Overview of NJDOT's Noise Mitigation Program

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In this paper, the specific noise procedures by which the New Jersey Department of Transportation (NJDOT) studies and constructs noise mitigation measures are discussed. Details on NJDOT's noise impact definition and environmental process are provided, along with a summary of NJDOT's noise mitigation program that highlights the type and cost of such measures. In addition, specific mitigation projects are presented as examples of concrete, wood, and metal freestanding walls. Two environmentally sensitive projects, I-78 Watchung and I-295/I-195, are discussed in depth. Finally, NJDOT's standardized designs for concrete and wooden walls are described.

The purpose of this paper is to present an overview of the noise mitigation process in New Jersey by providing some background on New Jersey Department of Transportation (NJDOT) procedures and a composite view of the state's noise mitigation projects. The report begins with a brief outline of the policies that define a noise impact and the criteria for recommending noise barriers, and ends with a presentation of the results of the noise mitigation program and preferred barrier types.

FEDERAL PROCEDURES

The Federal Highway Procedures for Abatement of Highway Traffic Noise (FHPM 7.7.3) provide a listing of various land uses and define their noise sensitivity. These categories are presented in Table 1. Although Category A and Category E areas are occasionally evaluated, Category B areas are the primary concern. Category B areas include residences, exterior school areas, and parks, whereas Category A contains lands for which serenity is of special significance and Category E areas are the interiors of public schools, libraries, and hospitals.

As written, the procedures provide considerable latitude for interpretation on the part of the FHWA division office and the state transportation agency. The definition of a noise impact that is used in this paper was developed from these procedures in conjunction with the FHWA division office.

NOISE IMPACT CRITERIA

The first definition of a noise impact is "predicted L_{eq} noise levels that approach or exceed the Noise Abatement Criteria," as given in Table 1. Because a 3-dBA change in noise levels approximates the threshold of perception, noise levels that approach the criteria are defined as occurring at 3 dBA less than this criterion.

The second definition is "a substantial increase in predicted noise levels over existing noise levels, even though the impact criteria level is not reached." The increase is considered to be 10 dBA or greater, which is a doubling or more of the perceived noise level. This criterion is not considered to be an absolute; increases in noise levels approaching 10 dBA may be evaluated and discussed as circumstances dictate.

When noise impacts are identified on a federally funded project that involves new alignment, lane addition, or horizontal or vertical modifications, FHWA regulations require an evaluation of noise mitigation measures. The lead NJDOT unit responsible for evaluating the need for noise mitigation and recommending such measures is the Bureau of Environmental Analysis (BEA). BEA was established as a unit within NJDOT to assess social, economic, and environmental factors in the development of highway projects. The multidisciplinary staff is capable of assessing such factors as water quality, ecology, socioeconomics, archaeology, historic architecture, air quality, aesthetics, hazardous waste, and noise. As highway projects are developed, they are given a Level of Action classification by BEA. As a result, the projects are then processed with one of the following procedures:

- Environmental Impact Statement (EIS),
- Environmental Assessment (EA), or
- Categorical exclusion.

A noise study, known as a Technical Environmental Study (TES), is generally performed only for EIS and EA documents. These environmental documents are compiled during the early stages of project development. If noise mitigation measures are recommended at this stage, then a Final Noise Study (FNS) is conducted as part of the final design of the project.

RECOMMENDED MITIGATION GUIDELINES

During the final design of a project, NJDOT will recommend the incorporation of noise barriers into a project if the following criteria are satisfied:

- The barriers are effective in providing a significant reduction in noise levels while also eliminating the majority of noise impacts identified. The initial goal used in designing a barrier is to reduce noise levels by at least 10 dBA. However, the 10-dBA goal is not an absolute value, and reductions approaching

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TABLE 1 FEDERAL HIGHWAY ADMINISTRATION NOISE ABATEMENT CRITERIA

Activity Category	Noise Abatement Criteria (dBA) L_{10}	L_{eq}	Description of Activity Category
A (Exterior)	60	57	Tracts of land for 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. Such areas could include amphitheaters, particular parks or portions of parks, open spaces, or historic districts that are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B (Exterior)	70	67	Picnic areas, recreation areas, playgrounds, active sports areas, and parks that are not included in Category A, and residences, motels, hotels, public meeting rooms, schools, churches, libraries, and hospitals.
C (Exterior)	75	72	Developed lands, properties, or activities not included in Category A or B above.
D	–	–	For requirements for undeveloped lands, see paragraphs 11*a* and *c* of the *Federal Aid Highway Program Manual*, Volume 7, Chapter 7, Section 3.
E (Interior)	55	52	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

or exceeding 10 dBA will be considered on the basis of reasonable cost.

- The barriers are reasonable in cost, considering the number of impacts mitigated.
- The barriers are feasible from a design perspective. For this criterion, the barriers are reviewed to evaluate any potential drainage problems, structural problems, or other design constraints.
- There is favorable community input.

NOISE PROGRAM BACKGROUND AND RESULTS

Since 1979, more than 19 mi of noise barriers have been constructed in New Jersey at a cost of more than $20 million. If those projects currently in final design are considered, an additional 22 mi of barriers will be constructed in the next 2 yr (Figure 1).

The vast majority of noise mitigation devices used in New Jersey have been free-standing walls. As can be observed in Table 2, concrete and wood are the primary types. Metal walls are restricted to those areas where dead load restrictions prohibit the use of wood or concrete (i.e., on bridges and retaining walls).

From an aesthetic viewpoint, earth berms would be the first choice for noise barriers. Because of a lack of the necessary right-of-way (ROW) in most projects, however, the use of this measure has been limited. Favorable noise mitigation results have been achieved with gabion walls on several recent projects, but because of ROW limitations, the use of such walls on future projects will be restricted. Design modifications have been incorporated into several projects and include such measures as a depressed roadway profile and the construction of ramps on fill instead of on structure.

Insulation of school buildings has been used at a number of projects to either mitigate construction noise or eliminate the impact of future traffic noise. These measures included the use of central air conditioning, unit air conditioning, and building modifications such as window replacements.

TABLE 2 NOISE BARRIER MATERIALS USED IN NEW JERSEY

Type	Constructed Length (mi)	Constructed Cost ($)	To Be Constructed Length (mi)	To Be Constructed Cost ($)
Concrete	15.40	16,302,000	15.41	23,878,600
Wood	3.06	3,495,000	2.24	2,322,000
Metal	0.78	462,000	0.63	822,000
Gabions or berms	0.51	(no cost)	4.10	4,869,000
School insulation	NA	611,000	NA	815,100
Total	19.75	20,260,000	22.38	32,706,000

MITIGATION PROJECTS

It is useful at this point to examine two projects that are significant examples of noise mitigation in New Jersey. These projects provide examples of two types of freestanding walls. Examples of other types of walls are also briefly considered.

Concrete Barriers on I-78

This project was considered to be very sensitive because it skirted the 2,000-acre Watchung Reservation. The plan involved the construction of a 5.5-mi, six-lane section of I-78. In conjunction with this project, an adjacent section of existing I-78 was upgraded (Figure 2).

Highway noise was a major consideration during the environmental analysis of I-78, in addition to concerns about parkland displacement and the effects on wildlife. After the noise study was conducted during the EIS phase, numerous final noise studies were undertaken during the highway's design phase. In all, seven final noise studies were completed, corresponding to each of the construction contracts.

Because of the project's sensitive nature, NJDOT took care to use mitigation treatments that were compatible with the environment. During the final noise study process, an aesthetics committee was formed to review and select the material type, color, and architectural treatments for the walls. The committee included representatives from the BEA; the

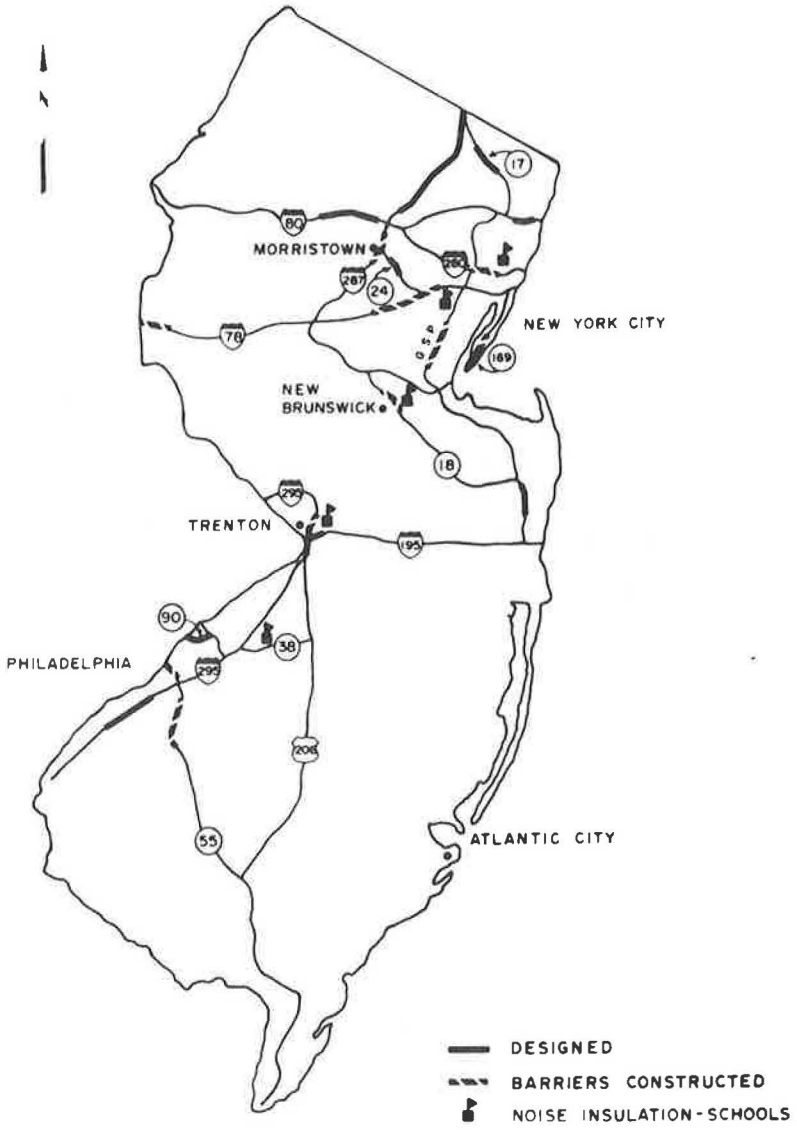

FIGURE 1 Location of noise mitigation measures designed or constructed in New Jersey.

NJDOT design, structures, and landscape divisions; and FHWA. The Watchung Park Commission was opposed to the construction of wooden walls, mainly because of their fire potential. For this reason, the committee selected concrete walls as the barrier type for this project.

To provide texture on the highway side of the concrete walls, a grape stake form liner was used. All noise barriers within the reservation were integrally tinted with an earth tone color (Pueblo Brown) that was selected to blend with the surrounding rock formations. The residential (nonhighway) sides of the walls have a "fuzzy finish" treatment (Figure 3). This finish is made by texturing the wet concrete surface to a rough finish with an asphalt rake in such a manner that tine marks do not remain. The fuzzy effect is a result of the contrast produced on the rough surface by reflection of light.

The final noise studies, under the direction of FHWA, proposed nearly 9 mi of noise barriers at a cost of $8.5 million. Construction of the project began in October 1982 and was completed in August 1986.

Basically, three types of barriers were used along this project. An integral panel and post barrier system, known as a "Sierra Wall," was the first barrier constructed along the site. The panel of the noise barrier is cast with one post, and the post is bolted to a footing that interlocks with an adjoining post and panel. As with all the barriers within the Watchung project, the posts and panels are integrally tinted Pueblo Brown and have a grape stake finish on the highway side. These barriers are 14 ft high.

The majority of barriers in the I-78 project are a separate post and panel design. The posts are first installed in the ground, and then the panels are positioned between the posts. In one section of the project, through the park, a parallel barrier situation occurred. Detailed analysis during the design stage noted that multiple reflections between the parallel barriers would degrade barrier performance. Because this area was Category A parkland (i.e., lands for which serenity and quiet are of extraordinary significance), measures to minimize this situation were studied. Incorporating absorptive

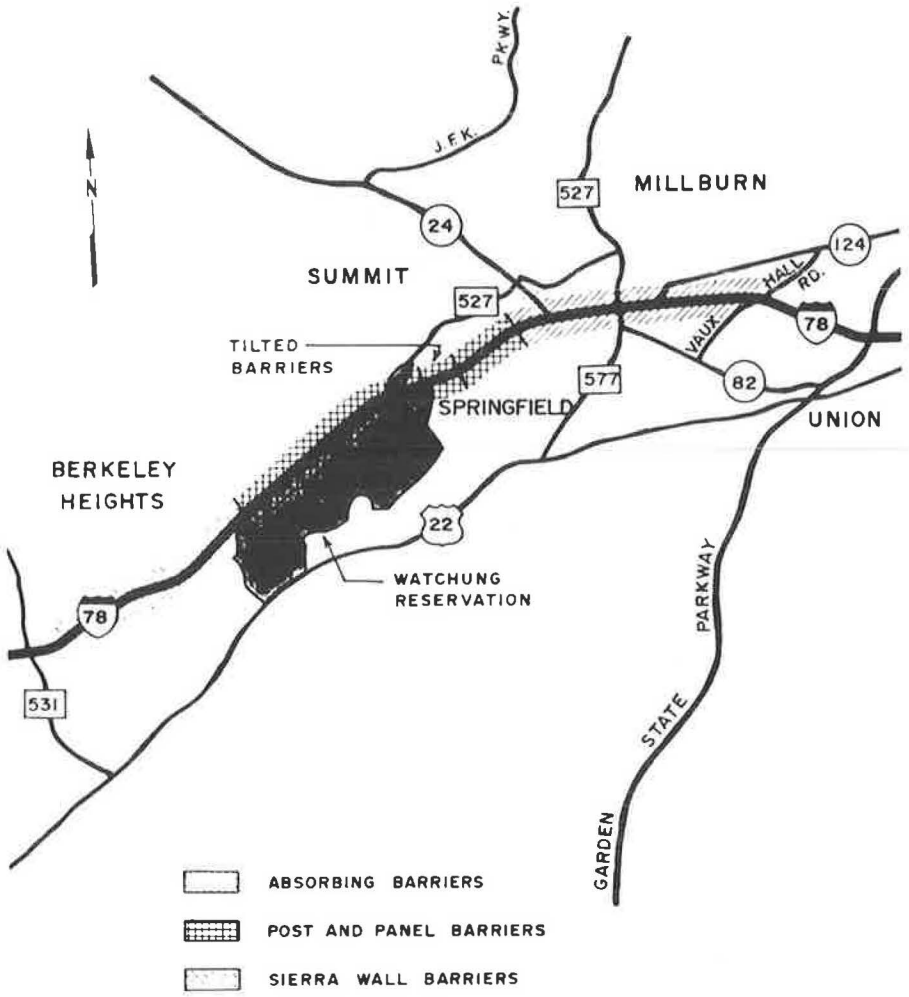

FIGURE 2 Location of barrier by type along I-78.

material into the exterior barrier surface, raising the barrier heights, and tilting the barrier were all investigated. Tilting the barrier was the most cost-effective alternative. The barriers are now tilted 10 degrees and are ~18 ft high (Figure 4).

The last area of special interest was to the east of the Watchung project on the existing section of I-78 that was upgraded during the project construction. The barriers are of a post and panel design, but they have an absorptive treatment known as "Sound Lok" to minimize barrier reflections. Tilting the barriers and raising their height were not considered practical alternatives because sections of this system were up to 24 ft high. Originally, the Sound Lok treatment was to be applied to the noise wall as a smooth 2-in. finish. Inspection of test sample barriers revealed that Sound Lok treatment fissured when it was applied as a smooth finish. A number of surface texturing methods were tried, and it was found that if a vertically ribbed form liner pattern was used on the Sound Lok surface (Figure 5), the fissuring was eliminated and the coefficient of absorption was increased.

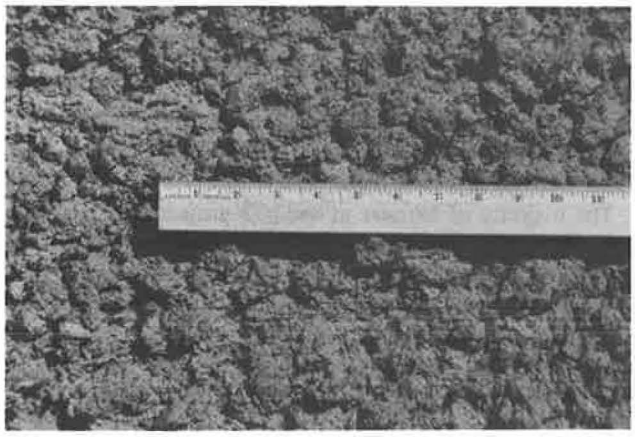

FIGURE 3 Fuzzy finish surface on nonhighway side of concrete barrier.

The surface architectural treatment is not the only difference between these walls and the majority of barriers along I-78: the walls in this section are also of a slightly lighter color (Sequoia Sand). The color was chosen to blend with existing natural concrete roadway structures in this section (e.g., barrier curbs and bridge parapets).

Wooden Barriers on I-295/195

Wooden noise barriers have been incorporated into several highway projects within New Jersey. They were recently used on the I-295/195 (Trenton Complex) project.

FIGURE 4 Separate post and panel barrier, tilted 10 degrees.

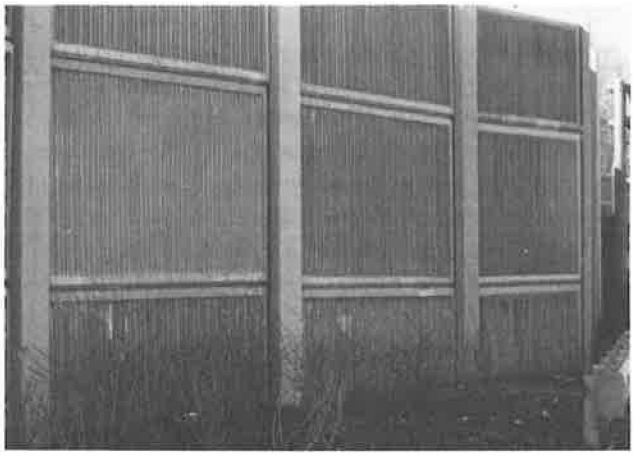

FIGURE 5 Concrete barrier with Sound Lok absorptive treatment.

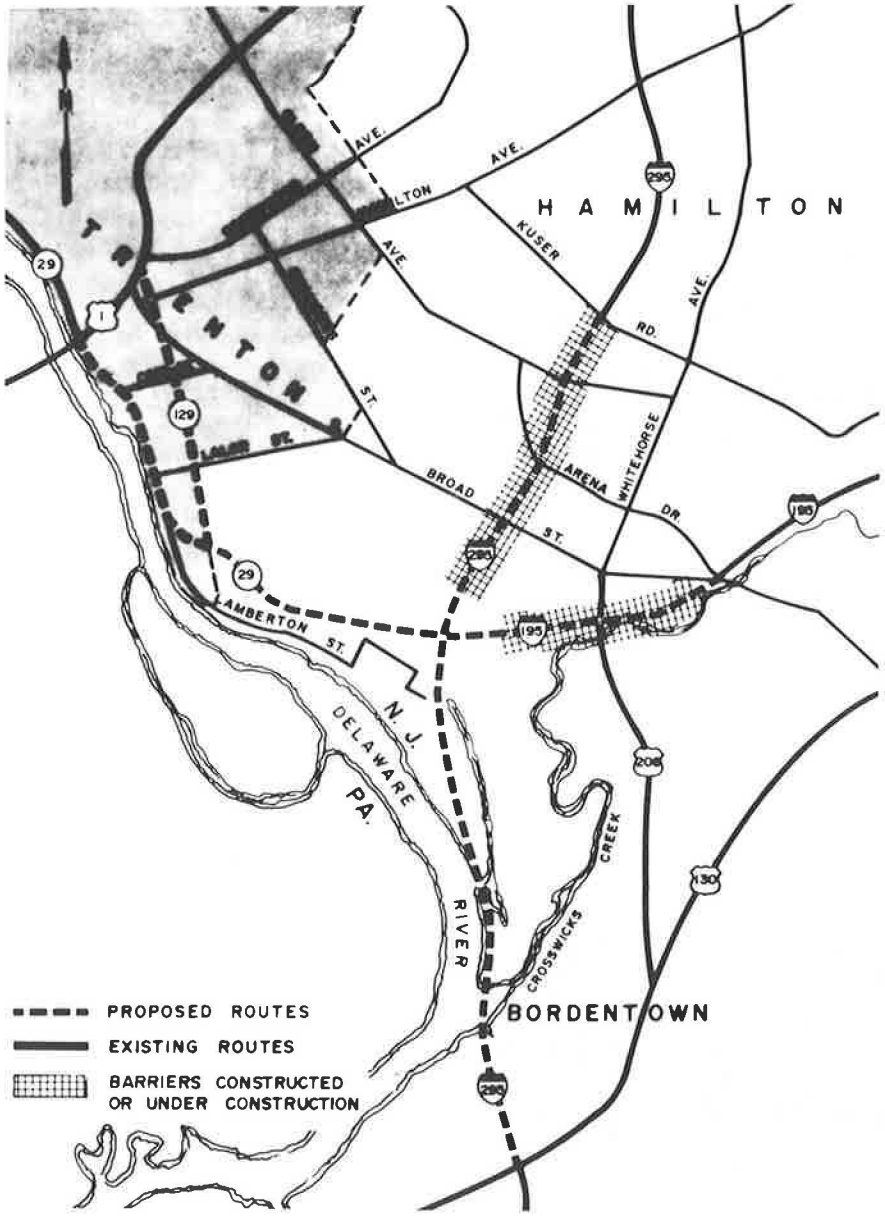

FIGURE 6 Barrier locations along I-295/195.

The Trenton Complex project will connect the present terminals of NJ-29 and Interstates 195 and 295 in and around Trenton. The project consists of 7.6 mi of Interstate routes and 5.9 mi of state highways for a total length of 13.5 mi. The construction of the first segment of the Trenton Complex began in 1983, and the last section is expected to be completed in 1993. Segments of the project are still in the design process.

Three FNSs have been completed to date, and several more will be completed in the next 2 years. As part of the three noise studies, 3.7 mi of noise barriers, ranging in height from 10 to 25 ft, were recommended and constructed (Figure 6). The major environmental issues for this project were wetlands, recreational lands, and cultural resources (archaeological and historic sites). Noise is a sensitive issue because the project will traverse a number of park and residential areas.

The post and panel noise walls were constructed of glue-laminated wood. Standard post spacing is 9 ft on center. Between each post are four individual panel sections, 22 in. wide, that interlock by the attachment of a batten. Purlins (horizontal structural supports) are placed at the top and bottom of the panels. The glue-laminated barrier is the standard design for wooden walls in New Jersey (Figures 7 and 8).

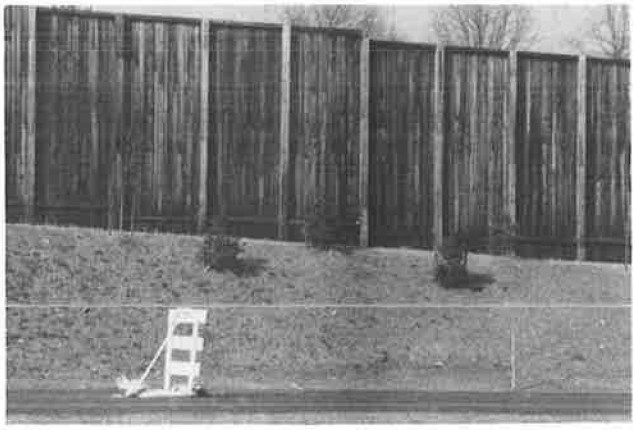

FIGURE 7 Standard wooden barrier located along I-295/195.

FIGURE 8 Wooden barrier supported by double wall along I-295/195.

Metal Barriers

Although more than 1 mi of these barriers have been constructed in New Jersey, their use has been limited to bridges and retaining walls, where they are used to minimize dead load on the structures. Only two types of free-standing metal barriers have been used: ARMCO type steel, a single-thickness barrier, and CAMEO, a double-layered aluminum barrier with a honeycomb-type material sandwiched between the metal sleeves (Figure 9). The metal panel thickness varies from 22 gauge (single layer) to 2.25 in. (double layer). Generally, there are 10-ft spaces between posts on this type of barrier.

FIGURE 9 Cameo double-layered aluminum barrier along I-280 in Harrison, New Jersey.

Earthen Berms and Gabions

During the study process, consideration is always given to the use of natural barriers. However, ROW limitations and material limitations often restrict the use of such barriers. Natural barriers have the least installation problems and are usually the most aesthetically pleasing.

To date, earthen berms in conjunction with free-standing walls have been used on a number of projects, including I-78. Gabions are being used on a section of I-78 that is under construction in Alpha, New Jersey. The standard size of the gabion cages is 3 ft × 3 ft × 6 ft.

Special Cases

There were several New Jersey cases in which noise mitigation involved the noise insulation of public schools. This was done in situations where barriers were found to be either ineffective or not feasible. The noise insulation primarily involved air conditioning of school buildings, such as Our Lady of Czestachowa along I-280 in Harrison, N.J., where noise barriers alone were not effective in reducing interior noise levels.

In conjunction with the NJ-18 freeway project in New Brunswick, a deck was placed over the highway to provide noise mitigation for three Rutgers University dormitories. The bottom two floors of these buildings contained classrooms. The deck also provided parkland replacement because the roadway had occupied recreational land in the construction of

the freeway over the bed of the Delaware and Raritan Canal. To mitigate noise in the classrooms during construction, a modular, vented sound-absorbing wall system was affixed to the exterior bottom two floors of the buildings (Figure 10). This was so effective in reducing noise levels that the university requested that it remain in place after the highway was completed.

NJDOT also has depressed the profile of a number of projects during the early stages of design. This modification has been incorporated into the design of such projects as I-287 and I-78.

FIGURE 10 Modular sound wall affixed to exterior of Rutgers University building.

CONCLUSIONS

In conjunction with New Jersey's transportation program, NJDOT has succeeded in providing effective noise mitigation measures as part of its highway projects. The goal for such projects is to provide the driving public and the residents of New Jersey with an effective, aesthetically pleasing noise mitigation system.

The primary method of noise mitigation employed by NJDOT has been free-standing walls constructed of either wood or concrete. NJDOT has been satisfied with the results of these efforts and will continue to use these two materials.

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