Perception of Traffic Noise Barrier Effectiveness

Public Opinion Survey of Residents Living near I-71

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The completion of the largest Ohio Department of Transportation traffic noise abatement project in 1995 was met with public controversy over the effectiveness of the noise barriers. A public opinion survey was designed to obtain the perceptions of the residents in the project area. In a departure from most surveys of traffic noise barrier effectiveness, the coverage was not limited to the first or second row of houses, but was extended to 800 m on each side of the roadway. It was found that the larger survey area was needed to avoid misleading conclusions. Overall perceptions of noise barrier effectiveness were found to vary with distance from the roadway and with noise barrier configuration.

In 1988, the Ohio Department of Transportation (ODOT) studied the I-71 corridor in Hamilton County, north of Cincinnati, to determine the environmental impacts of traffic lane additions. The study concluded that traffic noise abatement for residents living near the I-71 corridor was warranted according to FHWA noise abatement criteria. It was decided to add the traffic lanes with a commitment to design and build traffic noise barriers as a separate project.

The traffic noise abatement project, 11.3 km in length, has a wide variation in terrain and barrier configuration and is the largest and most complex ODOT project of its type to date. The noise barrier project was completed in April 1995, 5 years after the lane additions, at a cost of $9.4 million. The completion of the project was met with public controversy over the effectiveness of the noise barriers. Therefore, ODOT decided to study the project to determine the effectiveness of the abatement design.

A preliminary assessment project was initiated to determine the nature and extent of any problems that may have occurred with the construction of the noise barriers. As a first step, a public opinion survey was to be designed and conducted to gain the perceptions of the residents in the project area. The survey was to be used to provide information and direction to the physical and acoustical investigation of perceived problems for which no prebarrier noise measurements existed. The survey procedures and results are discussed in this paper.

PROCEDURE

A passive survey of citizen comments was conducted to obtain a summary of issues and types of complaints that concerned the residents. The comments were gleaned from the news media, letters from citizens written to ODOT, and interviews with city officials in the project area. The results of the passive survey along with a review of typical public opinion surveys of traffic noise issues along with statistical sampling considerations were used to design the survey instrument.

The survey consisted of 19 questions. In this paper, emphasis will be given to the critical issue of perceived noise level changes from construction of the traffic noise barriers. To minimize any bias that may be introduced by the wording of one question, this issue was approached by using three separate questions, each of which related to noise barrier effectiveness.

Survey Design

Residents were surveyed to determine the attitudes and perceptions of the effectiveness of the noise barriers in reducing traffic noise in the neighborhoods adjacent to I-71. Several survey options were considered: mail out/mail back, hand out/mail back, and telephone. The telephone survey was chosen for several reasons. In contrast to the mail-back options for which the response rate can only be known after the fact, the telephone method allows a guaranteed number of responses equal to the preselected value that is based on the desired confidence level for the study. That is, randomly selected telephone numbers are called until the desired number of responses is obtained. Both the location and number of responses were critical to this study because they were to be referenced geographically. Unlike most opinion polls, the location of residents relative to the I-71 roadway and noise barrier would have a definite effect on their perception for most of the questions. The telephone method allowed more control of the spatial distribution of responses (while maintaining the requisite of randomness).

Second, ambiguities that may inadvertently be present in a mail-out survey would not be known until the surveys were returned. The person conducting the telephone survey can clarify questions and ambiguities during the phone conversation. Further, contradictions in responses can be verified and useful information can be obtained through volunteered statements.

In addition to the three central questions, the survey contained other questions of a qualifying nature to determine whether the residents had lived at their present location before the noise walls were constructed, the length of their residency, the type of dwelling, sources of and satisfaction with preproject information, and so forth. There were also questions about changes in noise levels by time of day and month of the year, as well as questions about the effect of traffic noise on outdoor and indoor activities. A number of previous public opinion surveys have found that opinions of barrier aesthetics or availability of information before implementation of noise abatement

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measures can affect perception of barrier effectiveness (*1*). Therefore, these issues were also addressed with specific questions.

Sample Population

Public opinion surveys of noise barrier effectiveness are generally given to the first row and sometimes the second row of residents. However, the passive survey results suggested that survey coverage should be expanded well beyond the first row. An area 800 m wide on each side of I-71 was selected.

The study area, which is approximately 11.3 km long, extends from Cornell Road to Euclid Road (north and south), and Montgomery Road to Kenwood Road (east and west) in the cities of Blue Ash, Madeira, Montgomery, and Cincinnati, in Hamilton County, Ohio. For the purpose of this study, the east and west corridors were subdivided into three 270-m-wide zones, identified as Zones 1, 2, and 3 East or West (Figure 1).

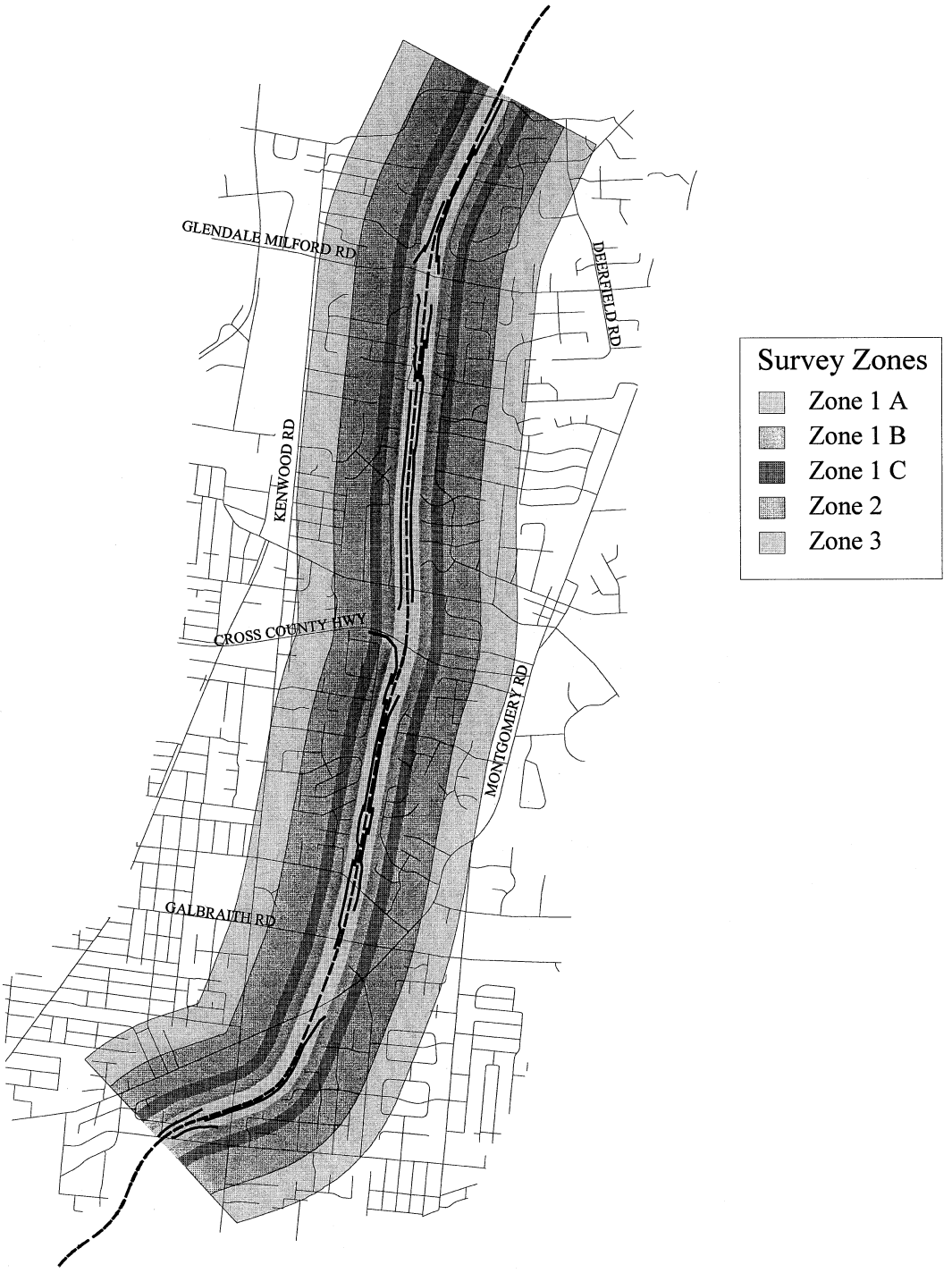

FIGURE 1 Division of survey study area, all zones.

It was hypothesized that the greatest variation/transition in the perception of effectiveness would be exhibited in the neighborhoods closest to the noise barriers. To measure this, the Zone 1 corridors were further subdivided into six equal-width subzones labeled Zone 1 East A, B, and C, and Zone 1 West A, B, and C.

Where residential streets are parallel to the highway, Subzone 1A includes mostly the first-row dwellings, those with backyards directly adjacent to the noise barrier and highway. Subzone 1B usually includes the second row of houses facing the highway, and the third row with backyards abutting those houses. Subzone 1C usually includes the fourth and fifth rows of houses away from the highway.

A stratified random sample was used for the selection of the houses to be sampled. Lists were created for each zone that consisted of parcel number, street address, owner, and phone number for each private residence within the study area. From these lists, more than 1,500 households were randomly selected for telephone interviews. A minimum of 200 valid surveys was sought for each of the six zones (Zones 1, 2, and 3 East and 1, 2, and 3 West) for a total sample of 1,200 surveys.

There were three sample populations to consider: (*a*) the entire study area consisting of the six zones, (*b*) the individual subzones, and (*c*) the subzones created from Zone 1 East and Zone 1 West, each split into subzones A, B, and C. The full sample consists of 1,201 responses; the subzones consist of 442 responses. A confidence level of 95 percent was used to determine the margin of error for the sample population. The overall margin of error for 1,201 surveys is ± 2.8 percent. The margin of error for analysis within Zone 1 East and Zone 1 West is 6.9 percent. The overall margin of error for Zone 1 is 4.7 percent.

RESULTS

The following analysis is presented first at the zone level and then in greater detail for the subzone level within Zone 1. The results are organized by the analysis done for each of the three major questions, as well as analyses to consider additional correlations.

Perceived Noise Level Changes from Noise Barrier

Residents were asked to rate the noise level at their location by answering the survey questions, "How would you rate the noise level at your residence since the noise walls were built?" (increased, same, or decreased). The responses were found to be very similar for residents living on the east and west side of I-71, the slight differences not being statistically significant.

Approximately half of the respondents reported that the noise level remained the same after construction of the noise barrier (Figures 2 and 3). That response was more frequent in Zones 2 and 3. More than one-third of the respondents reported that the noise increased after the construction of the wall. Approximately one respondent in seven reported a decrease in traffic noise. Responses were clearly more negative in Zone 2, with a higher percentage reporting an increase in noise and a lower percentage reporting a decrease. Of residents reporting a decrease in the noise level, most were in Zone 1. Likewise, residents in Zone 1 were less likely to report an increase.

When Zone 1 responses are examined by subzone, a clear pattern of responses can be detected (Figures 4 and 5). The share of respondents reporting a decrease in noise drops significantly with distance from the highway, from about half in Subzone 1A to a quarter or fewer in Subzone 1C. Likewise, the share reporting an increase in noise increases with distance from the highway. The pattern of responses on the east and west sides of the highway is remarkably similar. It is most improbable that such a pattern could have been repeated so clearly without some physical cause or a widely shared perception of a physical cause.

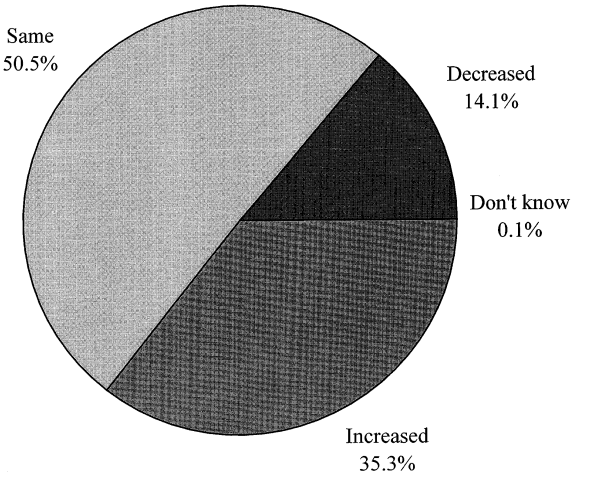

FIGURE 2 Residents' rating of noise level after barrier construction, all zones.

It appears that a decrease in noise is confined largely to those homes within 30 to 90 m from the centerline of the highway. Within the first 90 m (Zone 1A), more than 80 percent of all respondents reported the noise level to have decreased or remained the same. Beyond about 90 m, respondents were more likely to report an increase in noise. The pattern of increased negative responses with distance from the highway within the closest 270-m corridor contrasts sharply with responses within the 800-m-wide corridor as a whole. Negative responses increased rapidly with increased distance from the wall, reaching a maximum at about 240 to 300 m from the highway centerline. Beyond that distance, negative responses decline and positive responses remain low.

Effectiveness and Benefits of Noise Barrier

The other two survey questions that directly relate to noise barrier effectiveness were, "Are the noise barriers effective in reducing traffic

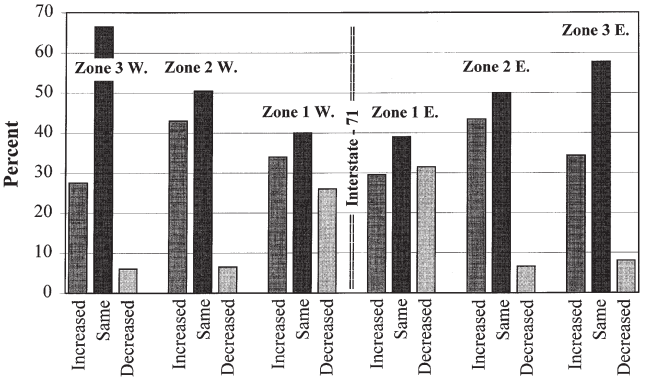

FIGURE 3 Residents' rating of noise level after barrier construction, by zone.

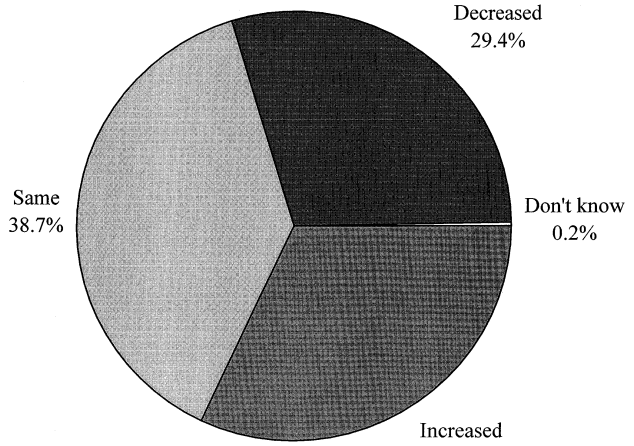

FIGURE 4 Residents' rating of noise level after barrier construction, Zone 1.

noise?" (yes, no, or not sure) and "In your opinion do the benefits of the noise barriers outweigh the disadvantages?" (yes, no, or not sure). Respondents are somewhat more negative in their evaluation of the benefits of the noise barrier. The more negative responses may come from residents who believe the noise level has remained the same and likely view it as ineffective, and some who believe that although the noise level has been reduced, the reduction is insufficient.

Approximately one in five consider the noise barrier to be effective (Figure 6), or think that the benefits of the barrier outweighed the problems (Figure 7). These positive evaluations fall off sharply with distance from the highway. About two-thirds of the sample believe the noise barrier is ineffective and that benefits do not outweigh problems. These negative evaluations range from well over half the residents in Zone 1, closest to the highway, to a substantial majority of those living farther away. The share of persons who are "not sure" about the effectiveness or benefits of the barrier wall increases with distance from the highway.

The analysis of responses in subzones within Zone 1 reveals a similar "distance decay" in perceived benefits of the barrier. The share of respondents that consider the barrier to be effective decreased from about half in Subzone 1A, closest to the highway, to about one-quarter in Subzone 1C (Figure 8). In Subzone 1C, about 180 to 270 m from the highway, the positive responses drop sharply

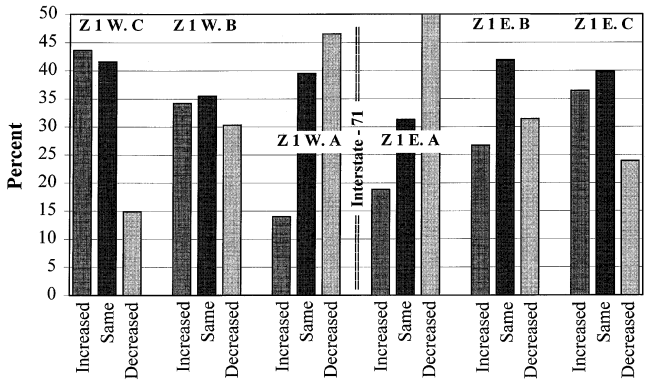

FIGURE 5 Residents' rating of noise level after barrier construction, Zone 1 subzones.

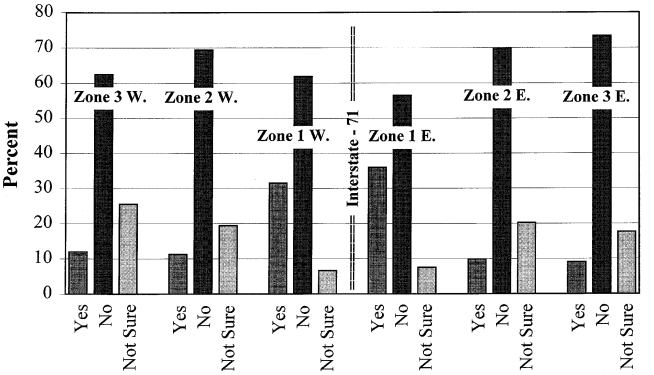

FIGURE 6 Residents' opinion of whether noise barriers effectively reduce traffic noise, by zone.

but are still higher than those in Zones 2 and 3. The respondents living in Subzone 1A are virtually split on whether the benefit of the noise barrier outweighs the disadvantages (Figure 9). The respondents are more negative about the benefits of the noise walls the farther they live from the Interstate. Positive responses are somewhat more common on the east side of the highway than the west side.

As expected, there is a close correlation between responses about the effectiveness of the noise barrier and change in noise level. Almost all those respondents who believe the wall is ineffective also reported that the noise level had increased or remained the same. Similarly, almost all those who believed the benefits of the noise barrier do not outweigh the disadvantages reported an increase, or no change, in the noise level. This correlation among the three questions suggests that there is little, if any, bias in the results due to wording of the questions.

Satisfaction with Wall Appearance

Most of the residents along the highway are displeased with the appearance of the wall (Figure 10). Only about one-quarter of the respondents expressed satisfaction with the appearance of the noise barrier. In general, the share expressing satisfaction tended to decline with distance from the highway. Among residents within Subzone 1A, perceptions were mixed, with only a slightly larger share expressing satisfaction with the appearance of the barrier.

There is a close correlation between responses to appearance and responses to change in noise level. More than three-quarters of those who believe the noise level has increased or remained the same after construction of the noise barrier are dissatisfied with the appearance of the wall. Likewise, almost half of those who believe the noise barrier has reduced the noise level are satisfied with the appearance. Two possible interpretations of this correlation are (*a*) people are more likely to accept the appearance of a structure they believe is effective, or (*b*) people who are displeased with the appearance of the wall are less likely to perceive the positive benefit of noise reduction. Since the distribution of positive responses is not randomly dispersed but is weighted toward residents living closer to the noise barriers, the first interpretation better fits the results.

Noise Barrier Configuration

The zones used for the comparison of survey responses were based primarily on distance *away* from the I-71 roadway centerline.

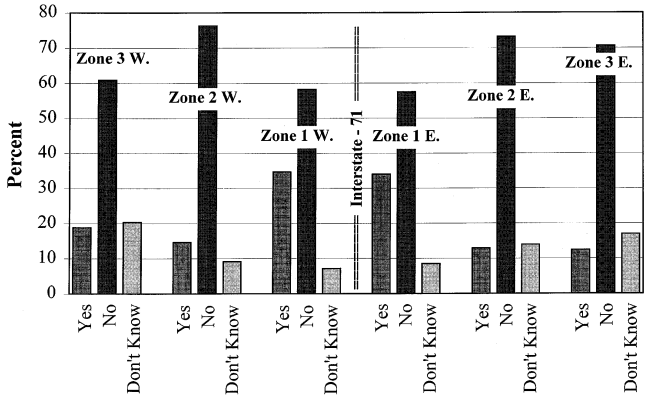

FIGURE 7 Residents' opinion of whether noise barrier benefits outweigh disadvantages, by zone.

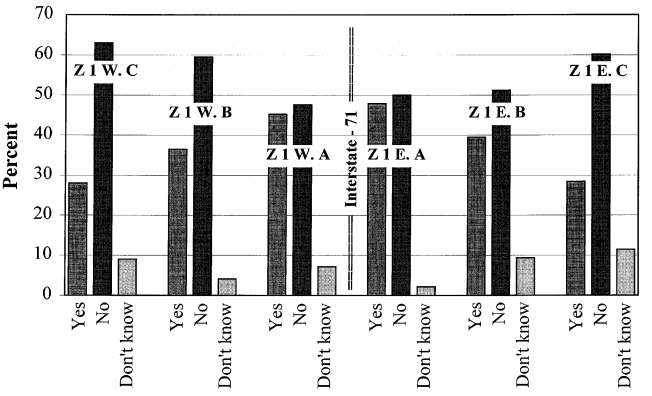

FIGURE 9 Residents' opinion of whether noise barrier outweigh disadvantages, Zone 1 subzones.

Another means of categorizing responses for comparison is to consider areas on selected sections *along* the I-71 centerline. This method was chosen to determine whether differences in response existed from the noise barrier configuration nearest the residents. The following categories were chosen: (*a*) single wall on opposite side of highway from residents, (*b*) single wall on same side of highway as residents, (*c*) parallel walls road fill, and (*d*) parallel walls road cut. Responses were analyzed according to the type of noise barrier configuration affecting the respondents.

It was hypothesized that responses for residents affected by Configuration b would be more favorable than Configuration a, because the respondent has no barrier between the highway and the residence with Configuration a. The analysis indicated that respondents with a single wall on the opposite side of the highway were much more negative on the impact of the wall than were those with a single wall separating them from the highway. Note that this configuration was used only where there were few or no houses near the highway (otherwise a barrier would have been constructed).

The second hypothesis to be tested was that Configuration b would be more favorable than responses in the parallel walls sections of Configurations c and d. Overall, respondents whose houses were located behind the single walls were much more likely to state that the noise level had decreased since the noise barrier was constructed than the respondents whose houses are located behind the sections of parallel walls. A more detailed analysis by zone indicates that there is no significant difference between respondents living behind single or parallel walls who live in Zone 1. In contrast, the residents living in Zones 2 and 3 who are affected by the parallel walls are much more likely to report an increase in the noise level than those who are affected by the single walls. Overall, the respondents living behind the single walls were significantly more positive about the effectiveness of the noise walls than those respondents living behind the parallel walls.

As with the previous question, there is no significant difference between respondents living behind the single or parallel walls in Zone 1 for the similar question regarding "effectiveness of noise barriers." Also, the respondents living in Zones 2 and 3 behind the parallel walls are less likely to report that the noise barrier is effective when compared with the respondents living in Zones 2 and 3 behind the single walls. In the case of the respondents living behind the parallel walls, the farther from the highway the respondent lives, the more negative his or her opinion of the effectiveness of the noise barrier.

For the question of "benefits of the noise walls," there is no significant difference between the two groups of respondents, those living behind the single walls or those living behind the parallel walls. The analysis of this question by zone likewise revealed no significant differences between the single and parallel wall configurations.

Overall, the analysis yields a strong statistical correlation between responses and the barrier configuration. Those residents protected by a single barrier were more likely to hold favorable opinions about the effectiveness of the noise barriers than either those residents protected by parallel barriers or those located in areas with the highway located between them and a single barrier.

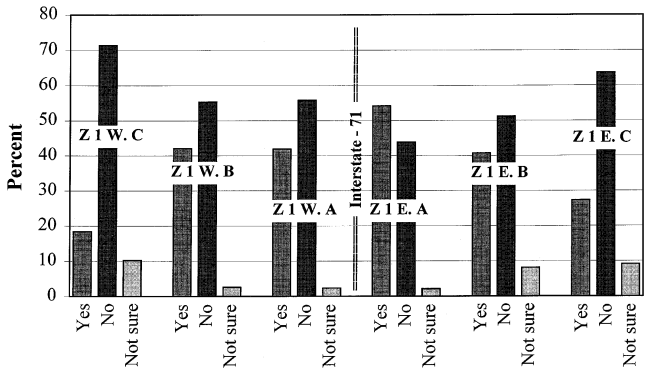

FIGURE 8 Residents' opinion of whether noise barriers effectively reduce traffic noise, Zone 1 subzones.

CONCLUSIONS

The analysis of the opinion survey indicates that resident responses are internally consistent with little or no survey bias. There is a high degree of confidence that the results of this study correctly depict the attitudes and perceptions of the community with regard to noise barrier effectiveness. The following conclusions were drawn from the results:

1. The ratio of respondents reacting positively to the questions about the noise barrier ranged from 1 in 5 to 1 in 7. These respondents generally believe the barrier is effective in reducing the noise level and improving the quality of life in the neighborhood.

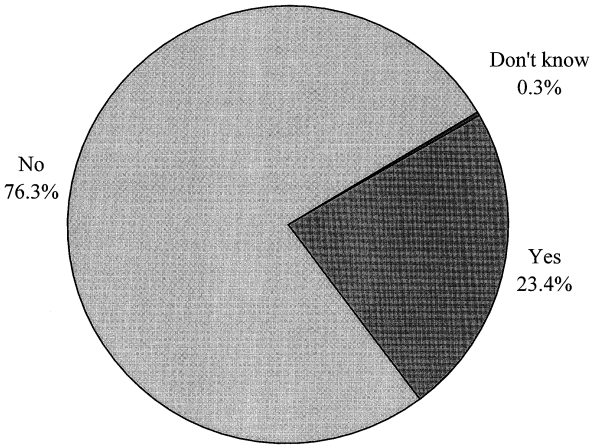

FIGURE 10 Satisfaction with the appearance of noise barriers, all zones.

2. Respondents living closer to the highway are generally more positive in their evaluation of the noise barrier. About half those residents within about 90 m of the highway hold positive views on the utility of the barrier. The percentage of respondents with positive views declines rapidly with distance from the wall, to about 40 percent in the subzone from about 90 to 180 m from the highway, and about 25 percent from 180 to 270 m away.

3. About two-thirds of the resident's sampled reacted negatively to most questions on the effectiveness of the noise barrier. Negative responses are more common beyond a distance of 180 m or so from the highway, where 60 to 80 percent reacted negatively.

4. The majority of the residents who think the barrier has caused the noise level to increase were living in Subzone 1C located from about 180 to 270 m from the highway and in Zone 2, the 270-m-wide corridor immediately beyond Subzone 1C. Beyond the distance of 540 m from the highway, in Zone 3, respondents were somewhat less likely to perceive an increase in noise levels or view the barrier as ineffective.

5. Respondents living at greater distances from I-71 where a single wall had been constructed on the opposite side of the highway were much more negative on the impact of the wall than were those with a single wall separating them from the highway.

6. Overall the analysis yields a strong statistical correlation between responses and the barrier configuration. Those residents protected by a single barrier were more likely to hold favorable opinions about the effectiveness of the noise barriers than either those residents protected by parallel barriers or those in areas with the highway located between them and a single barrier.

7. Most residents in the study area are dissatisfied with the appearance of the noise barrier. Satisfaction with the appearance of the walls is mostly limited to respondents living within 180 m of the walls, where perception of a reduction in the noise level may temper dissatisfaction with appearance.

From these conclusions, it is apparent that a survey limited to the first or second row of residents would have yielded different, even misleading results for this project. Overall, the survey design was found to be an effective means of identifying problems from noise barrier construction as perceived by residents near I-71. Further, the results provide information and direction to the physical and acoustical investigation of the perceived problems.

ACKNOWLEDGMENT

This paper was sponsored by the Ohio Department of Transportation and FHWA.

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Publication of this paper sponsored by Committee on Transportation-Related Noise and Vibration.