Traffic Noise Background Information

Introduction to Noise

Human response to noise is subjective and can vary greatly from person to person. Factors that can influence individual response include the loudness, frequency, and time pattern; the amount of background noise present before an intruding noise; and the nature of the activity (e.g., sleeping) that the noise affects.

The sensitivity of the human ear to sounds of different frequencies is measured by the A-weighted decibel scale (dBA). A 10-dBA change in noise levels is judged by most people as a doubling of sound level. The smallest change in noise level that a human ear can perceive is about 3-dBA. Increases of 5-dBA or more are clearly noticeable. Normal conversation ranges between 44 and 65 dBA when the people speaking are 3 to 6 feet apart.

Table 1 shows sound levels for some common noise sources and compares their relative loudness to that of an 80-dBA source such as a garbage disposal or food blender. Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful; levels higher than 80 dBA over continuous periods can result in hearing loss. Constant noises tend to be less noticeable than irregular or periodic noises.

Table 1
Sound Levels and Relative Loudness of Typical Noise Sources

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage, Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Garbage disposal, food blender (2 ft), Pneumatic drill (50 ft)	80	Moderately loud	Reference loudness
Vacuum cleaner (10 ft), Passenger car at 65 mph (25 ft)	70		1/2 as loud
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Bedroom or quiet living room, Bird calls	40		1/16 as loud
Quiet library, soft whisper (15 ft)	30	Very quiet	
High quality recording studio	20		
Acoustic Test Chamber	10	Just audible	
	0	Threshold of hearing	

Sources: Beranek (1988) and EPA (1971)

Traffic Noise Sources and Propagation

Noise sources associated with transportation projects can include passenger vehicles, medium trucks, heavy trucks and buses. Each of these vehicles produces noise; however, the source and magnitude of the noise can vary greatly depending on vehicle type. For example, while the noise from passenger vehicles occurs mainly from the tire-roadway interface and is therefore located at ground level, noise from heavy trucks is produced by a combination of noise from tires, engine, and exhaust, resulting in a noise source that is approximately 8 feet above the ground. The following list provides information on the types of transportation noise sources that will be part of a roadway project, and describes the type of noise each produces.

- **Passenger Vehicles (cars):** <u>*Noise emitted from 0 to 2 feet above roadway, primarily from tire-roadway interface.*</u> This category includes normal passenger vehicles, small and regular pickup trucks, small to mid-size sport utility vehicles, mini- and full-size passenger vans. Typical noise levels for passenger vehicles are 72 to 74 dBA at 55 mph at a distance of 50 feet.

- **Medium Trucks (MT):** <u>*Noise emitted from 2 to 5 feet above roadway, combined noise from tire-roadway interface and engine exhaust noise.*</u> This category includes delivery vans, such as UPS and Federal Express trucks, large sport utility vehicles with knobby tires, large diesel engine trucks, some tow-trucks, city transit and school buses with under vehicle exhaust, moving vans (U-haul-type trucks), small to medium recreational motor homes and other larger trucks with the exhaust located *under* the vehicle. Typical noise levels for medium trucks are 80 to 82 dBA at 55 mph at 50 feet.

- **Heavy Trucks (HT):** Noise emitted from 6 to 8 feet above the roadway surface, combined noise sources includes tire-roadway interface, engine noise, and exhaust stack noise. This category includes all log-haul tractor-trailers (semi-trucks), large tow trucks, dump trucks, cement mixers, large transit buses, motor homes with exhaust located at top of vehicle, and other vehicles with the exhaust located above the vehicle (typical exhaust height of 12 to 15 feet). Typical noise levels for heavy trucks are 84 to 86 dBA at 55 mph at 50 feet[2].

Several factors determine how sound levels decrease over distance. Under ideal conditions, a line noise source (such as constant flowing traffic on a busy highway) decreases at a rate of approximately 3 dB each time the distance doubles. Under real-life conditions, however, interactions of the sound waves with the ground often results in attenuation that is slightly greater than the *ideal* reduction factors given above. Other factors that affect the attenuation of sound with distance include existing structures, topography, foliage, ground cover, and atmospheric conditions such as wind, temperature, and relative humidity. The following list provides some general information on the potential affects each of these factors may have on sound propagation.

- **Existing Structures.** Existing structures can have a substantial effect on noise levels in any given area. Structures can reduce noise by physically blocking the sound transmission. (Under special circumstances, structures may cause an increase in noise levels if the sound is reflected off the structure and transmitted to a nearby receiver location.) Measurements have shown that a single-story house has the potential, through shielding, to reduce noise levels by as much as 10 dB or greater. The actual noise reduction will depend greatly on the geometry of the noise source, receiver, and location of the structure. Increases in noise caused by reflection are normally 3 dB or less, which is the minimum change in noise levels that can be noticed by the human ear.

- **Topography**. Topography includes existing hills, berms, and other surface features between the noise source and receiver location. As with structures, topography has the potential to reduce or increase sound depending on the geometry of the area. Hills and berms, when placed between the noise source and receiver, can have a significant effect on noise levels. In many situations, berms are used as noise mitigation by physically blocking the noise source from the receiver location. In some locations, however, the topography can result in an overall increase in sound levels by either reflecting or channeling the noise towards a sensitive receiver location.

- **Foliage.** Foliage, if dense, can provide slight reductions in noise levels. FHWA provides for up to a 5 dBA reduction in traffic noise for locations with at least a 30 feet depth of dense evergreen foliage.
- **Ground Cover.** The ground cover between the receiver and the noise source can have a significant effect on noise transmission. For example, sound will travel very well across reflective surfaces such as water and pavement, but can be attenuated when the ground cover is field grass, lawns, or even loose soil.

Traffic Noise Mitigation

In theory, there are a number of options that can be used to reduce or mitigate traffic noise. These include traffic management, highway design, and noise barriers including earthen berms. In reality, noise mitigation is often infeasible due to space requirements, aesthetic issues and financial costs, or because the costs outweigh the benefits. Any specific mitigation measure recommended as part of a project must be feasible and have a reasonable cost in relation to the benefit. Potential mitigation measures are described below.

- **Traffic Management**: Traffic management measures include modification of speed limits and restricting or prohibiting truck traffic. Restricting truck use on a given roadway would reduce noise levels at nearby receivers since trucks are louder than cars. However, displacing truck traffic from one roadway to another would only shift noise impacts from one area to another and may conflict with the planned function of the roadway (e.g., an arterial generally carries truck traffic). The level of truck traffic on Sunnyside Road is too low for truck restrictions to result in a significant reduction in overall noise in the area. While reducing speeds may reduce noise, a reduction of at least 10 mph is needed for a noticeable difference in noise to result. Also, because roadways are planned and designed to support speeds consistent with their functional classification (e.g., 35-45 mph on an arterial), changing speeds for the purpose of noise mitigation is not common.
- **Roadway Design**: Roadway design measures include altering the roadway alignment and depressing roadway cut sections. Alteration of roadway alignment could decrease noise levels by moving the traffic farther away from the affected receivers. Because there are noise sensitive receivers along both sides of Sunnyside Road, changing the alignment may benefit one side of Sunnyside Road, but would increase noise levels on the other.
- **Noise Barriers:** Construction of noise barriers between the roadways and the affected receivers would reduce noise levels by physically blocking the transmission of traffic-generated noise. Barriers can be constructed as walls or earthen berms. Earthen berms require more right-of-way than walls and are usually constructed with a 3-to-1 slope. Using this requirement, a berm 8 feet tall would slope 24 feet in each direction, for a total width of 48 feet. For the Sunnyside Road project, berms are not feasible because of the right-of-way requirement. Noise walls should be high enough to break the line-of-sight between the noise source and the receiver. They must also be long enough to prevent significant flanking of noise around the ends of the walls. Openings in the wall, such as for driveways and walkways, can significantly reduce the barrier effectiveness. Because of the frequent driveways and walkways on Sunnyside Road, noise walls would not be effective in most locations.