Road Engineering Journal

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Factors that Determine the Reduction in Property Values Caused by Traffic Noise

Factors that Determine the Reduction in Property Values Caused by Traffic Noise

Environmental noise caused by traffic can reduce property values. Planners, policymakers, and legislators must look at noise damage costs caused by motor vehicles when considering transportation options. Daniel Haling and Harry Cohen provided a method to estimate this type of noise impact in "Residential Noise Damage Costs Caused by Motor Vehicles" (Transportation Research Record 1559).

BACKGROUND

The majority of sounds detected by human hearing are within the range of 0 to 140 decibels (dB). The noise created by traffic normally resides in the range of 50 to 95 dB. The effects of transportation noise are routinely measured using an A-weighted decibel scale (designated dBA), which is useful for measuring the noise impact of a single occurrence but not the impact of continuous noise. A frequently used measurement for continuous noise is the equivalent sound level (Leq), known also as the energy mean sound level. Leq includes both the intensity and length of all sounds occurring during a given period; it indicates "the average acoustic intensity over time and is the equivalent noise energy level of a steady, unvarying tone."

The Environmental Protection Agency has developed a measurement for a community's exposure to noise (the average energy sound level) for a 24-hour period from midnight to midnight. The measure of this day-night sound level, designated DNL or Ldn, is commonly used to evaluate noise impacts on communities and residential areas.

NOISE PREDICTION MODEL / NOISE DAMAGE COST STUDIES

The most common model for estimating vehicle traffic noise levels is the Federal Highway Administration's (FHWA's) STAMINA 2.0/OPTIMA. Derived from long-standing research by the FHWA and the National Cooperative Highway Research Program (NCHRP), the FHWA model "is a two-level coordinate system-based program, based on energy-equivalent sound levels."

Studies in the 1970s "estimated that background noise in a typical urban neighborhood was roughly 55 Ldn and that housing prices decreased by 0.2 to 0.6 percent for every one unit increase in Ldn." A major study of noise costs conducted for the 1982 Federal Cost Allocation Study "assumed a 0.4 percent decrease in the value of a housing unit for each dBA (Leq) increase over a threshold value of 55 dBA."

NOISE COST CALCULATIONS

Calculating the impact of transportation noise on residential property values requires constructing a model for estimating the value of property that includes an estimate of traffic noise cost. One method for calculating noise impact cost is based on an estimating procedure developed in 1981 and used in the 1982 Federal Highway Cost Allocation Study. This procedure takes into consideration reduced residential property values caused by noise from vehicles. It operates on the theories that people will pay to avoid high noise levels and that housing values reflect location relative to a noisy roadway.

The procedure for estimating noise damage uses three main components: (1) the number of housing units affected, (2) the noise level in decibels above an established noise threshold, and (3) the average change in property values per decibel that can be attributed to the roadway. The number of housing units affected varies by location. The noise emission level of vehicles changes depending on the type of vehicle, its speed, its operating weight, and the volume of traffic on the roadway. The third component of the calculation is constant for all housing units, based on a survey of studies on residential property values affected by noise. Using these values, the noise damage caused by each vehicle-kilometer can be calculated--subject to the type of vehicle, its speed, the volume of traffic on the roadway, and the type of housing development surrounding the roadway.

TRANSPORTATION NOISE LEVEL

Calculating the noise damage cost of a single vehicle requires estimating the noise emission of that vehicle, as well as the noise emission of all vehicles on that segment of road. Noise emission level estimates of single vehicles are based on two emission equations developed by the FHWA--the first for large trucks and the second for passenger cars and light trucks. Truck noise levels, which are significantly different from those generated by passenger cars, are converted into noise passenger-car equivalents (NPCEs) using factors developed through a vehicle emission equation and a total noise level equation.

By combining transportation noise levels across vehicle classes, a composite noise emission level for the roadway is produced. (It should be noted that decibels add logarithmically rather than algebraically.)

The number of housing units affected by transportation noise depends on the density of the housing population and how close the housing unit is to the roadway. Noise distance ranges are estimated for each of the land development types shown in Table 1 below. The distance ranges are an estimated number of feet within which houses are subject to a given noise level range. Three noise levels are established at 55-65 dBA, 65-75 dBA, and greater than 75 dBA. The noise distance ranges are labeled A, B, and C, where C is closest to the roadway and assumed to begin at 9.14 m (30 ft), with no housing units located closer than that to the roadway.

After noise distance ranges are estimated, housing densities are needed to calculate the total number of housing units affected. Based on the 1981 noise cost study, Table 1 illustrates the housing densities per acre by land development type and noise distance range. As noted earlier, previous noise impact studies estimated that housing units lose 0.4 percent of their value for every decibel above the threshold level. The most recent survey of housing values (1993) showed a median house value of $86,529. Using this value annualized at a 10 percent discount rate and multiplied by the 0.4 value loss, the noise damage cost is found to be $34.61 per decibel per housing unit.

TABLE 1
Residential Housing Unit Densities per Acre (*4*)

Land Development Type	Distance Range A Units per Acre	Distance Range B Units per Acre	Distance Range C Units per Acre
Urban - Central Business District	4	4	4
Urban - Fringe	4	15	26
Urban - Outlying Business District	2	2	2
Urban - Residential	4	4	4
Urban - Rural in Character	0.3	0.3	0.3
Rural - Sparse Development	0.006	0.006	0.006
Rural - Dense Development	5	5	3

Note: Based on consensus of research staff.

NOISE DAMAGE COSTS PER VEHICLE MILE

Noise damage costs can be calculated per vehicle-mile for each land development type, traffic volume range, and vehicle speed. Noise damage costs reflect the number of housing units the vehicle affects and the number of decibels the vehicle adds to the existing traffic noise.

Table 2 shows the noise damage cost per NPCE-mile for each land type and traffic speed, based on average annual daily traffic (AADT). The table shows that, in all land-development categories, noise damage costs increase as traffic speeds increase. Similar results occur in urban areas devoted to residential use; as traffic speed increases, the damage costs per NPCE mile increase. However, as traffic volumes increase, the noise damage contributed by a single vehicle decreases. For example, at a traffic speed of 55 mph, the noise damage costs decrease from 0.25 cents per NPCE mile to 0.16 cents as traffic increases from 10,000- to 200,000-NPCE AADT.

Table 2: Noise Damage Costs per NPCE-Mile

Noise damage costs can also be estimated for a variety of truck types and operating weights. Costs will vary depending on the land development type. For example, a five-axle semitrailer operating at 65,000 pounds and traveling in an urban business district will cause 5.74 cents of noise damage per vehicle mile. In an urban fringe area, the cost will increase to 11.48 cents per vehicle mile.

CONCLUSIONS

Motor vehicle types, traffic volumes, and land development types surrounding roadways all play significant roles in estimating residential noise damage costs. Those responsible for transportation planning and policymaking should be aware of the variations in these costs and the three primary factors that define them.

Back to the Road Engineering Journal Index

Back to Article

TABLE 2
Noise Damage Costs per NPCE-Mile (1 mi = 1.61 km)

Land Development Type	20 mph (cents/mile)	25 mph (cents/mile)	30 mph (cents/mile)	35 mph (cents/mile)	40 mph (cents/mile)	45 mph (cents/mile)	50 mph (cents/mile)	55 mph (cents/mile)	60 mph (cents/m
Urban - Central Business District	0.02	0.03	0.05	0.07	0.10	0.13	0.16	0.20	0.24
Urban - Fringe	0.02	0.03	0.08	0.13	0.19	0.25	0.32	0.40	0.51
Urban - Outlying Business District	0.00	0.01	0.02	0.03	0.05	0.06	0.08	0.10	0.12
Urban - Residential	0.02	0.03	0.05	0.07	0.10	0.13	0.16	0.19	0.23
Urban - Rural in Character	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02
Rural - Sparse Development	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rural - Dense Development	0.02	0.03	0.06	0.08	0.12	0.16	0.20	0.24	0.28

Back to Article