NOISE STANDARDS FOR FEDERAL HIGHWAYS

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The Federal-Aid Highway Act of 1970 requires that noise standards be developed, promulgated, and applied to the planning and design of highway projects. Many considerations must be weighed during the development of such standards: the comprehensive overall strategy for traffic noise control, standards, or policies already adopted by other agencies; desirable noise levels; noise prediction capability; currently available abatement techniques (and their effectiveness); and the effect of standards on the highway program. Each of these factors has been given thorough examination. The standards will accomplish all that the law requires and more.

•THE nation is witnessing the beginning of an all-out effort to control noise. This effort is part of the overall response of government, industry, and institutions of higher learning to the public's expression of deep concern for the environment. The Congress shared this concern and expressed its desire to correct environmental intrusions such as noise by mandating the promulgation of highway noise standards. State and local governments have also taken action in this area. Some of the sources of noise that are currently being controlled or being considered for control are aircraft, motor vehicles, industries, appliances, electric power substations, and construction operations (1).

The highway-related noise problem is very complex, and there are no quick or simple solutions. Complete elimination of this nuisance may continue to elude us for a long time to come. Even so, substantial noise reductions are possible, though they will require coordinated efforts from a variety of directions. A three-part approach is needed to attack the traffic noise problem: reduction of sound at the source (the motor vehicle), control of the use of land in the vicinity of highways, and noise abatement measures in the planning and design of highway projects.

Trucks, particularly diesel trucks, are a chief source of motor vehicle noise. Many trucks are not equipped with mufflers by the manufacturer, and those mufflers provided by the manufacturers are sometimes removed or altered. Other noise comes from excessively noisy retread tire designs. Modification of exhaust systems on motorcycles, sports cars, and hot rods for the specific purpose of creating a higher noise level is commonplace (2).

Reduction of noise at the source, that is, on the vehicle itself, is potentially the most fruitful way to reduce the problems of motor vehicle noise (3). Quieter vehicles would bring about a substantial reduction of noise along millions of miles of existing roads and streets where no other corrective measures are possible. Legislation is being considered by Congress for control of noise from manufactured products. Several state and local governments have enacted numerical noise level limits that (from a noise standpoint) require proper maintenance and operation of motor vehicles (1). These actions are important beginning steps to achieve the first part of the three-part approach.

The second part of a balanced attack on the highway noise problem is the control of land use. Many years ago we learned that most kinds of development should be prohibited in flood plains subject to frequent and severe flooding. It is of comparable importance to consider land use control in areas where noise is a problem. The lands

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need not necessarily remain vacant. Most commercial and industrial activities can coexist with a noisy environment. Many other types of activities can be accommodated through proper site location, building design, and acoustical treatment (soundproofing) (4).

Not infrequently, complaints about highway traffic noise come from residents occupying homes built adjacent to a highway after the highway was already in place. Many of these highways were originally constructed through undeveloped lands. Even though highway agencies may be knowledgeable about existing zoning and planning, they are not able to foretell when and where future development will occur, what such development will be, and the degree of soundproofing that will be built into future buildings. To require noise abatement measures on highway projects based on such unreliable estimates would be unreasonable and uneconomical and would result in the construction of many white-elephant noise barriers along many new highways where expected development patterns changed. Moreover, there are several hundred thousand miles of existing highways that are bordered by vacant land. Much of this land will someday be developed. Sensible land use control could help prevent future traffic noise conflicts in these areas. Such controls need not prohibit development but rather should use reasonable setback distances, soundproofing, or abatement measures to avoid future noise disturbances.

The noise standards issued in 1971 by the Department of Housing and Urban Development (HUD), to avoid noise problems connected with future federally insured housing, are a step in the right direction. However, more measures, which are beyond the scope of the highway noise standards and are not covered by the HUD standards, are needed in this area.

The third part of the three-part approach, the consideration and abatement of traffic noise in the planning and design of highway projects, is required by the proposed standards. It has been pointed out previously that this part can only be regarded as a limited approach. It does have a major role in reducing the magnitude of the nation's traffic noise problem, but it cannot solve the entire problem alone.

The fundamental goal during the development of the standards has been to reduce the effects of traffic noise by the greatest possible extent without neglecting other important considerations. It is important to recognize that there will continue to be situations where, no matter what ameliorative measures are taken, some objectionable noise will remain. In some instances, measures taken to achieve compliance with the standards may conflict with other social and environmental objectives. For example, a wall constructed as a noise barrier could have an adverse aesthetic effect, or depressing a highway may reduce noise impacts on adjacent properties but increase the concentration of air pollution on the highway. The possibility of such detrimental effects should be carefully studied in each instance and a decision to proceed with a proposed noise abatement measure be made only if it is clear that the importance of noise abatement outweighs possible adverse effects. Noise is only one of many social, economic, and environmental factors considered, none of which is controlling. Section 136(b) of the Federal-Aid Highway Act of 1970 requires not only that social, economic, and environmental factors be fully considered but that "final decisions on highway projects (are made) in the best overall public interest taking into consideration the need for fast, safe, and efficient transportation, public services, and the costs of eliminating or minimizing such adverse effects." Therefore, it was considered neither feasible nor prudent to make noise the preeminent consideration in highway decisions. These conflicts have been foreseen during the development of standards, and provisions have been made for their resolution.

CONTENTS OF THE STANDARDS

The standards require that noise-sensitive land uses and activities in the vicinity of highway projects be identified and that anticipated noise levels be computed for the noise-sensitive areas on the basis of the worst noise situation expected to occur from the highway in question. The standards also contain design noise levels for different exterior land uses and activities and also for certain interior uses.

The design noise levels in the standards should not be exceeded more than 10 percent of the time during the worst hour of the day during the design year. This statistical description is needed because of the fluctuation of noise levels with time. For exteriors of schools and residences, the design noise level is 70 dBA (noise measured in decibels on A-scale). This means that, where the design noise level is met, the 70-dBA level would be exceeded not more than 6 min during the hour when the worst noise conditions exist. For 54 min of this hour, the noise would be less than 70 dBA. The abbreviation for the noise level exceeded no more than 10 percent of the time is L_{10}.

The noise predictions are to be compared with the appropriate design noise levels to determine the need for noise abatement measures. Such measures are to be taken on all projects to meet the design noise levels, to the extent that opportunities to control noise reasonably exist. However, there will be projects for which abatement measures cannot feasibly achieve the design noise levels. Consequently, the standards include provisions for handling exceptions.

The design noise levels apply only to developed lands. Even so, the standards indicate that highway agencies may consider the desirability of applying them to undeveloped lands subject to development. In addition, highway agencies are to furnish to local officials approximate generalized noise levels for various distances from the highway improvement and other information that would be useful to local governments in developing or implementing programs (such as zoning or subdivision control) to protect against future development along the highway that would be incompatible with the expected noise levels.

CONSULTATION AND COORDINATION

Extensive consultation and coordination have played a very important role in the development of the standards. These efforts have provided broad-based inputs from a variety of experts experienced in the study of highway noise problems. Individuals and organizational representatives with different perspectives have participated at various stages in the development of the standards.

Much of the technical foundation for the preparation of the standards was provided by the DOT Office of Noise Abatement and the DOT Transportation Systems Center (a center having good acoustical study facilities).

The first draft of the standards was prepared in November 1971. This was furnished to an advisory committee of highway noise experts that met in December 1971. The membership of this group included representatives from state highway departments, a city department of public works, city environmental agencies, acoustical consultants, the Society of Automotive Engineers, and the Highway Research Board.

Following review by the advisory committee, a second draft was circulated to state highway agencies and FHWA field offices for review and comments. While the states were individually reviewing the standards, a special task force from the American Association of State Highway Officials Operating Subcommittee on Roadway Design met to review the draft standards.

Meetings were also held with the noise staffs of the U.S. Environmental Protection Agency and HUD to explain the standards and to coordinate the standards with related activities of those two agencies.

BASIS OF THE DESIGN NOISE LEVELS

Establishing the proper figures for the design noise levels is essentially a problem of balancing the desirability of eliminating (or minimizing) future increases in highway noise levels against the economic, physical, and aesthetic considerations related to noise abatement measures.

Current ambient noise levels in many developed areas are, at best, annoying and, at worst, a hindrance to many human activities. Any measure that serves to limit future increases would be welcome. On the other hand, effective noise abatement measures are often extremely expensive or disruptive or both and, in some cases, are simply not feasible. The terrain can render abatement measures ineffective or cause the costs of corrective measures to be high in relation to the benefits achieved. The

measures required to abate noise conditions can conflict seriously with other important values such as desirable aesthetic standards, important ecological conditions, highway safety, air quality, or other similar considerations. It would be nearly impossible to incorporate noise abatement measures for highway projects involving an increase in traffic volume or speed (and therefore an increase in traffic noise) on existing city streets or arterials without completely disrupting existing development. The difficulties arise from numerous points of access, the close proximity of storefronts and dwellings, grade intersections, limited ability to acquire additional right-of-way as buffer zones, and the impossibility of altering roadway grades, constructing noise barriers, and taking advantage of the terrain and other natural features. Reduction of the noise source appears to offer the only possibility for reduction of noise levels in these situations. The problems are also complicated by the fact that, below the level of physical harm, reactions to noise are largely subjective, and people will have differing sensitivity to a given noise level.

Several approaches to the establishment of design noise levels on a relatively systematic basis have been considered. These include possible hearing impairment, annoyance or disturbance, and interference with speech communication (5).

The first approach deals in terms of very loud noises seldom encountered for a highway project beyond the roadway proper. The second approach is desirable in principle but insufficiently researched to be used as the sole basis. However, the third, speech interference, can be usefully applied to the problem of highway noise. A combination of the latter two approaches has been used to establish the design noise levels.

As previously mentioned, noise predictions are made for the worst hour (out of 24) and compared with the design noise levels. The worst hour was chosen because of the extreme difficulty in predicting hourly traffic variations for some future year. Highway engineers are usually happy when they can forecast future daily volumes of cars and trucks, let alone the manner in which these volumes will be distributed over a 24-hour period. Consequently, there are no design noise levels for night.

Figure 1 shows measured traffic and computed noise from a heavily traveled urban freeway with high truck volumes throughout the night. It can be seen that the computed noise levels during the night average about 6 dB less than the peak that occurs during the worst hour. For those roadways where night traffic is light, the reduction should be even greater.

If traffic forecasting techniques were sophisticated and precise enough to predict hourly traffic fluctuations, some basis other than the worst hour would have been used in the noise standards.

COMPARISON WITH HUD STANDARDS

A comparison of the standards with those already promulgated by HUD may be useful. For exterior residential use, the upper limit of the HUD normally acceptable range is 65 dBA, not to be exceeded more than 8 hours out of 24. The FHWA exterior design noise level for residential activities is 70 dBA, not to be exceeded more than 6 min out of the 60 min representing one of the noisiest hours of the day. When the HUD and FHWA values are put on a comparable basis, the exterior design noise level proposed by FHWA falls within the HUD normally acceptable range.

EFFECTS OF THE STANDARDS ON HIGHWAY PROJECTS

There is no question that it would be desirable to aim for even lower noise levels than those in the standards. For example, a residential backyard L_{10} level of 60 dBA would be preferable to the proposed 70-dBA value. Even so, although such lower levels were extensively explored in the development of the standards, they were finally judged beyond the reasonable capability of highway agencies to meet with highway measures alone. Figures 2 through 5 (prepared from procedures given elsewhere, 5) demonstrate some of the difficulties anticipated in the application of the proposed design levels.

Figures 2, 3, and 4 relate noise levels to distance from the nearest lane for four-, six-, and eight-lane freeways respectively and for differing traffic conditions. For example, in Figure 3, with the conditions indicated and 800 trucks per hour, the noise

Figure 1. Heavily traveled freeway noise levels.

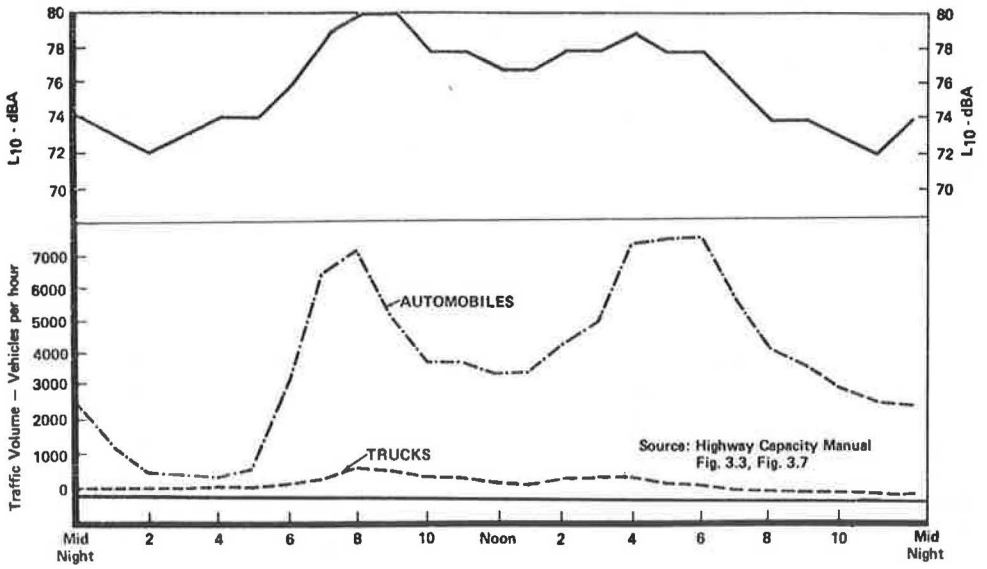


Figure 2. Noise levels for four-lane highway.

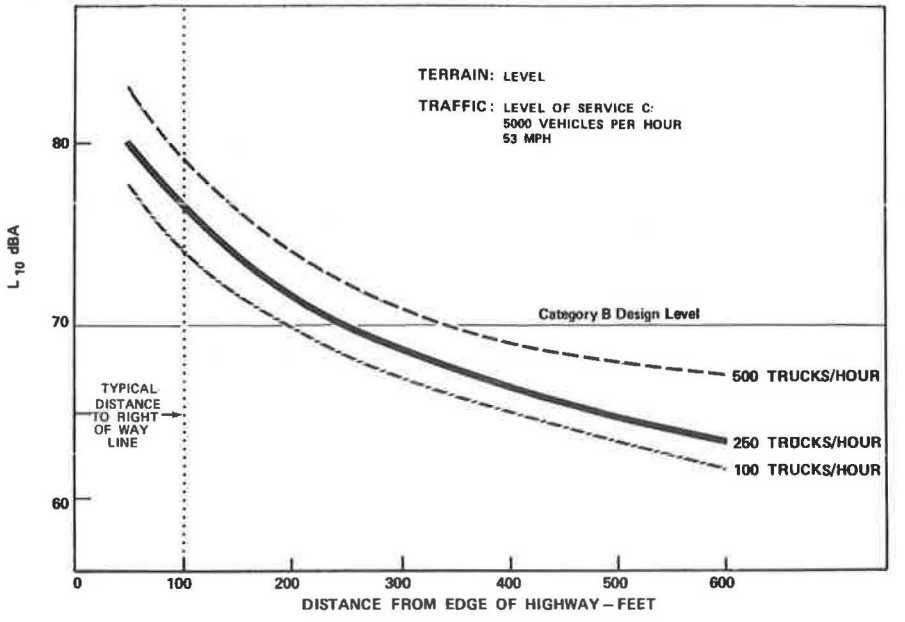


Figure 3. Noise levels for six-lane highway.

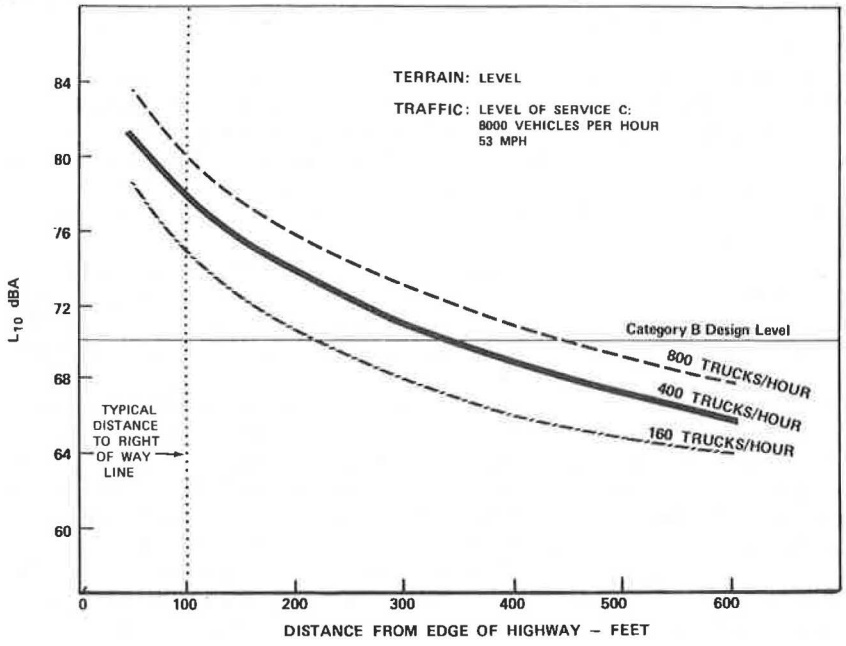
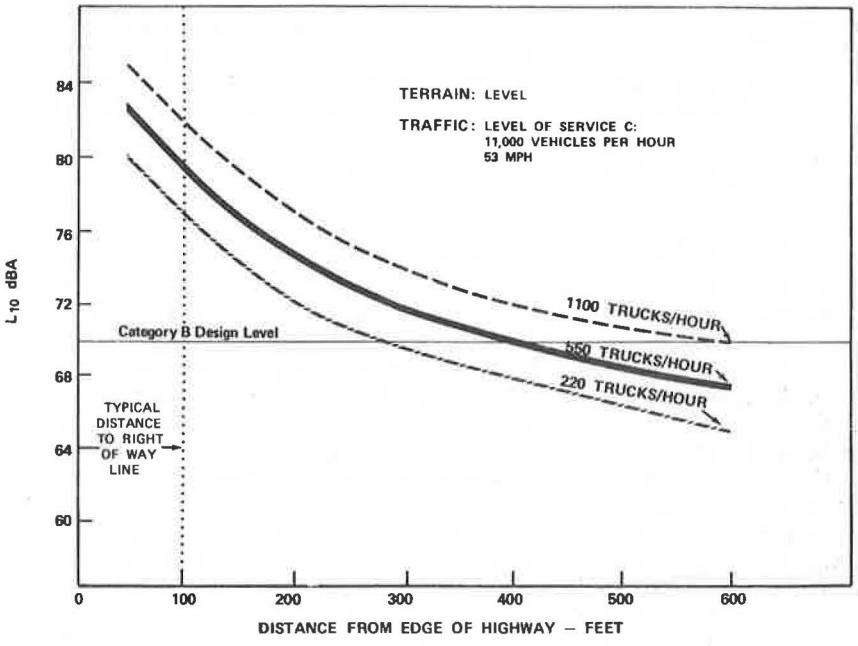


Figure 4. Noise levels for eight-lane highway.



level 200 ft from the nearest lane would be 76 dBA, that is, 6 dBA higher than the exterior design noise level for residential use. In fact, all of the examples shown in these three figures indicate noise levels higher than 70 dBA for distances ranging from 200 to nearly 600 ft from the nearest lane.

Figure 5 shows the same information for a two-lane highway (not a freeway). Even for this type of highway, all of the conditions shown produce noise levels exceeding 70 dBA for some distance from the near lane, although the distances are less than for the freeways shown in Figures 2, 3, and 4. For example, the most severe condition would result in a noise level exceeding 70 dBA for a distance extending up to 190 ft from the near lane. For highways of this type, developed land uses, such as residences, are typically found within 50 ft of the pavement edge.

Figures 6, 7, and 8 carry this analysis one step further. They show a comparison of the effect of noise abatement measures at varying distances from the roadway. For four-, six-, and eight-lane freeways (Figs. 6, 7, and 8) at a distance of 125 ft from the pavement (assumed as the typical distance to a residential backyard) and with no noise abatement measures, the exterior noise levels would be 75, 77, and 79 dBA respectively. All exceed the exterior design noise level for residential land use of 70 dBA by a considerable margin. For a four-lane freeway (Fig. 6) compliance with the design noise level of 70 dBA would require either (a) a buffer zone extending from the edge of pavement nearly 300 ft, (b) 100 ft of dense landscaping, (c) some type of barrier, or (d) depressing the highway 10 ft. It should be noted that, for vegetation to be effective, it must be very dense and high enough to intercept the line of sight between the noise source and a receiver. From Figures 7 and 8 for six- and eight-lane freeways, it can be observed that meeting the 70-dBA design noise level would be even more difficult, requiring either a 400-ft buffer zone, 200 ft of dense landscaping, or a solid barrier at least 6 ft high.

From this analysis it is evident that the design noise levels will call for substantial noise abatement measures for a large number of highway projects. However, there are serious questions as to the extent of relief that is possible from highway measures alone. Given the levels of noise currently generated by vehicles, it is doubtful that any more stringent design noise levels than those proposed by the standards are within the practical limits of the highway program. Additional reduction in traffic noise must come in the form of control of the source of noise itself, namely, through control of the noise generated by noisy vehicles, particularly trucks. If legislation for controlling vehicular noise is to be developed and applied, a reduction in design noise levels may well prove both desirable and feasible.

WHAT THE STANDARDS SHOULD ACCOMPLISH

The standards will not guarantee the elimination of annoyance or disturbance from traffic noise even in those situations where the design noise levels are met. The standards are designed to reduce overall background noises that interfere with human activity and the frequently repeated peak noises. Occasional peak noises, such as those that occur from the passage of a few trucks per hour, will not be controlled. The reduction of these occasional noise peaks (and concurrent reduction of annoyance) will come when the appropriate governmental agencies provide for reduction of the noise at its source—the motor vehicle. The same is true of the unmuffled or otherwise unnecessarily noisy vehicles.

The standards will ensure that noise is given proper consideration in the development of highway projects. Highway agencies will have to develop or obtain expertise in acoustics and noise control to apply the standards. This will ensure that detailed examination will be made of the noise aspects of future highway projects. Noise effects will be given greater weight during highway location studies now that a yardstick is available for quantifying noise effects. Noise abatement measures will be incorporated into many new highway projects.

The standards should also have an effect on local land use control because they require state highway agencies to cooperate with local officials by providing information on expected future highway noise levels for undeveloped lands near new highway projects

Figure 5. Noise levels for two-lane highway.

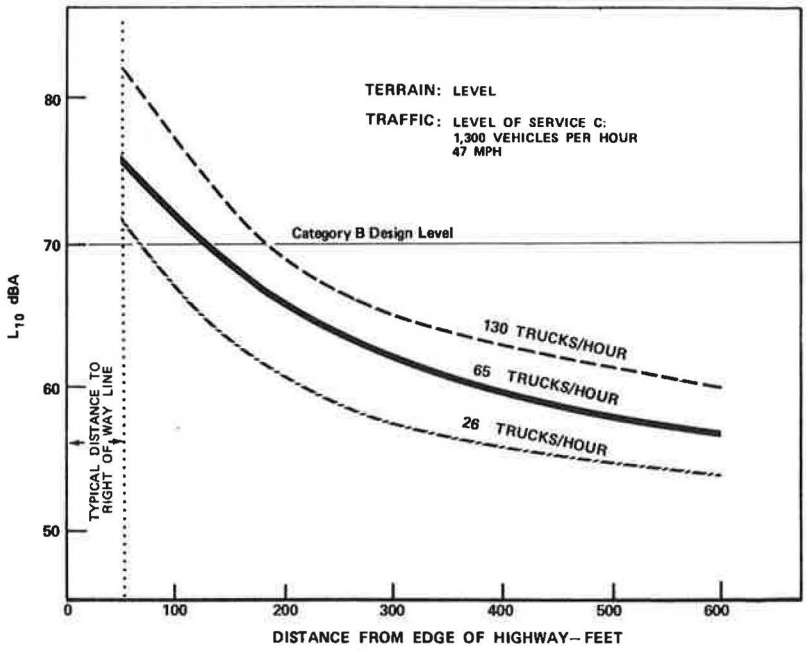


Figure 6. Highway noise from edge of four-lane highway.

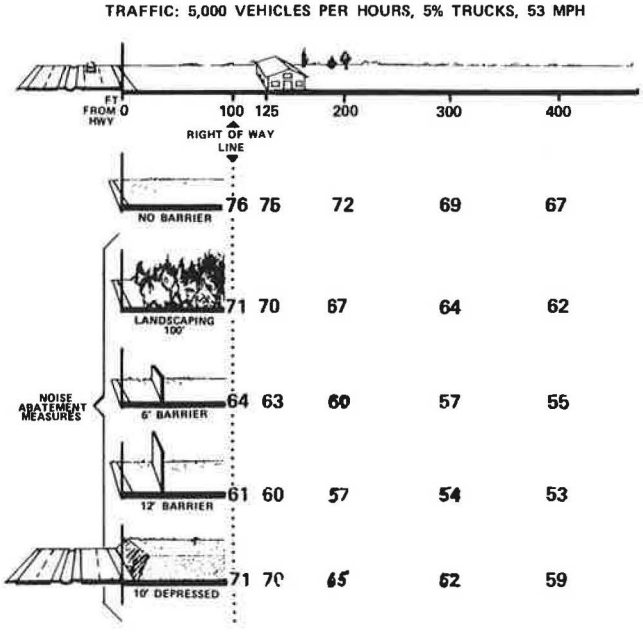


Figure 7. Highway noise from edge of six-lane highway.

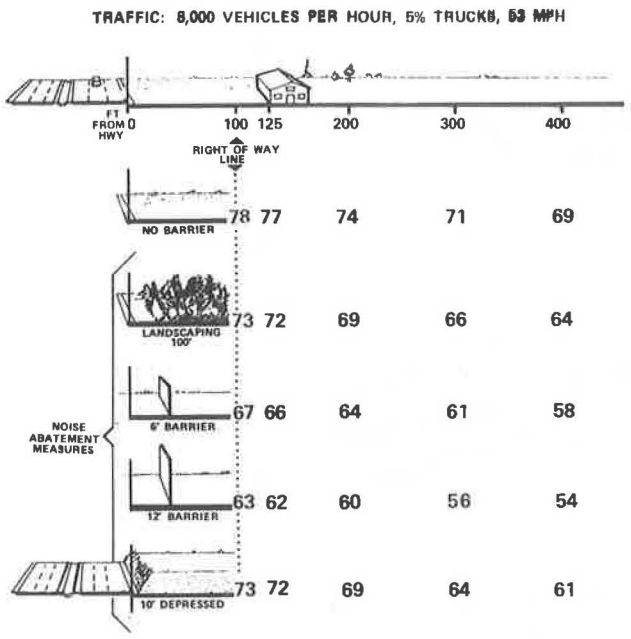
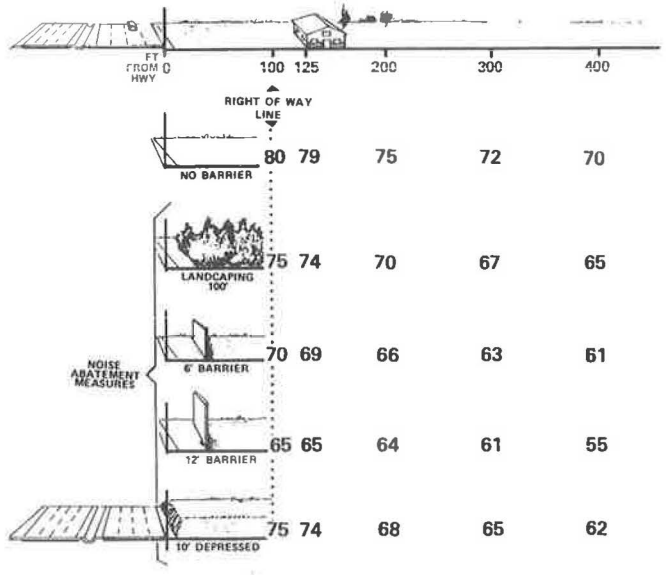


Figure 8. Highway noise from edge of eight-lane highway.



together with information on the types of new land uses that would be compatible with the highway. It is anticpated that this information will stimulate local officials to adopt zoning regulations and subdivision controls to prevent conflicts of traffic noise with future land uses that may occupy portions of transportation corridors. As previously mentioned, this would not necessarily prohibit future development but rather utilize reasonable setback distances, soundproofing, or other abatement measures to avoid future noise problems.

The standards will clearly accomplish all that Congress mandated, and more. However, it will take time for most of the results to become apparent. Our institutions are large and somewhat unwieldy. Many of the highway projects to which the noise standards will be applied in 1972 will not be constructed for at least 5 years. Much time will be required to develop regulations, technology, and manufacturing changes to reduce noise at the source. Local governments will have difficulty in overcoming resistance to land use controls to reduce noise effects. All of these things will happen, but it will take time. The FHWA will shorten this time by promulgation of the noise standards that have been developed.

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