Mitigating Construction Impacts on Rural and Urban Highways

ROSWELL A. HARRIS, LOUIS F. COHN, WILLIAM BOWLBY, ALBERT L. TATE, and RAYMOND BRISSON

ABSTRACT

The image of the typical state transportation agency has evolved from that of an organization that cared little for environmental impacts to one that has integrated mitigation of impacts on the environment into the project development process. Three examples are documented of how two state transportation agencies are implementing mitigative steps in historic preservation, noise abatement, and preservation of the natural environment during the construction phase of project development.

In the not too distant past, the typical state highway agency was viewed by the general public as an organization intent on building more highways, with little or no regard for the environmental cost. This image, however, has been slowly reversing itself during the last 10 years. Obviously the passage of the 1969 National Environmental Policy Act (NEPA), through its legal mandates, has played a major role in this reversal. Subsequent related legislation has also been a factor. More important, the citizens of the United States have demanded a greater role in the project development process.

It is inevitable that construction of transportation facilities will cause changes in the existing environment. However, adverse impacts resulting from these changes can be minimized if reasonable precautions and mitigation techniques are incorporated into the normal project development process. Thus, today's highway design engineer must function as a member of an interdisciplinary team for which environmental awareness is as important as pavement design or structural analysis.

The purpose of this paper is to present examples of how two state transportation agencies have handled the mitigation of impacts on the environment during the construction phase. Specific examples include historical resources, noise levels, and the natural environment.

PROTECTING HISTORICAL RESOURCES

The Federal Bridge Replacement Program is a plan authorized by the 1978 Surface Transportation Act to aid in upgrading and maintaining the U.S. infrastructure. Under this program, many of the bridges identified for replacement are characterized as potentially historic because they represent design techniques of a past era. By nature, most of the bridges marked for replacement are the oldest and thus have the highest potential for being historically significant. As a consequence, many historic structures are subject to physical destruction if preventive steps are not taken. In the following paragraphs one case is discussed in which the Tennessee Department of Transportation (TDOT) was able to preserve a portion of a locally significant bridge.

On May 10, 1979, the Anderson County Superintendent of Roads notified the Tennessee Commissioner of Transportation that the Massengill Bridge had been identified as the first priority for replacement among off-system bridges in the county. This bridge had been assigned a sufficiency rating of 23.4 points on a scale where 100 points is considered a perfect structure (1). To close the bridge without replacement would have left local residents without convenient access to nearby cities.

The Massengill Bridge is located on Coal Creek Road in a rural area in northeast Anderson County between Lake City and Norris, Tennessee. It was erected in 1916 by the Virginia Bridge and Iron Company of Tennessee, which was headquartered in Roanoke, Virginia. In 1915 Anderson County officials decided to improve the county's road system by replacing four ferries with bridges, which were funded and constructed in 1916. The Massengill Bridge is the only one of these bridges remaining.

The bridge derives its primary significance from engineering merits. Each of its four steel trusses is significant as a representative example of a specific truss design (the Pratt through, two through camelbacks, and the Pratt pony). In addition, the pony truss is also constructed with splayed or tapered vertical members, an unusual design often used by the Virginia Bridge and Iron Company (1).

Having determined the historical significance of the bridge, TDOT officials submitted appropriate documentation to the National Register of Historic Places for a determination of its eligibility for listing in the Register. The bridge was subsequently determined eligible for inclusion in the Register on August 14, 1981 (1).

Because the bridge was eligible for inclusion in the National Register, its removal was governed by Section 106 of the National Historic Preservation Act of 1966 and Section 4(f) of the Department of Transportation Act of 1966. As mitigation required by these laws, archivally stable photographs were made, and the bridge design was documented by drawings made to Historic American Engineering Record (HAER) standards (1).

In addition, cost estimates were made for relocating the individual trusses for reuse in some other capacity. It was determined that it would be economically feasible to relocate only the Pratt pony truss. Because this was the most significant part of the bridge, the decision was made that it would be preserved. It was then moved to a campground near Lake City, Tennessee, where it is being stored until the city can relocate it in a city park. A TDOT estimate placed the cost of moving, cleaning, painting, redecking, and placing the truss on new abutments at $16,000 (1). It is significant to note that federal funds were available to aid in the moving, cleaning, and painting. Without these funds, physical preservation of the bridge likely would not have been deemed economically feasible. As it now stands, the local government will only be responsible for the cost of providing new abutments for the truss and then moving it into place.

This is but one example of how federal, state, and local governments can work together to preserve a locally significant historical resource. It is also indicative of what can be accomplished when all parties involved work together in a conscientious effort toward a common goal.

MITIGATING CONSTRUCTION NOISE IMPACTS

The construction or reconstruction of a major highway in an urban area will invariably cause some disruption to an established community. If the affected community is located in the immediate vicinity of the proposed highway, noise generated by the construction of the highway itself is likely to be an issue. Because there are no federal criteria for construction noise and because construction activity is generally perceived as a temporary inconvenience, an in-depth analysis of the effects of construction noise is seldom performed on highway projects.

However, there are cases when a cursory analysis and specification of simple abatement strategies are simply not adequate. TDOT recently began construction on such a project, a new 7.5-mile Interstate (I-440) across south Nashville. Even though the proposed alignment followed an abandoned railroad right-of-way, the surrounding land use was largely residential. As would be expected, considerable public concern was expressed over the effects of constructing a major transportation facility in this area.

One of the problems faced by TDOT officials was the issue of construction noise. Given the high concentration of noise-sensitive land use adjacent to the proposed alignment, extensive noise abatement measures were planned to mitigate noise impacts generated by operation of the new highway. Because construction of this project would last several years, a logical extension of the overall noise abatement plan was to also provide abatement for construction noise where it was determined practical.

The proper analysis of a problem as complex as construction noise requires the use of a computer model. FHWA, in its leadership role of providing guidance and analysis tools to the state highway agencies, sponsored (through Vanderbilt University) the development of a comprehensive analytical model for predicting highway construction noise levels. This model permits detailed analysis of construction noise impact and effectiveness of subsequent mitigation strategy (2).

Noise barriers for line and area construction sources are analyzed in the same manner as highway noise barriers. In effect, a point source is moved along the line (roadway) and its insertion loss (IL) is computed at each point along the line. These ILs are then combined to obtain the total IL for the line source.

Specific application of the model to the proposed I-440 construction required a multiple-step process. First, construction plans for the project were thoroughly reviewed. Areas of potential impact were tentatively located in addition to areas of specific construction activities, such as rock drilling, earthwork, and hauling. Second, a detailed field review of the project was made to clarify questions raised during the plan review and to familiarize the engineer with potential abatement strategies. After the plan and field reviews had been completed, the list of potentially affected areas was made final.

At this point the highway construction noise computer program (HICNOM) was used to calculate typical noise levels in the impacted areas based on the major types of activities expected. Three main scenarios were tested: rock drilling, scraper earthwork, and truck hauling. It was determined that the highest noise levels would be generated by the rock-drilling operations. Generally the scraper and truck-hauling activities produced lower levels because of the time-varying nature of the levels (intermittent passbys versus continuous drill or compressor operations). Based on these results, several abatement strategies were developed. Two major considerations in the choice of strategies were cost and ease of implementation.

One strategy that is both economical and easy to implement is the use of earth stockpiles as noise barriers. Contractors typically store topsoil in mounds for future use in such tasks as landscaping. Strategic placement of these mounds can offer substantial noise protection. Because there were four locations on the project where earth berms were to be constructed as permanent noise barriers, TDOT officials elected to construct those berms at the beginning of the construction contract. This action not only provides a significant reduction in construction noise levels (3 to 10 dBA) at the affected receptors but costs significantly less in the beginning than at the originally scheduled construction time.

Another noise abatement strategy applicable to the I-440 project is the use of quiet air compressors in the rock-drilling operations. These compressors are manufactured to meet the 1976 U.S. Environmental Protection Agency (EPA) Portable Air Compressor Emission Standards and are 10 to 20 dBA quieter than older units.

Assuming that the compressors run full time and the rock drills are in operation about half of the time, the 8-hr L_{eq} would be reduced 3 to 5 dBA because of the shorter-term, but louder, drill noise. However, the affected areas would have periods of relative quiet while the drills were being reset as compared with a continuous high background level set by the older compressors.

There are numerous other methods of mitigating construction noise impacts. Some that were considered for the I-440 project include the following:

1. Constructing temporary noise barriers (a wall 8 ft high and approximately 240 ft long would reduce construction noise levels by 10 dBA at three residences located adjacent to the I-440 right-of-way),
2. Prohibiting the contractor from working on Sunday,
3. Positioning stationary equipment to take advantage of a material stockpile or some other obstacle to act as a noise barrier,
4. Locating haul roads as far away from noise-sensitive areas as possible,
5. Locating equipment parking and maintenance in remote areas, and
6. Using some type of warning device to alert residents of an impending blast.

As suggested by the preceding discussion, the noise impacts associated with building a major highway in an urban environment can be mitigated. The mitigation techniques recommended for the I-440 construction demonstrate some easily implemented strategies, analyzed through computer modeling, for reducing unwanted high noise levels.

PRESERVATION OF THE NATURAL ENVIRONMENT

Any highway construction activity will nearly always have an effect on the surrounding natural environment. Effects normally associated with the construction of a transportation facility include the loss of natural habitat, the impacts of erosion and sedimentation on streams and wetlands, and the potential threat to rare species. Although these concerns are real, steps can be taken to minimize harm caused by construction. Reclamation of marshland, modification of drainage structures to accommodate stream life systems, containment of silt, and erosion control are but a few of the methods available for mitigating disruption to the natural environment.

A common problem that is often overlooked is the effect of placing a drainage structure in an undisturbed stream. From an engineering standpoint, culverts are designed to accommodate a given water flow based on a desired flood recurrence interval, with little regard to minimum flow conditions. However, the typical stream rarely experiences maximum flow levels, and bankfull levels occur only about once every 1.5 years and then for only short periods of time (3). Even the mean annual flow is equaled or exceeded only about 25 percent of the time (3). Thus most forms of stream life are adapted to low flow conditions.

To avoid creating a barrier to the movement of fish and other aquatic life, culvert design should also consider the low flow characteristics of a stream. In larger streams, the streambed configuration is such that, even during long periods of low discharge, the stream bottom is usually covered with water. However, with low flow conditions in smaller streams, the water coverage is contracted so that half or less of the stream bottom remains covered. When this happens, the flat bottom of a conventionally designed culvert creates a sheet flow condition that provides inadequate depth and bottom roughness for many aquatic species and thus forms a barrier to passage.

The Georgia Department of Transportation (GDOT) uses two alternative culvert designs to mitigate this type of impact. One is a bottomless design in which the normal floor is simply eliminated. The other is a conventional design, but the culvert is constructed with the floor 1 ft or more below the normal stream bottom. In the latter case, the stream then fills the culvert with sand and rock material, making a natural stream bottom contour.

Another common concern associated with steam crossings is that of realigning the stream channel to a more perpendicular crossing of the highway. Small channel changes (up to several hundred feet) are not uncommon in highway construction. If proper steps are not taken, scars can be seen for several years in the form of a straight ditch covered with little or no vegetation.

Mitigation of such impacts can be accomplished with little difficulty. GDOT routinely builds a slight curve into the new stream channel and then lines the channel bottom and sides with stone riprap. Soil from the old streambank is then excavated to a depth of about 1 ft and dumped into the riprap along the new channel banks. This technique serves to rapidly restore the streambank vegetation along the new channel. The riprap placed in the bottom of the new channel provides roughness to the new stream contour and greatly enhances stream bottom habitat.

The preceding examples illustrate what can be accomplished in minimizing construction impacts to the natural environment. GDOT has managed to combine good engineering design and the preservation of the natural environment into a single objective: cost-effective highway construction that minimizes environmental impacts.

SUMMARY AND CONCLUSIONS

The examples offered in this paper provide evidence that the negative effects of highway construction on the environment can be minimized or eliminated. Cultural resources can be preserved, the quality of urban life can be aided through the abatement of construction noise, and the natural environment can even be enhanced with innovative construction techniques.

REFERENCES

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