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EPA 550/9-77-400

N-22

A Practical Application of Community Noise Analyses; -- Case Study of Allegheny County, Pennsylvania

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February 1977

Prepared for U.S. Environmental Protection Agency
Office of Noise Abatement and Control
Washington, D.C. 20460
by
Department of the Army
Construction Engineering Research Laboratory
P.O. Box 4005
Champaign, Illinois 61820

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER EPA 550/9-77-400	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A PRACTICAL APPLICATION OF COMMUNITY NOISE ANALYSES; -- CASE STUDY OF ALLEGHENY COUNTY, PENNSYLVANIA		5. TYPE OF REPORT & PERIOD COVERED FINAL 6. PERFORMING ORG. REPORT NUMBER CERL-TR-N-22
7. AUTHOR(s) R. J. Goff M. P. Valoski R. E. D'Amato		8. CONTRACT OR GRANT NUMBER(s) IAG #73217EAPE
9. PERFORMING ORGANIZATION NAME AND ADDRESS US ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005 Champaign, IL 61820		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Environmental Protection Agency Office of Noise Abatement and Control Washington, D.C. 20460		12. REPORT DATE February 1977 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

community noise
legislation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is designed to document the technical results of a 2-1/2 year Noise Control Program in Allegheny County, Pennsylvania. While the program consisted of many facets--public education, complaint analysis, community noise survey, publicity, legislation drafting, and public hearings--only the survey and legislation are detailed. First, metrics are selected for describing a

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community noise environment. Specific parameters influencing community noise are evaluated and used to develop a survey methodology. Survey data are presented and analyzed according to such parameters as time of day, noise source, land use, and municipality. Finally, the results are incorporated into community noise legislation.

ACKNOWLEDGMENTS

The following individuals are acknowledged for their efforts toward the noise control program in Allegheny County: T. Henderson, E. Smuts, L. Doerfler, P. Pelkofer, H. Dick, D. Giardino, F. Loefler, S. Rosenback, G. Fehr, and O. Muhonen (all members of the Citizens Advisory Committee); and T. Hartman, K. Wright, J. Duckett, W. Gerhold, and F. Tuplin (Allegheny County staff members).

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SECTION 1. INTRODUCTION

People must be realistic in accepting the fact that noise control is expensive, whether it is to be applied in the workplace or in the community. Government, industry, and the public will all have to make financial expenditures in order for a program to succeed--the government for establishment of the program and the others for compliance with the program--and the more complex and industrialized an area is, the more the program will cost. Thus, if noise control regulations are going to be enacted, it is imperative that they have a firm technical foundation. The reasons are twofold. First, if technology is going to be developed or used to reduce noise to a specific level, then that level must be correct; second, when that legislation is challenged in the courts--and it is inevitable that all environmental noise legislation will be challenged--it must be able to stand up to an extensive legal and technical cross-examination.

During 1973-1976, Allegheny County, Pennsylvania, undertook an extensive Community Noise Program whose end results were to have been such legislation. An integral part of that program was a comprehensive community noise survey to determine present noise levels and to identify major noise sources. The purpose of this report is to document the technical results of both the noise program and noise survey so that the methodology developed will be available as guidelines for future efforts.

Allegheny County, encompassing the City of Pittsburgh and 127 smaller municipalities, is a heavily industrialized area located in southwestern Pennsylvania. Major industries include mining, manufacturing, and trucking, with an emphasis on steel and coal. A number of years ago, Allegheny County pioneered stringent air regulations which were enacted after bitter legal struggles. Although significant progress has been made in cleaning up the air, these regulations are still being contested in the courts. Therefore, despite demands by private citizens and environmental groups for community noise legislation, the local industries were reluctant to submit to additional environmental constraints. Besides the financial considerations, they did not want any more environmental precedents to be established in Allegheny County. For a noise program to survive in this type of atmosphere, any proposed legislation would not only have to be realistic and enforceable, but would als have to have a firm technical foundation for each section. General or nuisance type regulations prohibiting "unnecessary loud noises" would not be effective in this situation.

During the planning stages of the Allegheny County noise program, it was anticipated that noise legislation could be based upon the numerous state and local ordinances already in existence. However, a detailed analysis of these programs indicated that only a handful were funded and even fewer had regulations that were being enforced. Furthermore, the technical documentation for these programs did not seem adequate for an area having both the size and uniqueness of Allegheny County with its 1700 sq kilometers (650 sq miles), 1.5 million people, 3 major rivers, and numerous hills and valleys. In addition, after studying several legal decisions on environmental issues, it was concluded that merely inserting the name "Allegheny County" into an ordinance initially drafted for Chicago or New York would not insure that the document could stand up to either legal or technical cross-examination. It is one goal to merely draft legislation and an entirely different goal to enforce that legislation. Since Allegheny County initially planned to do both, an extensive three-phase program was developed.

The first phase consisted of the county-wide noise survey. In the second phase, legislation was drafted based upon the survey results, presented at public hearings and revised for final adaption. In phase three, an enforcement agency was to have been established. Although the program was terminated before this final phase could be completed, much information was gathered, particularly during the Phase I survey. Besides establishing the technical foundation for the proposed Allegheny County community noise legislation, it also provided a baseline which was to have been used to prevent future increases in the existing acoustic environment.

This report describes the methodology used in the Phase I survey, documents the results, and, perhaps most important, investigates ways to formulate legislation based upon the results of that survey. Its organization is as follows: In Section 2, the existing statistics used in evaluating community noise are detailed and specific metrics for the Allegheny County survey are selected. Section 3 develops methodology needed to gather noise data based upon such considerations as quantity of sites, locations and time of measurements. The actual data recording procedure is outlined in Section 4. The results are analyzed in Section 5 according to such selected parameters as time of day, source, land use, and municipality. In each analysis, techniques were sought to present the data in a format that could be incorporated into legislation. While all the outlined techniques were not applicable to Allegheny County, they were nonetheless documented for possible use in other geographic areas.

The conclusions are listed in Section 6. Finally, selected portions of the proposed noise code are presented in the appendices along with samples of raw survey data.

SECTION 2. STATISTICAL ANALOGY

The dominant characteristic of community noise is its continuous fluctuation with time in a more or less random nature. This is illustrated in Figure 2-1, which shows how the noise at several different locations varies with time during a 2-minute period. The figure also identifies the sources of some of the conspicuous intruding sounds. Notice that in each case, the noise tends to hover around a low amplitude much of the time and that individual events intrude on this level to create peaks.

Next, consider a typical random time-varying pattern of community noise shown in Figure 2-2. The probability that the instantaneous A-weignted sound level lies between the levels L_1 and $L_1 + \Delta$ is given by:

$$P(L_1; L_1 + \Delta L) = \sum_{i=1}^{4} \frac{\Delta ti}{T} = \frac{\Delta ti_1 + \Delta ti_2 + \Delta ti_3 + \Delta ti_4}{T} \qquad (1)$$

Δt = time interval in seconds

T = total duration of signal in seconds, and

L = instantaneous A-weighted sound level

By knowing the percentage of time the A-weighted sound level lies in a narrow range such as ΔL, a probability density curve can be determined. The results may be plotted as a histogram to show the statistical distribution of the levels over the sampling period, i.e., the percent of time the A-weighted sound level spends in each class interval. However, a better statistical presentation of community noise is the cumulative distribution. This is obtained by adding the histogram data to determine the percent of time each A-weighted sound level is exceeded during the sampling period. A typical histogram and cumulative distribution are shown in Fibure 2-3. The various percentile levels do not represent directly measured data, but rather values inferred from the frequency distribution. In addition, the fluctuation of the noise can be determined from the cumulative distribution plot. If the curve is vertical, the noise is constant, while a slope indicates substantial fluctuations.

A community noise environment can be described using three percentile levels from the cumulative distribution in Figure 2-3. These are the levels exceeded 90 percent, 50 percent, and 10 percent of the time, which are designated by symbols L_{90}, L_{50}, and L_{10}.[1,2,3] *

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* Superscripts refer to references on p. 7-1.

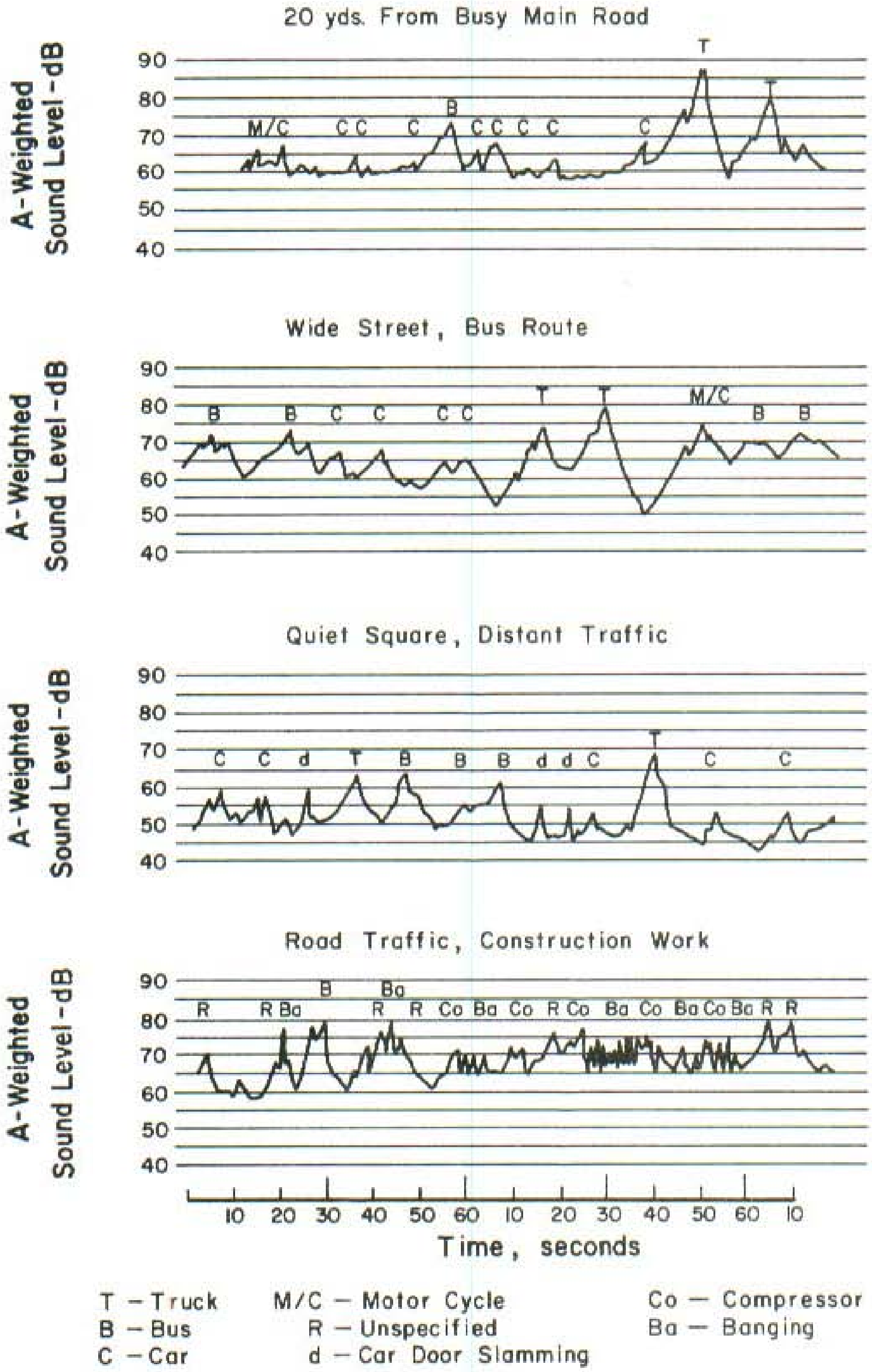

Figure 2-1. Pattern of A-Weighted Sound Levels at Urban Sites[4]

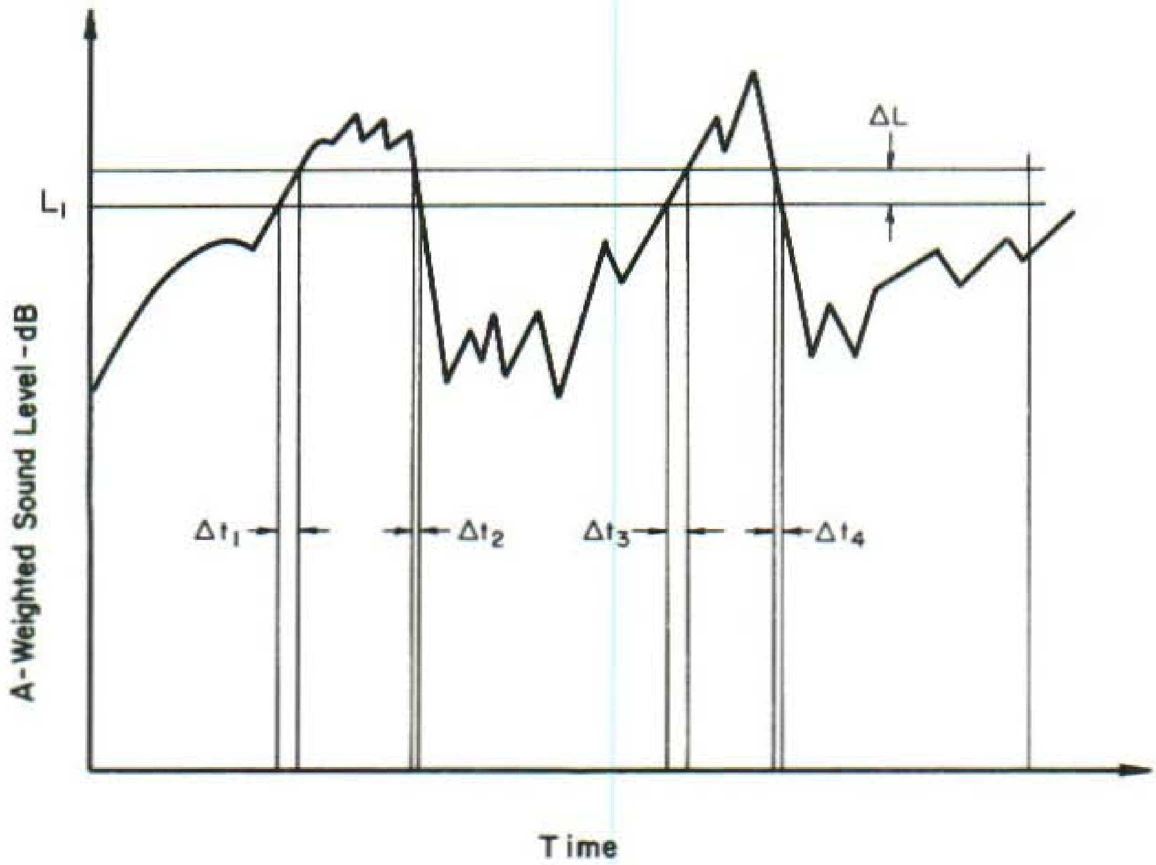

Figure 2-2. Example of the Random Fluctuations of an Urban Noise Signal[5]

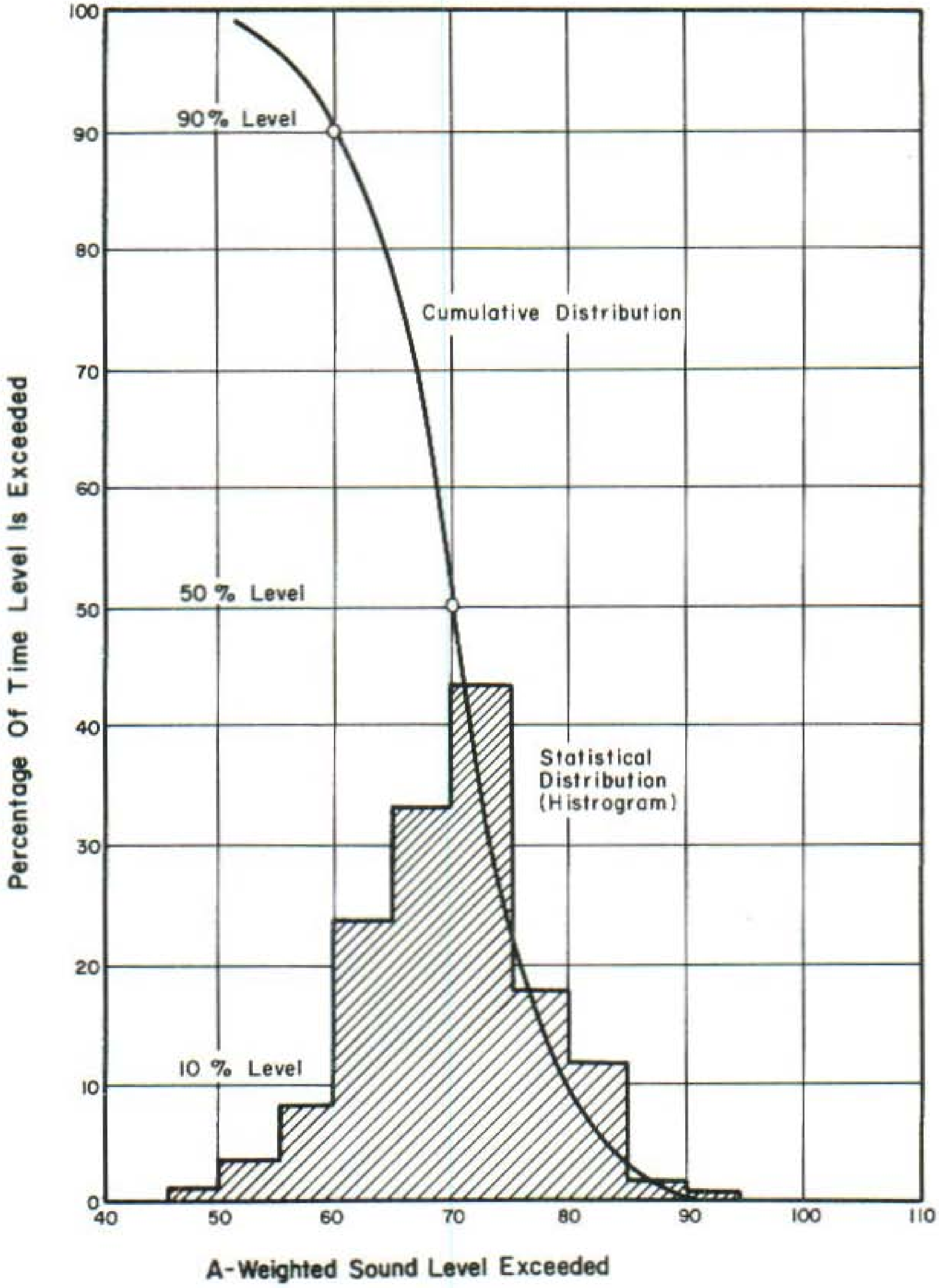

Figure 2-3. Sample Histogram and Cumulative Distribution of A-Weighted Sound Levels[5]

The L_{90} parameter indicates the residual background or ambient level.[6] It represents a low-level, quasi-steady, slowly changing noise for which no single source is identified. The L_{10} and L_{50} levels indicate the effects of the intrusive noise events. These are superimposed on the ambient noise, such as the aircraft overflight intruding a quiet neighborhood. The quantity $L_{10} - L_{90}$ has sometimes been called a measure of the noise climate, since it indicates the range in which noise occurs most (80 percent) of the time.[7] This quantity can be used to determine the fluctuations in the ambient noise and to measure the potential for disturbance. For example, while the sound of that aircraft overflight (L_{10}) is hardly noticeable at a busy intersection where the L_{90} is high, it is very intrusive in a quiet, residential neighborhood where the L_{90} is low.

Perhaps the most accurate parameter used to describe a community noise climate in relation to human response is the equivalent sound level or L_{eq}. This parameter was recommended by the Environmental Protection Agency in Reference 8, and is summarized in Table 2-1. L_{eq} is formulated in terms of the equivalent steady A-weighted sound level which, in a stated period of time, would contain the same noise energy as the time-varying noise during the same period. The mathematical definition of L_{eq} for a signal occuring between two points in time, t_1 and t_2, is:

$$L_{eq} = 10 \text{ Log } \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} \frac{p^2(t)}{Po^2} \, dt \right] \quad (2)$$

where: $p(t)$ is the time-varying A-weighted sound level and
Po is a reference pressure taken as 20 micropascals

When the noise exposure in a community has a level distribution that approximates a normal or gaussian distribution, the L_{eq} can be described in terms of the L_{50} value and standard deviation, s:

$$L_{eq} = L_{50} + 0.115s^2 \quad (3)$$

Also, for the normal distribution, the L_{10} value can be specified in terms of the L_{50} value and standard deviation, s:

$$L_{10} = L_{50} + 1.28s \quad (4)$$

Combining equations 3 and 4 yields:

$$L_{10} - L_{eq} = 1.28s - 0.115s^2 \quad (5)$$

Table 2-1

Yearly Average Equivalent Sound Levels Identified as Requisite to Protect the Public Health and Welfare[8]

	Measure	Indoor: Activity Interference	Indoor: Hearing Loss Considerations	Outdoor: Activity Interference	Outdoor: Hearing Loss Considerations
Residential with Outside Space and Farm Residences	L_{dn}	45	--	55	--
	$L_{eq(24)}$	--	70	--	70
Residential with no Outside Space	L_{dn}	45	--	--	--
	$L_{eq(24)}$	--	70	--	--
Commercial	$L_{eq(24)}$	*	70	*	70
Inside Transportation	$L_{eq(24)}$	*	70	--	--
Industrial	$L_{eq(24)}$	*	70	*	70
Hospitals	L_{dn}	45	--	55	--
	$L_{eq(24)}$	--	70	--	70
Educational	$L_{eq(24)}$	45	70	55	70
Recreational Areas	$L_{eq(24)}$	*	70	*	70
Farm Land and General Unpopulated Land	$L_{eq(24)}$	--	--	*	70

* Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity.

from which can be deduced

$$L_{eq} = L_{10} - 2 \text{ dBA}, \qquad (6)$$

which has an accuracy within $\pm$ 2 dB for $0 \leq s \leq 11$.

Another recommended community noise descriptor is the day-night A-weighted sound level or L_{dn}. This parameter, which is also listed in Table 2-1, is defined as the equivalent A-weighted sound level during a 24-hour time period with a 10-decibel weighting applied to the equivalent sound level during the nighttime hours of 1000 to 0700. The mathematical expression is:

$$L_{dn} = 10 \log_{10} \left[\frac{1}{24} \left[15(10^{L_d/10}) + 9(10^{(L_n+10)/10})\right]\right] \qquad (7)$$

where: $L_d = L_{eq}$ for daytime hours (0700-2200)

$L_n = L_{eq}$ for nighttime hours (2200-0700)

While time constraints prevented gathering enough information to apply L_{dn}, the other statistical parameters, L_{10}, L_{50}, L_{90}, and L_{eq} were used in the following sections to define the acoustical environment of Allegheny County.

SECTION 3. METHODOLOGY*

In any community, the noise levels and their corresponding statistical parameters will form certain spatial and temporal patterns. These are affected by such activities as traffic flow, construction, industrial operations, etc. Therefore, any attempt to describe a community noise environment must consider these and a number of other physical quantities related to the noise sources. As a result, the methodology for the Phase I survey had to make the following determinations in order to obtain data which were both statistically reliable and representative of the noise climate in Allegheny County.

1. Type of frequency weighting
2. Number of measurement sites
3. Location of measurement sites
4. Frequency of measurements at each site
5. Zoning/land use
6. Effect of various factors on sound propagation and attenuation

3.1 Type of Frequency Weighting

For many sounds, particularly those with broadband spectra and no prominent pure tones, the A-weighted sound level is as good as more complicated ratings for measuring a subjective response. These dB levels can also be measured directly in the field with a small inexpensive instrument or taped on a magnetic recorder for analysis at a future date. It is for these reasons that the A-weighted level was chosen as the basic measure of community noise.

3.2 Number of Measurement Locations

In order to determine the spatial variations of A-weighted sound levels in Allegheny County, a finite number of measurements had to be taken. To accomplish this a sampling area called the basic spatial sampling unit or BSSU was defined. The BSSU selected for this analysis was a two-dimensional square encompassing an area of 3.1 sq kilometers (1.2 sq miles); this size was sensitive to changes in noise levels produced by high-speed expressways, aircraft flight paths, or other localized (moving or

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*This methodology was developed directly from Reference 5.

stationary) sources of noise.[5] The division of Allegheny County into these BSSU's is illustrated in Figures 3-1 and 3-2. In Figure 3-1, the county is divided into rectangles with dimensions of 13.6 X 9.6 kilometers (8.5 X 6 miles). Each rectangle corresponds to the USGS* 880 series map and contains two 4-digit numbers. The first two digits represent a specific 880 series map number; the second two represent the range of BSSU's within each rectangle. (Each rectangle contained 35 BSSU's). The 659 individual BSSU's comprising the entire county are detailed in Figure 3-2. As an illustration, BSSU #2501 represents the first BSSU in USGS 880 series map #25. Similarly, BSSU #0835 represents the 35th BSSU in USGS 880 series map #08.

The number of measurement locations required within each BSSU is directly related to the homogeneity of the area with respect to the type, number, location, and distribution of noise sources. For example, consider the extreme case of the Mohave Desert and an area such as the City of Pittsburgh. On the desert where the noise levels are steady, one site would adequately represent the noise climate of many square miles. In Pittsburgh, one measurement location would most likely be representative of a very small localized area.

For this survey, 25 sites per BSSU were used inside the City of Pittsburgh, and 16 sites per BSSU were used for the rest of the county. The number 25 was determined from Reference 5, which assumed that the L_{90} A-weighted sound level was normally distributed between measurement locations, that the standard error was 5 dB for 95 percent confidence, and that the average L_{90} A-weighted sound level would be accurate within $\pm$ 2 dB. The number 16 was an adjustment after the City of Pittsburgh had been completed in order to expedite the survey.

3.3 Location of Measurement Sites

After the number of measurement sites was determined, each BSSU was divided into a corresponding number of sampling elements by using a square grid pattern with lines spaced at equal intervals. The actual measurement locations were placed at the geometric center of each sampling element or as close as possible to the intersection of two streets. If there was no developed land in the sampling unit, a measurement was not taken. The advantage provided by this system was that the location of the resultant grid intersection points would be independent of any bias while providing a maximum of different locations. A BSSU with 25 sampling elements and 25 measurement locations is shown in Figure 3-3.

*United States Geographical Survey

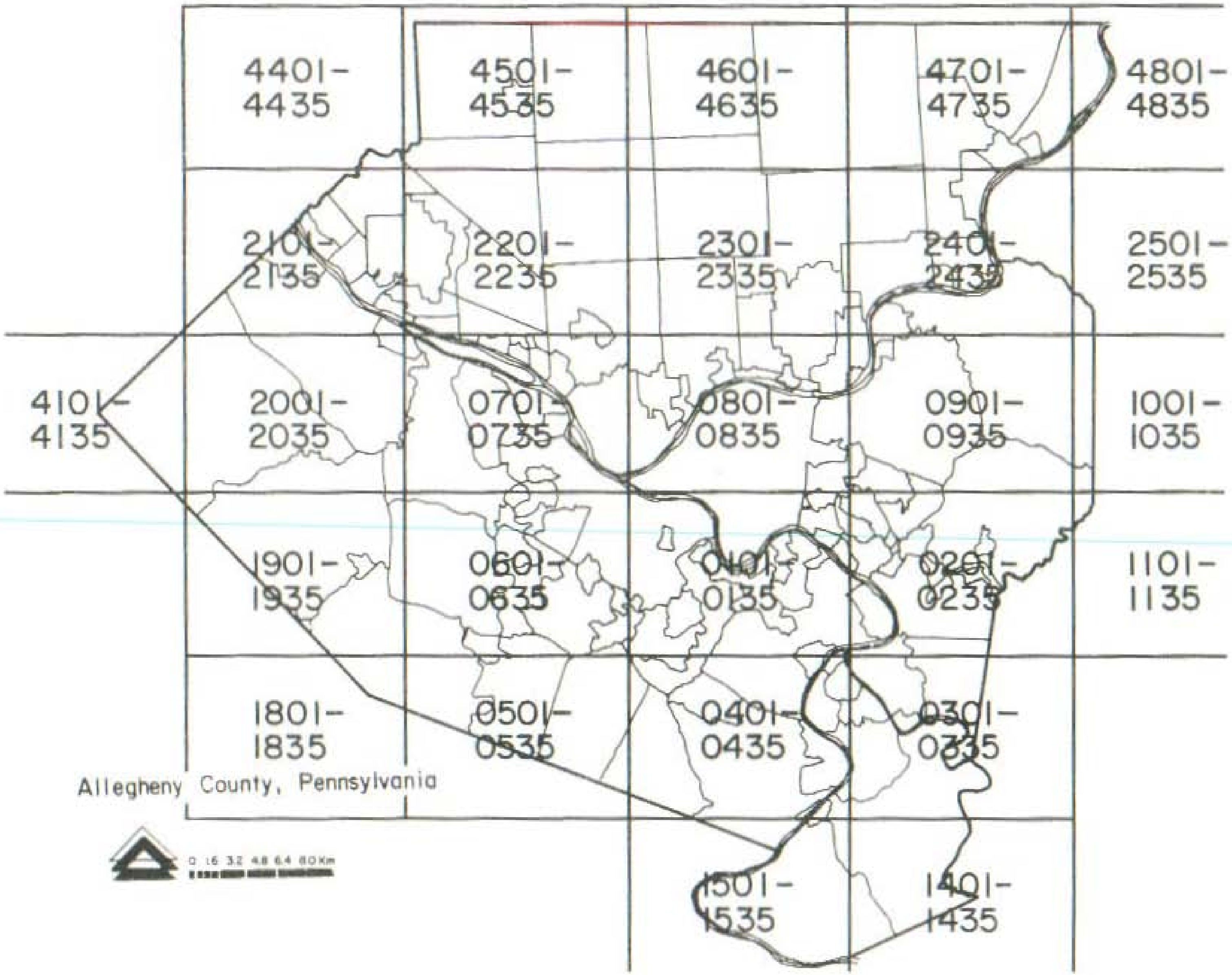

Figure 3-1. Division of Allegheny County Into USGS Rectangles

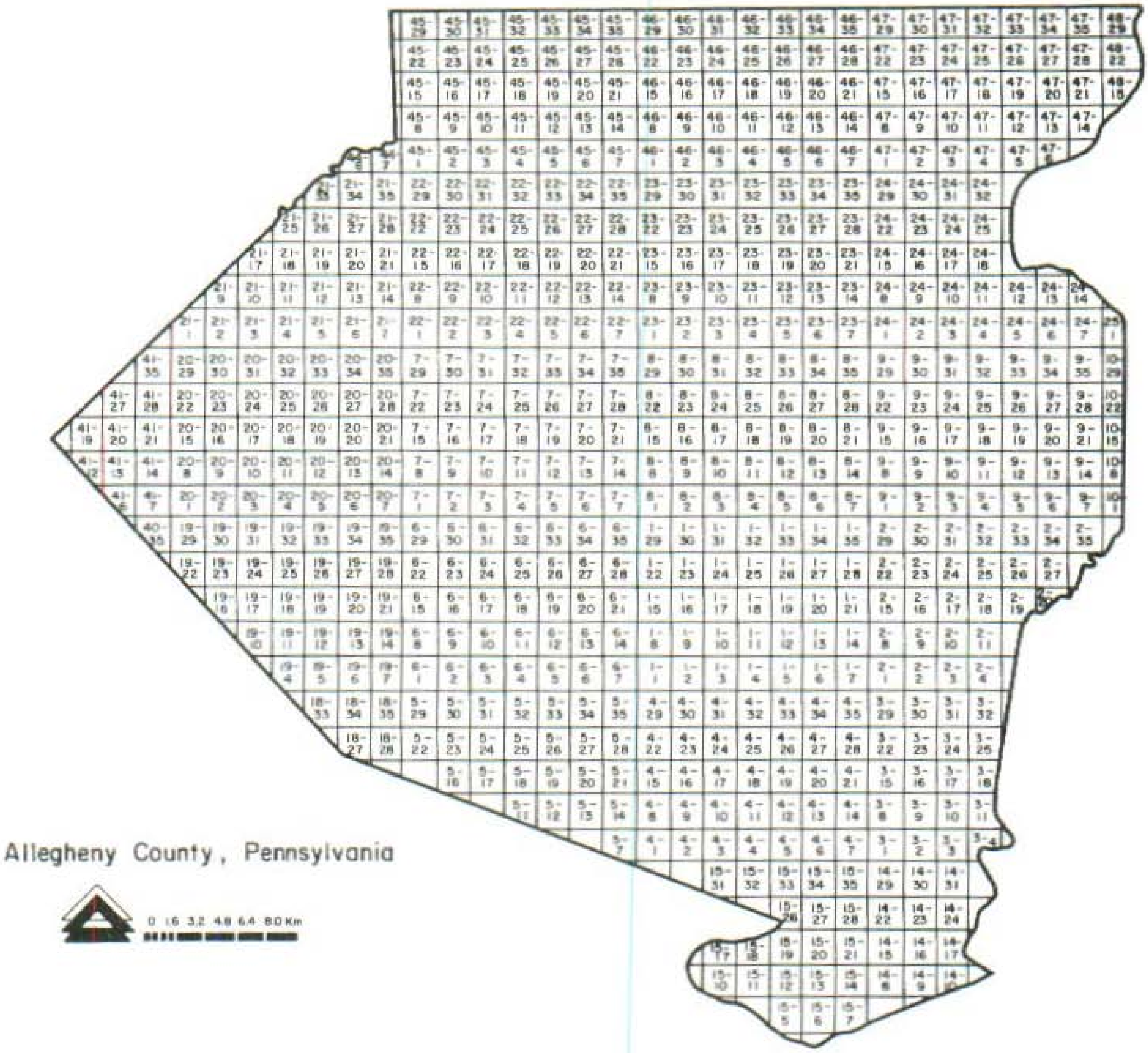

Figure 3-2. Individual BSSU's of Allegheny County

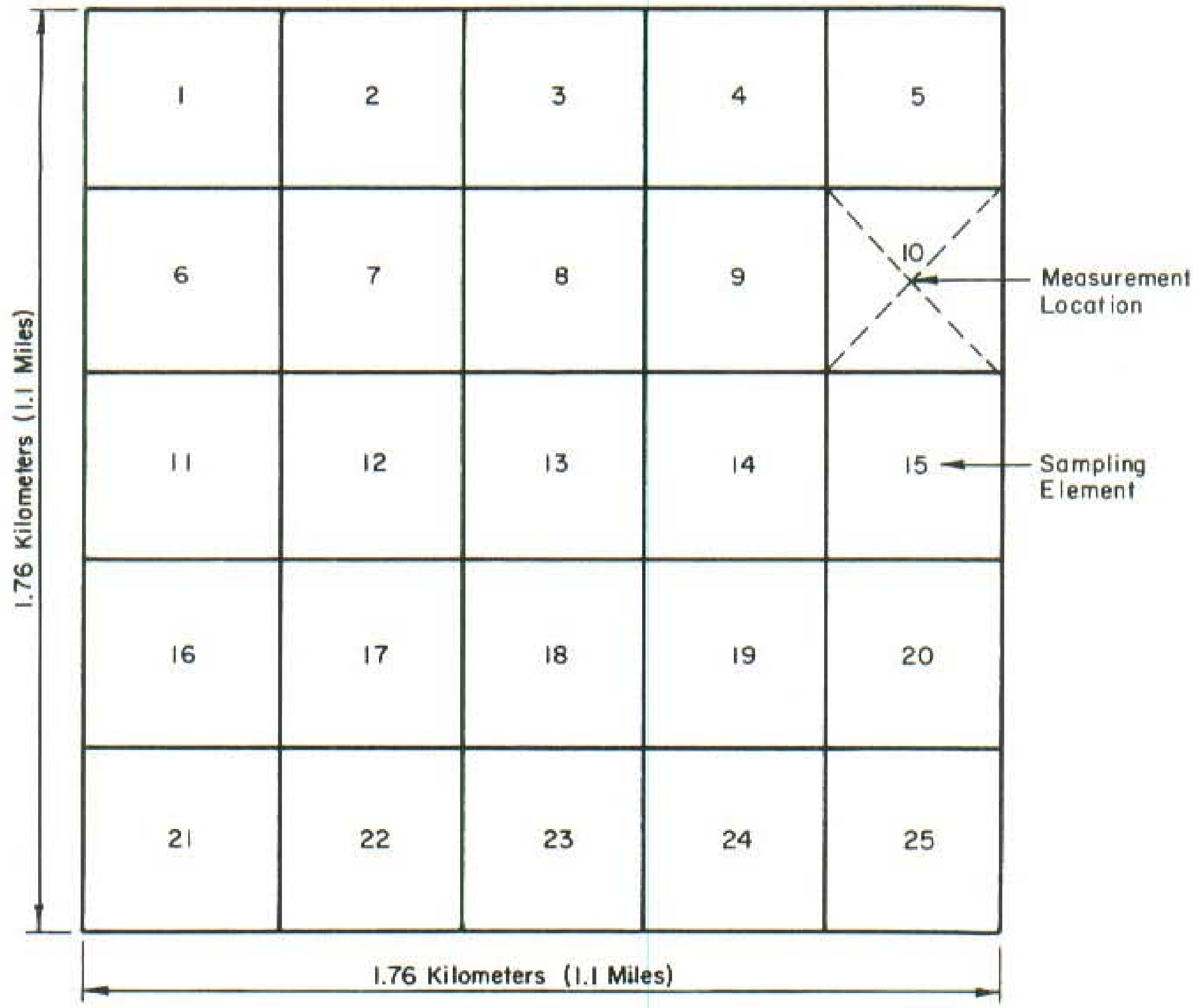

Figure 3-3. Sampling Elements for BSSU Used in Allegheny County Survey

3.4 Frequency of Measurements

The required frequency and length of measurements is a function of the temporal distribution of the A-weighted sound levels. Previous investigations have shown that low levels generally occur in the early morning hours, rise to a high daytime level, and fall off slowly in the evening to a low nighttime level.[1,4,9] This trend is illustrated in Figure 3-4. In addition, there may also be daily differences, particularly between weekdays and the weekend. Nevertheless, because continuous recording over a large area for a number of days would be too time-consuming and costly, some type of sampling had to be performed.

First, since realistic environmental standards could be established using worst-case conditions, a single measurement taken during the weekday between the hours of 0800 and 1700 would be used to define the noise climate of a given site.* Next, the length of this single measurement had to be determined. If the A-weighted sound levels were constant, then a few seconds duration would be adequate. Conversely, for completely random levels, a more lengthy recording would be required.

Finally, a sampling technique had to be selected. There are many schemes which usually involve one X-minute sample, where X is less than 60 minutes. One specific technique is "time compression sampling," achieved by construction an X-minute sample from a series of subsamples of shorter duration. For example, a 10-minute sample (600 seconds) can be constructed by using:

- 600 1-second subsamples, or
- 200 3-second subsamples, or
- 120 5-second subsamples, or
- 60 10-second subsamples

All of these schemes are based on the assumption that the statistical distribution of the A-weighted sound levels obtained from the X-minute sample is representative of the distribution which would be obtained from continuous sampling of the full 60-minute period.

For this survey a 10-minute tape recording was made at each measurement location and later analyzed using 6000 1/10-second subsamples. The 10-minute length was

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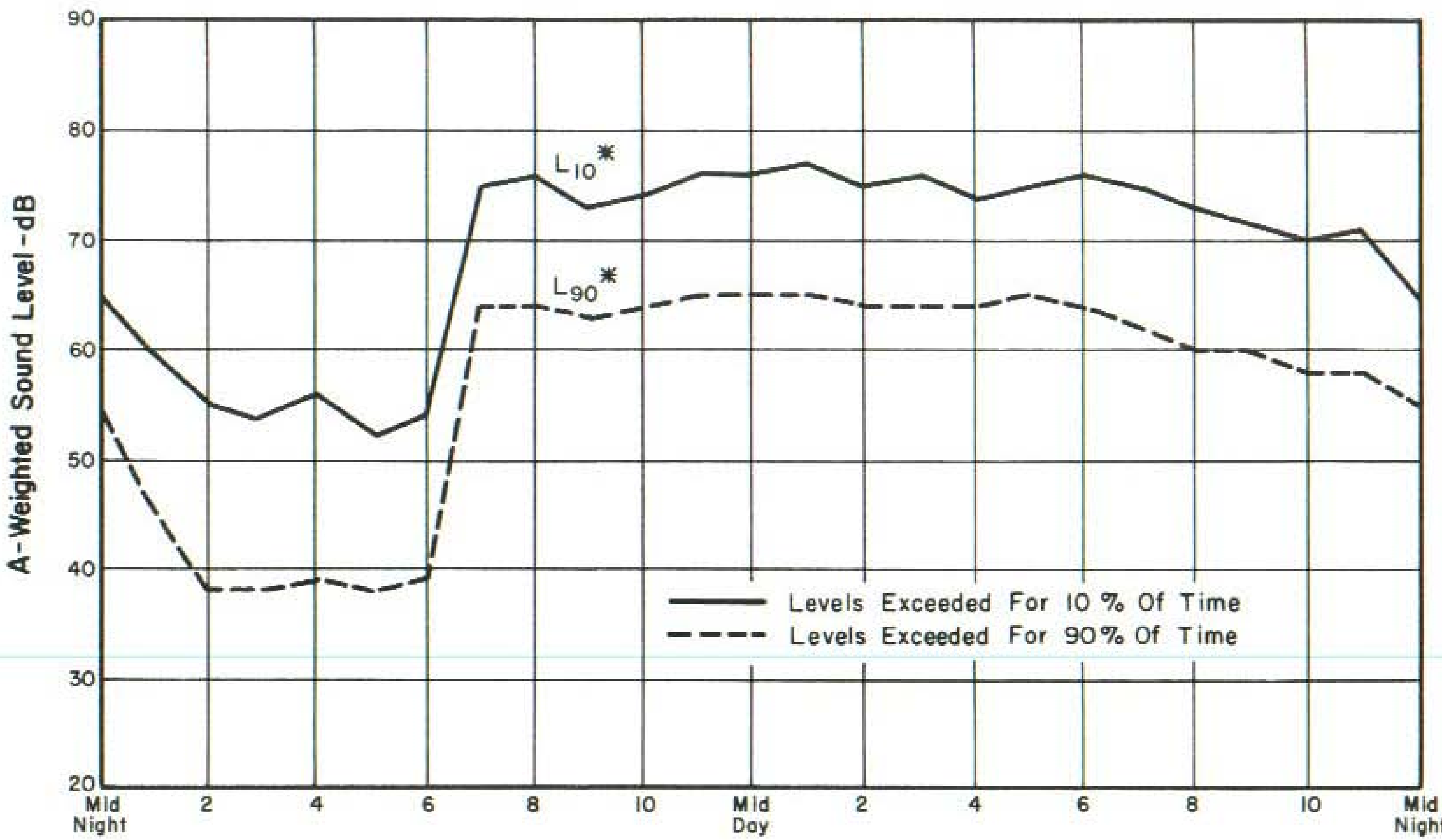
*In general, community noise legislation establishes maximum permissible A-weighted sound levels. In order to be compatible with the existing environment, the standards could be based on worst-case conditions. Thus, levels measured during the high noise period between 0800 and 1700 hours can be used as a basis for legislation. Since these levels are somewhat constant during this period, as indicated in Figure 3-4, it was decided that a single measurement would give adequate information on which to set standards.



* L_{10} and L_{90} A-Weighted Sound Levels were determined for each hour of the day.

Figure 3-4. Pattern of A-Weighted Sound Levels at Urban Site Over a 24-Hour Period[4] chosen so that the maximum land area could be surveyed while still obtaining somewhat reliable data. The 6000 1/10-second subsamples provided maximum use of the information of each magnetic recording. The resulting data would later by extrapolated to define the noise climate for the entire 0800 to 1500 time period.

3.5 Zoning/Land Use

Since attempts to control noise in Allegheny County were to be accomplished partially through regulations specifying maximum A-weighted sound levels along zone property lines, the existing noise environment in each zone had to be determined. However, before the methodology could be expanded into this area, the present zoning had to be defined. Allegheny County consists of 128 separate municipalities including the City of Pittsburgh, each with its own unique zoning ordinance. Therefore, consolidated county-wide zoning criteria were established, consisting of the classifications listed in Table 3-1.

3.6 Effect of Various Factors on Sound Propagation and Attenuation

Any program to measure, analyze, and eventually control noise requires at least a basic understanding of the effects of sound propagation and attenuation. This section will briefly discuss how the propagation of airborne sound from the source to a receiver is affected by the physical environment and other factors such as meteorological conditions. These factors may be acoustically significant and must be considered in any comprehensive urban noise survey. This section is directly quoted from Reference 5.

- Air Absorption

The absorption of airborne sound due to viscosity, heat conduction, diffusion, and radiation generally referred to as classical absorption is not significant in the frequency range of interest.

- Meteorological Factors

The most important meteorological factors that affect sound transmission outdoors over open, level terrain are air temperature and wind velocity. They cause variations in the measured levels as a function of time and space. At relatively short distances, usually less than 1.6 kilometers (1 mile), normal variations in atmospheric conditions have little effect. At greater distances, the effects are much more significant. The effects generally cause the measured levels to be less than the expected theoretical values due to distance alone. These effects are frequency dependent, with the greatest variations occurring in the higher frequencies. For example, the attenuation will range from less than 0.1 dB per 300 meters (1000 feet) at 31.5 Hz to 2.6 dB per 300 meters (1000 feet) at 8000 Hz at a temperature of 20 degrees C (68 degrees F) and 50 percent relative humidity at normal atmospheric

Table 3-1

Allegheny County Consolidated Zoning

Classification	Symbol	Definitions
Low-density residential	R1	One- and two-family residences with at least a 3 meter (10 foot) separation between buildings
High-density residential	R3	Multifamily residences, apartments, or homes within 3 meter (10 feet) of each other
Farmland	R5	
Airport expansion	R8	Former residential land purchased for the airport expansion
Commercial	C3	Structures used primarily for the sale of merchandise or for the performance of service, or for office and clerical work
Central business district	C5	Central business district
Light industrial	M1	Operations conducted entirely within an enclosed building
Heavy industrial	M4	Operations conducted outside or in semi-enclosed building
Strip mining	M6	
Airport	M8	
Special	SP	Parks, recreation areas, undeveloped land
Institutional	1C	Universities
Institutional	1M	Hospitals

pressure. This attenuation is in excess of the loss due to spherical divergence, which is 6 dB for each doubling of the distance from the source.

- Effect of Terrain

Sound propagation along the ground depends upon the surface roughness, the type of surface, and the topography. The acoustic impedance of a hard reflecting surface (e.g., concrete or asphalt) is very high, but for all practical purposes, the attenuation due to surface absorption is considered negligible in practice. However, ground attenuation depends upon the proximity of the propagation path to the ground, the distances involved and the elevation angle of the source.

- Effect of Precipitation

The effect of precipitation in the form of fog, drizzle, or snow on the attenuation of sound has not been studied extensively. From the limited data available, the excess attenuation caused by precipitation appears to be negligible. However, air saturated with moisture will propagate sound at a velocity faster than dry air. When sound is propagating through a medium with some precipitation present, consideration should be given to the effect on the noise when the microphone is located near the ground; the measured levels may increase appreciably. Under snow conditions, the levels may be effectively muffled. For example, when wet or snow-covered, the roadway surface directly affects tire noise. Snow tires on automobiles produce higher levels at highway speeds than conventional tires.

- Effect of Barriers

The attenuation due to an acoustical barrier, e.g., a depressed highway in a cut or an elevated embankment, must be known in order to predict traffic noise levels at a measurement location. The wavelengths of sound in the frequency range of interest are generally comparable to the physical dimensions of barriers normally encountered in urban areas. The attenuation of noise will be increased under the following conditions.

a) the higher the frequency of the noise,
b) the closer the barrier is to the source of noise or the receiver,
c) the higher the barrier, and
d) the wider the barrier.

However, the results of the studies indicate there is a limit of 15 dB to 20 dB attenuation that can be obtained in practice.

- Seasonal Effect

There is little information available on how noise levels vary with the time of year. Most previous noise surveys were conducted in the spring, summer or early fall. A seasonal problem that occurs in many areas is noise from insects, e.g., crickets and peepers that raise the higher frequency band ambient levels. Wintertime measurements are difficult to obtain from the point of view of the observer's comfort, and equipment operation in cold environments. Noise surveys are generally conducted at a time of year when the air temperature and relative humidity for the area are near their median values.

The results of one earlier survey indicate that ambient levels in residential areas drop 6 to 8 dB in most octave bands under winter conditions. However, this drop is undoubtedly due to the presence of snow on the road surface and the resultant change in traffic flow conditions. Because of the different character and density of the traffic during winter, traffic noise showed a drop in levels on the order of 5, 10, and 15 dB in the 400 to 800 Hz octave band for light, average, and heavy traffic flow conditions respectively. In many industrial areas, the main reason for reduced ambient levels in winter is due to the closing of factory windows.

While these factors were not studied specifically, it was hoped that the survey results could be applied to many of them in order to build up a wide data base for future studies.

SECTION 4. DATA GATHERING PROCEDURE

Once the methodology had been established, the following procedures were used to gather data. First, zoning maps were prepared for the entire county, which was then divided into BSSU's. Each BSSU was in turn divided into 16 to 25 sampling elements with a corresponding number of measurement locations. The measurement site was placed in the geometric center of each sampling element or as close as possible to the intersection of two streets. Ten-minute, A-weighted measurements were taken at each site; the sites were not sampled in numerical order but rather in a random pattern. The data for each site were then analyzed using 6000 one-tenth second subsamples, and then converted into the L_{90}, L_{50}, L_{10}, and L_{eq} statistical parameters discussed earlier. Schematics of the equipment used to obtain and analyze the data are shown in Figure 4-1.

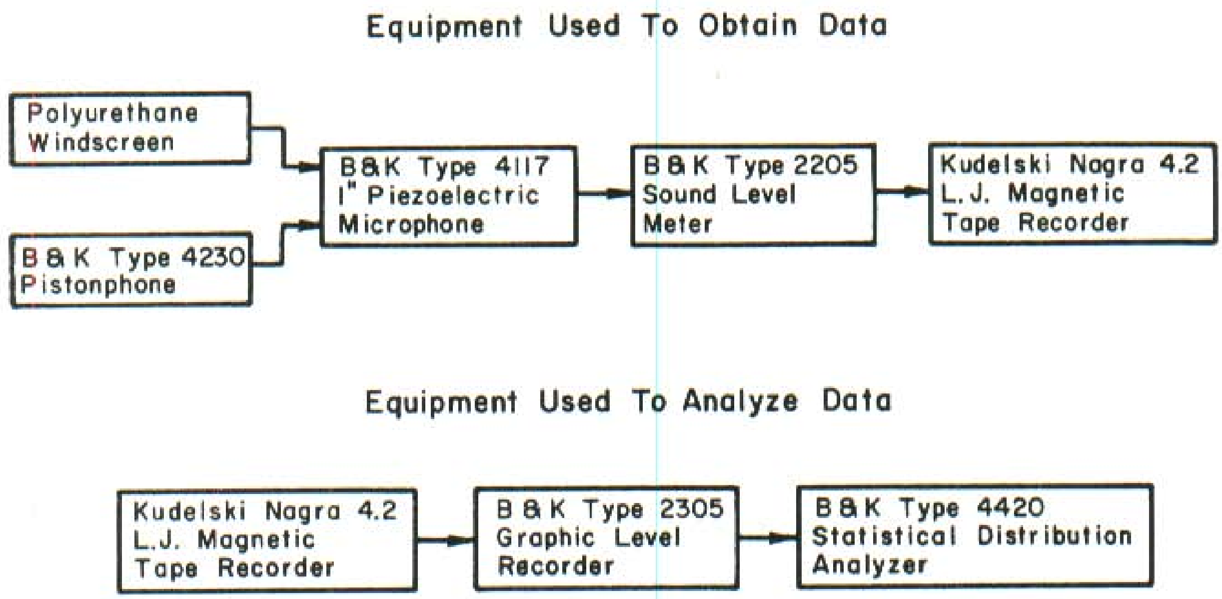


Figure 4-1. Schematic of Data-Measuring and Analyzing Equipment

To catalogue this information, special data sheets were compiled for each BSSU. BSSU 0628 and its corresponding data sheet are detailed in Figures 4-2 and 4-3 respectively. An explanation of Figure 4-3 follows: NO stands for the measurement location. For example, 062801 means the measurement was taken at the first site in BSSU #0628. LOCATION is self-explanatory. BORO represents one of the 128 municipalities comprising Allegheny County in which the site was located. Their specific codes are listed in Table 4-1. All the measurements in this particular BSSU were within the City of Pittsburgh.

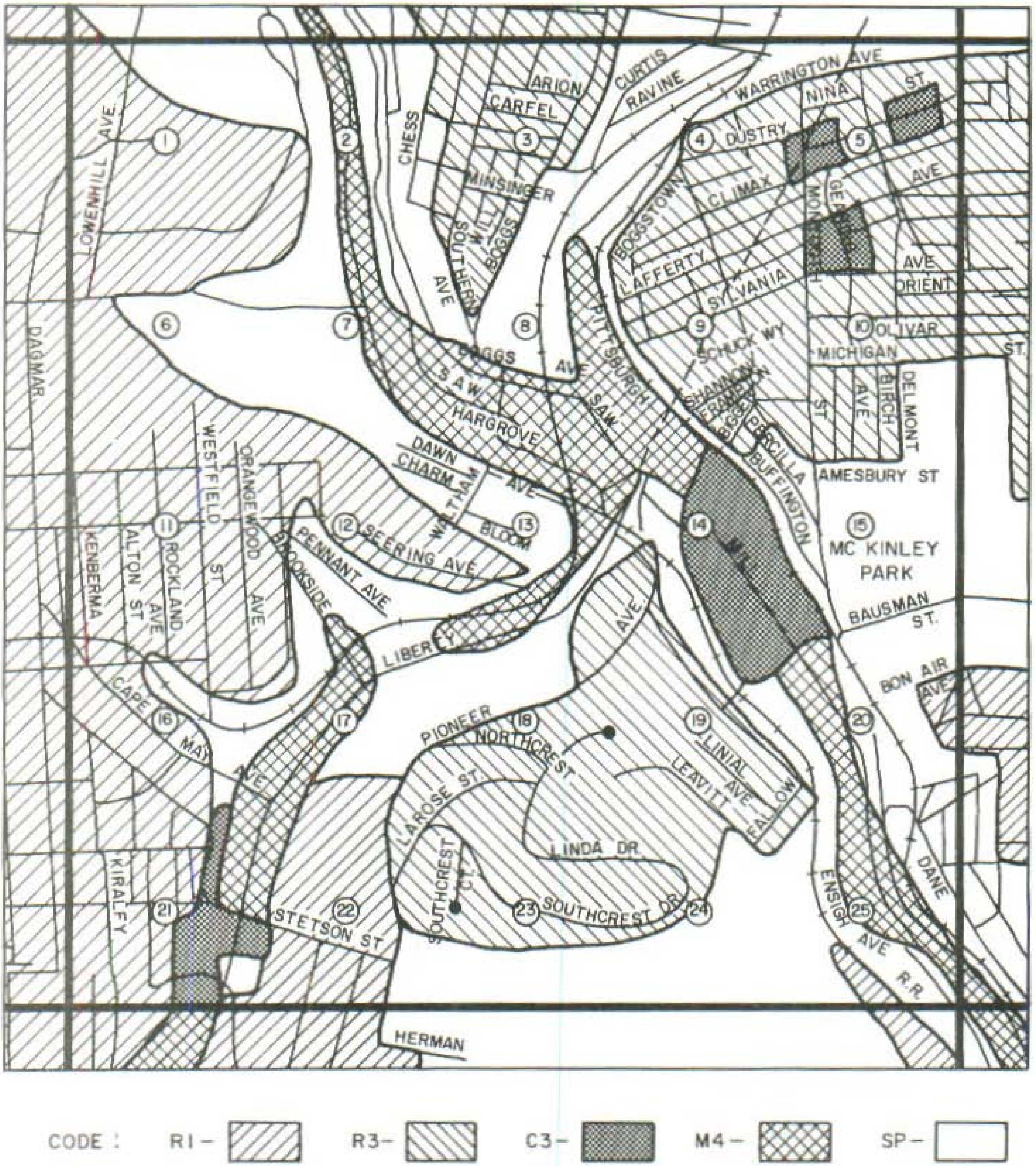


Figure 4-2. Detailed BSSU #0628

NO.	LOCATION	BORO	ZONE	MISC	SOURCES	DATE	TIME	RESULTS		
								L10	L50	L90
062801	LOWENHILL	188	R1SP	01	010204	111573	1442	66	58	55
062802	SAW MILL RUN	188	M4R1SP		01	111673	0903	79	70	63
062803	PECK/WILL	188	R3SP		01	111573	1405	70	59	56
062804	INDUSTRY	188	R3SP		0104	111573	1350	64	60	57
062805	PROXIM	188	R3C3		0111	111573	1340	64	54	51
062806	CRANE	188	SPR1		0102	111573	1430	68	60	53
062807	CRANE	188	SPM4		0104	111573	1419	79	69	61
062808	BOGGS	188	SPR3M4		0103	111573	1303	77	67	59
062809	SYLVANIA	188	R3		01	111673	0953	63	60	58
062810	BOLIVAR	188	R3SPC3		010411	111573	1321	59	54	51
062811	SEBRING/ROCKLAND	188	R1	01	010903	111573	0911	60	52	48
062812	SEBRING	188	R1SP		09	111573	0924	61	54	52
062813	BLOOM	188	SPR1M4		011304	111573	0940	66	63	55
062814	SAW MILL RUN	188	C3SP		01	111573	1250	77	69	64
062815	McKINLEY PARK	188	SP							
062816	CAPE MAY	188	R1SP		010214	111673	0850	69	58	52
062817	LIBERTY	188	M4SPR1		01	111673	0843	79	71	63
062818	NORTH CREST	188	R3SP		010904	111573	1107	54	49	46
062819	LINIAL	188	R3SPM4		011108	111573	1123	58	54	51
062820	SAW MILL RUN	188	SPR1M4		01	111673	0923	76	68	64
062821	FAIRACRES	188	R1C3M4		020304	111573	1006	52	49	46
062822	STETSON	188	R1R3SP		01	111573	1020	66	54	50
062823	SOUTHCREST	188	R3SP		010409	111573	1042	56	49	47
062824	SOUTHCREST	188	R3SP		0104	111573	1053	61	52	48
062825	SAW MILL RUN	188	M4SPR1		0113	111573	1144	80	74	67

Figure 4-3. Field Data Sheet for BSSU #0628

Table 4-1

Municipal Computer Codes

Code	Municipality	Code	Municipality	Code	Municipality
101	Aleppo	144	Fox Chapel	187	Pitcairn
102	Aspinwall	145	Franklin Park	188	Pittsburgh
103	Avalon	146	Frazer	189	Pleasant Hills
104	Baldwin Boro	147	Glassport	190	Plum
105	Baldwin Twp.	148	Glenfield	191	Port Vue
106	Bell Acres	149	Greentree	192	Rankin
107	Bellevue	150	Hampton	193	Reserve
108	Ben Avon	151	Harmar	194	Richland
109	Ben Avon Hts.	152	Harrison	195	Robinson
110	Bethel Park	153	Haysville	196	Ross
111	Blawnox	154	Heidelberg	197	Rosslyn Farms
112	Brackenridge	155	Homestead	198	Scott
113	Braddock	156	Indiana	199	Sewickley
114	Braddock Hills	157	Ingram	200	Sewickley Hts.
115	Bradford Woods	158	Jefferson	201	Sewickley Hills
116	Brentwood	159	Kennedy	202	Shaler
117	Bridgeville	160	Kilbuck	203	Sharpsburg
118	Carnegie	161	Leet	204	S. Fayette
119	Castle Shannon	162	Leetsdale	205	South Park
120	Chalfant	163	Liberty	206	S. Versailles
121	Cheswick	164	Lincoln	207	Springdale Boro
122	Churchill	165	Marshall	208	Springdale Twp.
123	Clairton	166	McCandless	209	Stowe
124	Collier	167	McDonald	210	Swissvale
125	Coraopolis	168	McKeesport	211	Tarentum
126	Crafton	169	McKees Rocks	212	Thornburg
127	Crescent	170	Millvale	213	Trafford
128	Dormont	171	Monroeville	214	Turtle Creek
129	Dravosburg	172	Moon	215	Upper St. Clair
130	Duquesne	173	Mt. Lebanon	216	Verona
131	East Deer	174	Mt. Oliver	217	Versailles
132	East McKeesport	175	Munhall	218	Wall
133	East Pittsburgh	176	Neville	219	West Deer
134	Edgewood	177	N. Braddock	220	West Elizabeth
135	Edgeworth	178	N. Fayette	221	West Homestead
136	Elizabeth Boro	179	N. Versailles	222	West Mifflin
137	Elizabeth Twp.	180	Oakdale	223	West View
138	Emsworth	181	Oakmont	224	Whitaker
139	Etna	182	O'Hara	225	Whitehall
140	Fawn	183	Ohio	226	White Oak
141	Findlay	184	Osborne	227	Wilkins
142	Forest Hills	185	Penn Hills	228	Wilkinsburg
143	Forward	186	Pine	229	Wilmerding

The symbols in the ZONE column are taken from Table 3-2. The first symbol represents the zone in which the measurement was taken; the rest are other zones located within the sampling element. MISC, whose symbols are defined in Table 4-2, lists the noise-sensitive areas in the vicinity of the measurement site. The SOURCE column contains major contributors to the noise levels for that measurement site. This was a subjective analysis, since the sources were determined by the staff taking the measurements. As many as four different sources could be placed in this column with the most important contributor listed first. These codes are defined in Table 4-3.

The DATE and TIME columns are self-explanatory, while the RESULTS include the L_{10}, L_{50}, and L_{90} A-weighted sound levels obtained from the 10-minute noise sample.

In Figure 4-3, which contains data from BSSU #0628, the measurement site 01 was located in Lowenhill Avenue in the City of Pittsburgh (BORO 188). The site was located in a low-density area bordered by undeveloped land (ZONE RISP) in the vicinity of a school (MISC 01). The major source of noise was traffic, although construction and aircraft contributed to the levels (SOURCE 010204). The measurement was taken November 15, 1973 (DATE 111573), at 2:47 p.m. (TIME 1447). The 10-minute sample had 66, 58, and 55 dB as its respective L_{10}, L_{50}, and L_{90} A-weighted sound levels.

After similar data sheets were completed for each of the 659 BSSU's in Allegheny County, a computer was programmed to store this information. A sample of the noise file is contained in Appendix B. Then, using a second program to sort this information, the data could be analyzed according to a number of different parameters. This analysis is detailed in the following sections.

Table 4-2

Noise-Sensitive Area Computer Code

Symbol	Area
01	Schools
02	Hospitals
03	Churches
04	Nursing Homes

Table 4-3

Noise Source Computer Code

01	Traffic	13	Industrial	25	Shoveling Snow
02	Construction	14	Trees	26	Transformer
03	Dogs	15	Garbage Col.	27	Boat Whistle
04	Planes	16	Rain	28	Idling Truck
05	Trains	17	Church Bells	29	Boat
06	Lawn Equipment	18	Industrial Sirens	30	Idling Trains
07	Leaf Comp.	19	Radios & TV	31	Airport Operations
08	Emer. Sirens	20	Street Cars	32	Farm Equipment
09	Birds	21	Raking Leaves	33	Gunshots
10	Crickets	22	Running Water	34	Thunder
11	People	23	Power Saws	35	Minibikes
12	Air Cond.	24	Pumps (oil, gas, etc.)		

SECTION 5. RESULTS

The Allegheny County community noise survey had two main objectives which somewhat established guidelines for the analysis procedure. The first was the evaluation of the existing acoustic environment; the second the development of the technical foundation for community noise legislation.*

As a result of the specific methodology used, a massive amount of data was obtained--over 700 sites were surveyed with such information as A-weighted sound level, major sources, location, time, and date recorded for each. In order to put this information into a workable format, the noise survey data were sorted and analyzed according to the specific parameters listed below:

- BSSU
- Hour
- Source
- Zoning/Land Use
- Noise Sensitive Area
- Municipality

Since prototypes of this specific program and objectives were not available, the outcome could not be anticipated. Consequently, not all the results could be used for this particular piece of legislation. Some parameters produced information that could be directly incorporated into the proposed regulation, while others produced only interesting numbers. Nonetheless, the results of each analysis are discussed in the following section along with their impact on the proposed regulations.

5.1 Results of BSSU Analysis

Figure 5-1 shows the computer analysis for BSSU #0628 whose data sheet was discussed in the previous section. Measurements were taken at 24 sites within the BSSU, and for each site, L_{10}, L_{50}, and L_{90} A-weighted sound levels were obtained. Cumulative distributions were then formed for the 24 L_{90} values and the following statistical calculations were made:

NUMBER. The number of records processed.

$$n = 24 \qquad (8)$$

* Selected sections of the proposed Allegheny County community noise legislation are presented in Appendix A.

MIDPOINT	LEVEL - 1 NO.	DIST	LEVEL - 10 NO.	DIST	LEVEL - 50 NO.	DIST	LEVEL - 90 NO.	DIST
26	0	.0	0	.0	0	.0	0	.0
29	0	.0	0	.0	0	.0	0	.0
32	0	.0	0	.0	0	.0	0	.0
35	0	.0	0	.0	0	.0	0	.0
38	0	.0	0	.0	0	.0	0	.0
41	0	.0	0	.0	0	.0	0	.0
44	0	.0	0	.0	0	.0	0	.0
47	0	.0	0	.0	0	.0	5	20.8
50	0	.0	0	.0	3	12.5	4	16.7
53	0	.0	2	8.3	7	29.2	3	12.5
56	0	.0	1	4.2	0	.0	4	16.7
59	0	.0	3	12.5	6	25.0	2	8.3
62	3	12.5	3	12.5	1	4.2	3	12.5
65	2	8.3	5	20.8	0	.0	2	8.3
68	2	8.3	2	8.3	4	16.7	1	4.2
71	3	12.5	1	4.2	2	8.3	0	.0
74	3	12.5	0	.0	1	4.2	0	.0
77	1	4.2	2	8.3	0	.0	0	.0
80	2	8.3	5	20.8	0	.0	0	.0
83	1	4.2	0	.0	0	.0	0	.0
86	4	16.7	0	.0	0	.0	0	.0
89	3	12.5	0	.0	0	.0	0	.0
92	0	.0	0	.0	0	.0	0	.0
95	0	.0	0	.0	0	.0	0	.0
98	0	.0	0	.0	0	.0	0	.0
NUMBER	24.0		24.0		24.0		24.0	
SUM	1,816.0		1,606.0		1,427.0		1,317.0	
MEAN	75.7		66.9		59.5		54.9	
SUM2	139,484.0		109,226.0		86,221.0		73,189.0	
S1	2,073.3		1,757.8		1,374.0		918.6	
S2	90.1		76.4		59.7		39.9	
S	9.5		8.7		7.7		6.3	
ERR-99	5.5		5.0		4.5		3.6	
ERR-95	4.0		3.7		3.3		2.7	
ERR-90	3.3		3.1		2.7		2.2	

COMPUTED L EQUIVALENT --- 63.343

Figure 5-1. Computer Analysis for BSSU #0628

SUM The total value of all records

$$SUM = \Sigma x_i = x_1 + x_2 + x_3 \ldots + x_n \quad (9)$$

MEAN The value of SUM divided by the number of records

$$MEAN = SUM/NUMBER = \Sigma x_{i/n} = u \quad (10)$$

SUM 2 The total value of each level result squared

$$SUM\ 2 = \Sigma x_i^2 = x_1^2 + x_2^2 + x_3^2 + \ldots + x_n^2 \quad (11)$$

S1 The value of SUM 2 minus the MEAN squared times the number of records.

$$S1 = SUM\ 2 - \mu^2 n = \Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n} \quad (12)$$

S2 The value of S1 divided by the number of records less one.

$$S2 = S1/(n-1) = [\Sigma x_i^2 - \frac{(x_i)^2}{n}]/n-1 \quad (13)$$

S The square root of the value of S2

$$S = \sqrt{S2} = \sqrt{S1/(n-1)} \quad (14)$$

$$ERR - 99^* = (S \times t_{99})/\sqrt{n-1} \quad (15)$$

t_{99} = value exceeded in both directions with a probability of .01 in a student t distribution with n degrees of freedom

$$ERR - 95^* = (S \times t_{95})/\sqrt{n-1} \quad (16)$$

t_{95} = value exceeded in both directions with a probability of .05 in a student t distribution with n degrees of freedom

$$ERR - 90^* = (S \times t_{90})/\sqrt{n-1} \quad (17)$$

t_{90} = value exceeded in both directions with a probability of .10 in a student t distribution with n degrees of freedom

After these calculations were repeated for the L_{50} and L_{90} parameters, the L_{eq} level was obtained using equations 18 and 19 which were developed from equations 3 through 6.

$$s = (\bar{L}_{10} - \bar{L}_{50})/1.28 \quad (18)$$

$$L_{eq} = \bar{L}_{50} + .115\ s \quad (19)$$

* From these error values, confidence intervals could be established. In this particular BSSU, the mean L_{90} A-weighted sound level with a 90 percent confidence interval was 54.9 ± 2.2 dB . Thus, if the measurement were repeated 100 times, the mean L_{90} A-weighted sound level would fall between 57.1 and 52.7 dB 90 times.

where: $\overline{L}_{10}$ = Mean or average L_{10} A-weighted sound level in BBSU

$\overline{L}_{10}$ = Mean or average L_{10} A-weighted sound level in BBSU

The entire procedure was repeated for each of the 659 BSSU's in Allegheny County. The results of the computation are shown in Figure 5-2. As this figure presented a current evaluation of the noise environment, it was used to formulate the anti-degradation section of the proposed legislation.* This section establishes "ambient" noise standards using the same reasoning behind the development of the ambient air standards.

While the range of A-weighted sound levels for measurement locations within each individual BSSU was small, the range of average levels from one BSSU to another was large, as indicated by the numbers in both Figure 5-2 and Table 5-1.

Table 5-1

Range of A-weighted Sound Levels of BSSU's

Location	$\overline{L}_{90}$ *		$\overline{L}_{50}$ *		$\overline{L}_{10}$ *	
	MAX	MIN	MAX	MIN	MAX	MIN
Allegheny County	67.3	31.3	73.5	34.3	87.3	40.6
City of Pittsburgh	61.5	41.0	67.0	47.8	75.0	55.1

* $\overline{L}$ represents average A-weighted sound level in the BSSU

5.2 Hour-by-Hour Analysis

To obtain a temporal analysis, the survey data were analyzed according to the hour in which the measurement was made. First, all measurements taken between the hours of 0800 and 0900 were sorted. Then, the individual L_{10}, L_{50}, and L_{90} parameters were put into histograms from which statistical averages were obtained using equations 8 through 19. Finally, the procedure was repeated for measurements taken from 0900 to 1000, 1000 to 1100, 1100 to 1200 hours, etc. The resulting computer printout for a typical hourly grouping (0900 to 1000 hours) is shown in Figure 5-3.

The hourly results for Allegheny County are listed in Table 5-2 and plotted in Figure 5-4. The analysis shows that between 0900 and 1700 hours, the hourly

* See Appendix A for exact wording of this legislation.

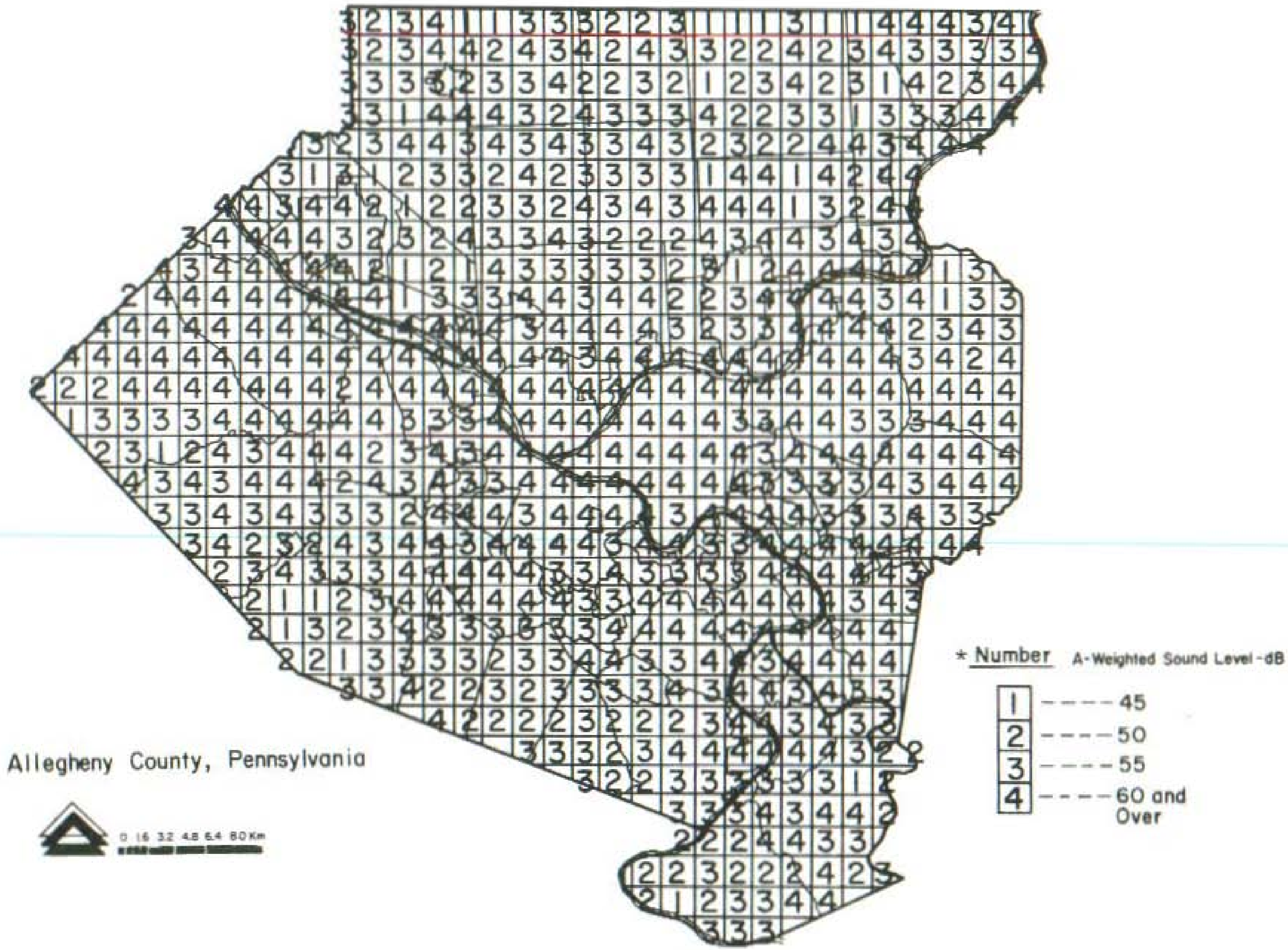


Figure 5-2. Anti-Degradation Map of Allegheny County

*All BSSU's with #1 had computed L_{eq} A-Weighted Sound Levels between 0 and 45 dB. Those with #2 had L_{eq} A-Weighted Sound Levels between 45 dB and 50 dB, #3 between 50 dB and 55 dB and #4, over 55 dB. The numbers were raised to the upper levels for legislative purposes.

MIDPOINT	LEVEL - 1 NO.	LEVEL - 1 DIST	LEVEL - 10 NO.	LEVEL - 10 DIST	LEVEL - 50 NO.	LEVEL - 50 DIST	LEVEL - 90 NO.	LEVEL - 90 DIST
26	0	.0	0	.0	0	.0	0	.0
29	0	.0	0	.0	2	.2	16	1.7
32	0	.0	0	.0	8	.8	22	2.3
35	0	.0	6	.6	30	3.2	70	7.4
38	2	.2	8	.8	46	4.9	99	10.5
41	5	.5	18	1.9	68	7.2	84	8.9
44	11	1.2	40	4.2	122	12.9	149	15.8
47	23	2.4	53	5.6	122	12.9	164	17.3
50	32	3.4	84	8.9	138	14.6	111	11.7
53	30	3.2	100	10.6	113	11.9	78	8.2
56	66	7.0	106	11.2	85	9.0	52	5.5
59	70	7.4	120	12.7	73	7.7	48	5.1
62	110	11.6	103	10.9	43	4.5	20	2.1
65	152	16.1	102	10.8	40	4.2	15	1.6
68	94	9.9	62	6.6	27	2.9	14	1.5
71	111	11.7	52	5.5	17	1.8	3	.3
74	77	8.1	44	4.7	7	.7	1	.1
77	65	6.9	27	2.9	4	.4	0	.0
80	39	4.1	13	1.4	1	.1	0	.0
83	27	2.9	8	.8	0	.0	0	.0
86	23	2.4	0	.0	0	.0	0	.0
89	7	.7	0	.0	0	.0	0	.0
92	2	.2	0	.0	0	.0	0	.0
95	0	.0	0	.0	0	.0	0	.0
98	0	.0	0	.0	0	.0	0	.0
NUMBER	946.0		946.0		946.0		946.0	
SUM	62,640.0		55,986.0		48,192.0		43,986.0	
MEAN	66.2		59.2		50.9		46.5	
SUM2	4,236,450.0		3,400,344.0		2,530,634.0		2,111,056.0	
S1	88,702.0		86,990.7		75,592.9		65,846.5	
S2	93.9		92.1		80.0		69.7	
S	9.7		9.6		8.9		8.3	
ERR-99	0.8		0.8		0.7		0.6	
ERR-95	0.6		0.6		0.5		0.5	
ERR-90	0.5		0.5		0.4		0.4	

COMPUTED L EQUIVALENT --- 55.734

Figure 5-3. Computer Analysis for Measurements Taken From 0900 to 1000 Hours

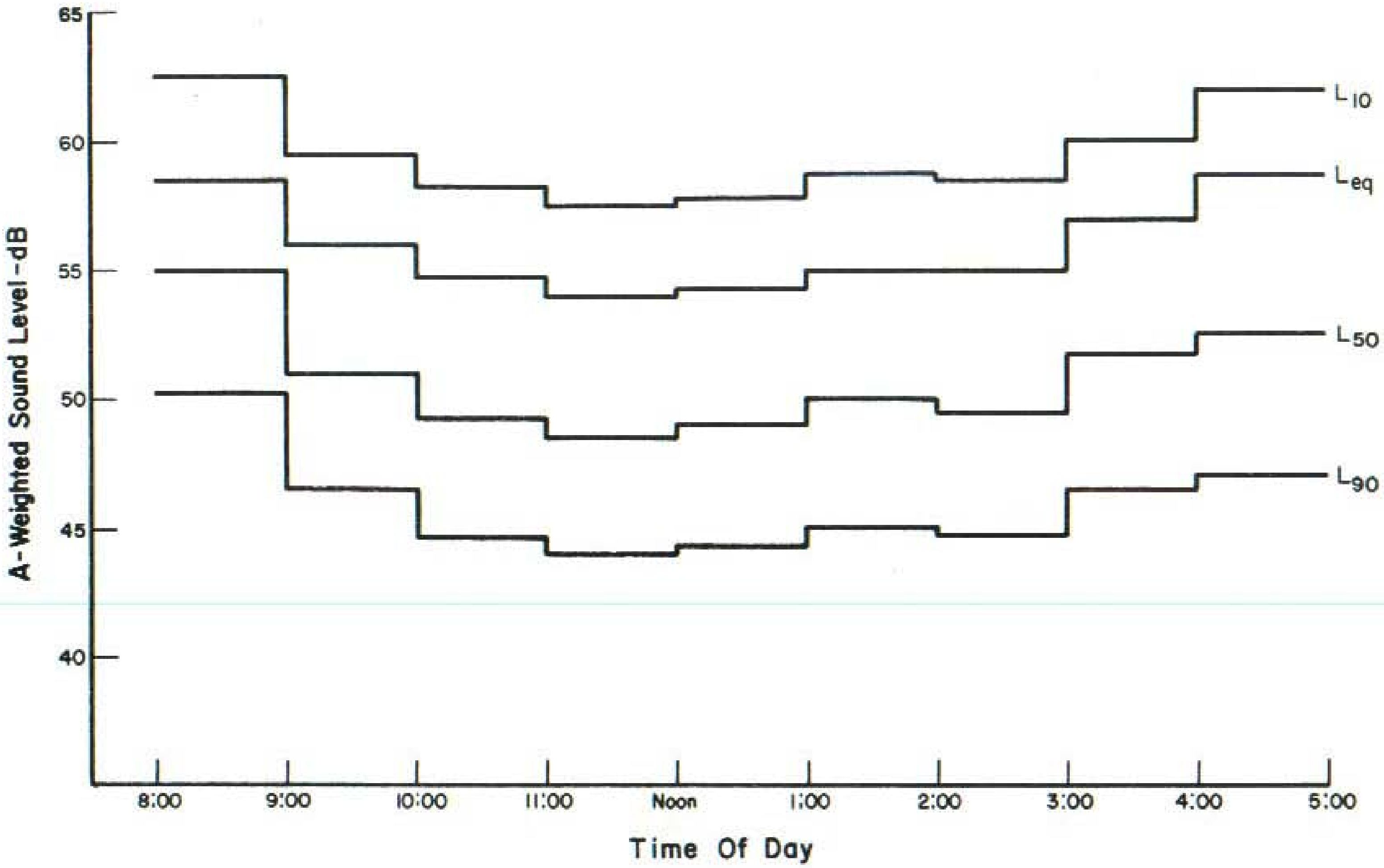


Figure 5-4. Hour-by-Hour County-Wide A-Weighted Sound Levels

variation was small enough to validate the earlier assumption that only a single measurement during this time period would be needed to determine the daytime noise climate.

Table 5-2.

Hourly Measurement Results

Time	No. of Measurements	$\overline{L}_{10}$*	$\overline{L}_{50}$*	$\overline{L}_{90}$*	$\overline{L}_{eq}$*
0800 - 0900	190	62.7	55.4	50.8	59.2
0901 - 1000	946	59.2	50.9	46.5	55.7
1001 - 1100	1504	58.1	49.3	44.6	54.8
1101 - 1200	1288	57.4	48.6	43.9	54.0
1201 - 1300	1006	57.8	49.2	44.3	54.4
1301 - 1400	1093	58.6	49.9	45.2	55.2
1401 - 1500	1076	58.4	49.5	44.8	55.1
1501 - 1600	576	60.3	51.7	46.7	56.9
1601 - 1700	59	62.0	52.5	47.0	58.8

*$\overline{L}$ represents average A-weighted sound level in specific time period.

It is conceded that nighttime and rush-hour measurements should have been taken to obtain more detailed results. However, since the purpose of this survey was to obtain a baseline for community noise legislation, these 0900 to 1700 hours readings would be sufficient. Standards based on the extremely high levels generated during the rush hours would tend to be too high, while the 10-decibel nighttime reduction specified in reference 9 eliminated the need for nighttime data.*

While the hourly parameter analysis established certain validity to the survey methodology, it produced no information that could be incorporated into the proposed legislation.

5.3 <u>Source-by-Source Analysis</u>

To analyze the major sources of noise, the following procedure was used. First, all measurements with traffic as their primary noise source was sorted. Next, histograms were made of the L-levels for these 5166 data points and the average L_{10}, L_{50}, and L_{90} A-weighted sound levels were obtained along with an L_{eq}. The computer analysis for this traffic source is shown in Figure 5-5. Finally, the procedure was repeated for the other significant sources. The results are summarized in Table 5-3.

* It should be noted that the 190 measurements taken during the 0800 to 0900 morning rush hour were used to establish the noise baseline for Allegheny County. However, since this number is a small percentage of the more than 7700 measurements taken, the distortion will be minimal.

MIDPOINT	LEVEL - 1 NO.	DIST	LEVEL - 10 NO.	DIST	LEVEL - 50 NO.	DIST	LEVEL - 90 NO.	DIST
26	0	.0	0	.0	0	.0	5	.1
29	0	.0	0	.0	8	.2	74	1.4
32	0	.0	1	.0	24	.5	135	2.6
35	1	.0	8	.2	126	2.4	359	6.9
38	0	.0	18	.3	224	4.3	507	9.8
41	9	.2	62	1.2	344	6.7	506	9.8
44	28	.5	164	3.2	620	12.0	951	18.4
47	75	1.5	251	4.9	815	15.8	883	17.1
50	99	1.9	388	7.5	723	14.0	596	11.5
53	129	2.5	455	8.8	599	11.6	377	7.3
56	278	5.4	638	12.3	499	9.7	292	5.7
59	305	5.9	649	12.6	381	7.4	206	4.0
62	449	8.7	609	11.8	261	5.1	129	2.5
65	972	18.8	646	12.5	227	4.4	69	1.3
68	608	11.8	428	8.3	134	2.6	49	.9
71	745	14.4	342	6.6	95	1.8	18	.3
74	508	9.8	212	4.1	56	1.1	8	.2
77	397	7.7	157	3.0	21	.4	1	.0
80	242	4.7	86	1.7	7	.1	1	.0
83	136	2.6	39	.8	2	.0	0	.0
86	109	2.1	12	.2	0	.0	0	.0
89	53	1.0	1	.0	0	.0	0	.0
92	19	.4	0	.0	0	.0	0	.0
95	3	.1	0	.0	0	.0	0	.0
98	1	.0	0	.0	0	.0	0	.0
NUMBER	5,166.0		5,166.0		5,166.0		5,166.0	
SUM	350,724.0		312,327.0		265,193.0		238,704.0	
MEAN	67.9		60.5		51.3		46.2	
SUM2	24,209,388.0		19,309,823.0		14,016,405.0		11,364,822.0	
S1	398,446.4		427,098.5		402,907.7		335,089.2	
S2	77.1		82.7		78.0		64.9	
S	8.8		9.1		8.8		8.1	
ERR-99	0.3		0.3		0.3		0.2	
ERR-95	0.2		0.2		0.2		0.2	
ERR-90	0.2		0.2		0.2		0.1	

COMPUTED L EQUIVALENT --- 57.239

Figure 5-5. Computer Analysis of Measurements With Traffic [01] as the Major Noise Source

Table 5-3

Noise Source Analysis*

Code	Source	No. of Sites	$\bar{L}_{eq}$	Loudness Rank	Numerical Rank
01	Traffic	5166	57.3	5	1
02	Construction	244	54.3	7	4
03	Dogs	190	48.3	13	6
04	Aircraft	946	51.6	10	2
05	Railroad Operations	62	59.9	2	11
06, 07	Lawn Equipment	156	50.8	12	7
08	Emergency Sirens	8	52.4	8	17
09	Birds	262	42.7	17	3
10	Crickets	42	42.2	18	13
11, 19	People	123	51.1	11	8
12	Fans, Air Conditioners	29	54.6	6	14
13, 18, 24, 26	Industrial Operations	216	58.7	4	5
14	Rustling of Leaves	93	47.2	16	9
15	Garbage Collection	8	59.2	3	17
22	Running Water, Rivers	66	48.2	14	10
23	Power Saws	21	52.3	9	16
31	Airport Operations	61	62.8	1	12
32	Farm Equipment	27	47.5	15	15

* In a separate analysis, the noise sources at sites within the City of Pittsburgh were ranked numerically. Traffic was the major source at 74.3 percent of the sites and the secondary source at an additional 15.6 percent. Other significant sources were people (major source at 10.4 percent and secondary source at 12.0 percent), aircraft (0.4 percent and 21.5 percent), dogs (03.0 percent and 14.3 percent), trains (01.2 percent and 14.6 percent), construction (01.9 percent and 04.1 percent), and industrial operations (02.8 percent and 14.1 percent). Primary sources were listed first in the source section of each data sheet (Figure 4-3). Secondary sources were listed second. Additional sources were not included in this analysis.

While this procedure may appear to be a rather simple method to analyze the data, Table 5-3 does reveal those sources which both need to be reduced and can be controlled by local regulations. Traffic was the major source in the greatest number of sites, while airport operations produced the highest L_{eq} value. Both of these sources can be regulated as well as most of the other major sources listed. However, this table could also be somewhat misleading, as shown by the low L_{eq} values of dogs. Their high-pitched barking was a common nuisance in Allegheny County.

Although the source evaluations produced no direct contribution to the regulations, it did prioritize problem areas as well as justifiy controls for such sources as traffic, construction, industrial operations, etc.

5.4 Zoning/Land Use Analysis

To define the existing A-weighted sound levels for the various land uses, the survey data were analyzed according to the zoning criteria in Table 3-1. To begin, all data obtained taken in an R1 (low-density residential) land use were sorted. Then the different statistical parameters were obtained using equations 8 through 19. Finally, the procedure was repeated for the other zoning categories with the results summarized in Table 5-4.

The table also classifies these results according to adjacent land uses. For example, the measurements made in low-density residential (R1) areas can be subdivided into such categories as R1C3, R1M4, R1SP, etc. The R1C3 classification represents measurements in a low-density residential area with an adjacent commercial land use in the same sampling element. Similarly, an R1M4 classification represents a measurement taken in low-density residential areas with an adjacent industrial land use in the same sampling element. Thus, the 4883 measurements obtained in R1 land use can be divided as follows: 2149 R1R1, 277 R1R3, 211 R1R5, etc. Similar analyses were made for the other zoning categories.

As indicated in Table 5-4, the adjacent land use did have a significant influence on the A-weighted sound levels. As an example, the L_{eq} for the R1R1 sites averaged 52.0 dB compared to 57.3 dB for the R1R3 sites. Similarly, the L_{eq} for the M1M4 sites averaged 65.8 dB compared to 59.7 dB for the M1R1. However, since regulations based on the categories listed would be far too complex to understand and enforce, Table 5-4 was consolidated into the combinations below with the results summarized in Table 5-5.

- Residential bordered by Residential - RR
- Residential bordered by Commerical - RC
- Residential bordered by Industrial - RM

- Commerical bordered by Residential - CR
- Commerical bordered by Commercial - CC
- Commerical bordered by Industrial - CM

- Industrial bordered by Residential - MR
- Industrial bordered by Commercial - MC
- Industrial bordered by Industrial - MM

Table 5-4

Zone-by-Zone Analysis

Zone	Sub	No. of Sites	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	$\overline{L}_{eq}$
	R1R1	2149	56.2	48.3	42.8	52.0
	R1R3	277	60.8	52.8	48.2	57.3
	R1R5	211	56.1	45.2	40.0	53.5
	R1SP	1519	56.0	46.7	41.9	52.8
	R1C3	471	60.8	52.5	47.4	57.3
R1	R1C5	4	65.8	56.0	52.0	62.7
	R1M1	110	59.4	50.8	45.4	56.1
	R1M4	124	59.4	52.8	49.0	55.6
	R1M6	14	57.3	49.5	47.5	53.8
	R1M8	4	54.5	47.5	45.0	50.9
TOTAL	R1	4883	57.0	48.5	43.4	53.7
	R3R3	94	60.5	53.0	48.9	56.9
	R3R1	158	59.4	51.4	47.4	55.9
	R3SP	84	60.0	52.4	48.7	56.5
	R3C3	139	63.4	55.6	50.9	59.9
R3	R3C5	5	63.4	54.0	49.6	60.2
	R3M1	19	62.5	55.6	52.0	59.0
	R3M4	55	63.4	57.4	53.3	60.0
	R3M6	2	56.0	52.5	50.5	53.4
TOTAL	R3	556	61.2	53.6	49.5	47.7
	R5R5	186	52.2	42.4	38.2	49.1
	R5R1	108	54.6	43.8	38.7	52.0
	R5R3	1	66.0	45.0	34.0	64.0
R5	R5SP	106	50.2	41.5	37.5	46.8
	R5C3	6	61.3	48.7	42.5	59.8
	R5M1	3	57.3	45.3	41.3	55.4
	R5M4	5	66.6	56.4	53.2	68.7
	R5M6	1	53.0	48.0	44.0	49.7
TOTAL	R5	416	52.2	42.8	38.4	49.0
	M4M4	93	70.3	63.1	57.8	66.7
	M4M1	13	68.5	61.8	58.0	65.0
	M4M6	1	65.0	59.0	56.0	61.5
	M4M8	1	87.0	73.0	61.0	86.7
M4	M4R1	89	66.3	58.6	53.7	62.7
	M4R3	32	69.1	62.5	58.3	65.6
	M4SP	66	66.0	58.6	54.1	62.4
	M4C3	38	70.6	62.7	57.2	67.1
	M4C5	2	73.0	67.0	63.0	69.5
TOTAL	M4	335	68.3	60.9	56.2	64.7

Zone	Sub	No. of Sites	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	$\overline{L}_{eq}$
	C3C3	87	66.2	57.8	53.7	62.9
	C3C5	1	77.0	69.0	64.0	73.5
	C3R1	227	67.2	58.6	51.8	63.7
C3	C3R3	71	67.0	59.3	53.8	63.5
	C3M1	21	67.5	59.3	53.3	64.0
	C3M4	23	66.5	61.9	55.9	65.0
	C3M8	2	76.5	67.5	62.0	73.1
TOTAL	C3	432	67.4	59.2	52.8	63.9
	C5C5	10	73.3	68.0	63.6	70.0
	C5C3	1	72.0	66.0	62.0	68.5
C5	C5R1	3	67.7	61.0	58.0	64.1
	C5R3	4	64.0	58.3	54.3	61.3
	C5M1	1	60.0	54.0	51.0	56.6
	C5M4	1	71.0	65.0	60.0	67.5
TOTAL	C5	20	70.2	63.9	60.2	66.7
	SPR1	294	59.4	51.0	46.2	56.0
	SPR3	51	61.8	54.9	50.3	58.2
	SPR5	32	54.1	44.8	40.1	50.9
SP	SPM1	19	65.1	56.6	51.1	61.7
	SPM4	41	65.9	58.8	54.1	62.3
	SPM6	5	53.6	44.8	41.2	50.2
TOTAL	SP	850	58.4	49.8	45.1	55.0
	M1M1	21	63.8	53.0	51.9	61.2
	M1M4	18	69.4	62.1	57.2	65.8
	M1R1	56	63.2	54.9	49.3	59.7
M1	M1R3	13	69.7	63.2	58.1	66.3
	M1R5	1	51.0	44.0	41.0	47.4
	M1SP	27	65.5	58.0	52.3	61.9
	M1C3	13	66.2	58.2	52.9	62.7
TOTAL	M1	149	64.7	57.0	51.8	61.2
	M6M6	7	58.2	50.4	49.8	54.6
	M6M4	1	78.0	71.0	63.0	74.4
M6	M6R1	6	63.5	57.7	54.3	60.1
	M6R5	2	46.0	41.5	38.5	42.9
	M6SP	13	60.3	50.6	44.2	57.9
TOTAL	M6	29	69.3	52.1	47.3	56.8
M8	M8M8	11	71.0	64.8	59.3	68.2
	M8R1	2	54.5	44.5	41.0	51.5
TOTAL	M8	13	69.2	61.7	56.5	65.6

Note: $\overline{L}$ is average A-weighted sound level for sites within a particular zone

Table 5-5

Combination Zone-by-Zone Analysis

Category	Sub	No. of Sites	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	$\overline{L}_{eq}$
Residential Bordered By Residential (RR)	R1R1	2149	56.0	48.3	42.8	52.8
	R1R3	277	60.8	52.8	48.2	57.3
	R1R5	211	56.1	45.2	40.0	53.5
	R1SP	1519	56.0	46.7	41.9	52.8
	R3R3	94	60.5	53.0	48.9	56.9
	R3R1	158	59.4	51.4	47.4	55.9
	R3SP	84	60.0	52.4	48.7	56.5
	R5R5	186	52.2	42.4	38.2	52.0
	R5R1	108	54.6	43.8	38.7	52.0
	R5SP	106	50.3	41.5	37.5	46.8
TOTAL	RR	4892	56.2	47.7	42.7	52.8
Residential Bordered By Commercial (RC)	R1C3	471	60.8	52.5	47.4	57.3
	R3C3	139	63.4	55.6	50.9	59.1
TOTAL	RC	610	61.4	53.2	48.2	57.9
Residential Bordered By Industrial (RM)	R1M1	110	59.4	50.8	45.4	56.1
	R1M4	124	59.4	52.8	49.0	55.6
	R3M1	19	62.5	55.6	52.0	59.6
	R3M4	55	65.3	57.4	53.3	60.0
	R1M6	14	57.3	49.5	47.5	53.8
TOTAL	RM	322	60.1	52.9	48.6	56.8
Commercial Bordered By Residential (CR)	C3R1	277	67.2	58.6	51.8	63.7
	C3R3	71	67.0	59.3	53.8	63.5
TOTAL	CR	298	67.1	58.8	52.3	63.6
Commercial Bordered By Commercial (CC)	C3C3	87	66.2	57.8	53.7	62.9
	C5C5	10	73.3	68.0	63.6	70.0
TOTAL	CC	97	66.9	58.9	54.7	63.4
Commercial Bordered By Industrial (CM)	C3M1	21	67.5	59.3	53.3	64.0
	C3M4	23	68.5	61.9	55.9	65.0
TOTAL	CM	44	68.0	60.7	54.7	64.4
Industrial Bordered By Residential (MR)	M1R1	56	63.2	54.9	49.3	59.7
	M1R3	13	69.7	63.2	58.1	66.3
	M4R1	89	66.3	58.6	53.7	62.7
	M4R3	32	69.1	62.5	58.3	65.6
	M6R1	6	63.5	57.7	54.3	60.1
TOTAL	MR	196	66.1	58.4	53.5	62.6
Industrial Bordered By Commercial (MC)	M1C3	13	66.2	58.2	52.9	62.7
	M4C3	38	70.6	62.7	57.2	67.1
TOTAL	MC	51	69.5	61.5	56.1	66.0
Industrial Bordered By Industrial (MM)	M1M1	21	63.8	53.0	51.9	61.2
	M1M4	18	69.4	62.1	57.2	65.8
	M4M4	93	70.3	63.1	57.9	66.7
	M4M1	13	68.5	61.8	58.0	65.0
	M8M8	11	71.8	64.8	59.3	68.2
TOTAL	MM	156	69.3	61.6	57.1	65.7

NOTE: $\overline{L}$ is average A-weighted sound level for sites within a particular zone.

While a sizeable spread still existed within the individual combinations, the number of entries was reduced to a workable amount. Table 5-5 is refined in Table 5-6, which was used in drawing up the proposed noise legislation in Appendix A.*

Table 5-6

Existing A-weighted Sound Levels Across Zone Property Lines

Emitting Land Use	Receiving Land Use		
	Residential	Commercial	Industrial
Residential	53	58	57
Commercial	64	63	64
Industrial	63	66	66

As a point of interest, Figure 5-6 compares the cumulative distribution of A-weighted sound levels taken at sites located in residential areas (only R1 or R3 land uses were in the sampling element) to those sites located in residential areas bordered by commercial or industrial activities. While there is a significant increase in the levels, the increase is not as great as was anticipated.

There are a number of other parameters that could be used in combination with the zoning to obtain more information. Figure 5-7 results from an hourly analysis of the L_{90} A-weighted sound levels of sites taken in separate M4, M1, R5, R3, and R1 land uses. The tabular information in this figure indicates the number of measurements taken in each zone for each hour. While these data make no direct contribution to the proposed regulations, they do, for the most part, verify the earilier assumptions of a constant noise level from 0800 to 1600 hours.

As an additional test to determine the direct effects of industrial operations on residential areas, the following criteria were used to sort and analyze the data.

- Sites located in low-density residential areas (R1) bordered by heavy industrial areas (M4)
- Industrial operations as the major noise source

The resulting computer printout is shown in Figure 5-8. Although it was anticipated that such information would be used in defining problem areas and setting more exacting standards, only a limited number of sites met the specific criteria.

* See Appendix A for exact working of proposed county legislation.

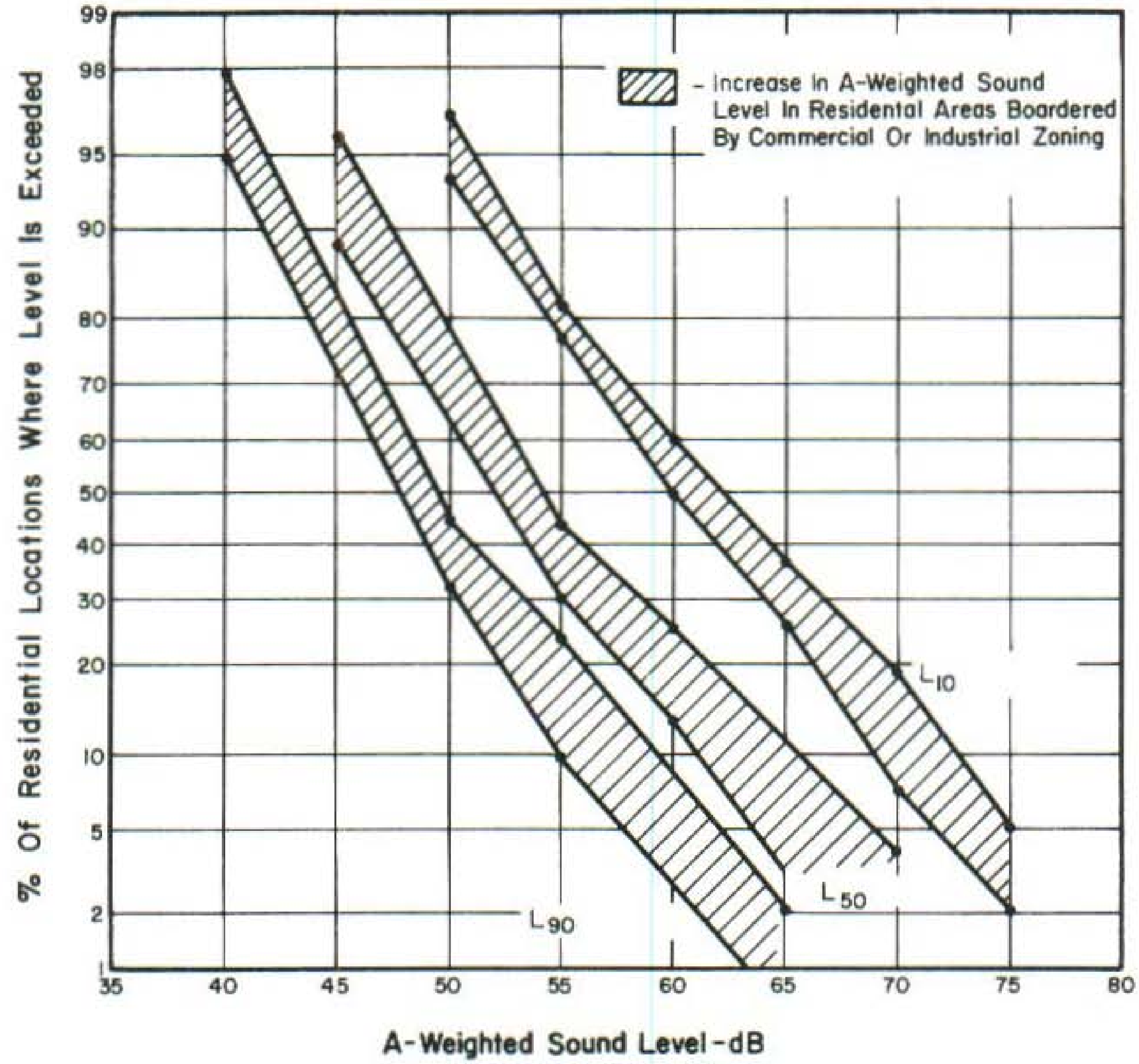


Figure 5-6. Increase in A-Weighted Sound Levels Caused by Commercial or Industrial Activity

Land Use	Time 8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5
m4	15	53	50	53	40	52	53	17	
m1		25	25	14	13	23	17	25	
R5		25	83	79	60	79	59	27	
R3	24	78	101	90	60	89	67	43	
R1	113	563	946	827	660	671	719	352	32

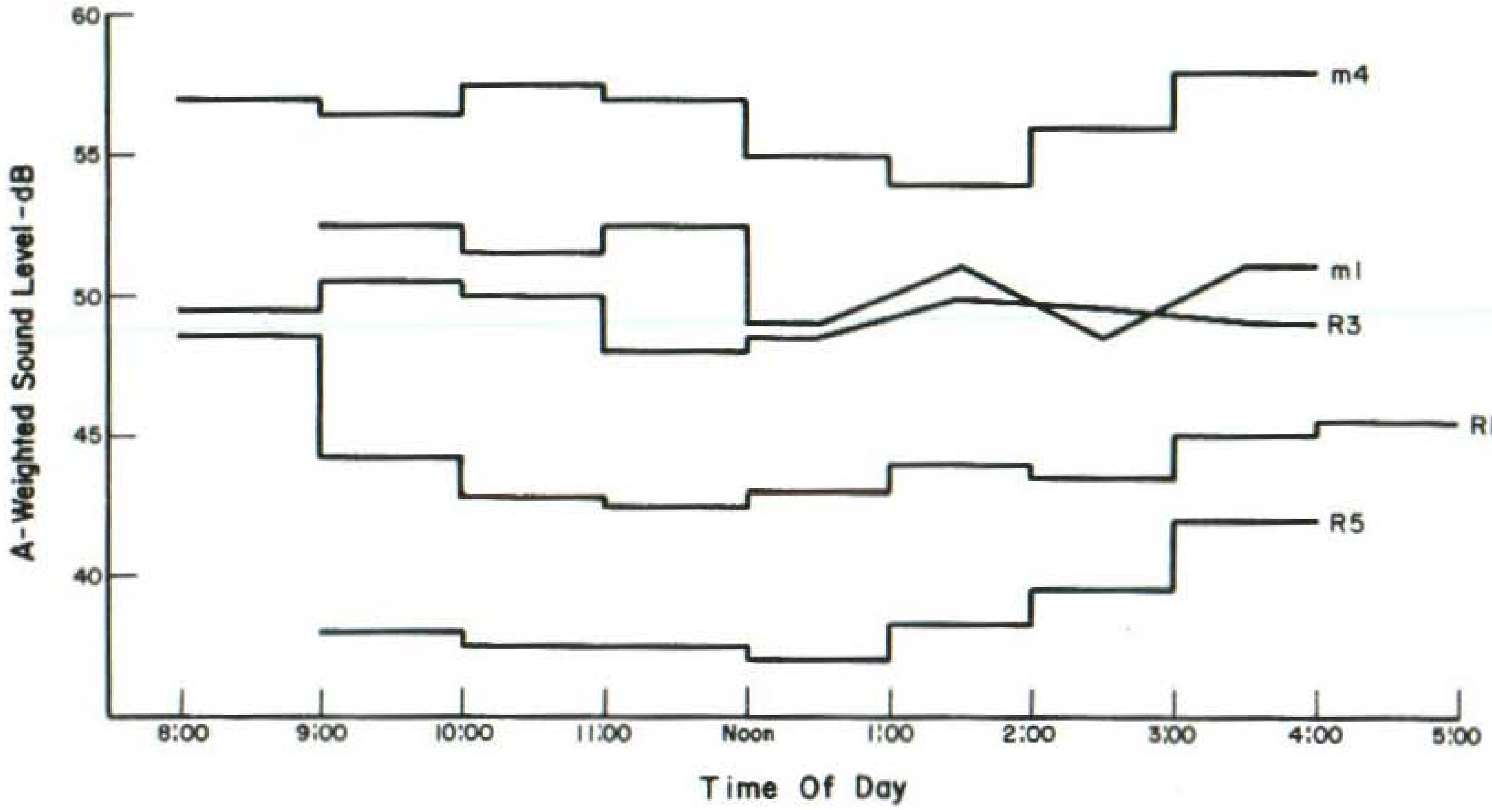


Figure 5-7. Hour-by-Hour L_{90} A-Weighted Sound Levels According to Zone

MIDPOINT	LEVEL - 1 NO.	DIST	LEVEL - 10 NO.	DIST	LEVEL - 50 NO.	DIST	LEVEL - 90 NO.	DIST
26	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0
35	0	.0	0	.0	0	.0	0	.0
38	0	.0	0	.0	0	.0	0	.0
41	0	.0	0	.0	0	.0	0	.0
44	0	.0	0	.0	0	.0	2	11.8
47	0	.0	0	.0	2	11.8	2	11.8
50	0	.0	2	11.8	1	5.9	2	11.8
53	1	5.9	0	.0	5	29.4	5	29.4
56	1	5.9	1	5.9	4	23.5	4	23.5
59	1	5.9	7	41.2	3	17.6	1	5.9
62	2	11.8	4	23.5	1	5.9	1	5.9
65	4	23.5	1	5.9	1	5.9	0	.0
68	1	5.9	0	.0	0	.0	0	.0
71	5	29.4	2	11.8	0	.0	0	.0
74	0	.0	0	.0	0	.0	0	.0
77	0	.0	0	.0	0	.0	0	.0
80	2	11.8	0	.0	0	.0	0	.0
83	0	.0	0	.0	0	.0	0	.0
86	0	.0	0	.0	0	.0	0	.0
89	0	.0	0	.0	0	.0	0	.0
92	0	.0	0	.0	0	.0	0	.0
95	0	.0	0	.0	0	.0	0	.0
98	0	.0	0	.0	0	.0	0	.0
NUMBER	17.0		17.0		17.0		17.0	
SUM	1,140.0		1,022.0		940.0		889.0	
MEAN	67.1		60.1		55.3		52.3	
SUM2	77,244.0		61,994.0		52,348.0		46,875.0	
S1	797.0		553.8		371.5		385.5	
S2	49.8		34.6		23.2		24.1	
S	7.1		5.9		4.8		4.9	
ERR-99	5.1		4.3		3.5		3.5	
ERR-95	3.7		3.1		2.5		2.5	
ERR-90	3.0		2.5		2.0		2.1	

COMPUTED L EQUIVALENT --- 56.917

Figure 5-8. Computer Analysis by Source and Zone Sorting

5.5 Noise-Sensitive Area Analysis

In order to establish appropriate standards for various noise-sensitive areas such as schools and hospitals, part of the survey was set aside to determine their acoustic environments. To obtain these results, the data were sorted and analyzed according to the specific type (if any) of noise-sensitive area in the vicinity of the measurement site. The results, summarized in Table 5-7, indicate that the four areas had approximately the same A-weighted sound levels.

Table 5-7

Noise-Sensitive Area Analysis

Code	Noise-Sensitive Area	No. of Sites	$\bar{L}^*_{10}$	$\bar{L}^*_{50}$	$\bar{L}^*_{90}$	$\bar{L}^*_{eq}$
01, 1C	Schools	566	60.7	52.7	48.0	57.2
01, 1M	Hospitals	68	62.3	56.3	52.6	58.8
03	Churches	397	61.6	53.4	48.6	58.1
04	Nursing Homes	20	60.9	51.6	56.1	57.9

* $\bar{L}$ represents average A-weighted sound levels in vicinity of paricular noise-sensitive areas.

A cumulative distribution was made for the 566 L_{10} values taken at sites located near schools. Similar distributions were made for the L_{10} values of the other four categories and the composite results plotted in Figure 5-9. This procedure was then repeated for the L_{50} and L_{90} levels. The figure somewhat contradicts Table 5-7, since the composition distributions have a significant range. Also shown in this figure is the distribution of L parameters for measurements taken in residential areas. Note that the residential distribution is slightly lower or quieter than that of the noise-sensitive areas. This result indicates that any criteria established for residential areas would be more than adequate for those noise-sensitive areas. To set special low criteria for the schools and hospitals would be inconsistent with the existing acoustic environment.

5.6 Municipality-by-Municipality Analysis

To obtain a municipal noise analysis, the survey data were analyzed according to the township or borough where the individual measurement was taken. For example, all sites located in Aleppo (Code 101) were listed and the statistical parameters were obtained using equations 8 through 19. The procedure was then repeated for the

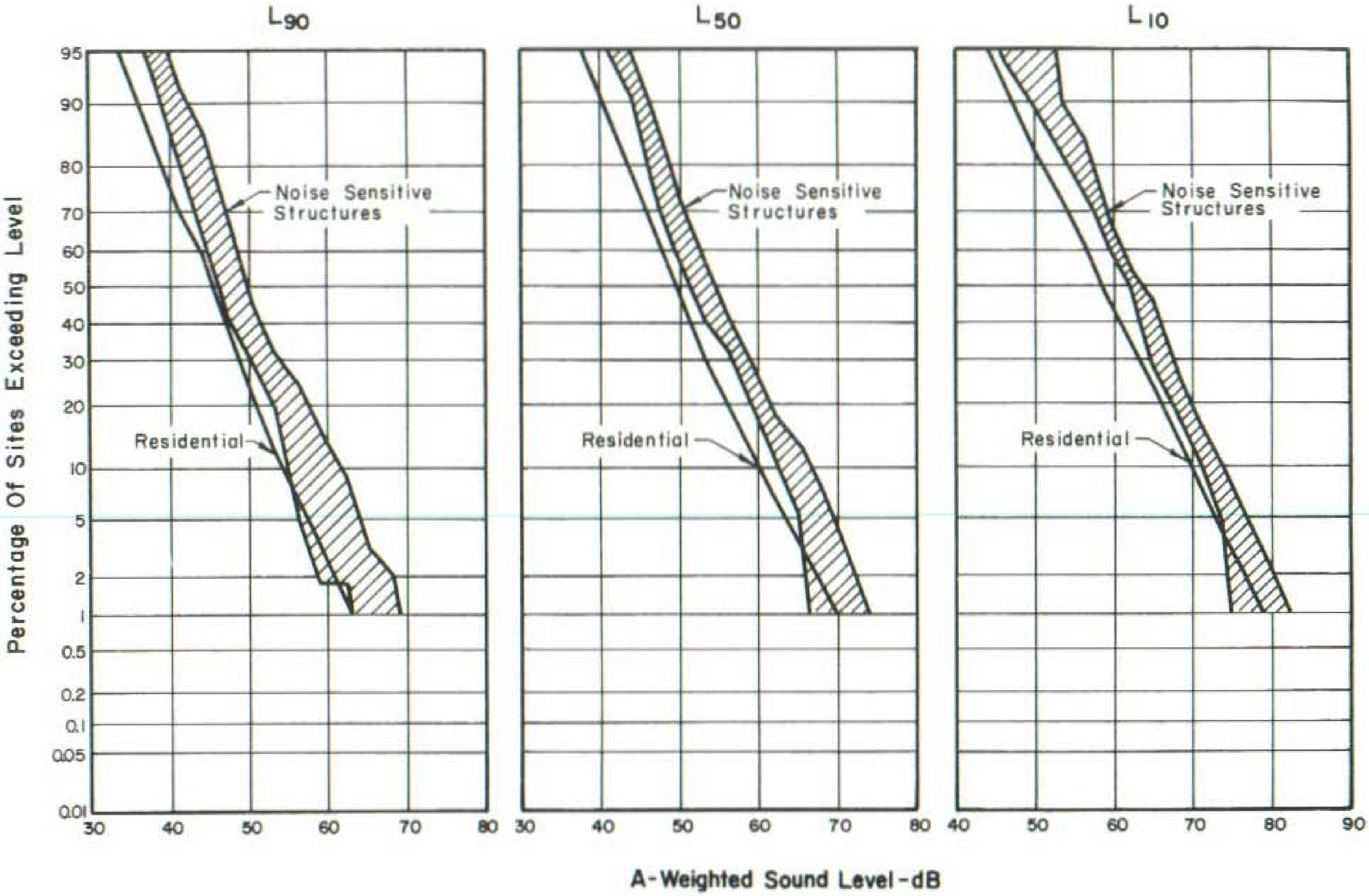


Figure 5-9. Cumulative Distribution Plots for Noise-Sensitive Areas

other 128 municipalities with the L_{eq} results summarized in Figure 5-10. Additionally, the survey data in each township or borough were subdivided into the different zoning classifications and analyzed. These results are summarized in Table 5-8. Originally, this information was studied to determine possible standards, but it eventually was used for publicity for the program. There was no justification for setting one level in Township A and a separate level in Township B, since the discrepancy of levels within a given township was too great. Also, to set levels according to zone and township would have been far too cumbersome to enforce.

5.6.1 Analysis for the City of Pittsburgh

Figure 5-11 contains the individual BSSU's comprising the City of Pittsburgh.* The L_{10}, L_{50}, and L_{90} A-weighted sound levels for each BSSU within the city are summarized in Table 5-9. As mentioned in Section 5.1, there was a large range of values for the BSSU's within the city limits. While this particular information was not used in preparing the noise ordinance, it was used as a prelude to the public hearings and workshops.

As a final point of interest, the computer results for the 979 sites comprising the City of Pittsburgh are listed in Figure 5-12. They are somewhat higher than the results of the 7741 sites comprising Allegheny County which are listed in Figure 5-13.

* This figure, prepared especially for publicity purposes, uses a different numbering system than the one in Figure 3-2. It was felt that the simple system used would be more easily understood by the general public.

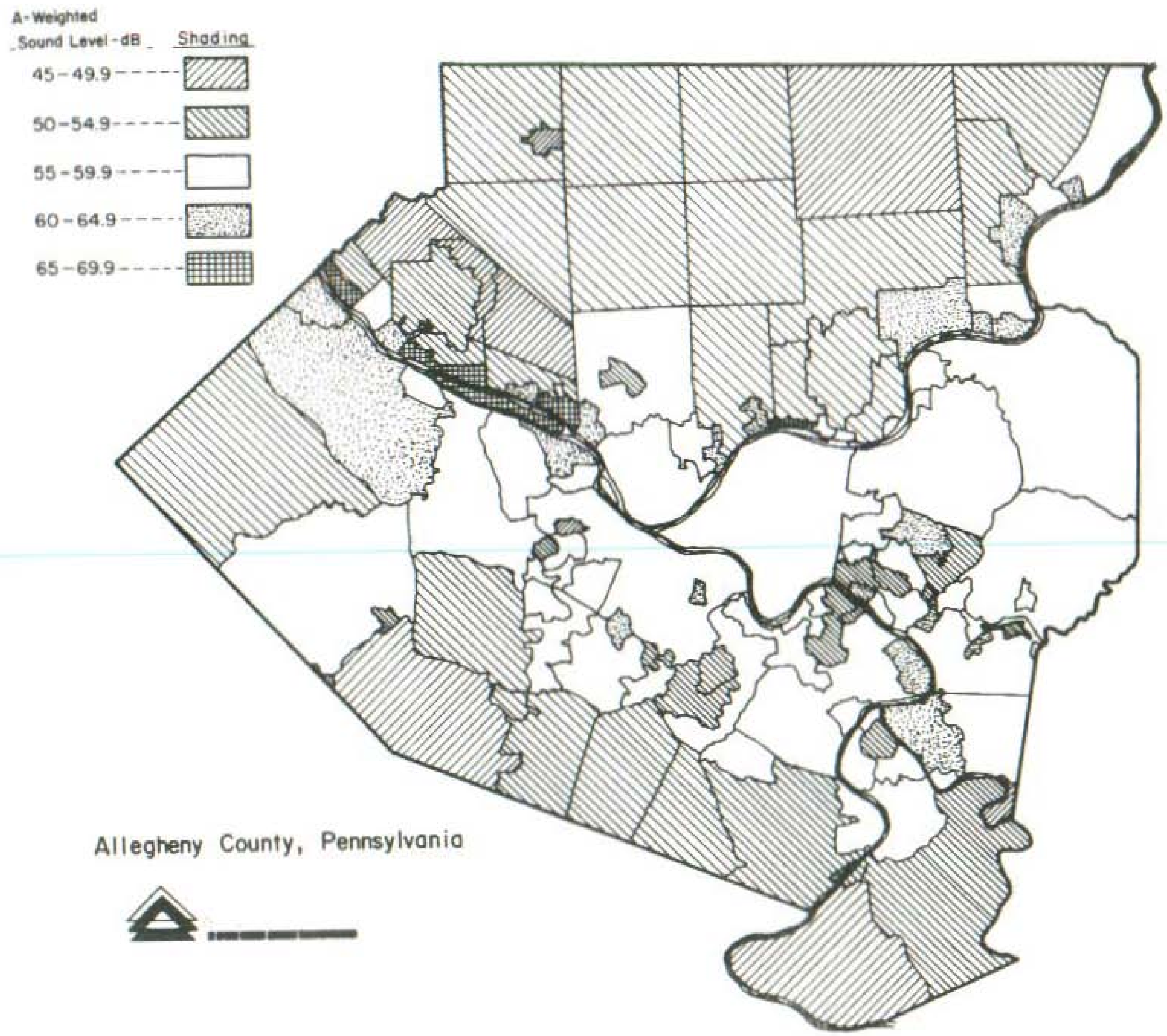


Figure 5-10. Municipality-by-Municipality Noise Analysis

Table 5-8

Municipal Noise Analysis

CODE	MUNICIPALITY	#sites	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	$\overline{L}_{eq}$	R1,R3		C3,C5		M1,M4,M6,M8	
							#sites	L_{eq}	#sites	L_{eq}	#sites	L_{eq}
101	Aleppo	15	53.6	45.5	40.9	50.1	10	51.7				
102	Aspinwall	8	59.9	54.5	51.0	56.5	6	65.8	1	54.8	1	57.2
103	Avalon	15	70.3	63.0	58.9	66.7	13	65.8	1	79.7		
104	Baldwin Boro	81	58.5	49.2	45.4	55.3	70	53.8	4	65.5	5	66.2
105	Baldwin Twp.	14	56.7	48.5	44.1	53.2	12	50.7	1	65.5	1	71.5
106	Bell Acres	51	51.9	42.5	38.1	48.7	37	49.5	1	59.8		
107	Bellevue	18	64.3	56.0	50.8	60.8	14	61.2	3	61.8		
108	Ben Avon	8	71.1	63.9	58.9	67.5	6	68.3			1	73.7
109	Ben Avon Hts	2	63.5	59.0	54.5	60.4	2	60.4				
110	Bethel Park	135	54.0	46.3	41.6	50.5	118	50.8	2	49.4	5	43.2
111	Blawnox	5	58.8	54.4	51.2	55.8	3	55.8	1	50.6	1	61.0
112	Brackenridge	9	64.2	57.6	52.7	60.7	6	57.3	2	61.9	1	81.1
113	Braddock	6	63.0	56.3	53.3	59.4	3	58.4			3	60.1
114	Braddock Hills	15	55.0	49.1	46.7	51.5	15	51.5				
115	Bradford Woods	14	51.5	41.9	38.4	48.4	14	48.4				
116	Brentwood	23	58.1	50.7	46.4	54.5	18	55.0	3	59.2		
117	Bridgeville	17	58.3	50.1	46.2	54.8	13	54.8	1	51.8	1	49.6
118	Carnegie	37	60.2	53.3	49.9	56.6	27	55.8	1	68.5	2	66.8
119	Castle Shannon	24	61.0	51.7	47.0	57.8	21	56.3	3	68.3		
120	Chalfant	2	55.5	48.0	46.5	51.9	2	51.9				
121	Cheswick	8	65.0	57.9	52.6	61.4	6	58.8	1	74.4	1	65.0
122	Churchill	22	65.9	59.1	55.1	62.3	16	62.5			1	69.1
123	Clairton	28	62.0	53.6	49.4	58.6	21	56.5	3	60.0	3	71.5
124	Collier	119	57.8	49.2	45.2	54.4	35	55.2	2	61.8	10	60.5
125	Coraopolis	21	62.2	54.6	50.3	58.7	18	56.7	1	72.0	2	70.3
126	Crafton	20	59.5	50.3	46.6	56.2	17	56.8	1	56.6	2	52.4
127	Crescent	30	63.4	53.9	48.0	60.2	22	58.8			5	68.4
128	Dormont	17	64.1	55.5	51.1	60.7	14	58.5	2	71.8		
129	Dravosburg	12	67.8	59.1	53.3	64.4	6	61.3	2	70.2	2	67.6
130	Duquesne	18	67.0	59.4	54.8	63.5	11	59.6			4	74.7
131	East Deer	21	64.2	52.1	46.2	62.4	18	61.8			1	70.5
132	East McKeesport	2	67.0	56.5	47.5	64.2	2	64.2				
133	East Pittsburgh	7	65.9	58.4	54.3	62.3	4	57.0			3	69.5
134	Edgewood	17	60.1	52.7	48.0	56.5	16	56.3			1	60.4
135	Edgeworth	14	62.8	54.6	49.9	59.3	12	58.2	1	77.5		
136	Elizabeth Boro	4	55.3	49.0	45.8	51.8	4	51.7				
137	Elizabeth Twp.	175	56.7	46.3	40.5	53.9	143	53.6	8	67.1	2	57.3
138	Emsworth	12	64.7	59.3	56.6	61.3	8	57.1	1	67.0	1	72.4
139	Etna	14	65.6	59.1	54.5	62.1	9	57.5	2	64.4	3	74.5
140	Fawn	94	56.2	44.8	39.3	53.9	72	54.0	1	72.3	5	58.6
141	Findlay	175	56.5	46.3	40.7	53.6	75	53.1	14	64.9	17	53.0
142	Forest Hills	23	60.6	52.2	47.6	57.2	19	57.6	2	62.6		
143	Forward	142	53.1	44.6	40.3	49.7	29	51.9			6	52.0
144	Fox Chapel	90	54.2	45.5	41.3	50.8	81	50.6				
145	Franklin Park	111	53.3	41.1	35.3	51.5	100	51.4	5	61.6		
146	Frazier	63	52.0	39.5	34.0	50.5	44	50.7	3	45.7		
147	Glassport	18	59.4	54.2	51.9	56.5	14	53.6	2	67.9	2	62.9
148	Glenfield	8	68.6	61.8	55.9	65.0	4	61.8			1	63.4
149	Greentree	31	62.8	55.5	51.5	59.2	19	58.3	4	69.7	2	66.4
150	Hampton	179	56.7	47.7	42.2	53.4	137	52.2	11	72.5	2	60.6
151	Harmar	57	64.2	55.1	49.2	60.9	31	57.5	3	70.5	13	65.2
152	Harrison	76	59.8	52.7	48.2	56.2	59	56.0	2	68.9	5	64.9
153	Haysville	3	69.7	58.3	54.0	67.4	3	67.4				
154	Heidelberg	3	58.3	52.7	51.3	54.9	3	54.9				
155	Homestead	16	60.2	53.5	50.3	56.6	8	54.4	4	60.4	3	60.6
156	Indiana	137	54.3	45.3	40.6	51.0	93	52.4	1	59.7	5	65.2
157	Ingram	9	51.7	47.0	44.8	48.5	9	48.5				
158	Jefferson	135	56.3	48.3	44.1	52.8	104	51.5	6	60.2	24	57.0
159	Kennedy	67	60.9	51.1	45.8	57.8	48	57.5	7	58.3	4	51.8
160	Kilbuck	29	57.7	51.0	47.0	54.2	11	53.4				
161	Leet	15	56.6	47.3	42.5	53.4	15	53.4				
162	Leetsdale	14	69.6	62.5	57.3	66.0	5	68.5	1	64.8	7	62.6
163	Liberty	15	58.8	49.3	44.9	55.6	12	54.3			2	64.5
164	Lincoln	39	58.5	49.1	44.7	55.3	28	54.5	1	67.0	2	63.4
165	Marshall	122	54.8	44.1	39.1	52.1	85	52.0	7	67.2	2	58.6
166	McCandless	185	55.9	47.3	42.5	52.5	138	51.3	11	62.8		

Table 5-8. (cont.)

CODE	MUNICIPALITY	#sites	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	$\overline{L}_{eq}$	R1,R3		C3,C5		M1,M4,M6,M8	
							#sites	L_{eq}	#sites	L_{eq}	#sites	L_{eq}
167	McDonald	3	63.7	47.7	39.0	65.7	3	65.7				
168	McKeesport	67	63.9	55.4	50.2	60.5	54	58.9	8	68.3	2	70.9
169	McKees Rocks	20	62.9	54.9	51.0	59.4	11	57.9	4	62.9	5	60.0
170	Millvale	11	66.5	57.2	50.7	63.3	9	61.3	2	72.0		
171	Monroeville	203	60.3	53.3	48.9	56.7	136	54.9	25	69.5	7	61.0
172	Moon	204	64.8	55.3	49.6	61.6	137	59.6	16	69.5	16	71.6
173	Mt. Lebanon	91	59.3	51.7	47.5	55.8	80	55.5	2	59.9		
174	Mt. Oliver	8	64.4	57.1	52.8	60.8	7	59.4	1	70.4		
175	Munhall	36	56.4	49.7	46.4	52.8	32	52.2	1	71.8		
176	Neville	19	72.5	64.4	58.3	69.0	5	61.4	1	60.5	13	72.8
177	N. Braddock	15	60.4	55.8	52.1	57.3	11	54.3	3	64.2	1	70.5
178	N. Fayette	176	59.6	48.8	43.2	57.0	99	57.0	8	64.7	9	62.4
179	N. Versailles	86	60.2	53.1	48.7	56.6	55	53.9	21	64.4	4	57.7
180	Oakdale	7	54.1	47.0	42.1	50.5	6	49.4	1	57.5		
181	Oakmont	24	62.0	55.4	51.0	58.5	20	58.3	1	67.5	2	61.2
182	O'Hara	88	58.3	51.3	47.3	54.7	61	52.1	7	64.1	11	61.5
183	Ohio	62	51.1	40.5	35.5	48.4	54	47.5	5	56.3	2	57.7
184	Osborne	7	69.6	60.0	54.3	66.5	6	68.1	1	57.5		
185	Penn Hills	258	60.2	52.2	47.3	56.7	202	55.3	23	64.6	13	62.1
186	Pine	153	55.7	45.5	40.3	52.8	102	53.1	8	66.3		
187	Pitcairn	9	62.3	53.8	47.2	58.9	5	55.7			3	63.4
188	Pittsburgh	979	62.4	55.2	51.0	58.8	630	56.3	57	66.3	138	66.5
189	Pleasant Hills	35	60.0	52.1	47.8	56.5	25	53.7	7	64.8		
190	Plum	265	58.7	48.9	43.9	55.6	196	55.5	7	68.4	12	65.3
191	Port Vue	13	57.8	49.4	43.0	54.4	11	53.9			1	58.8
192	Rankin	5	64.2	58.6	55.2	60.8	3	57.0			2	66.5
193	Reserve	29	58.8	48.7	43.0	55.9	23	56.2			2	55.0
194	Richland	158	53.9	45.0	40.3	50.6	129	50.5	5	68.0	1	47.1
195	Robinson	131	62.3	53.7	48.2	58.9	78	56.9	8	63.8	15	63.2
196	Ross	189	59.2	50.8	45.8	55.8	134	55.0	7	63.3	1	72.8
197	Rosslyn Farms	8	60.9	54.1	51.8	57.3	5	57.5			3	57.3
198	Scott	61	58.9	51.2	47.7	55.4	51	54.7	5	60.7	3	56.4
199	Sewickley	17	65.1	57.2	51.9	61.6	14	61.7	1	70.1		
200	Sewickley Hts.	61	55.7	43.6	38.5	53.9	50	52.6				
201	Sewickley Hills	25	48.1	38.2	34.2	45.1	21	47.5				
202	Shaler	148	57.8	49.3	44.9	54.4	130	53.3	5	63.9	7	70.1
203	Sharpsburg	14	69.2	61.9	57.5	65.6	4	60.5	1	73.0	8	67.7
204	S. Fayette	175	53.3	44.5	39.7	49.9	83	52.0	8	56.3	9	56.9
205	S. Park	82	55.5	45.3	40.6	52.6	54	51.4	4	58.4	13	53.4
206	S. Versailles	7	51.0	40.9	37.4	48.1	6	49.6				
207	Springdale Boro	11	65.5	56.8	52.6	62.1	8	62.0			3	62.3
208	Springdale Twp.	25	60.7	50.4	45.0	57.8	17	52.0	3	73.9	2	76.0
209	Stowe	26	65.1	56.2	51.2	61.8	15	61.5	4	65.2	4	62.5
210	Swissvale	19	57.7	51.4	47.7	54.2	15	53.8	4	55.6		
211	Tarentum	16	59.9	52.5	47.4	56.3	12	55.9			1	68.1
212	Thornburg	6	56.2	47.8	45.3	52.8	5	52.0			1	56.5
213	Trafford	2	67.0	56.5	47.5	64.2	2	64.2				
214	Turtle Creek	13	58.4	52.9	49.3	55.0	7	50.0	5	60.7	1	61.8
215	Upper St. Clair	109	55.4	47.1	42.5	51.9	89	50.4	6	61.9	1	56.9
216	Verona	8	60.1	53.9	50.1	56.6	7	56.8			1	55.5
217	Versailles	7	59.3	51.9	47.6	55.7	5	56.4	1	62.5	1	48.2
218	Wall	8	56.0	49.6	45.9	52.5	5	48.5	1	51.4	2	63.8
219	West Deer	262	52.0	41.3	36.2	49.3	183	50.0	6	57.4	4	55.4
220	West Elizabeth	3	66.7	57.7	53.3	63.4	1	61.0				64.6
221	West Homestead	10	59.3	53.4	49.2	55.8	7	52.1	6	65.3	3	64.8
222	West Mifflin	141	61.3	53.4	49.1	57.8	102	54.6	6	65.3	30	66.9
223	West View	16	57.7	48.8	43.8	54.4	14	53.0				
224	Whitaker	6	55.0	48.0	44.2	51.4	6	51.4				
225	Whitehall	51	54.8	47.9	43.6	51.2	41	50.9	8	53.9		
226	White Oak	65	58.9	50.3	44.9	55.5	54	55.2	7	60.0		
227	Wilkins	33	56.7	50.4	47.5	53.7	25	51.2	6	61.7	2	54.4
228	Wilkinsburg	47	59.6	52.4	48.3	56.0	36	55.1	6	60.8	1	59.1
229	Wilmerding	6	62.7	58.3	56.0	59.7	5	56.2	1	77.4		

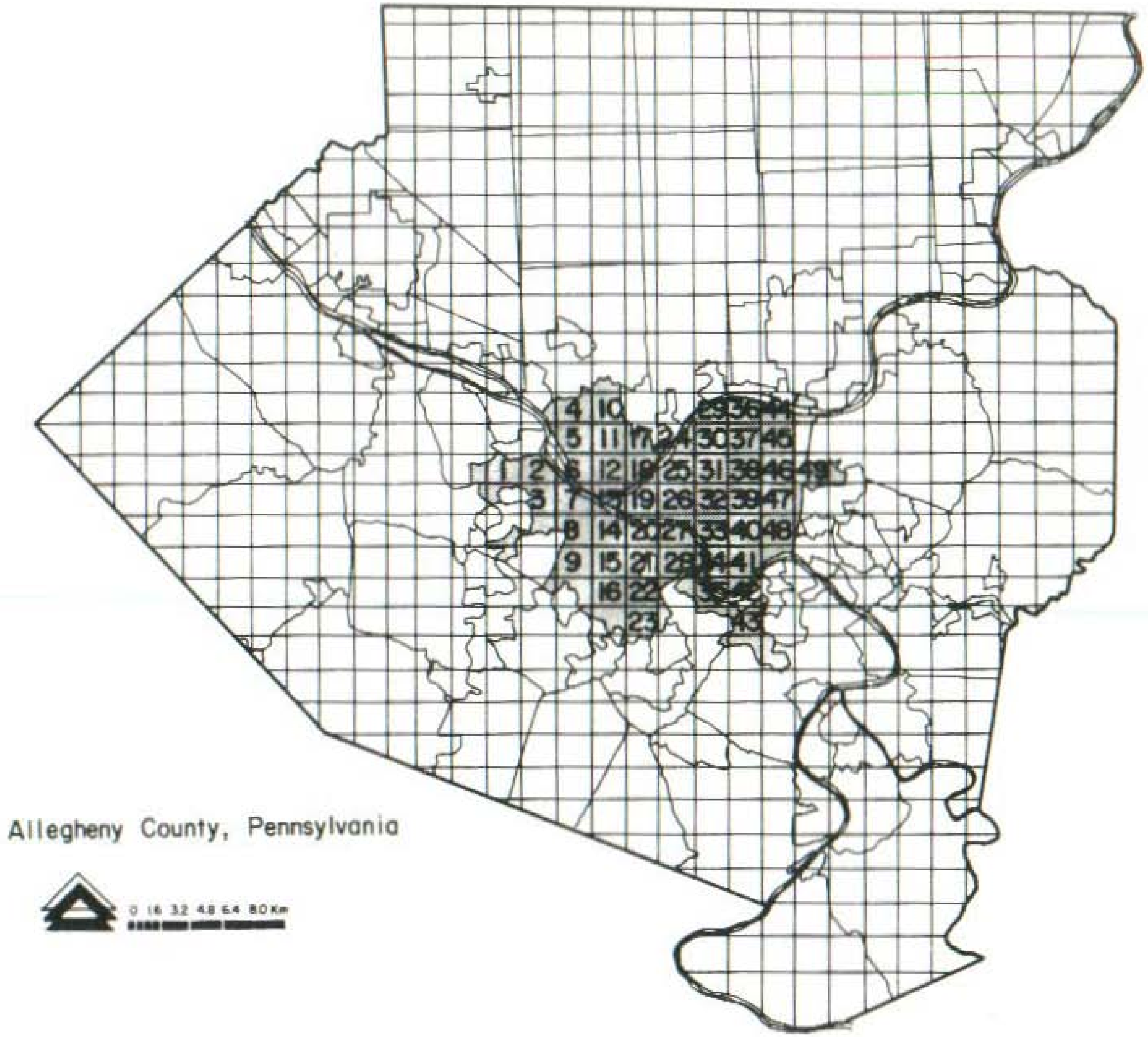


Figure 5-11. Individual BSSU's Comprising the City of Pittsburgh

Table 5-9

Average L_{10}, L_{50}, and L_{90} A-weighted Sound Levels (Pittsburgh)

BSSU	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	BSSU	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$	BSSU	$\overline{L}_{10}$	$\overline{L}_{50}$	$\overline{L}_{90}$
1	56.2	48.7	46.5	18	66.7	60.1	56.1	34	63.2	58.1	54.3
2	61.0	53.4	49.7	19	69.2	63.2	60.9	35	69.3	57.2	49.2
3	61.0	53.0	50.0	20	69.4	61.8	58.2	36	61.5	53.7	49.4
4	62.6	51.1	44.3	21	63.3	56.6	51.7	37	61.7	54.0	50.0
5	60.0	51.1	47.8	22	61.6	53.9	49.1	38	60.5	54.3	49.2
6	67.7	60.9	56.4	23	57.6	51.7	46.1	39	59.4	52.9	49.3
7	65.0	59.3	55.8	24	66.4	57.2	51.8	40	62.0	54.9	50.3
8	64.7	57.7	52.9	25	67.8	62.1	58.2	41	58.4	51.3	47.3
9	55.6	50.0	46.0	26	63.5	56.6	51.4	42	60.8	54.0	50.1
10	62.3	52.7	46.2	27	67.4	62.5	58.7	43	56.1	49.3	45.5
11	65.3	52.7	48.2	28	59.7	52.0	47.5	44	60.0	52.5	48.5
12	64.4	56.3	52.1	29	71.0	64.5	61.3	45	60.5	52.0	48.2
13	75.0	67.1	62.0	30	71.0	64.5	61.3	46	62.9	56.1	51.0
14	59.3	51.4	47.6	31	61.0	55.0	51.1	47	59.4	52.9	49.3
15	66.2	59.2	54.4	32	62.4	56.1	51.2	48	62.0	50.8	44.2
16	58.6	51.2	47.2	33	68.7	61.8	58.3	49	58.6	51.4	47.3
17	55.1	47.8	41.0								

MIDPOINT	LEVEL - 1 NO.	DIST	LEVEL - 10 NO.	DIST	LEVEL - 50 NO.	DIST	LEVEL - 90 NO.	DIST
26	0	.0	0	.0	0	.0	0	.0
29	0	.0	0	.0	0	.0	0	.0
32	0	.0	0	.0	0	.0	0	.0
35	0	.0	0	.0	0	.0	6	.6
38	0	.0	0	.0	4	.4	23	2.3
41	0	.0	1	.1	12	1.2	49	5.0
44	0	.0	5	.5	54	5.5	143	14.6
47	4	.4	24	2.5	143	14.6	220	22.5
50	9	.9	60	6.1	161	16.4	142	14.5
53	21	2.1	88	9.0	146	14.9	122	12.5
56	42	4.3	121	12.4	119	12.2	84	8.6
59	65	6.6	141	14.4	107	10.9	76	7.8
62	99	10.1	121	12.4	70	7.2	47	4.8
65	154	15.7	131	13.4	63	6.4	29	3.0
68	120	12.3	88	9.0	45	4.6	23	2.3
71	135	13.8	67	6.8	24	2.5	9	.9
74	94	9.6	58	5.9	22	2.2	3	.3
77	90	9.2	31	3.2	4	.4	1	.1
80	58	5.9	27	2.8	3	.3	2	.2
83	39	4.0	13	1.3	2	.2	0	.0
86	28	2.9	2	.2	0	.0	0	.0
89	14	1.4	1	.1	0	.0	0	.0
92	5	.5	0	.0	0	.0	0	.0
95	2	.2	0	.0	0	.0	0	.0
98	0	.0	0	.0	0	.0	0	.0
NUMBER	979.0		979.0		979.0		979.0	
SUM	67,886.0		61,071.0		54,072.0		49,957.0	
MEAN	69.3		62.4		55.2		51.0	
SUM2	4,779,252.0		3,879,953.0		3,048,464.0		2,603,039.0	
S1	71,888.4		70,282.9		61,966.4		53,803.2	
S2	73.5		71.9		63.4		55.0	
S	8.6		8.5		8.0		7.4	
ERR-99	0.7		0.7		0.6		0.6	
ERR-95	0.5		0.5		0.5		0.4	
ERR-90	0.4		0.4		0.4		0.3	

COMPUTED L EQUIVALENT --- 58.838

Figure 5-12. Computer Analysis for Measurements Taken in the City of Pittsburgh

MIDPOINT	LEVEL - 1 NO.	LEVEL - 1 DIST	LEVEL - 10 NO.	LEVEL - 10 DIST	LEVEL - 50 NO.	LEVEL - 50 DIST	LEVEL - 90 NO.	LEVEL - 90 DIST
26	0	.0	0	.0	0	.0	8	.1
29	0	.0	1	.0	25	.3	181	2.3
32	0	.0	5	.1	75	1.0	309	4.0
35	3	.0	43	.6	297	3.8	648	8.4
38	17	.2	86	1.1	482	6.2	915	11.8
41	59	.8	175	2.3	649	8.4	806	10.4
44	94	1.2	386	4.8	1,050	13.6	1,371	17.7
47	194	2.5	498	6.4	1,206	15.6	1,213	15.7
50	241	3.1	707	9.1	1,048	13.5	790	10.2
53	297	3.8	809	10.5	789	10.2	496	6.4
56	552	7.1	958	12.4	657	8.5	376	4.9
59	588	7.6	939	12.1	487	6.3	269	3.5
62	753	9.7	796	10.3	321	4.1	163	2.1
65	1,407	18.2	812	10.5	278	3.6	93	1.2
68	818	10.6	524	6.8	166	2.1	63	.8
71	945	12.2	423	5.5	106	1.4	26	.3
74	625	8.1	257	3.3	68	.9	9	.1
77	494	6.4	184	2.4	23	.3	2	.0
80	287	3.7	95	1.2	11	.1	2	.0
83	159	2.1	46	.6	2	.0	0	.0
86	120	1.6	12	.2	0	.0	0	.0
89	60	.8	2	.0	0	.0	0	.0
92	23	.3	1	.0	1	.0	1	.0
95	4	.1	0	.0	0	.0	0	.0
98	1	.0	0	.0	0	.0	0	.0
NUMBER		7,741.0		7,741.0		7,741.0		7,741.0
SUM		509,339.0		452,785.0		385,809.0		349,244.0
MEAN		65.8		58.5		49.8		45.1
SUM2		34,212,587.0		27,189,227.0		19,847,993.0		16,283,518.0
S1		699,317.8		705,018.7		619,394.1		526,978.6
S2		90.4		91.1		80.0		68.1
S		9.5		9.5		8.9		8.3
ERR-99		0.2		0.2		0.2		0.2
ERR-95		0.2		0.2		0.1		0.1
ERR-90		0.1		0.1		0.1		0.1

COMPUTED L EQUIVALENT --- 55.111

Figure 5-13. Computer Analysis for Measurements Taken in Allegheny County

SECTION 6. CONCLUSIONS

Community noise legislation must have a firm technical foundation if it is to be effective in controlling noise and in withstanding the anticipated legal and technical cross examination when it is enacted. During the initial stages of the Allegheny County noise program, it was thought that an extensive survey was necessary to formulate such legislation. Since the resulting ordinance was never enatced, however, this hypothesis was never put to a practical test. Nevertheless, this development should not affect the merits of the survey itself.

The survey had two main objectives: (1) to develop the technical foundation for the proposed community noise ordinance, and (2) to define the existing acoustic environment for the entire county. To achieve these goals, a methodology was developed to gather the data and techniques defined to evaluate the results.

The extensive information that was obtained seems to imply that the methodology was adequate to gather sufficient noise data. It should be stated that because the program was designated to encompass the entire county, a trade-off had to be made between the number of sites surveyed and the temporal length of noise sample. Ideally, each site should have been sampled for at least 24 hours, but that would have extended both the survey timetable and budget to unrealistic levels. However, by measuring during peak activity hours of the day (0900-1600 hours), a detailed evaluation of the spatial variation of levels during these high noise periods could be obtained and used as a basis for legislation. This somewhat justified the length of sample versus number of site trade-off.

Regarding the evaluation techniques developed to process the data and incorporate the results into the legislation, it cannot be stated strongly enough that this document only reports the results of a single survey. While some techniques may or may not work in Allegheny County, the results could be entirely different for another geographic area. Only after several surveys are completed can the analysis by the different parameters--BSSU, source, land use, etc.--be either accepted or rejected for universal usage.

The reasoning behind the evaluation by parameters was basic. Noise data were recorded in more than 7,000 sites, with the levels varying as much as 50 dB between different sites. By sorting the data according to the different parameters, it was hoped that statistical distributions with minimal standard deviations could be created around various mean values. For example, if the L_{50} A-weighted sound levels recorded in all the sites in municipality A formed a normal distribution around 60 dB with a standard deviation of 1 dB, then a L_{50} regulation of 60 dB. would be compatible with the existing environment. In the case of Allegheny County, this analysis did not provide usable data when municipalities were the parameter because the spread of values was too great. However, when the data were analyzed by zoning or land use, the results could be inserted almost directly into the legislation.

The hour-by-hour analysis was used primarily to verify the survey methodology. It had not been expected to produce any unusual results, and this fact is now documented.

The BSSU parameter was the only technique available for developing a spatial picture of the acoustic environment. It is conceded that by shifting the BSSU on the maps, the results in Figure 5.2 could be entirely different. Thus, alleged violators of the anti-degradation section (based on Figure 5.2) could have conducted a separate survey with an entirely different methodology, come up with a different number, and have been perfectly justified in challenging the citation. As a partial solution to this problem, measurement procedures for each section of the proposed noise code were specifically outlined. (See Appendix A). Nonetheless, it is urged that all community noise surveying methods be standardized for future usage.

Both analysis of noise-sensitive areas and of major sources produced results that could be used in the legislation. In the former, the techniques revealed that standards for residential land use would be compatible for noise-sensitive areas. In the latter, justification was provided for setting up regulations for such sources as industry, construction, ard traffic.

It is conceded that the present analytic methods could have been refined, and additional methods developed for more accuracy. However, since the major task of the noise program in Allegheny County was regulation and not research, neither the time nor the funds were available to continue these studies. Nevertheless, if the program were to be repeated, the data-gathering procedures would probably be identical and the technical analysis procedures similar.

One major drawback was the time required to completely survey the entire geographic area. However, this period allowed for the training of personnel and the enactment of a public relations program. Also, since the news media became interested in the program and periodically reported on its progress, both accurate and widespread publicity was obtained. This resulted in more than 1,000 individuals and organizations testifying at the public hearings on the proposed legislation.

It is hoped that the documented results presented in this report will contribute to future attempts to decrease noise.

SECTION 7. REFERENCES

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2. Noise Control Study in Toronto, Volume 2, October 1972.

3. Bishop, D. and Simpson, M., "Correlations Between Different Community Noise Measures," Noise Control Engineering, Volume 1, No. 2, 1973.

4. Chicago Urban Noise Study, BBN Report #1411, November 1970.

5. New York Urban Noise Survey, HUD TE/NA - 372, November 1972.

6. "Report to the President and Congress on Noise," US EPA Gov. Doc. #92-63, February 1972.

7. Dietrich, W., "Development of Regulations for Noise at Property Lines," BBN #2177, July 1971.

8. EPA #550/9-74-004, "Information on Levels of Environmental Noise Prerequisite to Protect Public Health and Welfare with an Adequate Margin of Safety," March 1974.

9. Goff, R. and Rosenberg, C., "Noise Evaluation of Liberty Harbor," BBN #2530, April 1973.

APPENDIX A

PROPOSED ALLEGHENY COUNTY NOISE LEGISLATION

This appendix contains the following isolated sections from the proposed Allegheny County Community Noise Legislation. *

1909 - Maximum Permissible Sound Levels Along Lot Boundary Lines

1910 - Vibration Criteria

1912 - Federal Standards

1913 - Construction Activities

1915 - Anti-Degradation

1916 - Measurement Procedure

Sections 1909, 1913, 1915, and 1916 were developed either entirely or partially from the methodology and results described in the text. Section 1910 was developed following an extensive measurement and analysis program, while Section 1912 was based directly on work performed by the Environmental Protection Agency pursuant to the Noise Control Act of 1972.

1909--Maximum Permissible Sound Levels Along Lot Boundary Lines

No person shall cause or no person who has charge, care, or control of any lot shall permit sound to emanate from a lot which exceeds the maximum permissible sound level established by this section.

.1) Maximum Permissible Sound Levels--The following maximum permissible sound levels are hereby established:

a) If the sound emanates from a lot classified as residential, the maximum permissible sound level is:

1) 55 dBA at any point on a boundary separating the residential lot from an adjacent residential lot.

2) 60 dBA at any point on a boundary separating the residential lot from a commercial lot.

3) 65 dBA at any point on a boundary separating the residential lot from an industrial lot.

b) If the sound emanates from a lot classified as commercial, the maximum permissible sound level is:

* Sections 1911, 1914, and 1917 have been omitted from this Appendix. Thus, all references to them in the text and especially in section 1916 have been deleted.

1) 58 dBA at any point on a boundary separating the commercial lot from a residential lot.

2) 60 dBA at any point on a boundary separating the commercial lot from an adjacent commercial lot.

3) 65 dBA at any point on a boundary separating the commercial lot from an industrial lot.

c) If the sound emanates from a lot classified as industrial, the maximum permissible sound level is:

1) 60 dBA at any point on a boundary separating the industrial lot from a residential lot.

2) 63 dBA at any point on a boundary separating the industrial lot from a commercial lot.

3) 65 dBA at any point on a boundary separating the industrial lot from an adjacent industrial lot.

d) In all instances in which the lot from which noise emanates does not directly adjoin a residential, commercial, or industrial lot, the performance standards governing noise in this section shall apply at the nearest residential, commercial, or industrial lot boundary.

e) If a mixed lot exists, the least restrictive lot standard shall be used when establishing maximum permissible sound levels under this section.

.2) Deviations from Maximum Permissible Sound Levels Established in Section 1909.1--The following deviations from the maximum permissible sound levels are permitted for non-impulsive sounds:

a) The maximum permissible levels established in Section 1909.1:

1) May be exceeded by no more than:

DURATION	ALLOWANCE dBA
up to 15 min/half hour	+3
up to 7-1/2 min/half hour	+6
up to 5 min/half hour	+8

2) Shall be reduced by 5 dBA for sound with a pure tone component.

3) Shall be reduced by 10 dBA for all measurements taken in residential lots between the hours from 10:00 p.m. to 7:00 a.m., prevailing time.

4) The adjustments in subsection .2(a) of this section shall be cumulative.

.3) Deviations from Maximum Permissible Sound Levels Established in Section 1909.1--The following deviations from the maximum permissible levels are permitted for impulsive sounds:

a) The maximum permissible levels established in Section 1909.1:

1) May be exceeded by no more than:

NUMBER OF PEAKS PER HALF HOUR	ALLOWANCE dBA
1	+24
2	+18
4	+12
8	+ 6

2) Shall be reduced by 10 dBA for all measurements taken in residential lots between the hours from 10:00 p.m. to 7:00 a.m., prevailing time.

3) The adjustments in subsection .3(a) of this section shall be cumulative.

.4) The levels established in this section shall not apply to sound originating from:

a) The human larnyx without amplification.

b) Refuse vehicles.

c) Circulation devices located on residential lots and operating between the hours from 10:00 p.m. to 7:00 a.m., prevailing time.

d) In-flight operation of aircraft, including pre-takeoff run-up of aircraft engines.

e) Propulsion of railroad trains.

f) Recreational facilities.

g) Any operation required by the Occupational Safety and Health Act passed as Public Law 91-596 on December 29, 1970.

h) Barking dogs unless a petition is submitted which contains an enforcement request by the occupants from two or more dwelling units.

i) Commercial farming activities.

j) Building repair and lawn maintenance activities between the hours from 7:00 a.m. to 10:00 p.m., prevailing time unless a petition is submitted which contains an enforcement request by the occupants from two or more dwelling units.

k) Any unit of a multi-unit dwelling and traveling to any other unit in the same dwelling.

l) Any site whose reference noise level as defined in Figure 1 of Section 1915 is lower than the criteria established in subsection 1909.1.

m) Emergency work, operations, and warning devices.

1910--Vibration Criteria

.1) No person who has charge, care or control of any lot from which earthborne vibrations emanate shall produce or permit the production of earthborne vibrations which, when measured at any point on any structure located beyond his boundary line, exceed the criteria in Table I.

TABLE I

TYPE OF VIBRATION	CENTER FREQUENCY IN Hz OF THIRD OCTAVE BAND	ALLOWABLE LEVEL
Impulsive Shock	*	.0142 cm/sec (.0056 in/sec)
Intermittent	1.0	.61 cm/sec^2 (.24 in/sec^2)
	1.25	.61 cm/sec^2 (.24 in/sec^2)
	1.6	.61 cm/sec^2 (.24 in/sec^2)
	2.0	.61 cm/sec^2 (.24 in/sec^2)
	2.5	.61 cm/sec^2 (.24 in/sec^2)
	3.15	.66 cm/sec^2 (.26 in/sec^2)
	4.0	.66 cm/sec^2 (.26 in/sec^2)
	5.0	.66 cm/sec^2 (.26 in/sec^2)
	6.3	.66 cm/sec^2 (.26 in/sec^2)
	8.0	.66 cm/sec^2 (.26 in/sec^2)
	10.0	.90 cm/sec^2 (.35 in/sec^2)
	12.5	1.10 cm/sec^2 (.43 in/sec^2)
	16	1.38 cm/sec^2 (.54 in/sec^2)
	20	1.79 cm/sec^2 (.70 in/sec^2)
	25	2.17 cm/sec^2 (.85 in/sec^2)
	31.5	2.76 cm/sec^2 (1.09 in/sec^2)
	40	3.48 cm/sec^2 (1.37 in/sec^2)
	50	4.35 cm/sec^2 (1.71 in/sec^2)
	63	5.55 cm/sec^2 (2.19 in/sec^2)
	80	7.04 cm/sec^2 (2.77 in/sec^2)

* Use overall level as defined in subsection 1916.3)b)3).

.2) Deviations from Maximum Permissible Vibration Levels:

a) If a structure has internal vibrations which exceed the criteria in Table I, then a violation shall occur if the level of external vibrations exceeds the level of internal vibrations in at least one one-third octave band.

1912--Federal Standards

.1) The following standards promulgated by the Administrator of the United States Environmental Protection Agency pursuant to the provisions of the Noise Control Act of 1972 are hereby incorporated, by reference, as part of the standards and requirements of this article:

a) Motor Carriers in Interstate Commerce, Part 202 of Title 40 of the Code of Federal Regulations.

b) Compliance with Interstate Motor Carrier Noise Emission Standards, Part 325 of Title 49 of the Code of Federal Regulations.

c) Noise Emission Standards for Construction Equipment, Part 204 of Title 40 of the Code of Federal Regulations.

d) Railroad Noise Emission Standards, Part 201 of Title 40 of the Code of Federal Regulations.

1913--Construction Activities

No person engaged in construction activities or no person who has charge, care, or control of any lot on which construction activities occur shall permit sound to emanate from that lot which exceeds the maximum permissible sound levels established by this section.

.1) The following maximum permissible sound levels are hereby established:

a) If the sound emanates from a lot on which construction activities occur, the maximum permissible sound level is:

1) 80 dBA at any point on a boundary separating the lot on which construction activities occur from a residential lot.

2) 83 dBA at any point on a boundary separating the lot on which construction activities occur from a commercial lot.

3) 86 dBA at any point on a boundary separating the lot on which construction activities occur from an industrial lot.

.a) Maximum permissible levels shall apply at a distance no less than 50 feet from source.

b) In all instances in which the lot from which noise emanates does not directly adjoin a residential, commercial, or industrial lot, the performance standards governing noise in this section shall apply at the nearest residential, commercial, or industrial lot boundary.

c) If a mixed lot exists, the least restrictive lot standard shall be used when establishing maximum permissible sound levels under this section.

.2) Deviations from Maximum Permissible Sound Levels Established in Section 1913.

a) The same as permitted by Sections 1909.2 and 1909.3.

1) Any construction activity which is required by state or local regulation to occur between the hours of 10:00 p.m. and 7:00 a.m., prevailing time, will be allowed the deviations in Sections 1909.2(a)1, 1909.2(a)2, 1909.2(a)4, 1909.3(a)1, and 1909.3(a)3 only.

.3) The levels established in this section shall not apply to sounds originating from:

a) Lawn maintenance and home repair.

b) Pile drivers.

c) Any operation required by the Occupational Safety and Health Act, passed as Public Law 91-596, on December 29, 1970.

d) Emergency work, operations, and warning devices.

1915--Anti-Degradation

.1) If any residential lot is located in an area whose reference noise level as defined in Figure 1 is below those levels established in Section 1909.1, the reference noise level shall represent the maximum permitted noise limitation that may be received at the boundary line of the residential lot.

.2) Deviations from Maximum Permissible Sound Levels Established in Section 1915.1.

a) The same as permitted by Sections 1909.2 and 1909.3.

b) The maximum permissible levels established in Section 1915.1 may be exceeded by:

1) 3 dBA for sounds emanating from commercial lots.

2) 5 dBA for sounds emanating from industrial lots.

c) The adjustments in subsection .2 of this section shall be cumulative.

.3) Exemptions.

a) Same as in Section 1909.4.

.4) Updating.

a) Figure 1 shall be updated every 5 years using a methodology determined by the Director.

1916--Measurement Procedures

The measurement procedures listed in this section shall be used as the method to determine the existence of a violation of this article.

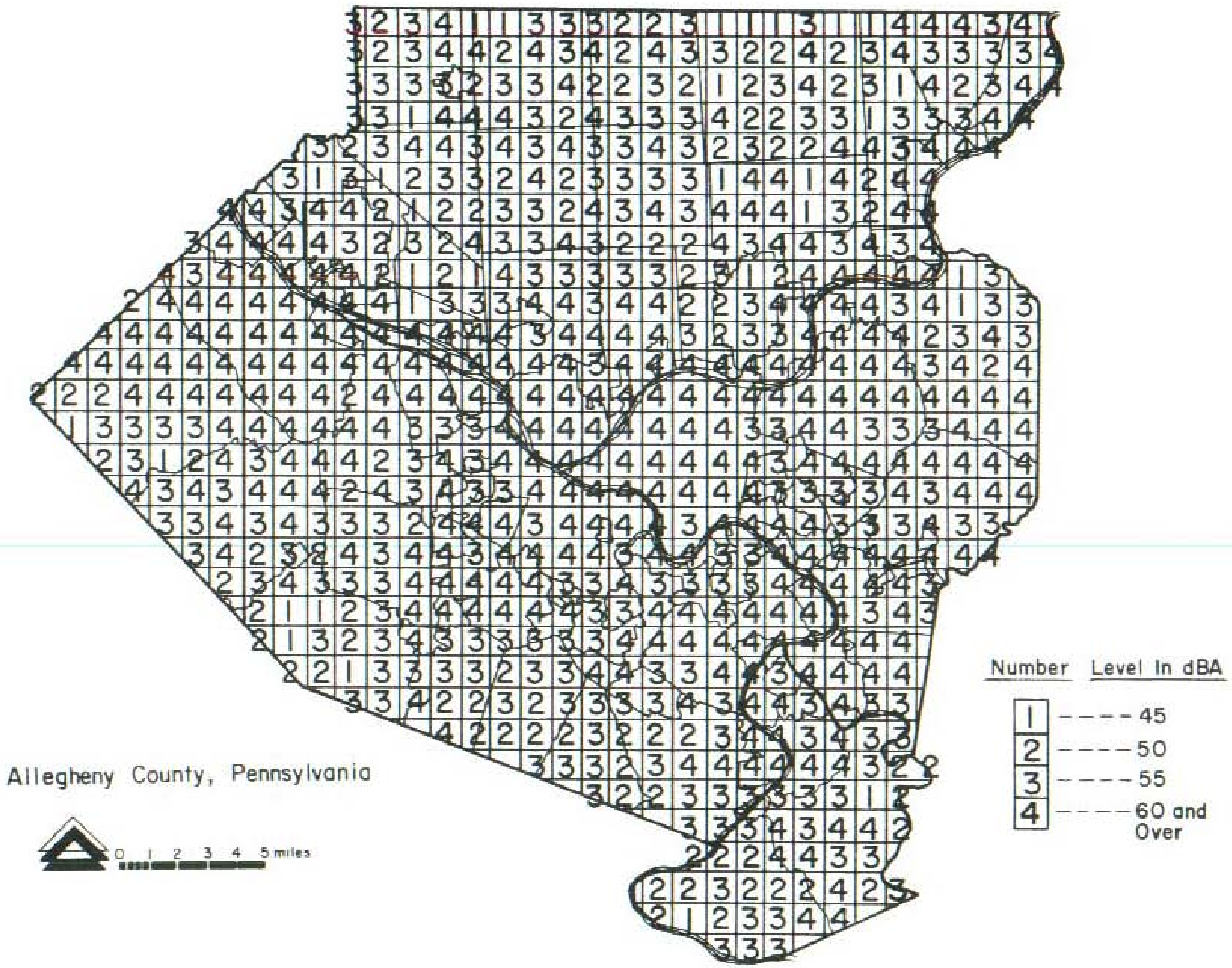

Figure 1. Reference Noise Level

.1) Measurement Instrumentation

a) Instruments used for measurements shall conform to or exceed the following standards, unless otherwise stated:

1) A.N.S.I. S1.4-1971--Specifications for Sound Level Meters, Type II.
2) A.N.S.I. S1.11-1966--Specifications for Octave, One-Half Octave, and One-Third Octave Band Filter Sets, Class II.
3) A.N.S.I. S1.6-1967--Preferred Frequencies and Band Numbers for Acoustical Measurements.
4) A.N.S.I. S1.8-1969--Preferred Reference Quantities for Acoustical Levels.

b) All measurement instruments shall be acoustically calibrated in accordance with the manufacturer's instructions before and after each noise survey and at intervals not exceeding two hours when the instrument is used longer than a two-hour period.

c) Windscreens shall be used with all microphones according to the manufacturer's specifications. Measurements shall not be taken whenever the wind speed exceeds 24.16 kph (15 mph).

.2) The following measurement procedure shall be used to determine if a violation exists pursuant to Section 1909.

a) Set sound level meter microphone at a height of 1.2 meters (4 feet) $\pm$ .3 meters (1 foot) on adjacent boundary closest to noise source or on lot from which a complaint arises.

1) If a complaint arises from a multi-story structure, the height of the sound level meter shall be adjusted so that it is on a direct line between the noise source and noise receiver.

b) Calibrate sound level meter according to manufacturer's specifications before and after each noise survey.

c) The microphone shall be fitted with a windscreen and oriented consistent with the manufacturer's recommendations for the flattest frequency response and at least .9 meters (3 feet) away from any adjacent structures.

d) Set meter for A-weighting and fast response.

e) Compare measured levels with permissible criteria.

1) Non-impulsive noise.

.1) Connect third octave band pass filter set and determine if pure tone component exists.

.2) Determine permissible noise levels.

.3) Fill in Row #2 of Table 3 by adding the permissible noise level to the numbers in Row #1.

.4) Read needle of sound level meter and check appropriate column.

.a) If an extraneous noise occurs, such as a car passby, ignore the reading, wait another 10 seconds and continue the procedure.

.5) A violation occurs when the checks in any column exceed the shaded squares or if the sound level at any time exceeds the levels in Column #4 by 3 dBA or more.

2) Impulsive noise.

.1) Determine permissible noise level.

.2) Fill in Row #2 of Table 4 by adding the permissible noise level to the numbers in Row #1.

.3) Read maximum deflection of sound level meter for each impulse and check appropriate column.

.a) If sound level is below criteria in column #1, ignore reading and wait for next impulse.

.b) Continue survey for one-half hour.

.4) A violation occurs when:

.a) The checks in any column exceed the shaded squares; or

.b) The criteria in column #4 is exceeded for any impulse by 3 dBA or more; or

.c) $D > 1.5$ where:

$$D = \frac{(C_1)}{8} + \frac{(C_2)}{4} + \frac{(C_3)}{2} + \frac{(C_4)}{1}$$

where C_n = # counts in nth column

f) Maintain acoustic surveillance of extraneous noise sources to insure that measurements are from sound under investigation. In order for a violation to occur, the source or sources of noise must be identifiable in relation to the ambient noise and must exceed the ambient noise by 5 decibels or more in at least one octave band.

TABLE 3

	Column #1	Column #2	Column #3	Column #4
Row #1	Below 0 dBA	0.1 to 3 dBA	3.1 to 6 dBA	6.1 to 8 dBA
Row #2				
	# of Occurrences	# of Occurrences	# of Occurrences	# of Occurrences
	01 02 03 04 05	01 02 03 04 05	01 02 03 04 05	01 02 03 04 05
	06 07 08 09 10	06 07 08 09 10	06 07 08 09 10	06 07 08 09 10
	11 12 13 14 15	11 12 13 14 15	11 12 13 14 15	11 12 13 14 15
	16 17 18 19 20	16 17 18 19 20	16 17 18 19 20	16 17 18 19 20
	21 22 23 24 25	21 22 23 24 25	21 22 23 24 25	21 22 23 24 25
	26 27 28 29 30	26 27 28 29 30	26 27 28 29 30	26 27 28 29 30
	31 32 33 34 35	31 32 33 34 35	31 32 33 34 35	31 32 33 34 35
	36 37 38 39 40	36 37 38 39 40	36 37 38 39 40	
	41 42 43 44 45	41 42 43 44 45	41 42 43 44 45	
	46 47 48 49 50	46 47 48 49 50	46 47 48 49 50	
	51 52 53 54 55	51 52 53 54 55		
	56 57 58 59 60	56 57 58 59 60		
	61 62 63 64 65	61 62 63 64 65		
	66 67 68 69 70	66 67 68 69 70		
	71 72 73 74 75	71 72 73 74 75		
	76 77 78 79 80	76 77 78 79 80		
	81 82 83 84 85	81 82 83 84 85		
	86 87 88 89 90	86 87 88 89 90		
	91 92 93 94 95	91 92 93 94 95		

TABLE 4

	Column #1	Column #2	Column #3	Column #4
Row #1	0 to 6 dBA	6.1 to 12 dBA	12.1 to 18 dBA	18.1 to 24 dBA
Row #2				
	1	1	1	1
	2	2	2	
	3	3		
	4	4		
	5			
	6			
	7			
	8			

.3) The following measurement procedure shall be used to determine if a violation exists pursuant to Section 1910.

a) An accelerometer meeting the following specifications shall be used:

1) A flat frequency response between at least 1 to 200 Hz, over which the sensitivity shall not vary by more ± 5 percent.

2) The transverse axis sensitivity shall be less than 5 percent of the main axis sensitivity.

3) The variation in sensitivity shall not exceed 1 percent per degree Celsius between -20.0 and +50.0 degrees Celsius (-4° F. to +122° F.).

b) Using the manufacturer's instructions, connect the accelerometer to a sound analyzer which meets the following specifications:

1) Applicable parts of A.N.S.I. Standard S1.4-1971, Type 1.

2) A.N.S.I. Standard S1.11-1966, Class II.

3) The frequency response of the measurement system shall be limited from 1 to 100 Hz when used to measure the "overall" acceleration level.

c) Calibrate the measurement system before and after vibration survey in accordance with the manufacturer's instructions by coupling the accelerometer with a calibration system meeting the following specifications:

1) The calibration frequency shall be within the range of 1 to 125 Hz.

2) The vibration output of the calibrator shall be known to within ± 10 percent when loaded with the accelerometer mass.

d) Mount accelerometer to floor, walls, or ceiling by imbedded stud, magnet, adhesive, or probe.

1) Mass of accelerometer shall be less than 10 percent of the mass of the vibrating member.

e) Set sound analyzer for fast response.

f) Compare measured levels with permissible criteria.

1) Intermittent vibration

.a) Set sound analyzer to "overall" as defined in step 1916.3)b)3).

.b) Affix the accelerometer to at least two measurement locations on the structure (floor, walls, ceiling, etc.).

.c) Read maximum deflections of needle.

.d) At the location having the largest "overall" acceleration, connect the third octave band pass filter and determine the maximum level in each third octave band.

.e) A violation occurs if the measured level exceeds the criteria in Table I in any one-third octave band.

2) Shock vibration

.a) Set sound analyzer to "overall" as defined in step 1919.3)b)3).

.b) Affix the accelerometer to at least two measurement locations on the structure (floor, walls, ceiling, etc.).

.c) Read maximum deflection of needle.

.5) The following measurement procedure shall be used to determine if a violation exists pursuant to Section 1913.

a) Set sound level meter microphone at a height of 1.2 meters (4 feet) ± .3 meters (1 foot) on adjacent boundary closest to noise source or on lot from which a complaint arises.

1) Relocate microphone so that it is at least 15.2 meters (50 feet) from the nearest piece of construction equipment emitting noise.

b) Follow steps b through f in subsection 1916.2.

.7) The following procedure shall be used to determine if a violation exists pursuant to Section 1915.

a) Same as Subsection 1916.2.

APPENDIX B

SAMPLE OF RAW NOISE SURVEY DATA

080318YARROW	1881CR3		0104	110573112966625654
080321MAGEE WOMENS HOSPITAL	1881C	02	0107	102273092063545048
080322CRAFT/MCKEE	188R3C3		01	102273062266625854
080323ATWOOD/DAWSON	188R3		010711	110573114874676052
080401PEMBRUKE/AMBERSON	188R1R3		01	102273090076665553
080402WESTMINSTER PLACE	188R1R3		01	101773084070635451
080403IVY ST	188R3R1		01	101773085865586349
080404OFF MURRAY HILL RD	188R3R1		01	101773090770655954
080405BENEDUM HALL AT CHAT	1881C		02	101673160564605854
080406DEVON/WARWICK	188R1R3		0107	101673152060565350
080407UNGER	188R1		02	101773092872665654
080408DUNMDYLE/KIMPLING	188R1		0103	101773094556514846
080409NEGLEY/FAIROAKS	188R1R3		01	102473154162524441
080410MURRAY HILL PL/WOODL	1881C		74	101673155070645752
080411C M U	1881C		0107	101673153366575452
080412FAIROAKS/MALUERN	188R1		01	101673091062585553
080413IVERNESS	188R1		01	101773101804565048
080414SOLEWAY	188R1	01	14	101773103250555047
08415SOLEWAY/MURRAY	188R1		0111	101673133061565250
080417FORBES/ALBERMELF	188R11C		01	101673134068585148
080418NORTHUMBERLAND/BENNI	188R1		01	101673093572655650
080419AYLESBORO	188R1R3		01	101673095068625148
080420MURRAY/AYLESBORO	188R1		01	101673131570655450
080423MURDOCK/DARLINGTON	188R1R3		01	101673125871645954
080424DARLINGTON/WIGHTMAN	188R1R3		01	101673100565564644
080425MURRAY/BARTLETT	188C3R1		01	101673102068605044
080501BEECHWOOD/BEECHMONT	188R1		01	101673103578766255
080502HASTINGS/EDGERTON	188R1		01	101673143074706253
080502JUNIATA	188R1		03	101673144264544947
080504MURTLAND	188R1		040111	101673146769675256
08050PENN/LANG	188R1		01	103073126565504441
080506HASTINGS	188R1		01	103073114883736460
080507WICKINS	188R1		01	101673136466625450
080508WILLARD/CEMETARY	188SPR1	01040111		101673141576555450
080509EDGERTON/LLOYD	188R1		010311	103073123776685954
080510ELM	228R1		0111	103073125264534338
080510REVNOLD/FRICK PARK	188SPR1		010401	011474101966605452
080511DENNISTON	188R1	01	0112	103073130967584339

080203BEDFORD/JUNHILL	188R3		01	100173083449575452
080204MORGAN ST	188R3		03	100173085073665852
080205NEAR HERON	188R3C3		01	100173092576695648
080206BEDFORD/SEAL	188R3	01	11	100173100580696250
080207WEBSTER/PERRY	188R3C3		01	092173112081756558
080208CHAUNCEY/WYLIE	188R3		01	100173105580675853
080209OFF ELBA	188R3		01	100173111567605450
080210OFF BRAKENRIDGE	1881C		01	100173113068615349
080211CENTER/GREEN	188C3R3		01	100173151561565044
080212ROSE/ADDISON	188R3		01	092173113576666056
080213FOOTBALL FIELD	188SPR3		10	092173115088635546
080214NEAR WADSWORTH	188R3		11	092173120559514542
080215ROBINSON/DARRIAGH	188R310		01	092173122561544441
080216DINWIADLE	188R3		01	100173144566625753
080217BENTLEY/NIGH	188R3		01	092173104571655756
080218BENTLEY/KIRKPATRIK	188SPR3		01	092173102064595844
080219ALLEQUIPPA CIRCLE	188R3		11	092173093075665848
080220DUNSEITH TERRACE	188R310		01	092173095660524847
080221TUSTIN/MILDEABURGER	188M1		01	092173100572605248
080222TUSTIN/SUMMONVILLE	188M1SP		01	092173081588645955
080223MOULTRIE/TUSTIN	188SP		01	092173084576686259
080224BRENHAM/5TH	188SP		01	092173090074706866
080225ROBINSON/CRAFT	188M1		01	092173101586786860
080301CHEROKEE	188R1		0106	092173091562585553
080302CENTRE	188R1		01	102273124261585238
080303DITHRIDGE	188R3		0106	102273125777696153
080304BAYARD	188R3R1		0104	102273132086595452
080305DEVONSHIRE	188R1R3		10604	102273133756494442
080306UNIVERSITY DRIVE	1881CRL	020101		102273135369666049
080307LYTTON	188R11C		0111	110573102164584843
080308RUSKIN	1881C		0111	110573095758504643
080309HENRY	188R3C3		0111	102273144068615754
080310DEVONSHIRE PLACE	1881CR3		0104	102273142167595248
080311DESTO/TERRACE	1881C		0111	102273141066544744
080312FIFTH/THACKERY	1881C		01	102273120475686157
080313FORBES/SCHENLEY	1881C		01	102273093483766862
080314FORBES	1881C		01	110573111276666056
080315BUREAU OF MINES	1881C		0120406	102273152570646861
080316FIFTH/DARRAGH	188C31C		01	110573105066605652
080317ATWOOD/SENNOTT	188C3R3		0111	102273114578736660

073416BELLVUE	196SPR1	040109	011174102757524846
073417JACKS RUN	196R1SP 04	0104	041874092877715344
073419ALLEMAC	196R1SPC301030102		041874084360534742
073420HANWAY	196SPR1	01030103	041874084951484440
073424PERRYSVILLE	196SPR1	0104	041874090655524845
073425PERRYSVILLE	196SPR1 01	0104	041874091671665851
073501HAWTHORNE	223R1SP	0301	041874094768534035
073502GROVE	196R1SP	011721	041874095770534139
073505MCKNIGHT	196R3R1C	01	041874101071655854
073506RIDGEWOOD	223R1SP 03	041114	041874104565554437
073510MICKNIGHT	196C3SPRL	01	041874101974696154
073515MCKNIGHT	196SPR1C3	01	041874110577696257
073520RENFER	196SPR1	0103	041874115361555249
07322WEST VIEW	196SPR1 04	011104	041874112666604842
073523WALNUT	196R1SPC304	0104	041874111757574945
073524EAKIN	196R1SP	010406	041874114056524845
080101MEADOTA	188M4	0113	111472090966625856
080102LACOCK/GOODRICH	188M4	0105	111473092374706460
08010416TH	188M4	01	092073144586817065
080105COLEVILLE/PENN	188M4	01	092073150580686158
080108ETNA/12th	188C5	05	092073141569645957
080109LIBERTY/14TH	188M4SP	01	092073143078736561
080110CLIFF/CASSATT	188R3SP	030405	092073125076675654
08011FT DOQ/6TH	188C5	01	092073135080736764
080112LIBERTY/9TH	188C5	01	092073133082766964
080113LIBERTY/GRANT	188C5	01	092073131080746459
080114BEDFORD	188C5R3	02	092073123560575351
080115WYLIE/PROTECTORY	188C3R3	01	092073122071625654
080116MARKET/FORBES	188C5	01	092073111575686361
080117WM PENN/5TH	188C5	01	092073114078737067
080118COURT/TUNNEL	188C5C3	01	092073115577726662
080119COURT	188R303	01	092073120567716463
080120CRAWFORD/FORESIDE	188R3	01	092073090076656058
080121WOOD/FORT PITT	188C5	01	092073105581757168
080122GRANT/2ND	188C5	01	092073104081756865
080123LOCUST/BOYD	1881CC5	01	092073102568656260
080124LOCUST DUQ UNIV	1881C	01	092073101561585554
080125LOCUST/PRIDE	1881CM1	02	092073091578756865
080201BIGELOW BLVD	188SPM4	01	092073091578756865
080202SOMMERS ST	188R3SP	10	100173103576716662

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