noise-sensitive locations, depressing roadways, and avoiding steep inclines in roadways. Building highways several hundred feet from noise-sensitive locations will minimize noise exposure. Where this is impractical, highways can be built closer to areas that are not noise-sensitive, such as industrial areas. Building highways below ground level creates natural barriers between the highways and any noise sensitive locations. Steep inclines in roadways cause more noise to be generated by vehicles, especially trucks, as they accelerate uphill and decelerate downhill. A level roadway elevation avoids this extra noise generation.

Noise Barriers & Other Available Abatement Options

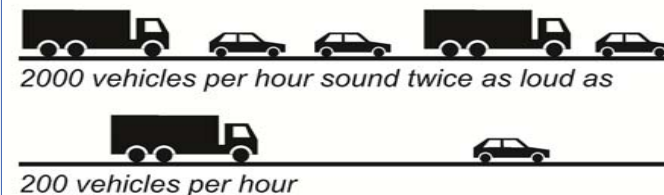
In Pennsylvania, the noise abatement options considered most often are alternative highway designs and noise barrier construction. Designs that would minimize noise while not compromising safety and practicality are incorporated into highway plans. PENNDOT only uses noise barriers that have been approved through a rigorous product evaluation process to ensure safety, integrity, longevity, and preservation of aesthetics. The pictures on the back page of this brochure show some of the different types of noise abatement options PENNDOT has available. Consult the local PENNDOT Engineering District for color and texture availability in your area.



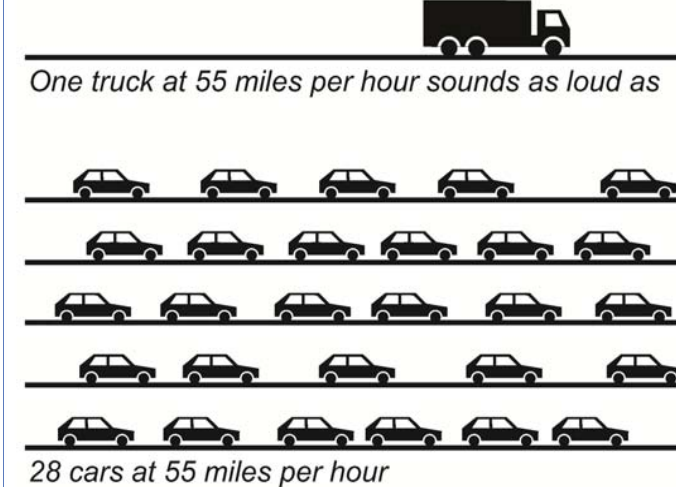
How Speed Affects Traffic Noise



How Traffic Volume Affects Noise



How Trucks Affect Traffic Noise



Sound Pressure Levels for Common Sources		
dB(A)	Perception of Loudness	Sound Sources
10	1/6 as loud as 50 dB(A)	Normal breathing
20	1/8 as loud as 50 dB(A)	Broadcast studio
30	1/4 as loud as 50 dB(A)	Library
40	1/2 as loud as 50 dB(A)	Refrigerator
50	Reference level	Clothes dryer
60	2 times louder than 50 dB(A)	Air conditioning unit
70	4 times louder than 50 dB(A)	Pick-up truck @ 50mph, 50'
80	8 times louder than 50 dB(A)	Medium truck @ 50mph, 50'
90	16 times louder than 50 dB(A)	Motorcycle @ 50mph, 50'
100	32 times louder than 50 dB(A)	Jet flyover @ 1000'