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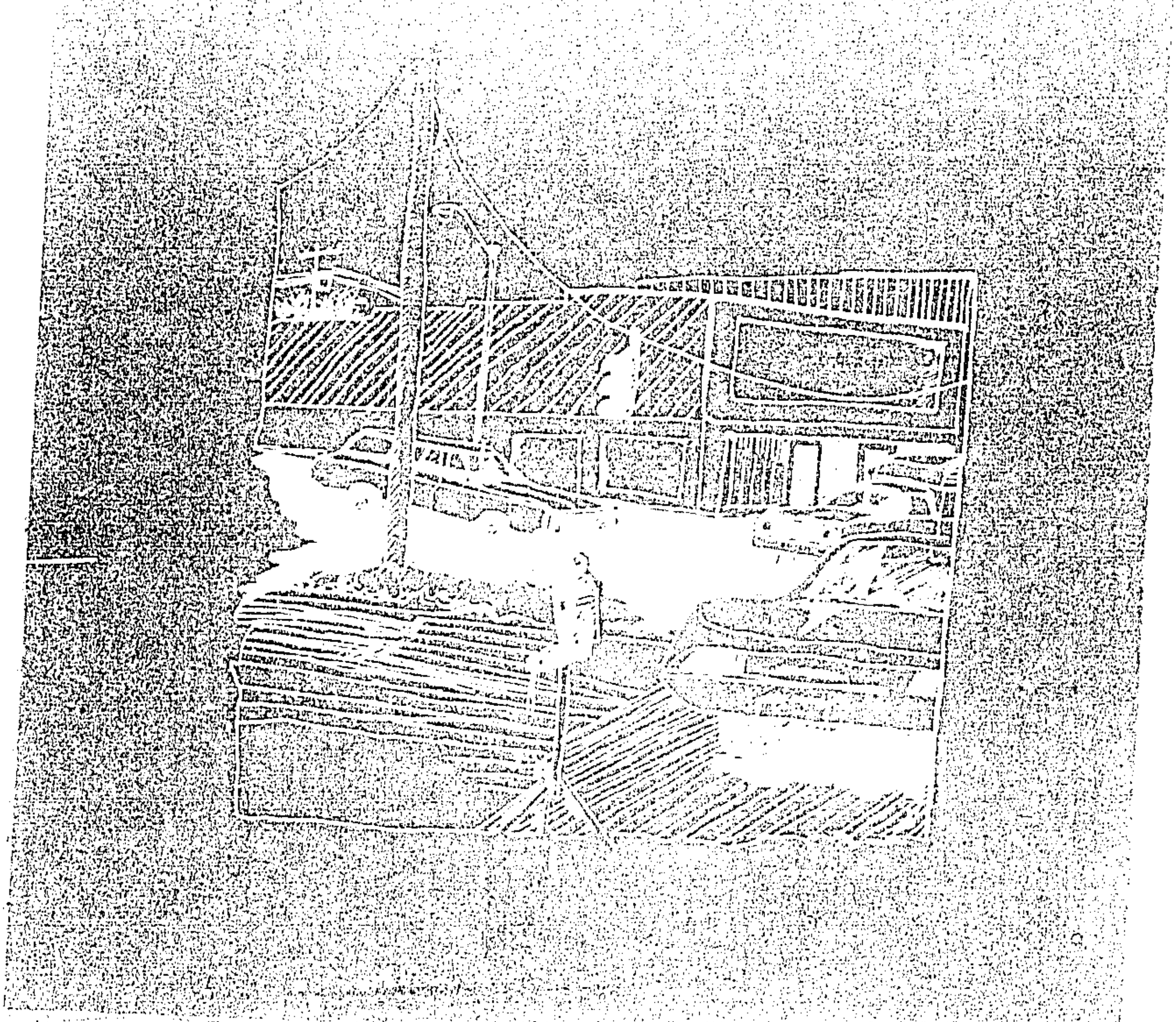
# Noise Survey



EPA 550/9-79-402

# BOISE COMMUNITY NOISE SURVEY

MAY 1979

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
Washington, D.C. 20406

Table of Contents

Table of Contents

<u>Section</u>

# FOREWORD

In conjunction with the Ada Planning Association, the United States Environmental Protection Agency (EPA) through its Office of Noise Abatement and Control and its Region X office inventoried the noise climate in Boise, Idaho to test the accuracy of a physical measurement protocol. EPA hopes it will become part of a broad technical assistance package available to communities who may wish to develop or improve a noise control program. Based on the Boise results, the spatial sampling method will be revised slightly so that the sample will better represent the real noise climate.

ACKNOWLEDGEMENTS

EPA would like to thank the following for their help in this project.

City of Boise
Ada Planning Association
Boise State University Urban Research Center
Boise State University Student Volunteers
Borah High School Ecology Club Members

Without their time and effort, this project would not have been successful.

# 1 INTRODUCTION

A noise measurement survey was carried out in Boise, Idaho to (1) determine existing sound levels, (2) assist area planners, and (3) develop a useful noise measurement procedure for use in other cities. Survey results concerning the noise environment of Boise, Idaho are presented.

## 1.1 General Noise Climate

In Boise, a city with a population exceeding 100,000, the average sound levels for residential and park areas ($L_{dn}$ values from 53 to 54 dB) are near those of typical quiet suburban or small town environments. Sound levels at night often diminish to those of the natural geographical area without human activity (A-weighted sound levels to 30 dB). Thus, on the average, it is a quieter place to live than would be expected of a city that size. The industrial, commercial, and central business districts, however, have average sound levels typical of a noisy urban environment ($L_{dn}$ 62-66 dB)*, and in places these levels decrease by only a moderate amount even late at night. The airport influence area contains a region generally considered unsuitable for residential use (within the NEF-40** noise contour), although most industrial or agricultural activities would be compatible with this area's average noise levels. The outer section of the influence area (between the NEF-30 and NEF-40 contours) is marginally compatible for residential usage, but the interior and exterior noise

* See Glossary

**NEF-Noise Exposure Forecast is a method for developing noise contours in the vicinity of airports, contours generally range from less than 20 NEF for lightly impacted areas to more than 40 NEF for heavily impacted areas.

environments would be less desirable than those of other residential areas of the city.

## 1.2 Major Noise Sources

The principal source of noise in Boise is street traffic. Approximately three-quarters of the local noise intrusions occurring outside of the airport influence area are due to cars or trucks, with an additional 10 percent due to jet aircraft and 4 percent to dogs barking. Even within the airport influence area, over half of the intrusions are due to street traffic. The average sound levels along principal arterials and freeways carrying average daily traffic (ADT) greater than 6000 vehicles per day were significantly greater than those along roads with ADT less than 6000 (10 dB difference in $L_{dn}$).

## 1.3 Recommendations

To preserve the low average residential sound levels and to prevent growth of sound levels in industrial and commercial areas, planners should consider limiting maximum ADT for major arterials through residential areas to below 6000. The use of multiple, low volume arterials may be necessary to accomplish this as development expands further into the foothills to the north and farmland to the southwest.

To remove some of the most intrusive roadway sounds, a vehicle noise enforcement program could be instituted to reduce the sound levels produced by heavy trucks. An enforced requirement that the A-weighted sound level of a vehicle not exceed 86 dB at 15m (50 feet) when operated on a surface street would be consistent with regulations in effect in other cities and States and would result in a reduction in sound level of approximately the loudest 2 percent of trucks operating in the city.

Airport influence area development should be carefully planned based on predicted future NEF contours. Residential development should not be permitted within the predicted 1992 NEF-40 contour. Residences constructed between the projected 1992 NEF-40 and NEF-30 contours will require special sound-insulating construction techniques to attain average interior sound levels equivalent to those in other residential areas. Housing with limited outdoor space, such as planned community developments or condominiums containing enclosed recreational facilities, appear more appropriate for this area than single family residences with large outdoor living spaces.

It should be noted, that these recommendations are made for the sole purpose of controlling noise. There are of course, other factors that must be taken into consideration, such as economic impacts, effects on community growth, etc. Conflicts with the recommendations presented in this report may arise, and where they do compromises will have to be made.

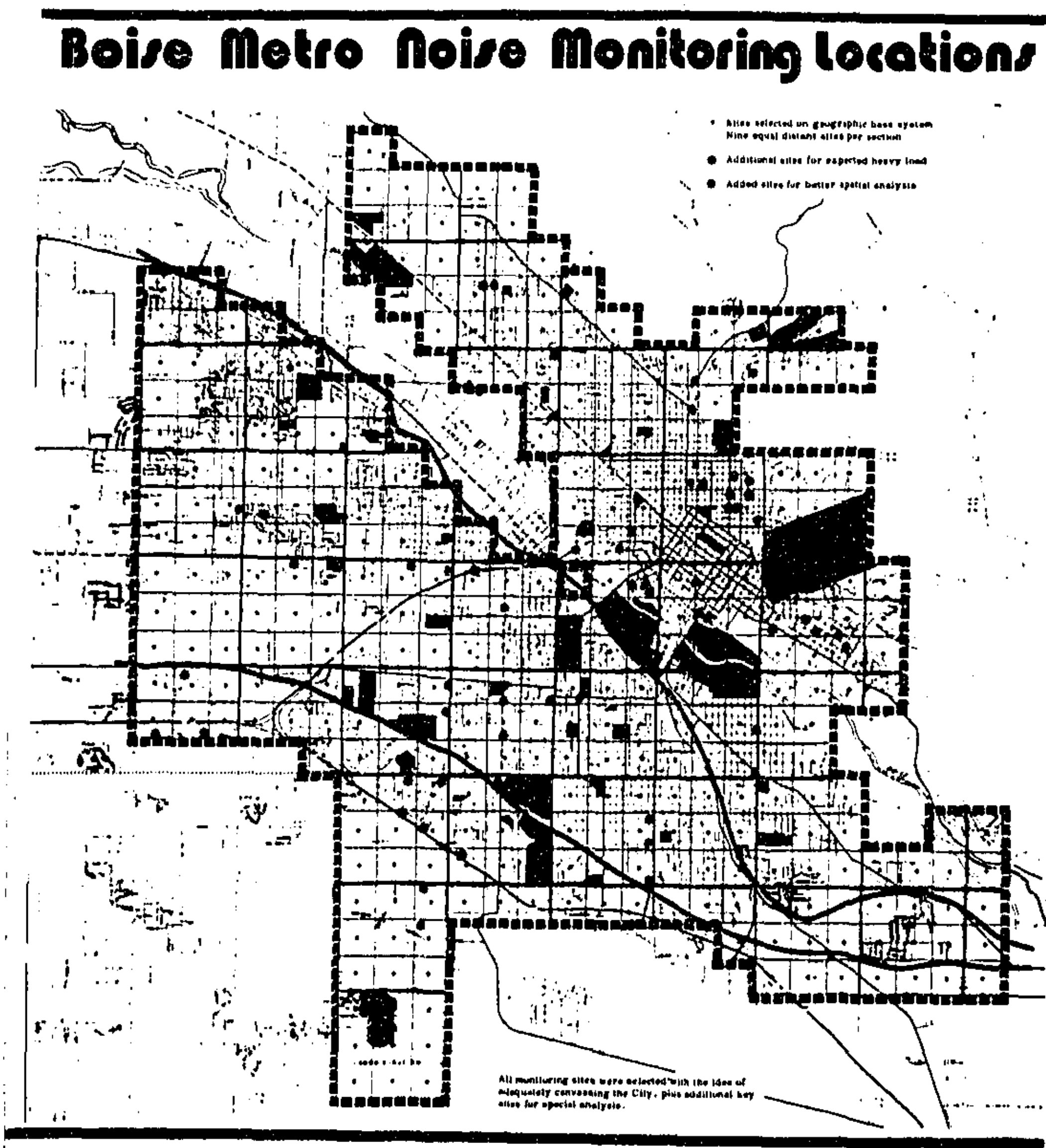



Figure 1-1. Map to "Boise Noise Monitoring Locations"

## 2.1 Background

Noise pollution can be a major contributor to the deterioration of the quality of the community environment. This fact is best exemplified by the Bureau of Census 1976 Annual Housing Survey, which showed that Americans' biggest complaint about their neighborhoods is noise. The survey revealed that 24 percent of America's urban households feel that noise is the most undesirable neighborhood condition. By contrast the other most commonly cited complaints were heavy traffic (14 percent), street repair (13 percent), street lighting (9 percent), and crime (8 percent).

Since noise is primarily a local problem, it is no wonder that communities are beginning to take a harder look at community noise and its adverse impacts. Understanding noise patterns and impacts enables a community to effectively plan and manage land use and to deal with significant noise sources.

Communities desiring to maintain or improve the quality of the noise environment must first have an understanding of the existing noise climate. A noise inventory (i.e., a survey of the acoustical climate of the community) is the basis from which to determine the need for a noise control program and the most effective measures (e.g., planning and legislation) for its implementation. The noise inventory can provide city officials with a basis for exploring alternative programs for achieving or maintaining desired noise levels and for forecasting future noise levels. In addition, it permits the validation of noise prediction models. Finally, the inventory permits officials and planners to gain a better grasp of how various levels of environmental noise translate into community noise problems.

To assure that communities have a method or protocol to allow them to effectively conduct a noise survey, the Environmental Protection Agency (EPA) has been developing a noise monitoring manual.[3]* This project is one of several aimed at providing EPA technical noise control assistance to communities interested in beginning or expanding a noise control program. The noise monitoring manual had reached the stage of development in which an interim protocol had evolved and required testing. As the city selected for testing this interim protocol, Boise offers a moderate size community having a climate that permits acoustic sound level measurements in the month of January, a university having an environmental sciences program to which the project could be tied, and, finally, a city government and an area planning agency that realizes the importance of preserving a quality environment.

*Superscripts designate references.

## 3 THE NATURE OF COMMUNITY NOISE

### 3.1 Nature of Community Noise

Sound consists of small rapidly varying pressure fluctuations that travel through the air and that are perceived to have the qualities of tone and loudness. These sound waves generally become less intense (appear quieter) as they move away from a source, but can reflect back off of surfaces such as buildings, refract around surfaces such as noise barriers, be absorbed by surfaces such as grass, and even be focused by the atmosphere to cause unusually loud or quiet areas. In a community, the surfaces that can obstruct or redirect sound waves produced by the various sources of sound in the community are many. Thus, the loudness perceived by a listener at any one moment will vary greatly depending on his location. Small movements, even as small as 3 meters (10 feet), can cause dramatic differences in the level of the community noise. Added to this complicated spatial variation of noise level is the fact that the intensity and location of the various noise sources usually change as time passes (e.g., accelerating motor vehicles). Thus, the fine, complex spatial patterns of loudness found in the community are continually changing. For example, during certain periods at a given location, the noise environment may be dominated by intrusively loud sounds from specific sources such as automobiles or airplanes. At other times, it will consist of a constant background of many indistinguishable sounds.

To measure these spatial and temporal changes of community noise in detail requires an extremely intense effort. It has been accomplished only for small areas, such as one city block, in scientific studies in which there were available methods of interpreting the necessary voluminous data. To assess and describe the "noise climate" of an entire community, much simpler techniques based on averages of the noise level fluctuations in time and space must be used.

### 3.2 Measures of Community Noise

In community noise work, the subjective loudness experienced at any instant is measured objectively with a sound level meter as the instantaneous A-weighted sound level. The term "level" indicates a measure of what is perceived as loudness, and the term "A-weighted" indicates that a relative weighting of the sound level at various pitches that corresponds to the pitch response of human hearing has been applied. Sound level meters are designed to indicate the A-weighted sound level in units called decibels, on a meter face as the sound level changes with time. The decibel scale is a logarithmic scale based on the pressure of the sound waves, and a unique aspect of the scale is that almost any sound increasing in level by 10 decibels (dB) will be judged to have approximately doubled in perceived loudness. Thus, a passing truck causing a maximum A-weighted sound level reading of 85 dB will seem twice as loud to the average listener as a bus at 75 dB.

Likewise, a residence near a highway where continuous traffic causes a constant A-weighted sound level of 65 dB will seem twice as loud as one a block or two away where the reading is normally 55 dB.

Since the sound level at any given location within a community will with time, a way to determine an average level is necessary to easily describe the total sound environment at that point. One good measure of the average sound arriving at a point is the equivalent sound level ($L_{eq}$ - see glossary for technical definition). The equivalent level of fluctuating environmental noise over a given period is a single value representing the noise for that period. For example, the $L_{eq}$ of the 8 minutes of recorded fluctuating noise shown in Figure 3-1 is 50 dB. The figure also shows short, but loud,

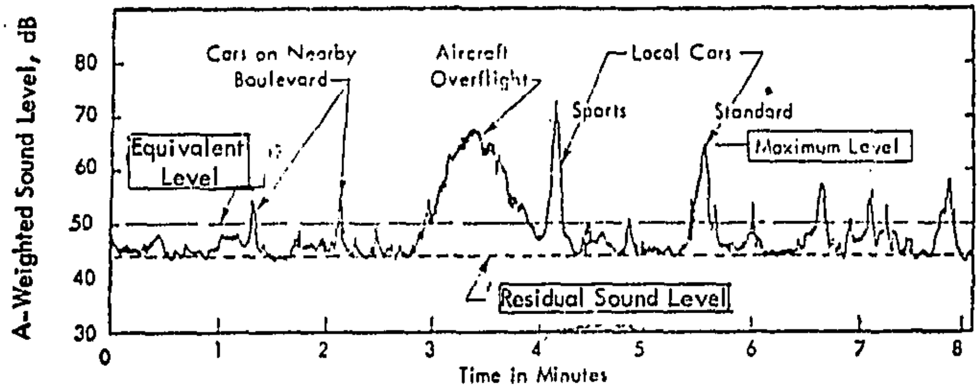



Figure 3-1. Eight Minute Sample of Typical Fluctuating Sound Level in Residential Area Showing Maximum, Equivalent, and Residual Sound Levels for the Period

intrusive sounds such as aircraft or individual cars, and the background ambient sound level, which is the "background" level composed of many indistinguishable sounds.

To completely assess a community noise environment, the entire 24-hour period must be considered. To describe 24 hours of community noise at a particular location with a single value, the quantity day-night sound level ($L_{dn}$) has been devised. $L_{dn}$ is the same as an equivalent sound level for 24 hours of fluctuating sound, except that the levels measured during the nighttime hours of 10 PM to 7 AM are increased by 10 dB to account for increased sensitivity to sounds at night. One way to estimate the $L_{dn}$ value for a particular location would be to take sufficient sound level readings to estimate the equivalent sound level for each hour. The $L_{dn}$ can then be computed for the 24 hours, including the 10 dB nighttime weighting. Figure 3-2 shows values of $L_{dn}$ obtained in various cities using similar procedures and associates a qualitative description of "noisiness" with $L_{dn}$ ranges. An advantage of using the $L_{dn}$ measure in a community noise evaluation is that accurate correlations between $L_{dn}$ value and community reaction to noise have been widely made for community type sounds. Figure 3-3, based on several European and American studies, indicates the degree of annoyance and community reaction that can be expected as the $L_{dn}$ value of typical community noise rises.

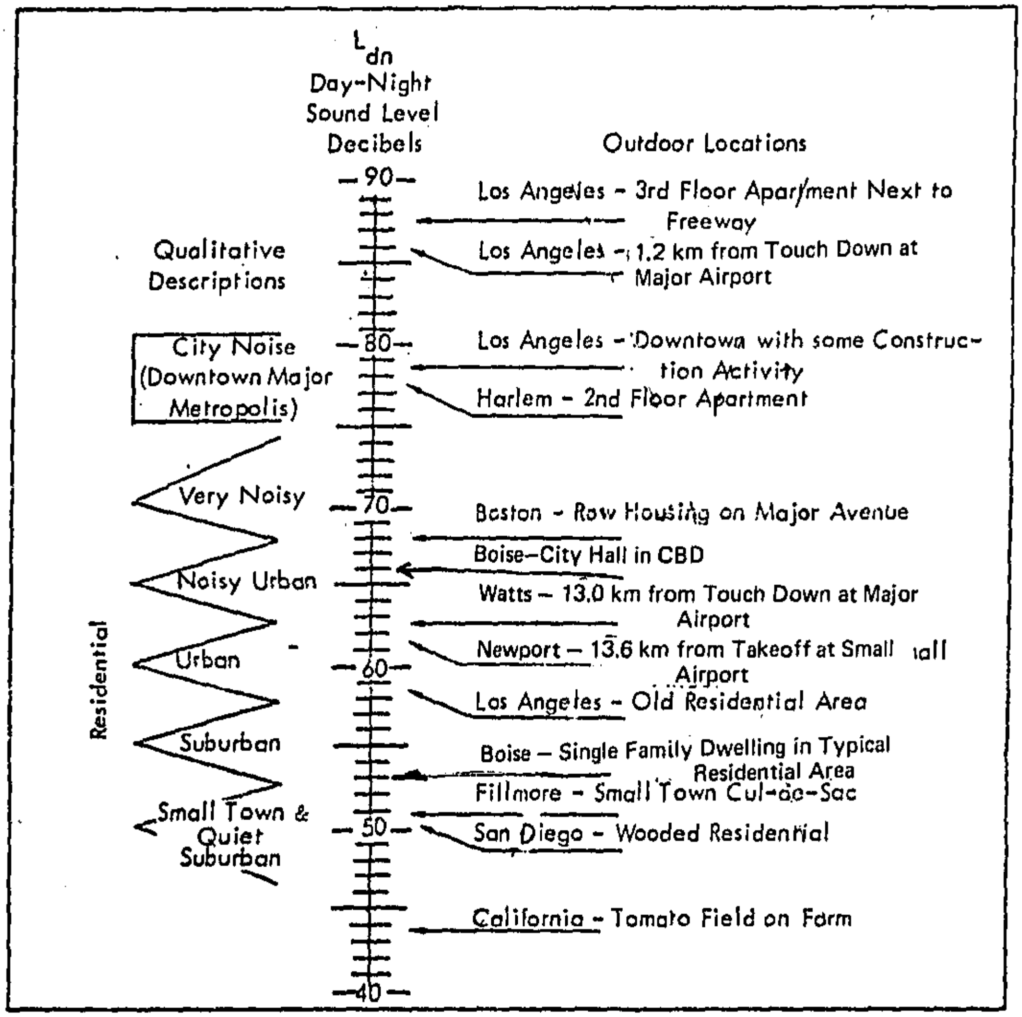



Figure 3-2. Outdoor Day-Night Average Sound Level, $L_{dn}$ - in Decibels at Various Locations

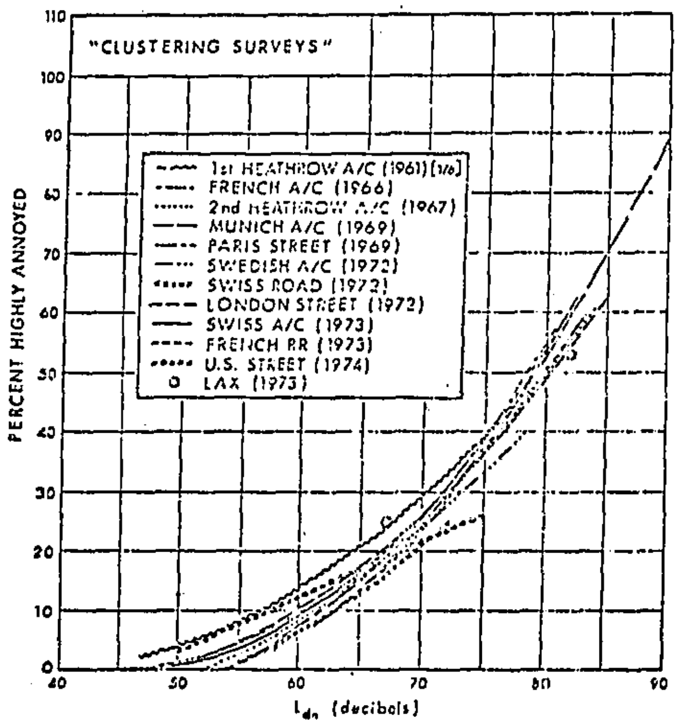



Figure 3-3. Summary of Annoyance Data from Eleven Surveys that Show Close Agreement. Two Points from a Recent Study of Aircraft Noise Annoyance at Los Angeles International Airport (LAX) [From Reference 2]

## 4 PROGRAM STRUCTURE

The community noise measurement program in Boise was carried out under management and guidance of the U.S. Environmental Protection Agency, with field work arranged by the Ada Planning Association. The program proceeded in four phases: identification of program goals and study area, selection of measurement sites, field team organization and field monitoring, and data reduction and analysis.

### 4.1 Goals and Study Area

As the program's purpose was not only to assess the community noise climate in Boise, but also to evaluate various survey and analysis techniques for general application in community noise surveys, more data collection and manipulation was performed than is ordinarily necessary for a community noise study. The study area therefore included almost all the land area within the city limits. Some areas to the west were neglected due to lack of development and similarity to other included areas, but the survey boundary was extended beyond city limits in areas of new developments or possible annexation which were of interest to planners.

### 4.2 Measurement Site Selection

Two basic types of sites were devised to survey noise over the wide ranges of land use and noise exposures in the city. These sites were supplemented with special sites providing supplementary supportive data.

### Basic Sites

Two types of sites provided the basic project data - interior sites representative of the community in general, and roadway sites representative of the environment along major streets. The interior sites were arranged according to a north-south grid pattern with 540 m (1/3 mile) grid spacing. This pattern produced 266 square cells 540 m (1/3 mile) on a side covering the entire study area with the measurement point selected as close to the cell center as possible. Sound level measurements were taken at all of these sites. Roadway sites were located adjacent to surface streets and limited access highways. 40 sites were selected along high volume (ADT>18,000) medium volume (18,000>ADT>6000) and low volume (ADT<6000) roads to assess the noise environment with useful accuracy. (See Appendix A for sample size rationale).

### Supplementary Sites

Two additional types of sites were used to provide supplementary data: 24-hour sites and quiet period sites. 10 sites for placement of 24-hour monitoring equipment were selected throughout the city to obtain a record of hourly sound level variation. These sites were generally located at homes of people associated with the project for convenience. Quiet period sites throughout the area were visited between 1:30 and 5:30 a.m. on a typical night to quickly spotcheck minimum noise levels during the quietest hours. Approximately half of these sites were co-incident with interior, roadway, or 24-hour measurement sites.

## 4.3 Noise Measurement Methods[3]

Principal data for the study were obtained from the basic sites located on the 1/3 mile (540 m) grid or along roadways. All measurements made at these sites employed the same procedure. Different procedures were used at the 24-hour and quiet-period sites.

### Basic Sites -- 20-Minute Measurement

At each interior or roadway site, sound level readings were continuously made for a 20-minute period sometime between the hours of 9 AM and 5 PM during weekdays. Monitoring assignments were selected for efficient personnel usage, and this resulted in the measurements being uniformly distributed throughout most times of the day. A total of 10 days were spent with one to three measurement teams in the field each day.

For each 20-minute measurement period, the A-weighted sound pressure level was monitored using an ANSI Type II sound level meter set for slow meter response. Every 15 seconds, the instantaneous meter reading was observed and the value recorded as a tick mark in a space for the appropriate level on a standard data sheet. In this way, approximately 80 sound level values were recorded during the 20 minutes at each site for subsequent computer reduction. At each of the 15 second intervals, any sound level meter readings from local sources which caused the reading to exceed 70 dB were described on the data sheet by a special notational code which identified the source.

Field personnel consisted of Ada County Planning Association employees, local college students studying environmental sciences, and volunteer high school students. All participants were given thorough instruction and demonstration regarding these specific sound measurement procedures. Field teams of two were organized at first to facilitate timing, reading and recording, but with a day's practice, a single person could easily manage the technique.

Special Sites

Twenty-four-hour measurements were made using a community noise analyzer which automatically determined the equivalent sound level for each hour. EPA personnel set up this equipment which was self-operating for the measurement period.

The quiet period nighttime measurements were made by a trained acoustics technician using an ANSI Type I sound level meter having a minimum reading ability of 30 dB. With the meter set for slow response, it was observed for 30 seconds and the estimated central tendency of the meter reading was recorded. Care was taken to exclude the effects of local events such as automobile passbys or dogs barking.

4.4 Data Reduction

The data from each of 307 20-minute measurements consisted of approximately 80 individual sound level meter readings. Primary reduction of these data was done by the Boise Center for Urban Research — a group affiliated with Boise State University — using a FORTRAN IV program to calculate $L_{eq}$ and other measures for each site based upon the 80 readings for each 20-minute measurement. The $L_{eq}$ values for interior sites were then divided according to five types of land use. This yielded a set of $L_{eq}$ values from sites representing each of the five land use categories plus low, medium, and high volume roads. The mean for each set of $L_{eq}$ values was hand-calculated resulting in an average daytime $L_{eq}$ for the following types of areas:

| | | |
|---|---|---|
| 53.7 dB — Residential | | Land Use Catagories |
| 62.9 dB — Commercial | | |
| 54.2 dB — Industrial | | |
| 65.4 dB — Airport Influence NET 40 Zone | | |
| 57.7 dB — Airport Influence NET 30-40 Zone | | |
| 52.5 dB — Parks, Open or Undeveloped Space | | |
| 65.9 dB — High Volume Roads | | Road Traffic Volume |
| 64.0 dB — Medium Volume Roads | | |
| 54.2 dB — Low Volume Roads | | |

An approximate conversion from average daytime $L_{eq}$ to $L_{dn}$, which represents the 24-hour noise environment, was developed based on the 24-hour data. (The $L_{eq}$ to $L_{dn}$ conversion is described in Appendix B.)

This conversion was then applied to the average $L_{eq}$ values to determine $L_{dn}$ for each land use area. The resulting values are presented in Section 5.

An advantage of the on-the-spot sound level meter technique is that the field teams are able to note those local sources which are loudest or occur most frequently. The identifiable sources causing the regular sound level measurement to exceed 70 dB were counted in a special portion of the data sheet and the raw data were manually tabulated to determine the relative frequency with which the various noise sources caused the measurement to exceed 70 dB. These results are also shown in Section 5.

The 24-hour data were directly transcribed from the community noise analyzer to tables and then to 24-hour charts which are included in Appendix E. The data for the quiet nighttime levels were manually recorded average values of the A-weighted sound level as observed for 30 seconds and required no reduction.

# 5 RESULTS AND RECOMMENDATIONS

## 5.1 Results and Conclusions

Shown in Figure 5-1 are the average $L_{dn}$ values for various land use categories that were within the survey boundaries. Comparison of these average levels with the interpretive scale which was shown on Figure 2 in Section 3 reveals that the average Day-Night Sound Level for residential areas is considerably lower than one might expect for a city of Boise's size, where many residential areas closely adjoin commercial areas or busy streets. However, it is also evident that noise in the industrial, commercial, and central business districts has crept to the same disturbing levels encountered in many urban areas.

### Industrial and Commercial Areas

It is apparent that in Boise, the principal noise source outside of the airport influence area is street traffic. The average $L_{dn}$ value for roadway measurement sites selected along roads having an average daily traffic (ADT) volume greater than 6,000 vehicles per day corresponds quite closely to the $L_{dn}$ from interior sites located in commercial or industrial areas. This indicates that vehicle traffic probably accounts for the high sound levels measured in these areas, and that traffic volume increases can be expected to increase the average $L_{dn}$ accordingly.

Table 5-1. Average Sound Levels for Area Types Surveyed With 20 Minute Interior Measurements

| Land Use Category | No. of Sites | Mean Day-Night Average Sound Level ($L_{dn}$)* in dB | 95% Confidence Limits, dB |
|---|---|---|---|
| Central Business District | 5 | 66 | >+5 |
| Commercial/Industrial | 37 | 62-63 | ±4.5 |
| Residential | 170 | 54 | ±1.5 |
| Parks/Unused/Open | 24 | 53 | ±5.5 |
| Adjacent to Roads > 6000 ADT | 35 | 63-66 | ±3.5 |
| Adjacent to Arterials < 6000 ADT | 6 | 54 | ±5.5 |
| NEF 40 Zone | 13 | 66 | >±5.5 |
| NEF 30-40 Zone | 17 | 58 | ±4.5 |

*Approximately value from 20 mm measurements during day, Central Business District

The average $L_{dn}$ for the central business district (CBD) shown in Table 5-1 has a value as high or higher than that of any other land use. Figure 5-2 shows the hourly equivalent sound levels of a 24-hour measurement made at City Hall in the heart of the CBD. Observation of the area indicates the primary sources to be traffic and construction noise. The continuous nature of these two sources during the day is indicated by the regularity of the $L_{eq}$ line. This is particularly true during late morning and afternoon where high $L_{eq}$ levels are consistently maintained, indicating a continuous high volume of traffic flow. Even after this period and into the middle of the night, the hourly $L_{eq}$ decreases only 13 dB. This is a much smaller decrease than normally occurs for other land use areas in Boise (as will be seen), and indicates a concentration of traffic in the CBD at all hours.

Residential Areas

The average $L_{dn}$ value for roads with an ADT of less than 6,000 vehicles per day is the same as that for residential interior sites. This indicates that on the average, local traffic sound levels along residential streets equal those generally prevailing in residential areas. Thus, any increase in local traffic volume would be expected to immediately cause increases in the average residential sound level. The difference in average $L_{dn}$ values between residential and industrial/commercial areas of almost 10 dB indicates that residential areas are not yet extensively crossed by

Summary of sound levels at
City Hall - January 10, 1977

Day-Niight Average Level
($L_{dn}$): 65.7 dB

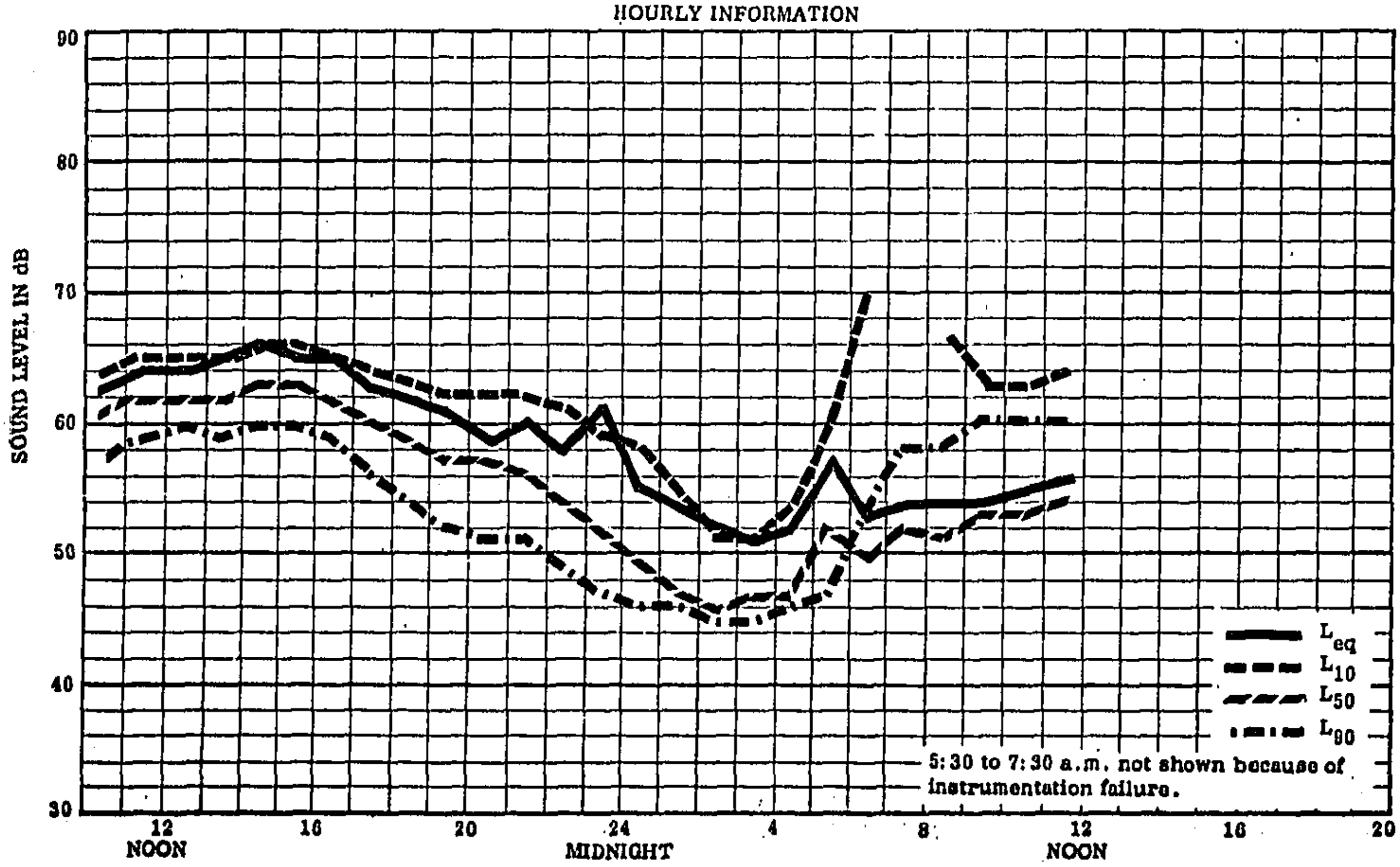



Figure 5-2. Hourly Sound Levels at Boise City Hall

roads of ADT greater than 6,000. This is a situation which should be preserved to prevent imposition into residential areas of the much greater sound levels measured for roads with ADT over 6,000. Figure 3-3 indicates that such imposition could instigate significant community action. Figure 5-3 shows the general trend of sound level data taken along roadways in Boise as compared with ADT, and illustrates how the sound level of a residential area might increase as it becomes criss-crossed with roads of ADT greater than 6,000.

A further correspondence between current residential $L_{dn}$ and the $L_{dn}$ of roads carrying an ADT under 6,000 is revealed by the 24-hour data. Figure 5-4 is a plot of hourly $L_{eq}$ values measured in a residential area near the open foothills of the eastern city limits. (See Appendix F for a complete set of the residential 24-hour data taken.) Figure 5-5 is a similar plot of data taken at a site along a wide surface boulevard leading through the older residential north section to newer subdivided sections of the city which are expanding into the foothills to the northeast. The boulevard - having an ADT under 6,000 - shows low sound levels late at night, beginning to rise at 6AM with a morning peak, and rising again to a fairly constant level which tapers off during the evening to the low nighttime levels. The residential pattern of Figure 5-4 is similar with the noticeable exception of pronounced peaks around 5 and 7PM. It is likely that these peaks correspond to returning home and evening traffic, and thus the importance of vehicle noise to the residential noise climate

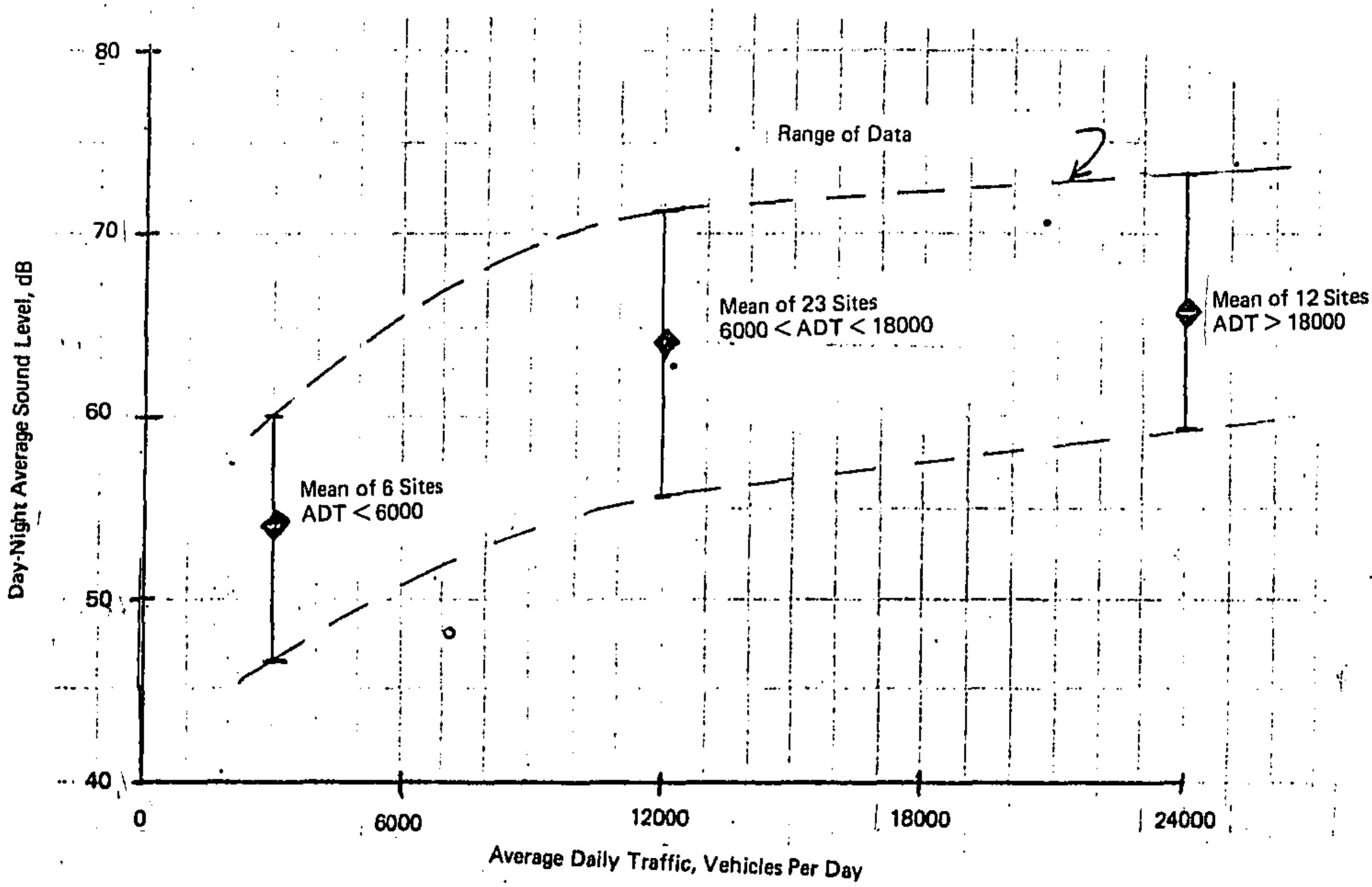



Figure 5-3. Sound Levels Adjacent to Major Roadways in Boise

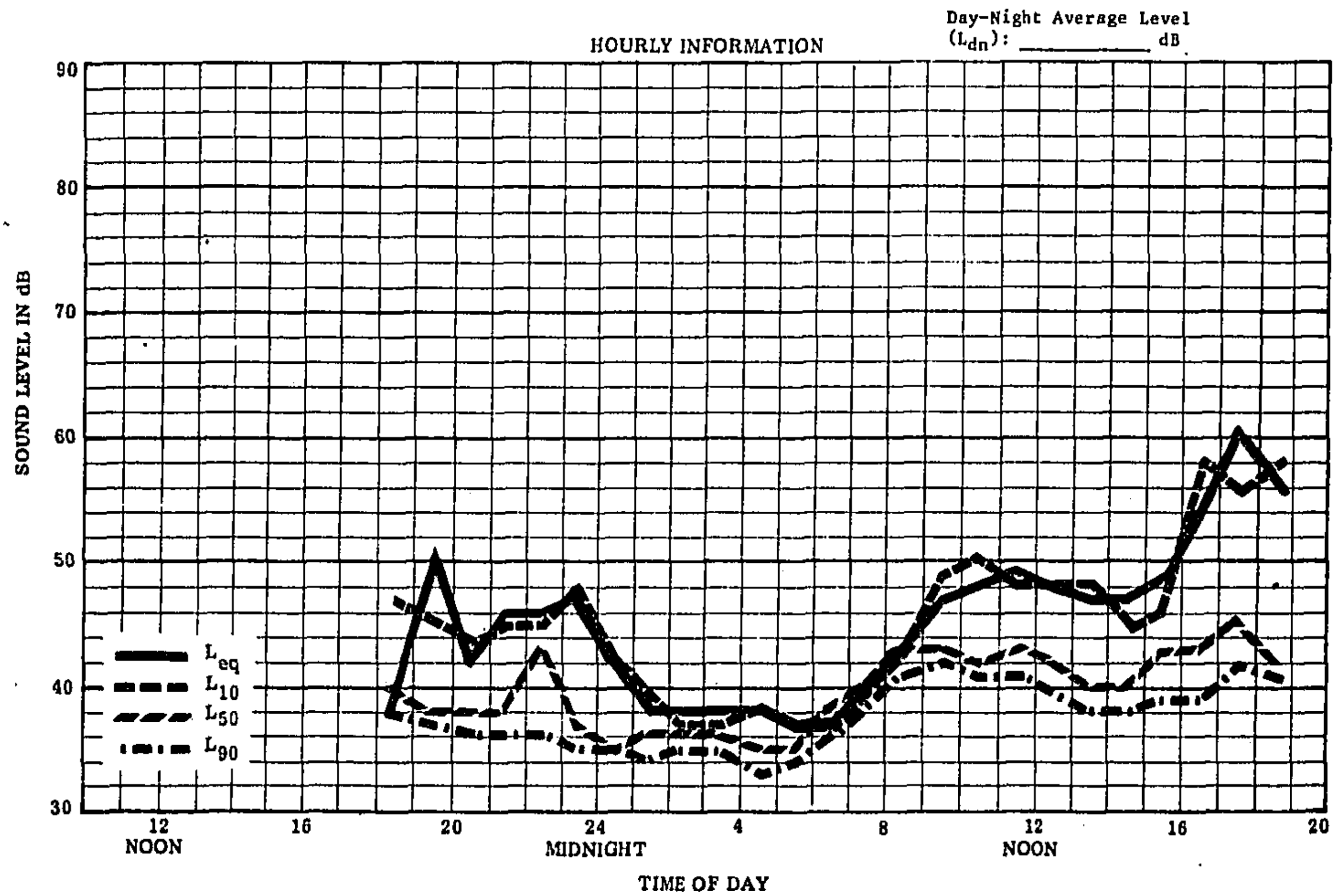



Figure 5-4. Hourly Noise Levels in a Typical Residential Site Near Open Foothills Near Eastern City Limits of Boise

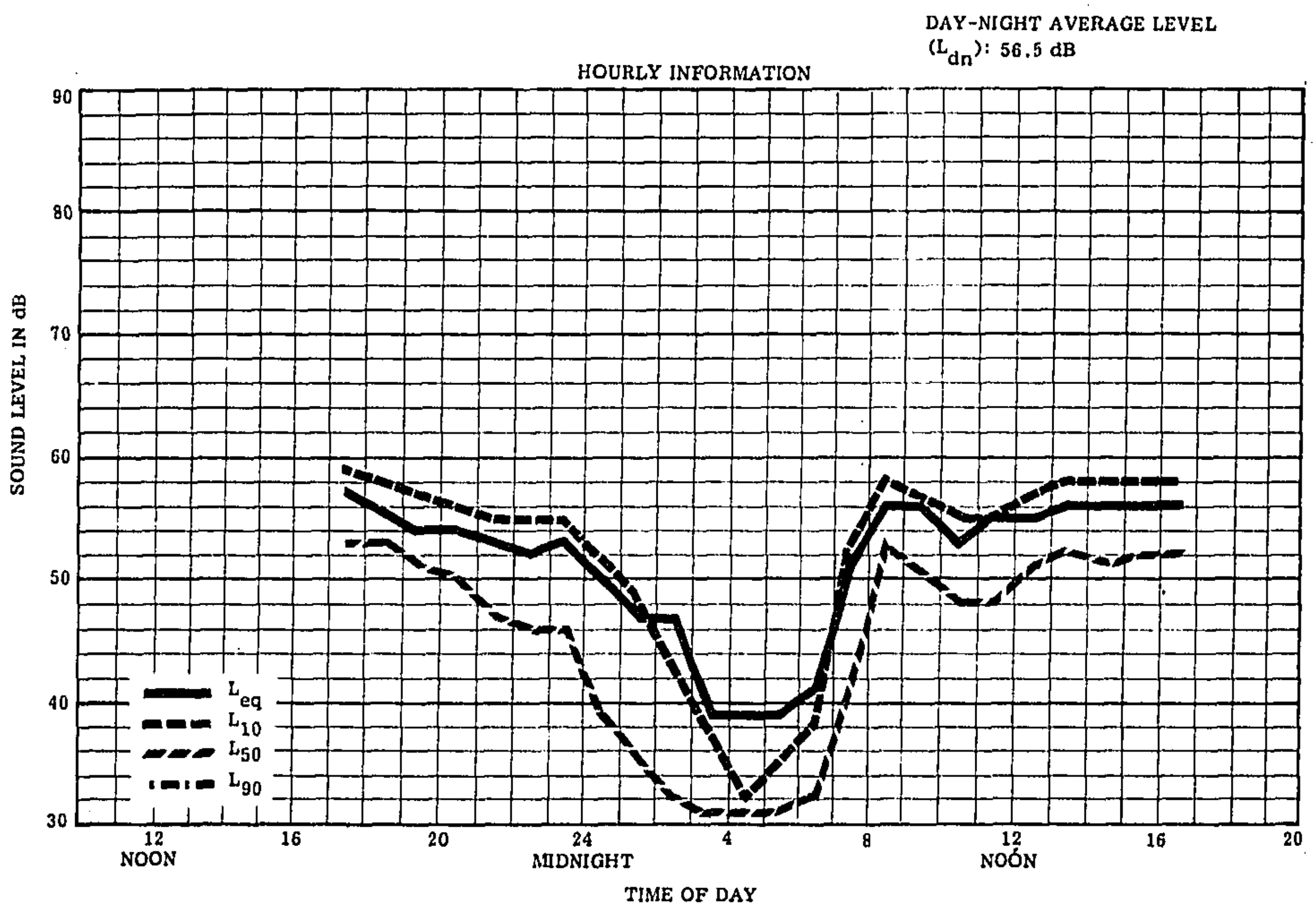



Figure 5-5. Hourly Noise Levels Along a Major Arterial Through Residential Areas in Northern Area of Boise

is demonstrated. Changes in the sound levels or use-patterns of motor vehicles will immediately and directly affect residential sound levels.

Parks and Open Space

For simplicity, all open space, including parks, undeveloped land, and agricultural land has been considered as a single land use category. As indicated in Table 5-1, the average $L_{dn}$ for all these areas is low, but not extremely so for a city like Boise. In actual fact, the sound levels measured throughout these areas were widely distributed between extremely quiet and excessively loud areas. Thus, the sound level at each individual section of open space reflects the levels of surrounding sources or land use. On the average, the levels are just slightly higher than those for residential areas.

Airport Influence Area

Several of the regularly spaced interior measurement sites were located within the airport influence area to the north and west of the runways. Since measurements among these sites were made during several different days, allowing for several different flight patterns, it is assumed that the resulting data approximately represent the airport influence area.

Figure 5-1 shows the area within the present Noise Exposure Fore-Cast (NEF) 40 contour* to have a high average $L_{dn}$ similar to commercial

*NEF contours were previously developed in the report "Boise Airport Influence Area Study" for the Ada County Council of Governments.

and industrial areas. The nature of the noise is quite different, however, in that it consists of periodic loud but short duration overflights occurring in an otherwise quiet region. Figure 5-6 illustrates this with hourly $L_{eq}$ values for a 24-hour period measured near the edge of the NEF 40 zone off the west end of the runways. The $L_{eq}$ line, which is an indicator of the total acoustical energy received each hour, is quite high indicating the presence of high noise level sources. The $L_{10}$ line, which indicates the sound level which was exceeded only 10 percent of the time during each hour, is far below the $L_{eq}$ line. Thus, the sources which presented the large amounts of sound energy (aircraft) were present much less than 10 percent of the time. A similar but less dramatic pattern would be expected in the zone between the NEF 40 and NEF 30 contours (NEF-30 zone), where a lower average $L_{dn}$ is evident.

Reference to Figure 5-1 clearly indicates that average sound levels within the NEF 40 contour are much higher than would generally be acceptable for residential areas in a city of Boise's size and density. The introduction of typical local industry, however, would not be expected to change the average $L_{dn}$ for the area which is determined by the noise from aircraft overflights. Thus, industry in the NEF-40 zone would exist with an average $L_{dn}$ similar to that of other industrial areas in Boise. It is possible that the loud single events (flyovers) might cause occasional interference with some industrial activites where speech communication is involved. Along the same lines, introduction of high volume streets in this area will not appreciably raise the average $L_{dn}$. For

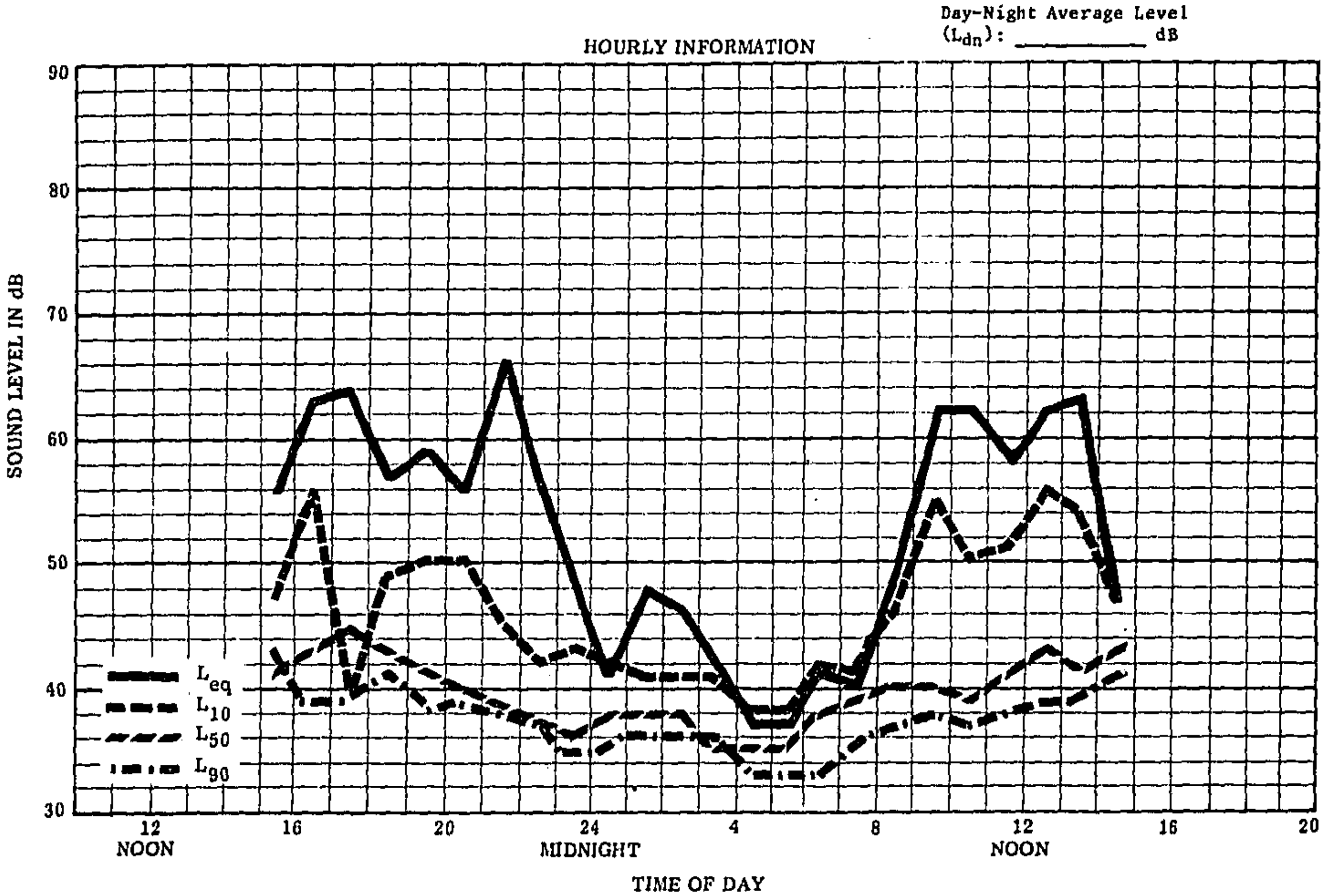



Figure 5-6. Residential Area Impacted by Airport Noise

the NEF 30-40 zone, the average $L_{dn}$ is significantly higher than that for other residential areas. In this zone, indoor environments would be marginally acceptable for residential use but with attention to construction details (such as proper fitting and sealing of wall panels, windows, and other building elements), would be nearly equal to those of residences in other areas. The outdoor environment, however, would be noticeably less desirable. This indicates a possibility for housing, such as planned unit developments or condominiums which do not feature the private yards and local outdoor living opportunities of the single-family residences found in most of Boise. The introduction of streets with ADT greater than 6000 to the NEF 30-40 zone would increase the local $L_{dn}$ and also the residual sound level between overflights.

Major Sources

Figure 5-7 shows the relative numbers of various sources which could be identified as causing the A-weighted sound level to exceed 70 dB during most of the 20 minute measurements. The figure is for the entire study area, excluding the airport influence zone, and indicates - not unexpectedly - that autos and trucks most frequently cause high local sound levels. A more detailed examination of vehicle sound levels is presented in Figure 5-8. This shows that the apparent A-weighted sound levels of automobiles throughout the community are closely grouped, with few cars being much noisier than the bulk. Thus, a noise regulation or enforcement program

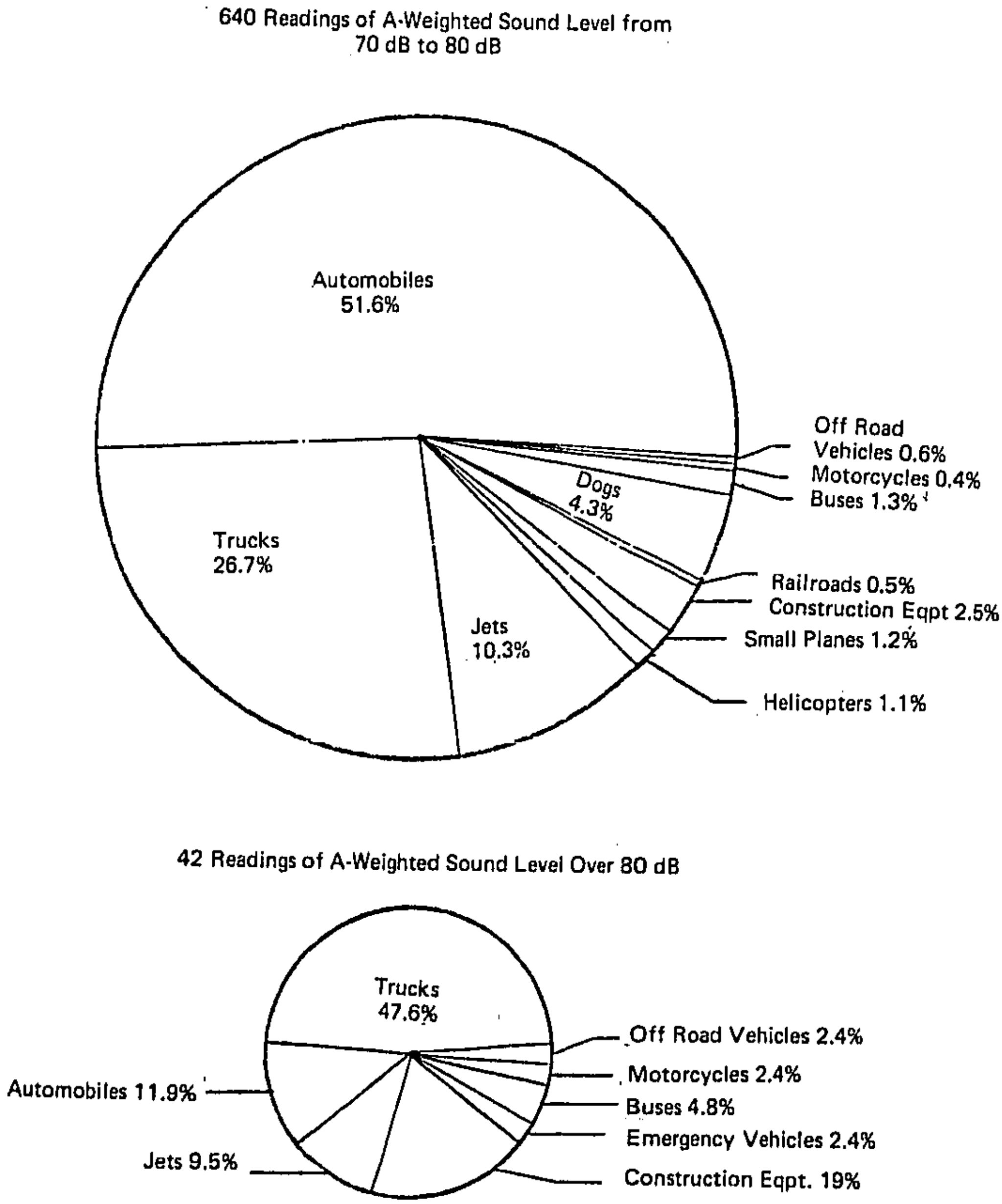



Figure 5-7. Sources of Intrusive Single Event Noise Levels in Boise Excluding Airport Influence Area

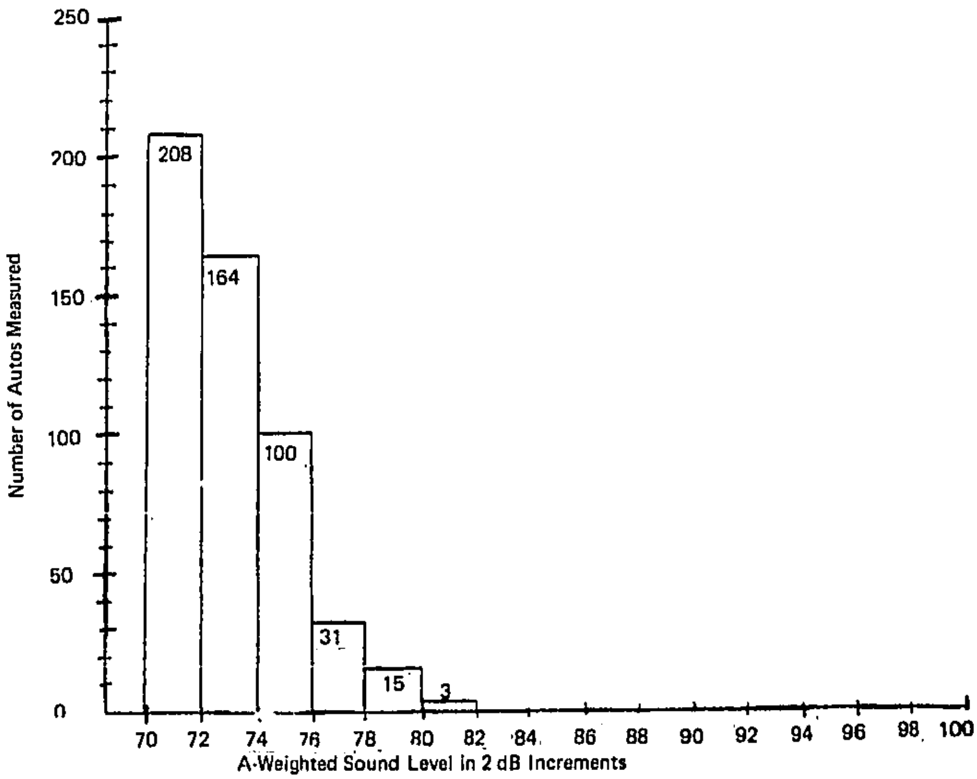



Figure 5-8. Distribution of Automobile Sound Levels Above 70 dB Measured at Various Community Locations in Boise

for cars would probably not cause a significant reduction in automobile traffic noise levels unless virtually all of the cars were made quieter. However, as illustrated in Figure 5-9, one to two percent of the trucks with measured sound levels exceeding 70 dB were significantly noisier than the majority. This suggests that a noise enforcement program for trucks to insure adequate muffling and reasonable operation within city limits could result in a noticeable reduction in truck traffic sound levels along truck routes. Figure 5-10 shows that in the airport influence area, jet aircraft join trucks and autos as a frequent source of high sound levels. It is interesting that even at very high levels over 80 dB, trucks constitute nearly as many intrusions as aircraft.

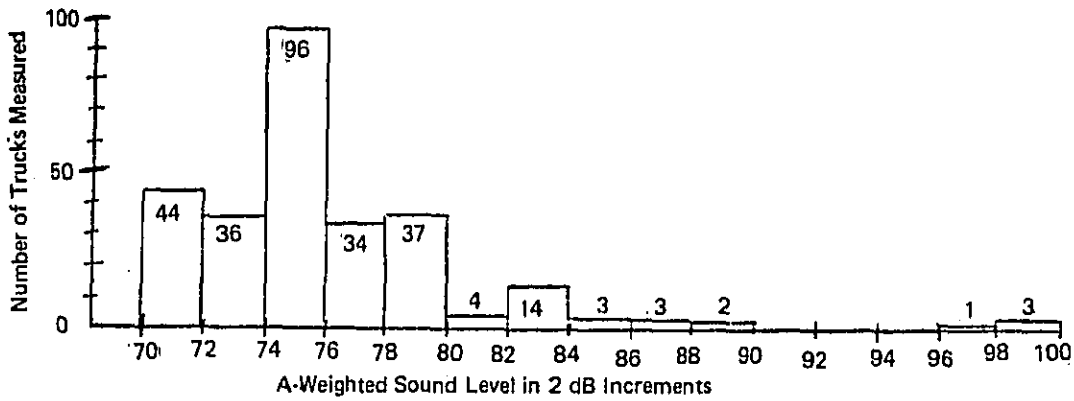


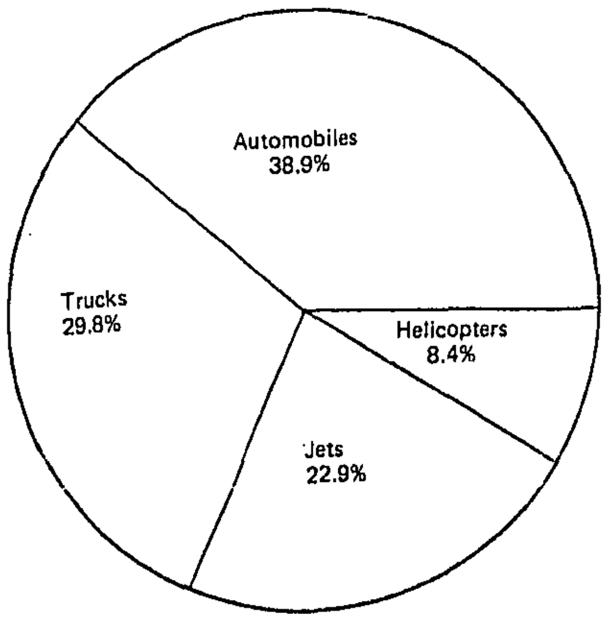

Figure 5-9. Distribution of Truck Sound Levels Above 70 dB Measured at Various Community Locations in Boise

This implies that the airport area average sound levels may be more sensitive to increased truck traffic than indicated in Section 5.1.5.

## 5.2 Recommendations

The natural silence of the Boise Valley has not been completely eliminated within Boise city limits by modern activities. Late at night, when the movement of people is at a minimum, the extremely low A-weighted sound levels shown in Table 5-2 were measured. Such low levels, averaging 37 dB, are never achieved in many metropolitan areas, and serve to illustrate the real opportunity that the City of Boise has to preserve its peaceful environment. The following recommendations, based on the sound survey, will help area planners prevent the increase of sound levels throughout the city.

131 Readings of A-Weighted Sound Level
from 70dB to 80dP




43 Readings of A-Weighted Sound Level Over 80 dB

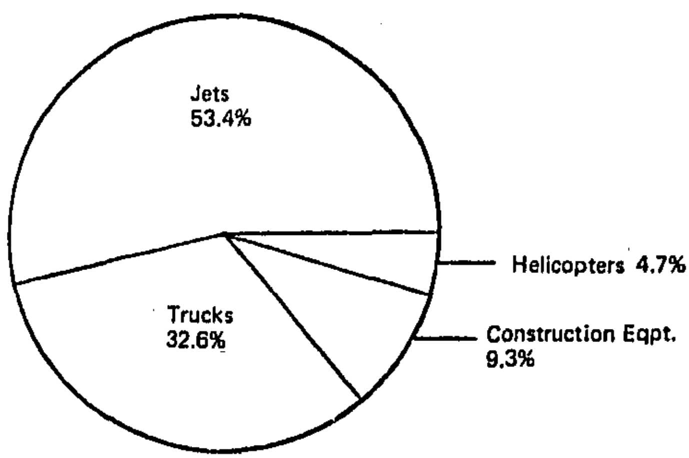



Figure 5-10. Sources of Intrusive Noise in the Boise Airport Influence Area

Table 5-2

Minimum Sound Levels Found in Boise

| Time | Site Also Used As 24-Hour Site | Site Address | Average A-Weighted Sound Level for 30 Seconds, dB | Land Use |
|---|---|---|---|---|
| 0135 | | Elmer & Eugene | 38 | Residential |
| 0155 | | Hill Road | 39 | Residential |
| 0200 | | 2715 28th Street | 35 | Residential |
| 0216 | | Clover & Moore | 39 | Park, Open Space |
| 0219 | | 501 Rose Street | 37 | Residential |
| 0227 | X | Harrison | 42 | Residential |
| 0233 | | Highland View and Heather Place | 34 | Residential |
| 0241 | X | 8th Street | 34 | Residential |
| 0245 | | Franklin & 11th Street | 39 | School, Open Space |
| 0251 | X | 1050 Kroll Street | 39 | Residential |
| 0305 | | 529 Bacon | 30 | Residential |
| 0308 | | 207 Louisa | 33 | Residential |
| 0315 | X | City Hall (No. Side) | 51 | CBD |
| 0324 | | 1916 Larch | 33 | Residential |
| 0335 | X | 2800 Frye | 33 | Residential |
| 0347 | | 9801 Skycliffe | 32 | Residential |
| 0355 | | Edna & Dalton | 37 | Residential |
| 0404 | | 2951 Dalton Ln | 34 | Vacant |
| 0412 | | Preece at Dead End | 36 | Agricultural |
| 0419 | X | 7111 McMullen | 38 | Residential |
| 0425 | | 6603 Holiday Drive | 41 | Residential |
| 0439 | | Victory & Eagleson | 44 | Vacant |
| 0445 | | 4256 Bonner Street | 38 | Residential |
| 0458 | | Nez Pierce & Taggart | 36 | Residential |
| 0509 | X | 217 Redfish Lane | 44 | Residential |
| 0520 | | 2801 Harmony Road | 31 | Agricultural |
| 0525 | | Boise & Holcomb Road | 36 | Agricultural |
| 0534 | | 1308 Euclid | 39 | Residential |
| 0549 | | Julia Davis Park | 40 | Park, Open Space |

Mean = 37.3 dB
St. Deviation = 4.5 dB

Industrial and Commercial Areas

Since average sound levels in these areas result principally from road traffic, the growth of traffic volume should be limited to those roads bounded by compatible land use zones. This is particularly important for commercial areas where greater volume will readily increase sound levels to which the public is exposed during routine nonoccupational activities. In some cases, it may be desirable to direct traffic to several streets at lower volumes rather than a few principal streets at high volumes.

Residential Areas

Average sound levels in residential areas are also closely tied to road traffic and thus traffic volume along local and collector streets should not be allowed to grow markedly. The use of arterials through residential sections intended to carry high traffic volumes (>6000 vehicles per day) should be discouraged, or coupled with provisions for compatible land use or buffer zones (or sound barriers) along the road.

Parks

In order for park areas to provide visitors the tranquility of the quiet natural environment of Boise, they should not be located adjacent to commercial or industrial areas, or roads with ADT approaching 6,000.

Airport Influence Area

The area within the NEF 40 contour is presently compatible with nonresidential activities such as most industry, agriculture, or rangeland use. Traffic growth, including heavy trucks to supply industry, will increase average sound levels by a small amount. The NEF 30-40 zone is suitable for the same activities as the NEF 40, and also commercial and/or shopping areas. Growth in surface traffic volume - especially to the 6,000 vehicle per day level - will noticeably increase average sound levels. If residential development is contemplated for areas within the projected 1992 NEF 30-40 zone construction should provide a noise reduction of A-weighted noise levels at least 5 dB greater than that of typical construction in other areas to assure a comparable interior environment. It would also be desirable to arrange the housing so as to minimize the need for outdoor activities; for example, by providing covered communal recreation areas.

Major Sources

To remove some of the most intrusive roadway sounds, a vehicle noise enforcement program could be instituted to reduce the sound levels produced by heavy trucks. An enforced requirement that the A-weighted sound level of a vehicle not exceed 86 dB at 50 feet when operated on a surface street would be consistent with regulations in effect in other cities and states, and would result in a reduction in sound level of approximately the loudest 2 percent of trucks operating in the city.

REFERENCES

1. Impact Characterization of Noise Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure, Henning von Gierke, Task Group Chairman, U.S. Environmental Protection Agency, July 27, 1973.

2. Schultz, T.J., et al "Recommendations for Changes in HUD's Noise Policy & Standards, Appendix B - Social Surveys on Noise Annoyance - A Synthesis" Bolt, Beranek and Newman Report for U.S. Housing and Urban Development, Report No. 3119R, November 1976.

3. Wyle Research "Community Noise Monitoring - A Manual for Implementation" for U.S. Environmental Protection Agency, Report WR 76-8, July 1976.

GLOSSARY

| | |
|---|---|
| A-Weighted Sound Level | A sound level determined using the "A" frequency weighting of a sound level meter which selectively discriminates against high and low frequencies to approximate the auditory sensitivity of human hearing at moderate sound levels. Measures such as $L_{dn}$ and $L_{eq}$, which are developed in terms of A-Weighted sound levels, have been widely correlated with degrees of community noise impact and annoyance. |
| Day-Night Sound Level ($L_{dn}$) | $L_{dn}$ is a calculated single number which describes environmental noise for 24 hours based on the average energy content. It is often calculated by averaging the energy content of all hourly $L_{eq}$'s. (See equivalent sound level.) To account for increased nighttime sensitivity to noise, the $L_{eq}$ values for the nighttime hours (2200 to 0700) are increased by 10 dB for the calculation. |
| Decibel (dB) | A unit for describing the amplitude or level of acoustical quantities - see Level. |

| | |
|---|---|
| Equivalent Sound Level ($L_{eq}$) | A measure which describes the sound level of a time period of fluctuating environmental noise with a single number. $L_{eq}$ is an average level based on the average energy content of the sound rather than average sound level. It is the constant sound level which would contain the same amount of acoustical energy as the fluctuating level for the given period. When reporting $L_{eq}$ values, the time period over which the noise is averaged must be specified; for example, for measurements taken over an 8 hour period, the equivalent sound level is expressed $L_{eq}(8)$. These measurements, and the resulting $L_{eq}$ values, are A-Weighted, unless specifically designated otherwise. |
| Frequency | The number of sound pressure fluctuations per second of a particular sound expressed in hertz (cycles per second). Frequency is the property of sound that is perceived as pitch. |
| Level | A scale for describing the amplitude of acoustical quantities. In environmental acoustics, usually ten times the logarithm (base 10) of the ratio of an acoustical quantity which is proportional to power (i.e., sound power, sound pressure squared, |

sound intensity, etc.) to a reference quantity of the same kind. The value is assigned the unit decibels.

| | |
|---|---|
| Background Ambient Sound Level | The sound level which exists in the absence of any local identifiable sound sources. Usually perceived as a background rushing sound of many indistinguishable sources. |
| Sound Level | The instantaneous sound pressure level in decibels defined as $L_p = 10 \log (p^2/p^2_{ref})$ where p is the acoustic pressure and $p_{ref}$ is 20 micropascals. In practice, this quantity is measured in decibels directly with a sound level meter, usually applying the A-weighting network of the meter (see A-weighted sound level). |
| Statistical Sound Level ($L_x$) | The sound level which is exceeded for a particular percentage of the time during a given period. The percentage of time exceeded corresponds to the subscript for each metric. For example, the $L_{90}$ of a period of environmental noise is a low level exceeded 90 percent of the time, but the $L_{10}$ is a higher level which was exceeded only 10 percent of the time. |

# APPENDIX A

## SURVEY METHOD

PLANNING

From the point of view of deriving information, the survey was classified into two types of sites -- those representative of the community in general and those representative of highway impact. From the planning perspective, it was necessary to develop two separate site selection techniques to characterize these different types of sites.

To characterize the community in general, the city and surrounding areas were divided into 54 1.6 km (1-mile) square sections each corresponding to an official section as used in the standard surveying scheme. The survey boundary did not include all of the 54 sections. Using section maps having a scale of one inch to 200 feet, each section was divided into a three-by-three matrix thus producing nine cells of equal area. In residential areas, the closest street to the centroid of each cell was located and the measurement site located at the edge closest to the centroid. The actual measurement point was located by applying one of two criteria. If a building was located at the site, the measurement point was located 2 meters (6 feet) in front of the building and 2 meters (6 feet) from the edge opposite the driveway as shown in Appendix D attached. If there were no building located at the site, then the measurement point was located 15 meters (50 feet) back from the curb.

Initially all cells (originally 360) within the survey boundaries were to be measured. Owing to resource limitations, the size of the survey was reduced in area such that only 266 were measured.

The method for selecting sites along roads having medium traffic (i.e., the average daily traffic (ADT) flow is between 6,000 and 18,000 vehicles) and for roads having high traffic (i.e., the ADT was greater than 18,000 vehicles) as follows.

First, for each road category (i.e., medium and heavy traffic), potential sites were located along each road at approximately 13 km (12 mile) intervals. For medium traffic roads, 222 potential sites were identified. For high traffic roads, 50 potential sites were identified. Assuming standard deviations of sound levels along the medium and high traffic roads of 5 and 3 dB respectively, the required sample sizes were determined by referring to Figure A-1. Thus, to be able to generate mean sound level values with 95 percent confidence that they are correct within $\pm 2$ dB, medium traffic and high traffic samples of 27 and 11 measurement locations would be required respectively. Again, due to resource limitations, different sample sizes were actually obtained and the standard deviations of the measured data were slightly different than assumed. Actual sample sizes are given in Appendix B. Owing to particular concern for low volume streets, additional measurement locations adjacent to various local streets (ADT <6,000) were also selected.

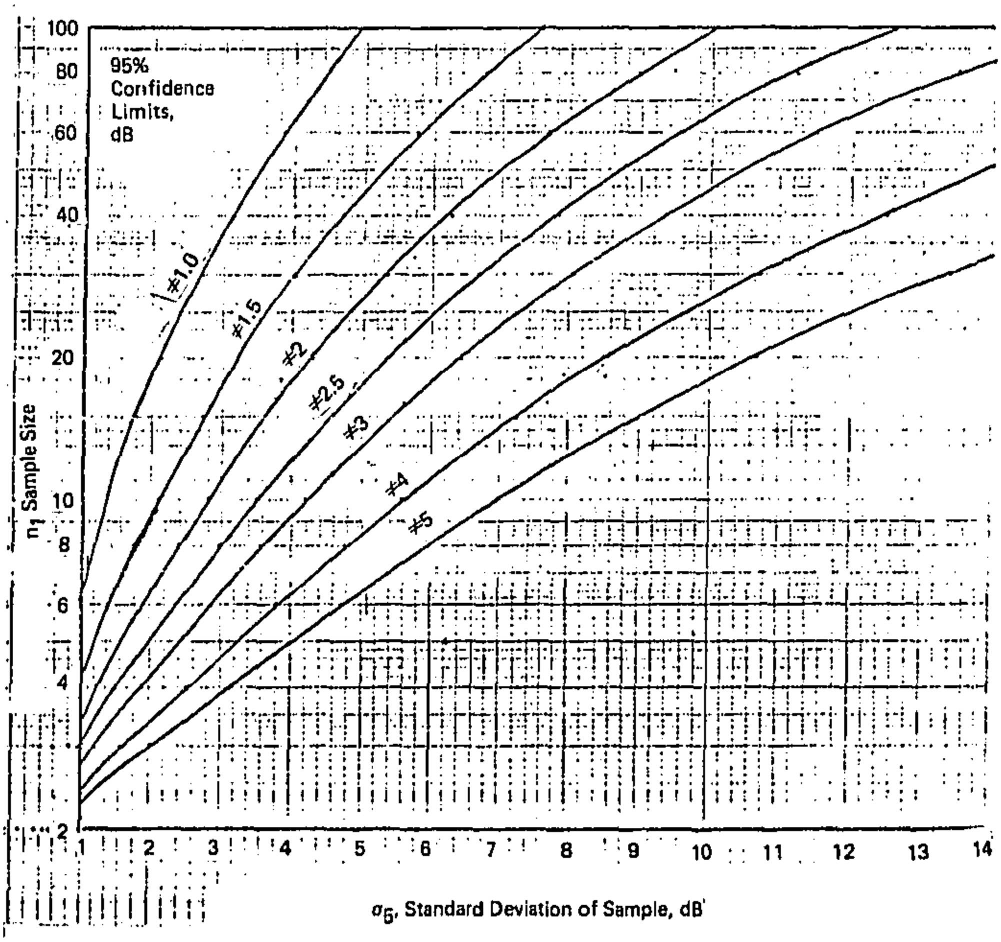



**Figure A-1. Required Sample Size for Various 95 Percent Confidence Limits On Population Standard Deviation**

The actual microphone locations for road measurements were obtained moving 2 meters (6 feet) in front of any building located on the site or 30.5 meters (100 feet) away from the curb for high traffic roads, or 15.2 meters (50 feet) away from the curb for medium traffic roads.

TEMPORAL METHODS

The survey utilized two temporal techniques: manual 20-minute samples and automatic 24-hour samples. The former technique was utilized to generate statistical data and derive the $L_{eq}$'s for a 20-minute non-peak traffic period. It required the collection of data by personnel (either APA, EPA or City staff, Boise State University students or Borah High School students) who at each site measured the A-weighted sound level using an ANSI Type II sound level meter set to slow response. At the end of every 15-second interval, the instantaneous meter reading was recorded. For levels less than 70 dB, the level was tallied by placing slashed lines corresponding to each occurrence in the appropriate 2 dB-wide sound level band on the data sheet (see Appendix D). Above 70 dB, source codes rather than slashed lines enabled a means of source identification. Thus each observer constructed a distribution of the sound levels, indicated the sources of all events over 70 dB, and noted general comments on road conditions, source environment, and any other pertinent input.

Three Metrosonics dB 602 Community Noise Analyzers automatically collected the 24-hour data. The units were located at 10 locations throughout the city. To provide equipment security and AC power, the measurement locations were flexible; however, all locations were visually unobstructed from the street. The community noise analyzers were set to collect the following information on an hourly basis -- $L_{eq}$, $L_{10}$, $L_{50}$, and $L_{90}$.

## ANALYSIS

The 20-minute samples were coded onto computer cards and processed using the computer program listed in Appendix B. The 24-hour hourly data were directly read from the community noise analyzers. $L_{dn}$ was calculated by a separate computer program from the hourly $L_{eq}$ values.

## APPENDIX B

## DATA REDUCTION AND ANALYSIS

This appendix provides supplementary and background material to sections 4.4 and 5.0 of the report. Data handling or analysis details not fully covered in those sections are presented here.

### Data Reduction

Approximately 24,560 individual sound level readings were made during the 20-minute measurements throughout interior areas or along roads. These readings were reduced by computer to a few useful average values. For each 20-minute measurement, the computer produced one page of information including:

- o Equivalent sound level ($L_{eq}$) for the 20-minute measurement period.
- o Sound level distribution of sources exceeding 70 dB
- o Time of day of the measurement
- o Land use of the measurement area
- o Exact measurement location coordinates.

An example reduced data page is shown in Figure B-1. The computer program which was used is included at the end of this appendix.

Using the land use or site codes of the printed output, the data were separated into the area categories shown in Table B-1, each category containing the indicated number of 20 minute samples. In each category, the numerical means of the $L_{90}$ and $L_{eq}$ values for the

NJ IE = ERI D = 30 IATC =M -HDI FFER 1 = _ =33 _ _ SL...DN =___IE ___ =1.

SITE = 125 YARDS FROM FREEWAY
DATE = JAN 11 1977 SHEETS = 1

1 HOURLY INFORMATION 125 YARDS FROM FREEWAY JAN 11 1977

IMPACT =FREEWAY TRAFFIC
GENERAL COMMENTS =BARKING DOGS-CHAINSAW-FREEWAY NOISE
HOUR = 11.48-12.09
WEATHER: CONDITIONS =F TEMPERATURE = -6. C .WIND SPEED = 5. (KTS)

| DB | NUMBER OF OCCURRENCES | | | |
|---|---|---|---|---|
| 0- 2 | 0 | | | |
| 2- 4 | 0 | | | |
| 4- 6 | 0 | | | |
| 6- 8 | 0 | | | |
| 8- 10 | 0 | | | |
| 10- 12 | 0 | | | |
| 12- 14 | 0 | | | |
| 14- 16 | 0 | | | |
| 16- 18 | 0 | | | |
| 18- 20 | 0 | | | |
| 20- 22 | 0 | | | |
| 22- 24 | 0 | | | |
| 24- 26 | 0 | | | |
| 26- 28 | 0 | | | |
| 28- 30 | 0 | | | |
| 30- 32 | 0 | | | |
| 32- 34 | 0 | | | |
| 34- 36 | 0 | | | |
| 36- 38 | 0 | | | |
| 38- 40 | 0 | | | |
| 40- 42 | 11 | | | |
| 42- 44 | 7 | | | |
| 44- 46 | 20 | | | |
| 46- 48 | 5 | | | |
| 48- 50 | 4 | | | |
| 50- 52 | 10 | | | |
| 52- 54 | 4 | | | |
| 54- 56 | 6 | | | |
| 56- 58 | 7 | | | |
| 58- 60 | 2 | | | |
| 60- 62 | 2 | | | |
| 62- 64 | 1 | | | |
| 64- 66 | 0 | | | |
| 66- 68 | 1 | | | |
| 68- 70 | 0 | | | |
| 70- 72 | 0 | 0 | 0 | 0 |
| 72- 74 | 1 | 1 | 0 | 0 |
| 74- 76 | 0 | 0 | 0 | 0 |
| 76- 78 | 0 | 0 | 0 | 0 |
| 78- 80 | 0 | 0 | 0 | 0 |
| 80- 82 | 0 | 0 | 0 | 0 |
| 82- 84 | 0 | 0 | 0 | 0 |
| 84- 86 | 0 | 0 | 0 | 0 |
| 86- 88 | 0 | 0 | 0 | 0 |
| 88- 90 | 0 | 0 | 0 | 0 |
| 90- 92 | 0 | 0 | 0 | 0 |
| 92- 94 | 0 | 0 | 0 | 0 |
| 94- 96 | 0 | 0 | 0 | 0 |
| 96- 98 | 0 | 0 | 0 | 0 |
| 98- 100 | 0 | 0 | 0 | 0 |

TOTAL NUMBER OF SAMPLES = 81

LMAX = 73
L.1 = 73
L1 = 73
L10 = 57
L50 = 47
L90 = 41
L99 = 41
LMIN = 41

TNI = 75.0
LNP (GAUSSIAN ) = 67.3
LNP = 74.1
LEQ = 55.9

Figure B-1. Reduced Data From 20-Minute Measurement Site

Table B-1

Summary of 20-Minute Measurements
Taken Between 9:00 AM and 5:00 PM in Boise

| Type of Site | No. of 20 Minute Samples | Mean $L_{90}$ (Ave. Residual) | Mean $L_{eq}$ ($\approx L_{dn}$) | Standard Deviation of $L_{eq}$ Values | 95 Percent Confidence Interval of Mean $L_{eq}$ Based on (Figure B-2) |
|---|---|---|---|---|---|
| | | ← | dB | | → |
| Residential | 170 | 42.1 | 53.7 | 8.56 | ± 1.5 |
| Commercial | 26 | 52.7 | 62.9 | 5.75 | ± 2.5 |
| Roads < 6000 ADT | 6 | 37.7 | 54.2 | 5.12 | ± 5.5 |
| Roads > 18000 ADT | 12 | 57.0 | 65.9 | 5.11 | ± 3.5 |
| Roads 6000<ADT<18000 | 23 | 51.1 | 64.0 | 4.31 | ± 2 |
| Industrial | 11 | 51.6 | 62.1 | 6.27 | ± 4.5 |
| Central Business District | 5 | 55.8 | 66.4 | 6.23 | >± 5 |
| Parks/Open Space | 24 | 44.1 | 52.5 | 11.89 | ± 5.5 |
| Inside NEF 30 Contour | 17 | 45.2 | 58.2 | 8.65 | ± 4.5 |
| Inside NEF 40 Contour | 13 | 46.4 | 65.9 | 12.65 | >± 5.5 |
| Total | 307 | | | | |

20 minute samples were calculated, along with the standard deviation of the $L_{eq}$ values. These are also tabulated in Table B-1 and were the principal reduced data used for analysis.

Data Uncertainty

The survey technique used in Boise contains two principal types of data uncertainty - sampling error and measurement error.

Sampling Error

In each land use area, a finite number of 20 minute samples was taken to estimate the mean $L_{eq}$ for the area. The sample size (number of 20 minute $L_{eq}$ values) necessary to estimate the actual area mean $L_{eq}$ to within a certain confidence interval with a specified confidence is related to the standard deviation of the population of all possible 20 minute $L_{eq}$ samples. In order to be sure, with a specified degree of confidence, that a sample estimate of population mean falls within a given confidence interval, $\pm\Delta$, it is appropriate to apply the equation:

$$\Delta = \frac{t\sigma}{\sqrt{n}}$$

where: t = the confidence parameter (from a student's "t" distribution) which depends upon the degree of confidence desired in the sample and on the sample size

$\sigma$ = the standard deviation of the population of all possible samples (in this case, of all possible 20 minute $L_{eq}$ values) and

n = the sample size.

A graph of this equation is shown in Figure B-2.

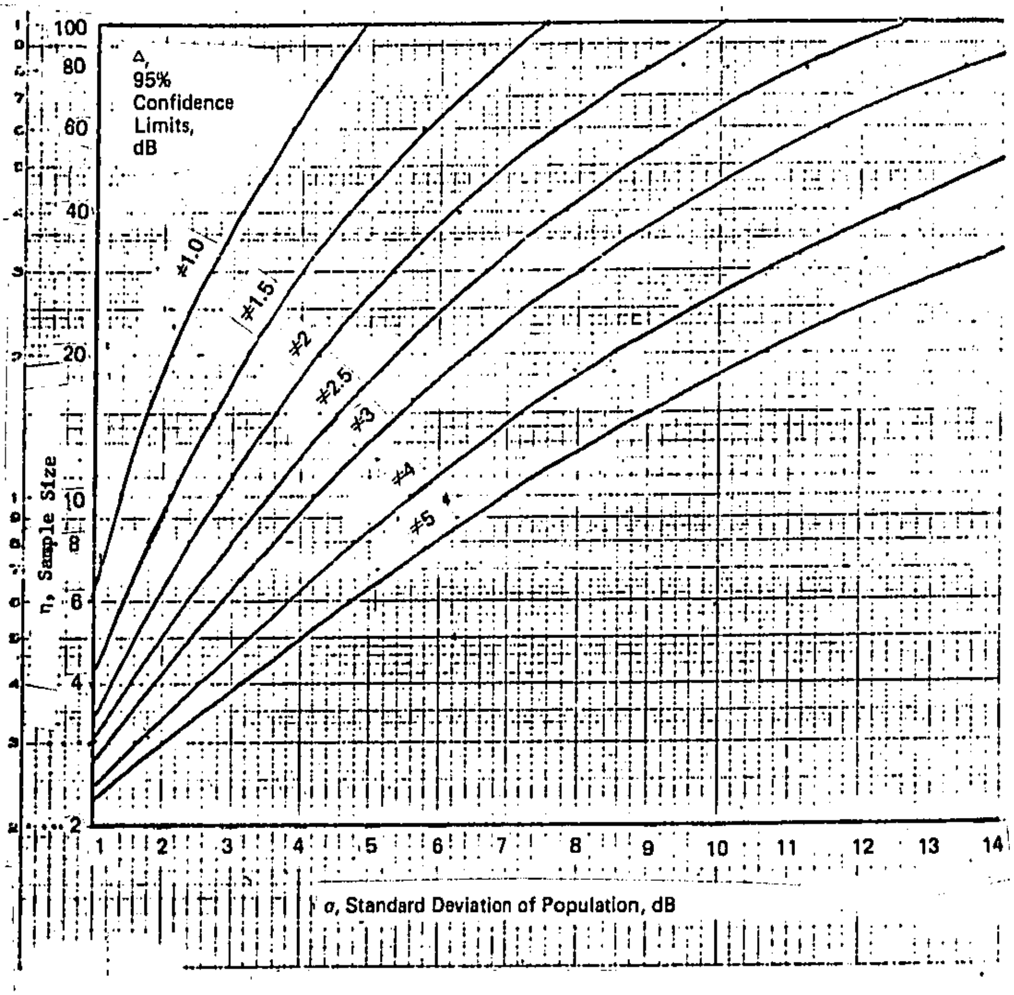



Figure B-2. Sample Size Needed to Measure a Population Mean with 95 Percent Confidence

This figure was used as explained in Appendix A, to estimate desired sample sizes for the land use area categories based on a standard deviation estimate for each category. These desired sizes were not always reached, however, due to logistical and manpower difficulities. Thus it was necessary to determine the confidence intervals for the sample sizes which were achieved. These were obtained from Figure B-2 using the standard deviation of the sample as an estimate of that of the entire population. These estimated confidence intervals for a 95 percent confidence level are given in Table B-1 for each land use area category.

Measurement Error

The 20 minute measurements were performed by manually reading a sound level meter at 15-second intervals. Uncertainty in these readings is provoked by calibration accuracy, meter accuracy, and reading accuracy. Although all field personnel were trained in the use of electronic sound level meter calibrators, insufficient calibrators were on hand for assignment to every field team. Thus, some teams were unable to check calibration at regular intervals throughout a day of measurements. For these teams, the meter was calibrated at the beginning of the day, and this calibration was checked upon the team's return. In general, these beginning and end checks indicated the meters to have maintained calibration within 1 dB even with the varying low outdoor temperatures. This may have been partially due to the consistent use of fresh batteries. Meter and reading accuracies can be considered together. The accuracy of a Type II sound level meter required by ANSI Standard S1.4 - 1971 when indicating A-weighted levels of community noise is no worse than plus or minus 1 dB. Also, since instantaneous "snapshot" type readings were often required while the meter needle was moving (slow meter damping), it is judged that reading accuracy was no better than plus or minus 1 dB. For both meter and reading accuracies, however, there is no reason to expect that the errors would be biased toward the plus or minus side, since several different combinations of meters and observers were used. Thus no significant fixed error would have been induced into either the calculated $L_{eq}$ for each 20 minute sample or the calculated mean $L_{eq}$ for a group of samples representing a land use category.

Uncertainty Summary

The confidence with which the mean values of the measured samples represent the true community noise level mean values was determined using Figure B-2 and is expressed in Table B-1. Uncertainty of the measured samples due to sound level meter calibration was seen to be insignificant. Measurement errors due to instrument or reading errors are presumed to be randomly distributed about the equivalent or mean values, and therefore will not significantly alter the calculated equivalent sound levels or their means. Hence, measurement uncertainties do not degrade the confidence intervals and levels established by the sample sizes selected.

Table B-1 shows that the mean $L_{eq}$ values determined for almost all areas of the survey are within 5 dB of the actual population means with 95-percent confidence. In particular, the mean noise levels in the important residential and medium to high volume road areas have been determined with an especially narrow confidence interval. Thus, the confidence in principal data is sufficient to allow the conclusive interpretations of Section 5.0 of the report.

$L_{eq}(8)$ to $L_{dn}$ Conversion

The principal survey data for each site consisted of the $L_{eq}$ for a 20-minute period between the weekday hours of 9:00 AM and 5:00 PM. Each land use area within the city contained several such sites, and their 20 minute samples were uniformly distributed throughout the 9:00 to 5:00 period. Thus, for each land use area, the 20 minute $L_{eq}$ values could be arithmetically averaged to estimate, with a certain confidence, the average $L_{eq}$ in the area for the 9:00 to 5:00 period. (The confidence in the average $L_{eq}(8)$ estimation is developed elsewhere in this appendix.) A method was then developed to determine the average $L_{dn}$ for each land use area based on this average $L_{eq}(8)$.

The method for determining the $L_{eq}$-to-$L_{dn}$ conversion was derived from the 24-hour sound level measurements, which gave hourly $L_{eq}$ values for several locations around the city. From these values the $L_{dn}$ and the $L_{eq}(8)$ from 9:00 to 5:00 were calculated for each site. This allowed a direct and accurate comparison of the 9:00 to 5:00 $L_{eq}$ with the $L_{dn}$

for these sites. The 24-hour results were then separated according to land use, yielding an assessment of the difference between 9:00 to 5:00 $L_{eq}$ and $L_{dn}$ for each type of area. These differences are shown in the fourth column of Table B-2, where it can be seen that, on the average, the magnitude of this difference is always much less than 1 dB.

It was then assumed that the differences between the average $L_{eq}(8)$ and $L_{dn}$ values measured at the 24 hour sites are representative of the differences between the average measured $L_{eq}$ and the true average $L_{dn}$ for the 20 minute sites. This was made based on the similarity between microphone locations, measurement periods, and measured 9:00 to 5:00 $L_{eq}$ for the 24 hour and 20 minute measurements. Thus, the average values in column 4 of Table B-2 are adjustments which may be applied to the average $L_{eq}$ data from the 20 minute surveys in order to estimate average $L_{dn}$.

From the above, it is seen that the differences between average daytime $L_{eq}$ (9:00 to 5:00) and $L_{dn}$ for Boise are much less than 1 dB in all areas. (It is presumed that a similar difference exists for parks and open space, which were not included in 24-hour measurements but are similar to residential areas.) This is in accordance with a major previous study which indicated that, for areas with $L_{dn}$ less than 55 dB, the nighttime $L_{eq}$ is typically 10 dB below the daytime $L_{eq}$.* This

*Information on the Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety, U.S. Environmental Protection Agency, March 1974

Table B-2

Differences Between $L_{eq(8)}$ (9:00 AM — 5:00 PM) and $L_{dn}$ Calculated from Weekday 24-Hour Measurements in Boise

| Land Use | $L_{dn}$, dB (24-hour measurements) | $L_{eq(8)}$, dB (24-hour measurements) | $L_{dn} - L_{eq(8)}$, dB (24-hour measurements) | Average $L_{eq(8)}$, dB (20-minute measurements) |
|---|---|---|---|---|
| | 59.3 | 57.1 | 2.2 | |
| Residential | 45.4 | 43.4 | 2.6 | |
| | 51.5 | 53.6 | -2.1 | |
| | 51.7 | 53.2 | -1.5 | |
| | 54.7 | 54.3 | 0.4 | |
| Averages: | - | 52.3 | 0.32 | 53.7 |
| | 56.5 | 55.5 | 1.0 | |
| Arterial | 58.0 | 59.7 | -1.7 | |
| <6000 ADT | 59.6 | 60.7 | -1.1 | |
| Averages: | - | 58.6 | -0.6 | 54.2 |
| Airport Influence | 60.4 | 60.9 | -0.5 | 58.2 to 65.9 |
| CBD | 65.7 | 65.3 | 0.4 | 66.4 |

would cause the calculated $L_{dn}$ value to just equal the daytime $L_{eq}$ as is the case on the average for Boise's quiet areas. The previous study also showed that, as $L_{dn}$ increased from 55 to 65 dB, the difference between daytime and nighttime $L_{eq}$ would decrease to 4 dB, which would permit the nighttime values to dominate the $L_{dn}$ calculation (when the 10 dB weighting is added) and cause the $L_{dn}$ to exceed the daytime $L_{eq}$. It is apparent that in Boise this does not happen. In areas of Boise with a high $L_{dn}$, the nighttime levels apparently are not great enough to increase the $L_{dn}$, but remain at a level sufficiently low to keep $L_{dn}$ approximately equal to daytime $L_{eq}$.

It is concluded that the approximate difference between the daytime average $L_{eq}$ determined by the 20-minute surveys and $L_{dn}$ at the same site in Boise should be zero. This is particularly reasonable in light of two final relationships. First, the 20-minute survey measurements themselves are probably accurate to no more than plus or minus 1 dB, but the average differences between the 24-hour $L_{eq(8)}$ and $L_{dn}$ values are on the order of only one-half dB. Second, the 95-percent confidence intervals for the average $L_{eq}$ values derived from the 20-minute measurements are much larger than the above one-half dB differences. Thus the differences between $L_{eq(8)}$ and $L_{dn}$ resulting from the 24-hour measurements are very, very small when compared to the normal 20-minute survey uncertainty, and do not represent a significant adjustment.

Development of Noise Zones

General

Via the data manipulations previously described, $L_{dn}$ values were obtained for areas of various land use within the survey area. The land use codes used to categorize the data for interior measurement sites were assigned to the sites by an Ada County assistant planner. Thus, accuracy of the land use assignments was assured. To indicate these assignments and corresponding sound levels on a city map, a photograph from a Landsat satellite was used. This photograph indicates the predominant land use for each one-sixteenth mile square in the area by color. (The predominant land use for each square is deduced by the satellite based on the reflected and radiated light characteristics of each type of land use.) The Landsat photo of the Boise area was simplified by the Ada County Staff to limit the total number of land use types indicated. It is believed that the land use assignments made by the assistant planner correspond well with the land use interpretations of Landsat, and that the Landsat photograph is an accurate pictorial display of the land use categories for which $L_{dn}$ values have been established.

Additional areas were added to the Landsat photograph to show distinctive sound patterns not directly related to land use. The central business district core is represented as a separate commercial area defined by the area's intense commercial buildings, activities, and traffic. The airport influence area is shown based on NEF-30 and NEF-40 contours prepared in a previous airport study. Noise zones that are shown along roadways have widths determined according to the following procedure.

Highway Noise Zone Boundary Determination

The following Table B-3 can be used to roughly estimate the width of roadway noise influence zones along roadways in the Boise area. This may be desirable where local planning or complaint difficulties arise. The table is based on the mean $L_{dn}$ values determined for roadway and interior areas, and on a nominal attenuation of 4.5 dB per doubling of distance from the roadway. It was assumed that, for the Boise sound survey program, the average measurement distance from the roadway edge was 15.2 m (50 ft) for roadway sites. The outer edge of the roadway noise influence zone is taken to be the location where traffic sounds from the subject road cease to measurably increase the average $L_{dn}$ for the surrounding type of area.

Table B-3

Roadway Noise Influence Zone Approximate Widths

| | Influence Zone Half Width-Roadway To Zone Outer Edge-Without Buildings* | |
|---|---|---|
| Roadway ADT | Residential/Parks | Commercial/Industrial |
| < 6000 | 24.4 m (80 ft.) | No Influence |
| 6000 - 18000 | 58 m (190 ft.) | 24.4 m (80 ft.) |
| > 18000 | 67 m (220 ft.) | 36.6 m (120 ft.) |

*If buildings are present lining the roadway, the influence zone width will equal, either the building setback plus the building length, or the above distance, whichever is smaller. See text.

To determine the influence zone width for a given roadway, note whether there is a continuous line of buildings along the road. If so, the influence zone will generally not extend beyond this first row of buildings. For high volume roads in residential areas, some influence may be apparent at the second row of homes, particularly if the size of the spacing between the first row buildings approaches the average building width. If buildings are not present close to the road, or if the spacing is greater than building width, then the zone widths given in Table B-3 for the various traffic volumes and land uses apply. In general, the roadway noise influence zone widths should not exceed those given in the table.

Data Reduction Program

The data reduction program (Figure B-3) was written in FORTRAN by the Boise State University Urban Research Center. This program is based upon a data reduction program developed by the EPA Region VI office in Dallas, Texas.

```
0001          DIMENSION ENVIR(18),SITE(13),NDB(50),NDBA(50),LDB(55),LDBA(55),
             1AAL(6),JAL(6),CASE(6),SOURCE(18),AL10(24),AL50(24),ALEQ(24),
             2SUMN30(50),SUMD1(50),SUMD2(50),SUMD3(50),OPER(5),SIT1(2),SECT(2),
             3IMPACT(9),COMM(9),ISAV(15,3),SOURC(15,3)
0002          DIMENSION WEATH(10,24,3)
0003          DIMENSION DAYS(10),TIMTAD(24)
0004          REAL      LDN,LNP,LUM,LUMM,NPL
0005          INTEGER DAY,DAYS
0006          DATA DAYS/' 10',' 11',' 12',' 13',' 14',' 15',' 18',3*' '/
0007          DATA TIMTAH/1.,2.,3.,4.,5.,6.,7.,8.,9.,10.,11.,12.,13.,14.,15.,16.
             1,17.,18.,19.,20.,21.,22.,23.,24./
0008          DATA IDAY1/' 30'/,IDAY2/' 1 '/,IDAY3/' 2 '/,IDAY4/' 3 '/
        C****************************************************************************
        C    THIS PROGRAM IS GOOD FOR NOISE-LEVELS THAT FALL BETWEEN  1DB AND 99DB
        C****************************************************************************
0009          ICOUNT=0
0010          KKK=50
0011          LLL=KKK+5
        C READ IN THE NUMBER OF DAYS NOT TO EXCEED 10.
0012          READ(1,8000) NDAYS
        C
0013    8000  FORMAT(I2)
0014          DO 8010 N=1,NDAYS
        C  READ IN 4 CARDS PER DAY WHICH CONTAIN THE 24 HOUR WEATHER INFORMATION
        C  NOTE: THE DAYS MUST BE IN ORDER AND THE DATA BY HOUR MUST BE IN ORDER.
0015          I=N
0016          DO 8040  NI=1,3
0017          N1=((NI-1)*8)+1
0018          N2=N1+7
0019          READ(1,8030)((WEATH(I,J,K),K=1,3),J=N1,N2)
0020    8030  FORMAT(8(A4,F3.0,F3.0))
0021    8040  CONTINUE
0022    8010  CONTINUE
0023          NDAY=1
0024          DO 840 I =1,KKK
0025          SUMN30(I)=0.
0026          SUMD1(I)=0.
0027          SUMD2(I)=0.
0028          SUMD3(I)=0.
0029      840 CONTINUE
0030          TOTN30=0.
0031          TOTD1=0.
0032          TOTD2=0.
0033          TOTD3=0.
0034    2000  CONTINUE
0035          WRITE(3,73)
0036          READ(1,4,END=2001) MACH,ISERNO,OPER,SIT1,SECT,ISIC
0037          ICOUNT=ICOUNT+1
0038    4     FORMAT(A1,I6,5A4,2A3,2A3,I2)
0039          WRITE(3,11) MACH,ISERNO,OPER,SIT1,SECT,ISIC
0040    11    FORMAT('1','MACHINE =',A1,2X,'SERIAL NO =',I6,2X,'OPERATOR(S) =',
             15A4,2X,'SITE =',2A3,2X,'SECTION =',2A3,2X,'SIC =',I2)
0041          READ(1,10) NCASES,(SITE(I),I=1,13),MON,DAY,YEAR
0042    10    FORMAT(I4,12A4,A2,3A4)
0043          WRITE (3,50)
0044       50 FORMAT(100H*************************************************************
             1***************************************)
0045          WRITE (3,51)  (SITE(I),I=1,13)
0046    51    FORMAT(3X,7HSITE = ,13A4)
0047          WRITE (3,52) MON,DAY,YEAR,NCASES
0048    52    FORMAT(3X,7HDATE = ,3A4,15X,8HSHEETS =,I4)
0049          WRITE (3,50)
0050          IDATE=DAY
0051          DO 99 M=1,LLL
0052          LDB(M)=0
0053          LDBA(M)=0
0054       99 CONTINUE
0055          DO 100 M=1,KKK
0056          NDBA(M)=0
0057      100 CONTINUE
0058          SUM10=0.
0059          SUM50=0.
0060          SUMEQ=0.
0061          KSUM=0
0062          MMAX=0
0063          MMIN=500
```

Figure B-3. Computer Program Used for Initial Data Reduction

```
            NCASE=1
            TS=00.00
            TF=00.00
            KDAY=0
            NIGHT=0
       1000 CONTINUE
            WRITE(3,72)
            WRITE (3,60) NCASE, (SITE(I),I=1,13),MON,DAY,YEAR
         60 FORMAT(3X,I3,5X,18HHOURLY INFORMATION,5X,13A4,3A4/)
            READ(1,12) TS,TF,(CASE(I),I=1,8)
    12      FORMAT(2F5.2,7A4,A2)
            READ(1,41) IMPACT, COMM
    41      FORMAT(9A4,9A4)
            WRITE(3,42) IMPACT
    42      FORMAT(1X,'IMPACT =',9A4)
            WRITE(3,43) COMM
    43      FORMAT(1X,'GENERAL COMMENTS =',9A4)
            READ(1,13) (ENVIR(I),I=1,18)
         13 FORMAT (18A4)
    C       READ IN DESCRIPTION OF SOURCES
            READ(1,980) (SOURCE(I),I=1,12)
        980 FORMAT(12A5)
    C            READ IN NUMBER OF SAMPLES
            READ(1,44) (NOB(N),N=1,35)
    44      FORMAT(35I2)
            READ(1,45) (((ISAV(I,J),SOURC(I,J),J=1,3),I=1,8)
    45      FORMAT(24(I2,A1))
            READ(1,46) (((ISAV(I,J),SOURC(I,J),J=1,3),I=9,15)
    46      FORMAT(21(I2,A1))
            DO 48 I=1,15
            N=35+I
            NOB(N)=0
            DO 47 J=1,3
            NOB(N)=NOB(N)+ISAV(I,J)
    47      CONTINUE
    48      CONTINUE
            WRITE (3,61) TS,TF ,(CASE(I),I=1,8)
    61      FORMAT(3X,6HHOUR =,3X,F5.2,1H-,F5.2,10X,8A4)
            DO 8050 I=1,10
            IF(DAY.EQ.DAYS(I)) GO TO 8060
    8050    CONTINUE
            WRITE(3,8055) ICOUNT,SITI
    8055    FORMAT(' ','DAY DOESN''T MATCH THE TABLE',1X,'COUNT =',I3,1X,'SITE
           1 =',1X,2A4)
            CALL PDUMP (DAY,DAY,0,DAYS(1),DAYS(10),0)
    8060    DO 8070  J=1,24
            IF(TS.LE.TIMTAB(J)) GO TO 8080
    8070    CONTINUE
            WRITE(3,8075) ICOUNT,SITI
    8075    FORMAT(1X,'TIME DOESN''T MATCH THE TABLE',1X,'COUNT = ',I3,1X,'SIT
           1E =',1X,2A4)
            CALL PDUMP (TS,TS,0,TIMTAB(1),TIMTAB(24),0)
    C
    C  CHANGE TEMPERATURE TO CELSIUS
    C
    8080     TEMP=-(5./9.)*(32.-WEATH(I,J,2))
            WRITE(3,62) WEATH(I,J,1),TEMP,WEATH(I,J,3)
    62      FORMAT(3X,'WEATHER:',4X,'CONDITIONS =',A4,' TEMPERATURE =',F4.0,1X
           1,'C ,','WIND SPEED =',2X,F3.0,' (KTS)')
            WRITE(3,981) (SOURCE(I),I=1,12)
        981 FORMAT(3X,12A6)
            WRITE (3,63)
         63 FORMAT(11X,3HDB ,4X,21HNUMBER OF OCCURRENCES)
    C            PRINT OUT AMPLITUDE DISTRIBUTION
            DO 98 N =1,35
    C
            NS=2*N-2
    C
            NT=NS+2
            IF(NOB(N).LE.0) NOB(N)=0
            WRITE (3,71) NS,NT,NOB(N)
         98 CONTINUE
            DO 7111 N=36,50
            I=N-35
            NS=2*N-2
            NT=NS+2
```

Figure B-3. Computer Program Used for Initial Data Reduction
(Continued)

```
               IF(NDB(N).LE.0) NDB(N)=0
               WRITE(3,7112) NS,NT,NDB(N),(ISAV(I,J),SOURC(I,J),J=1,3)
         7112  FORMAT(8X,I3,1H-,I3,2X,I5,3X,3(1X,I3,1X,A1))
         7111  CONTINUE
         71    FORMAT(9X,I3,1H-,I3,2X,I5)
            72 FORMAT(1X,2H  )
            73 FORMAT(1H )
C            FIND TOTAL NUMBER OF SAMPLES FOR THE HOUR
               ISUM=0
               DO 101 N=1,KKK
               ISUM=ISUM+NDB(N)
           101 CONTINUE
               WRITE (3,75) ISUM
            75 FORMAT(3X,26HTOTAL NUMBER OF SAMPLES = ,I4/)
C                   FIND PERCENT OF TOTAL
               AAL(1)=.001*ISUM
               AAL (2)=0.01*ISUM
               AAL(3)=00.1*ISUM
               AAL(4)=  .5*ISUM
               AAL(5)=  .9*ISUM
               AAL(6)= .99*ISUM
C                         SEARCH FOR LMIN
               DO 704 N =1,KKK
               IF(NDB(N)-1)  704,701,701
           701 CONTINUE
C
               LMIN=2*N-1
C
               GO TO 702
           704 CONTINUE
C                    SEARCH FOR LMAX
           702 CONTINUE
               DO 703 N =1,KKK
               MPP=KKK-N+1
               IF(NDB(MPP)-1)  703,705,705
           705 CONTINUE
C
               LMAX=2*MPP-1
C
               GO TO 706
           703 CONTINUE
C              CALCULATE LN.NE.5
           706 CONTINUE
               DO 102 MM=1,6
               ISUB=0
               DO 707 NN =1,KKK
               KK=KKK-NN+1
               ISUB=NDB(KK)+ISUB
               IF(ISUB-AAL(MM))   707,708,708
           708 CONTINUE
C
               JAL(MM)=-1.+2.*KK
C
               GO TO 102
           707 CONTINUE
           102 CONTINUE
C          CALCULATE LNP (GAUSSIAN) AND TNI
               DD=JAL(3)-JAL(5)
               NPL=JAL(4)+DD+DD*DD/60.
               TNIH=4.*DD+(JAL(5)-30.)
C                        CONTROL FOR NIGHTTIME PENALTY
               IF(TF.LT.7..OR.TF.GT.22.)  GO TO 521
               KDAY=KDAY+1
               DO 116 I=1,KKK
               LDB(I)=NDB(I)
           116 CONTINUE
               GO TO 525
           521 CONTINUE
C                    APPLY 10DB PENALTY FOR NIGHT
               NIGHT=NIGHT+1
               DO 115 KL=1,KKK
               LP=KL+5
               LDB(LP)=NDB(KL)
           115 CONTINUE
           525 CONTINUE
C                 SUMMATION OF NUBER OF SAMPLES FOR THE DAY
```

Figure B-3. Computer Program Used for Initial Data Reduction (Continued)

```
            DO 105 JJ=1,KKK
            NOBA(JJ)=NOB(JJ)+NOBA(JJ)
            LOBA(JJ)=LOB(JJ)+LOBA(JJ)
        105 CONTINUE
            KSUM=KSUM+ISUM
            IF(LMAX.GT.MMAX)  MMAX=LMAX
            IF(LMIN.LT.MMIN)  MMIN=LMIN
      C       PRINT OUT LN,NT,S,TNI AND LNP (GAUSSIAN)
            WRITE (3,76) LMAX
            WRITE (3,77)  JAL(1)
            WRITE (3,78)  JAL(2)
            WRITE (3,79)  JAL(3)
            WRITE (3,80)  JAL(4)
            WRITE (3,81)  JAL(5)
            WRITE (3,82)  JAL(6)
            WRITE(3,83)  LMIN
         76 FORMAT(10X,7HLMAX  = ,I3)
         77 FORMAT (10X,7HL.1    = ,I3)
         78 FORMAT(10X,7HL1     = ,I3)
         79 FORMAT(10X,7HL10    = ,I3)
         80 FORMAT (10X,7HL50   = ,I3)
         81 FORMAT (10X,7HL90   = ,I3)
         82 FORMAT (10X,7HL99   = ,I3)
         83 FORMAT (10X,7HLMIN  = ,I3/)
         84 FORMAT (3X,6HTNI = ,F5.1)
         85 FORMAT (3X,17HLNP (GAUSSIAN ) = ,F5.1)
            WRITE (3,84)   TNIH
            WRITE (3,85)  NPL
      C               COMPUTE LAV AND MEAN
            VE=0.
            UNN=0.
            DO 106 LL =1,KKK
      C
            PP=0.1*(2.*LL-1.)
      C
            XPO=FLOAT(NOB(LL))/FLOAT(ISUM)
            UN=XPO*10.**PP
            UNN=UN+UNN
            VER=XPO*PP*10.
            VE=VE+VER
        106 CONTINUE
            AV=10.*ALOG10(UNN)
            AL10(NCASE)=JAL(3)
            AL50(NCASE)=JAL(4)
            ALEQ(NCASE)=AV
            SUM10=SUM10+AL10(NCASE)/FLOAT(NCASES)
            SUM50=SUM50+AL50(NCASE)/FLOAT(NCASES)
            SUMEQ=SUMEQ+ALEQ(NCASE)/FLOAT(NCASES)
      C               COMPUTE SIGMA AND LNP
            DQQ=0.
            DO 107 LL=1,KKK
      C
            FN=ABS(2.*LL-1.-VE)
      C
            DQ=FLOAT(NOB(LL))*FN*FN/FLOAT(ISUM)
            DQQ=DQ+DQQ
        107 CONTINUE
            SIG=SQRT(DQQ)
            LNP=AV+2.56*SIG
            WRITE(3,99)  LNP
            WRITE(3,97)  AV
         91 FORMAT(3X,6HLAV = ,F5.1)
            WRITE(3,12)
            WRITE(3,50)
            WRITE(3,73)
      C * INSERTED TO DO 1 CASE PER SITE ONLY
            GO TO 2000
      C ****
      C * INSERTED TO STOP PGM AT EOF
      2001  STOP
      C ****
      2002  NCASE=NCASE+1
            IF(NCASE.LE.NCASES) GO TO 1000
      C*****************************************************************************
      C               START CALCULATIONS FOR THE WHOLE DAY
      C                     FIND PERCENT OF TOTAL
```

Figure B-3. Computer Program Used for Initial Data Reduction (Continued)

```
      C*******************************************************************************
            AAL(1)=.001*KSUM
            AAL(2)=0.01*KSUM
            AAL(3)=  .1*KSUM
            AAL(4)=  .5*KSUM
            AAL(5)=  .9*KSUM
            AAL(6)= .99*KSUM
      C     CALCULATE THE LN.NE.S AND TNI
            DO 108 MN=1,6
            JSUB=0
            DO 709 NM =1,KKK
            KK=KKK-NM+1
            JSUB=NDBA(KK)+JSUB
            IF(JSUB-AAL(MN)) 709,710,710
      710   CONTINUE
            JAL(MN)=1.+2.*KK
            GO TO 108
      709   CONTINUE
      108   CONTINUE
            TNID=4.*(JAL(3)-JAL(5))+(JAL(5)-30.)
      C  COMPUTE LAV AND MEAN
            AVE=0.
            DUNN=0.
            DO 111 LL=1,KKK
            PDM=0.1*(2.*LL+1.)
            DBA=NDBA(LL)
            EXPR=DBA/KSUM
            DUN=EXPR*10.**PDM
            DUNN=DUNN+DUN
            AVER=EXPR*PDM*10.
            AVE=AVE+AVER
      111   CONTINUE
            AAVER=10.*ALOG10(DUNN)
      C  COMPUTE LON
            LUMM=0.
            DO 119 LL=1,LLL
            PDN=0.1*(2.*LL+1.)
            DBAL=LDBA(LL)
            EDN=DBAL/KSUM
            LUM=EDN*10.**PDN
            LUMM=LUM+LUMM
      119   CONTINUE
            LON=10.*ALOG10(LUMM)
      C  FIND SIGMA AND LNP
            SSQQ=0.
            DO 120 LL=1,KKK
            FN=ABS(2.*LL+1.-AVE)
            SSQ=FLOAT(NDBA(LL))*FN*FN/FLOAT(KSUM)
            SSQQ=SSQ+SSQQ
      120   CONTINUE
            SIGMA=SQRT(SSQQ)
            LNP=AAVER+2.56*SIGMA
            WRITE(3,72)
            WRITE(3,86) NDAY,(SITE(I),I=1,10),MON,DAY,YEAR
      86    FORMAT(1X,I3,10X,17HDAILY INFORMATION,5X,10A6,3A4/)
            WRITE(3,63)
      C     PRINT OUT AMPLITUDE DISTRIBUTION FOR THE DAY
            DO 97 N=1,KKK
            NS=2.*N+0
            NT=NS+2
            WRITE(3,71) NS,NT,NDBA(N)
      97    CONTINUE
            WRITE(3,72)
            WRITE(3,75) KSUM
            WRITE(3,76) MMAX
            WRITE(3,77) JAL(1)
            WRITE(3,78) JAL(2)
            WRITE(3,79) JAL(3)
            WRITE(3,80) JAL(4)
            WRITE(3,81) JAL(5)
            WRITE(3,82) JAL(6)
            WRITE(3,83) MMIN
            WRITE(3,84) TNID
            WRITE(3,87) AAVER
            WRITE(3,90) KDAY,NIGHT
            WRITE(3,88) LON
```

Figure B-3. Computer Program Used for Initial Data Reduction (Continued)

```
DOS FORTRAN IV 360N-FO-479 3-9          MAINPGM              DATE   02/15/77      TIME    17.55.34
           WRITE(3,89) LNP
           WRITE(3,72)
      87   FORMAT(3X,6HLEQ = ,F5.1)
      88   FORMAT(3X,6HLDN= ,F5.1,5X,
          174H  55 IS EPA IDENT.INTERFERENCE LEVEL.  75 IS EPA INDENT.HEARING
          2PROT. LEVEL)
      89   FORMAT(3X,6HLNP = ,F5.1)
      90   FORMAT(2X,13HLDN BASED ON ,I2,19H DAYTIME HOURS AND ,I2,16H NIGHTTIME HOUR
          1IME HOURS)
           WRITE(3,50)
           EX81=0.
           EX75=0.
           EX65=0.
           EL45=0.
           DO 711 J=27,KKK
           EX81=NDBA(J)+EX81
     711   CONTINUE
           PG81=EX81/KSUM*100.
           DO 712 J=24,26
           EX75=EX75+NDBA(J)
     712   CONTINUE
           PG75=(EX81+EX75)/KSUM*100.
           DO 713 J=15,23
           EX65=NDBA(J)+EX65
     713   CONTINUE
           PG65=(EX81+EX75+EX65)/KSUM*100.
           PL65=100.-PG65
           DO 714 J=8,KKK
           EL45=EL45+NDBA(J)
     714   CONTINUE
           PL45=EL45/KSUM*100.
           WRITE(3,92) PG81
           WRITE(3,93) PG75
           WRITE(3,94) PG65
           WRITE(3,96) PL45
      92   FORMAT(3X,15HEXCEEDS 81 DBA ,F6.2,20H PERCENT OF THE TIME,3X,
          143H 4.2 PERCENT (24HR) NOT ACCEPTABLE (HUD))
      93   FORMAT(3X,15HEXCEEDS 75 DBA ,F6.2,20H PERCENT OF THE TIME,3X,
          147H 33.3 PERCENT (24HR) STRONGLY DISCOURAGED (HUD))
      94   FORMAT(3X,15HEXCEEDS 65 DBA ,F6.2,20H PERCENT OF THE TIME,3X,
          148H 33.3 PERCENT (24HR) NORMALLY UNACCEPTABLE (HUD))
      96   FORMAT(3X,15HEXCEEDS 45 DBA ,F6.2,20H PERCENT OF THE TIME,3X,
          148H 33.3 PERCENT (24HR) NORMALLY   ACCEPTABLE (HUD))
           WRITE(3,50)
           R1=0.
           R2=0.
           R3=0.
           S10=0.
           S50=0.
           SEQ=0.
           DO 811 I=1,NCASES
           S10=S10+(AL10(I)-SUM10)**2
           S50=S50+(AL50(I)-SUM50)**2
           SEQ=SEQ+(ALEQ(I)-SUMEQ)**2
           R1=R1+(AL10(I)-SUM10)*(ALEQ(I)-SUMEQ)
           R2=R2+(AL50(I)-SUM50)*(ALEQ(I)-SUMEQ)
           R3=R3+(AL50(I)-SUM50)*(AL10(I)-SUM10)
     811   CONTINUE
           SIG=SQRT(S10/FLOAT(NCASES))
           SIG50=SQRT(S50/FLOAT(NCASES))
           SIGEQ=SQRT(SEQ/FLOAT(NCASES))
           REQ10=R1/(SIG1*SIGEQ)/FLOAT(NCASES)
           REQ50=R2/(SIG50*SIGEQ)/FLOAT(NCASES)
           R1050=R3/(SIG10*SIG50)/FLOAT(NCASES)
           WRITE(3,812) REQ10
           WRITE(3,813) REQ50
           WRITE(3,814) R1050
           WRITE(3,815) SUM10
           WRITE(3,816) SUM50
           WRITE(3,817) SUMEQ
           WRITE(3,818) SIG10
           WRITE(3,819) SIG50
           WRITE(3,820) SIGEQ
     812   FORMAT(5X,28HCORRELATION BET L10 AND LAV=,F7.3)
     813   FORMAT(5X,28HCORRELATION BET L50 AND LAV=,F7.3)
     814   FORMAT(5X,28HCORRELATION BET L50 AND L10=,F7.3)
```

Figure B-3. Computer Program Used for Initial Data Reduction (Continued)

```
DOS FORTRAN IV 360N-FO-479 3-9          MAINPGM          DATE      5/77      TIME     12.53.34
815   FORMAT(5X,10HL10(AVE) =,F7.3)
816   FORMAT(5X,10HL50(AVE) =,F7.3)
817   FORMAT(5X,10HLEQ(AVE) =,F7.3)
818   FORMAT(5X,9HSIG(10) =,F7.3)
819   FORMAT(5X,9HSIG(50) =,F7.3)
820   FORMAT(5X,9HSIG(EQ) =,F7.3)
C*************************************************************************************
C
C*************************************************************************************
      IF(IDATE.NE.IDAY1) GO TO 830
      DO 839 K=1,KKK
      RATIO=FLOAT(NDBA(K))/FLOAT(KSUM)
      SUMN30(K)=SUMN30(K)+RATIO
839   CONTINUE
      GO TO 853
830   CONTINUE
      IF(IDATE.NE.IDAY2) GO TO 831
      DO 841 K=1,KKK
      RATIO=FLOAT(NDBA(K))/FLOAT(KSUM)
      SUMD1(K)=SUMD1(K)+RATIO
841   CONTINUE
      GO TO 853
831   CONTINUE
      IF(IDATE.NE.IDAY3) GO TO 832
      DO 842 K=1,KKK
      RATIO=FLOAT(NDBA(K))/FLOAT(KSUM)
      SUMD2(K)=SUMD2(K)+RATIO
842   CONTINUE
      GO TO 853
832   CONTINUE
      IF(IDATE.NE.IDAY4) GO TO 833
      DO 843 K=1,KKK
      RATIO=FLOAT(NDBA(K))/FLOAT(KSUM)
      SUMD3(K)=SUMD3(K)+RATIO
843   CONTINUE
      GO TO 853
833   CONTINUE
      WRITE(3,834)
834   FORMAT(5X,41HDATE HAS BEEN FOULED UP - CHECK DATE CARD)
853   CONTINUE
      NDAY=NDAY+1
      IF(NDAY.LE.NDAYS) GO TO 2000
      WRITE(3,860)
      DO 844 N=1,KKK
      NS=2*N+0
      NT=NS+2
      WRITE(3,861) NS,NT,SUMN30(N),SUMD1(N),SUMD2(N),SUMD3(N)
      TOTN30=TOTN30+SUMN30(N)
      TOTD1=TOTD1+SUMD1(N)
      TOTD2=TOTD2+SUMD2(N)
      TOTD3=TOTD3+SUMD3(N)
844   CONTINUE
860   FORMAT(6X,3HDBA,8X,12HNOV  30 1973,8X,12HDEC  1  1973,8X,12HDEC  2  1973,
     1  1973,8X,12HDEC  3  1973)
861   FORMAT(5X,I2,1H-,I2,4(6X,F14.10))
      WRITE(3,862) TOTN30,TOTD1,TOTD2,TOTD3
862   FORMAT(4X,6HTOTAL=,4(6X,F14.10))
      END
```

Figure B-3. Computer Program Used for Initial Data Reduction (Continued)

## APPENDIX C

## EQUIPMENT DETAILS

The two levels of temporal sampling used in the survey required two types of instrumentation. For the manually collected data, the observation teams employed ANSI Type 2 sound level meters (with windscreens) mounted on tripods. The sound level meters were calibrated prior to and immediately after each day's session utilizing a compatible acoustic calibrator. (Figure C-1 depicts the manual collection of data.) Quiet-period nighttime measuremants were taken with a B&K ANSI Type I sound level meter.

The 24-hour surveys required a more sophisticated system. The noise signal detected by the B&K 4921 outdoor microphone system (Figure C-2) was fed into the Metrosonics dB-602 Community Noise Analyzer (Figure C-3) which digitized the data at a rate of one sample per second, classified the data into 100 bins each one decibel wide and computed the hourly $L_{eq}$, $L_{10}$, $L_{50}$, and $L_{90}$. The information was stored for an internal solid-state memory from which it was read out at the end of each 24-hour period.

The B&K 4921 microphone system contains a 1/2 inch air condenser microphone, assembled in a comprehensive weather and moisture-proof arrangement including windscreen, raincover, bind spike, and humidifier. Using the build-in electrostatic actuator, the system was calibrated at the start and conclusion of each 24-hour period. The microphone was connected to the community noise analyzer via a 30-meter cable.

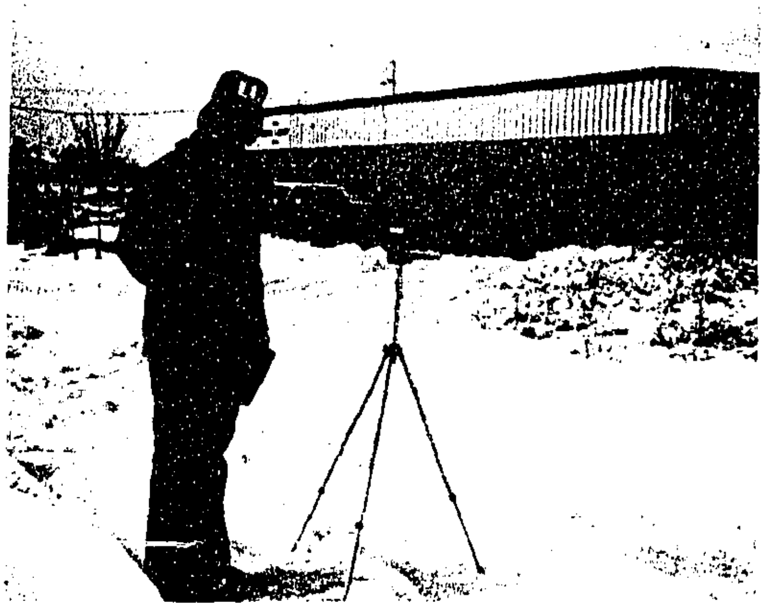


Figure C-1. Field Personnel Preparing to Collect a
20-minute Noise Sample Using Sound Level Meter

Figure C-2. Outdoor Microphone in Place for 24-hour Data Collection

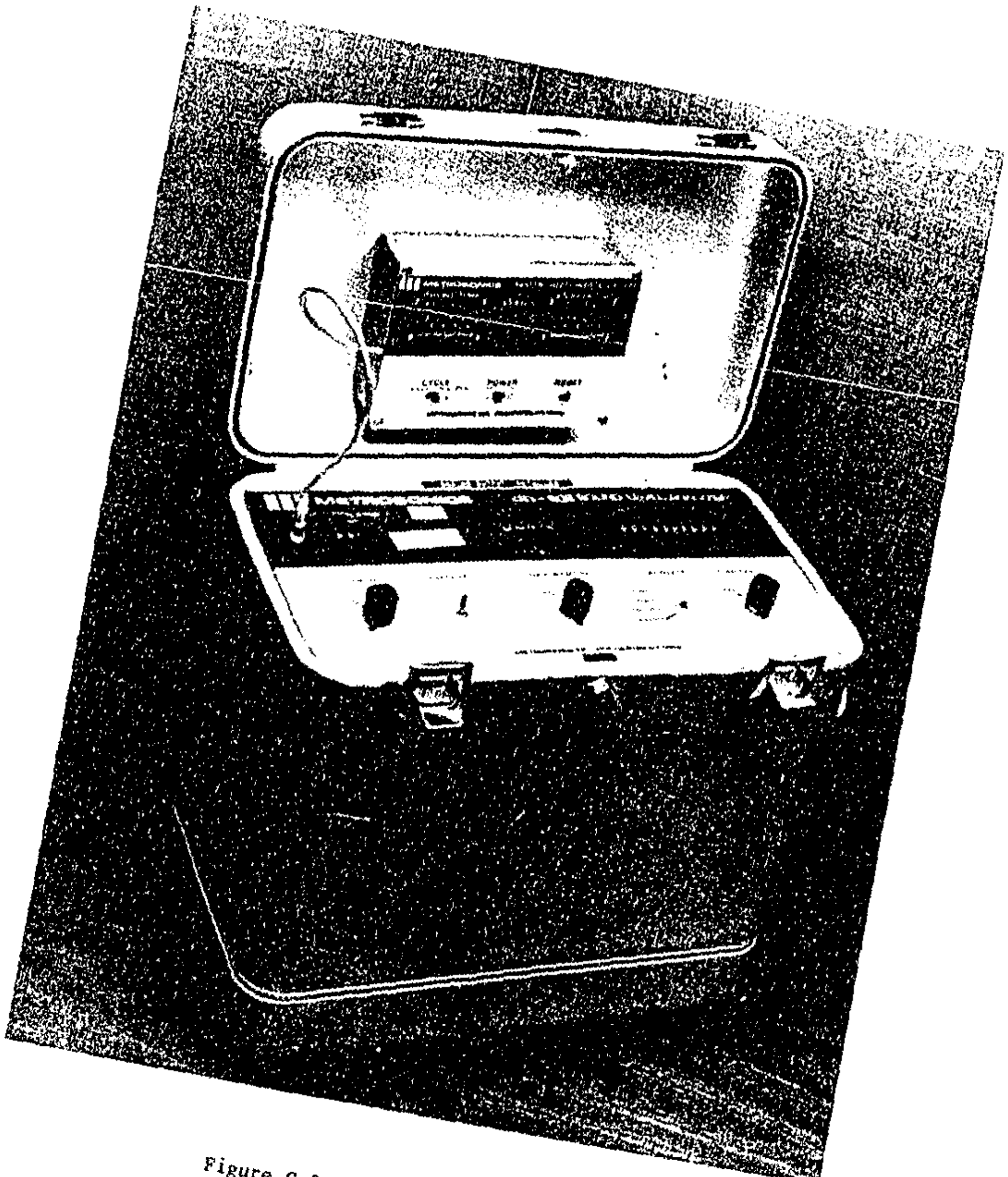



Figure C-3. Community Noise Analyzer

## APPENDIX D

## DATA FORMS AND INSTRUCTIONS

All project personnel who performed 20-minute measurements received personal training in sound level meter use and field data acquisition techniques. Only after this practice were instrument operators sent into the field. The written data collection package given to each operator or team consisted of:

- o Cover sheet indicating the exact 540 m (1/3-mile) square cells containing the sites to be measured.
- o Complete list of procedures for obtaining and recording a 20-minute sample of data at a given site.
- o Figures indicating preferred microphone placement for different types of sites (e.g., grid site, roadway site, etc.).
- o An example data sheet showing correct procedures for completion and data logging.
- o Blank data sheets to be completed.
- o A large scale map upon which was marked the intended measurement location.

Examples of these items (with exception of the map) are presented in this appendix. Note that the data sheet easily allows the observer to record comments and a site sketch as well as sound level data.

Telephone number for
assistance: 384-4394

Section: ________ Cells: ________

Section: ________ Cells: ________

Section: ________ Cells: ________

Name: ____________________ Phone No: ________________

Name: ____________________ Phone No: ________________

Date: ____________________

SLM:

Model ________________________

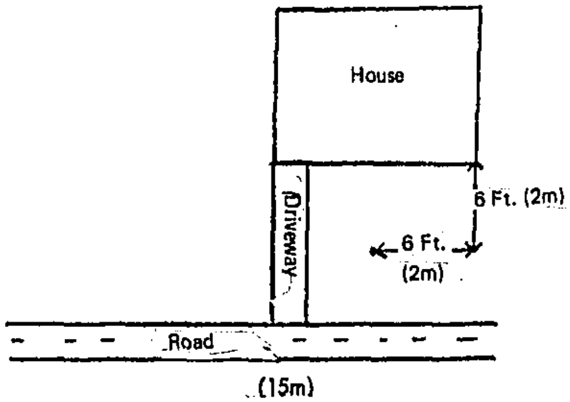
S.N. ________________________

## TEST PROCEDURE

1. Write name, date, and section number assigned in upper right hand corner of Data Log Book.
2. Locate site.
3. Fill in top part of Data sheet.
4. Set up tripod at test site. Make sure SLM is in a vertical position.
5. Make sure windscreen is on microphone.
6. Place weighting adjustment to A.
7. Place fast-slow adjustment to slow.
8. Turn meter on.
9. Set dB adjustments according to noise levels at test site.
10. Take dB reading every 15 seconds and record for a 20 minute period.
11. Turn off SLM at end of 20 minute period.
12. Total up readings on data sheet.
13. Fill in post-survey comments.
14. Move to next test site.

AREA

Green Mark



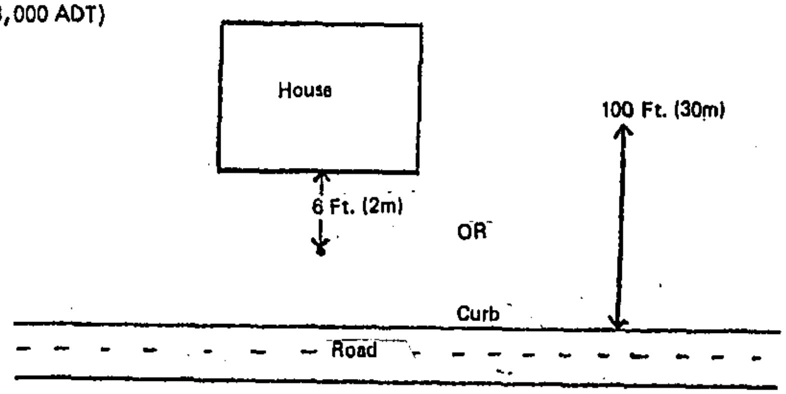

Use standard distance of 50 ft./in all applications if no building is at site

HI

(> 18,000 ADT)

Blue Mark

Whichever one is closer

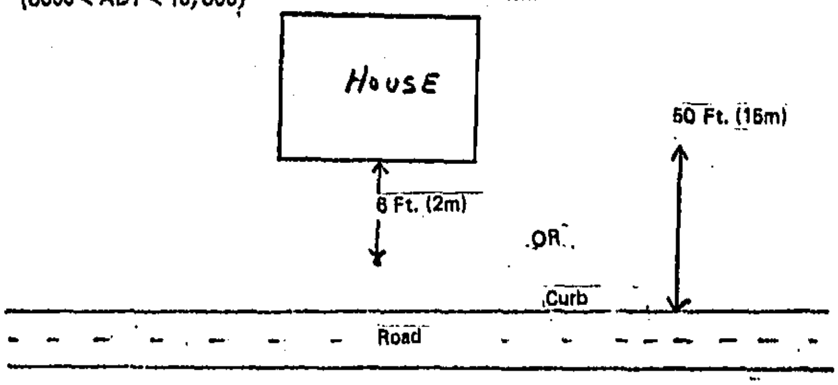



LO

(6000 < ADT < 18,000)

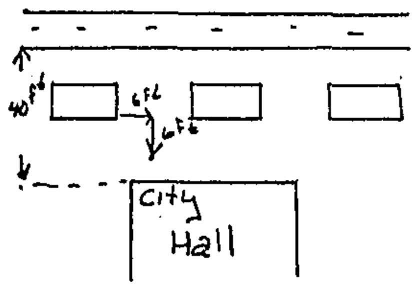
Red Mark

Whichever one is closer



| PRE-SURVEY COMMENTS: | GENERAL | SITE |
| --- | --- | --- |
| orginal site is now a building took reading from steps | Operator: swiltz | Site No. 29-2A |
| | Date: 7 Jan 77 | Location: 150 Nth capitol |
| | Time: 10:00 To 10:20 | Site Description: commercial |
| | Day S M T W Th (F) S | |
| | Micro. Distance to Wall: 6 ft | |

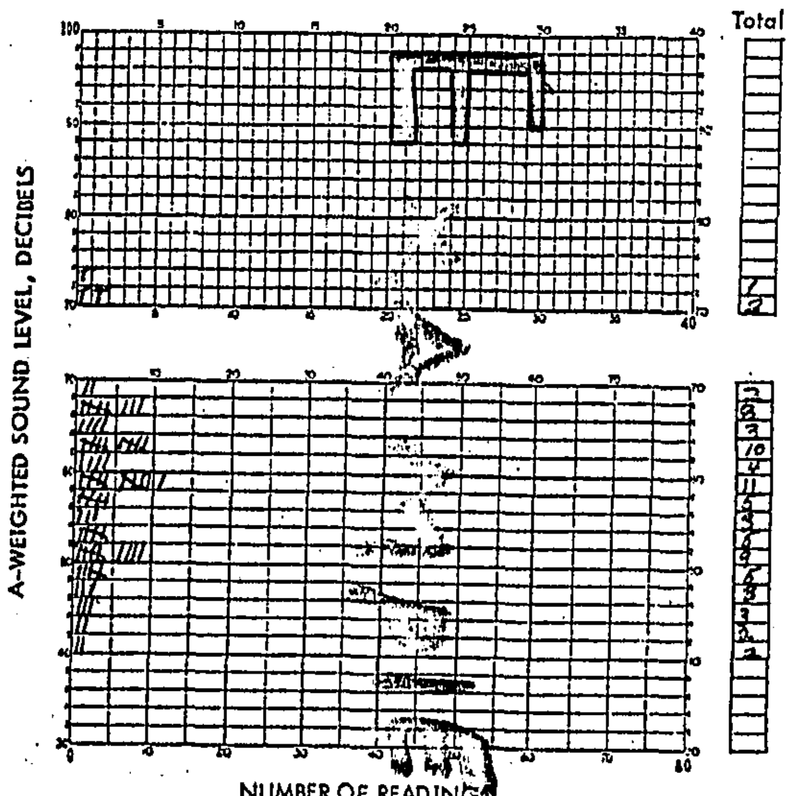
SITE SKETCH:




POST-SURVEY COMMENTS:

IMPACT: automobile

GENERAL COMMENTS: 3 Big trucks passed while taking readings




**Code for Noises Above 70 dB**

TRANSPORTATION
- E ___ EMER. VEH.
- P ___ SMALL PLANE
- J ___ JET
- H ___ HELICOPTER
- R ___ RAILROAD
- T ___ TRUCK
- A ___ AUTO
- B ___ BUS
- M ___ MOTORCYCLE
- W ___ WATER CRAFT
- V ___ OFF RD. VEH.

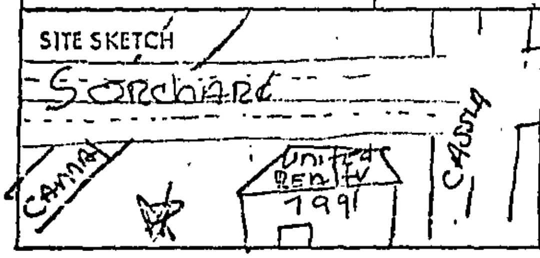
MACHINERY
- C ___ CONSTRUCTION EQUIP.
- Y ___ YARD MAINT. EQUIP.
- F ___ FACTORY EQUIP.
- h ___ HOUSEHOLD EQUIP.

OTHER
- D ___ DOG
- L ___ LOUD SPEAKERS

S 173N2E

| GENERAL | EQUIPMENT | SITE 835-58 |
| --- | --- | --- |
| Operator Dwight Liggett | Type | Site No 5 35 G |
| Date 1/11/78 | Serial # | Location 799 S Orchard at Cassia, at United Realty |
| Time 9:55 To 10:15 | Cal. Date | |
| Day S M T W Th F S | Micro. Height | Site Description Cannot Left of United Realty Industrial |
| Wind Speed ____ Direction ____ | Micro. Distance to Wall | |
| Temp. ____ Rel. Hum. ____ | SLM Setting ____ Fast, ____ Slow | |
| Other Weather | Other | |

SITE SKETCH

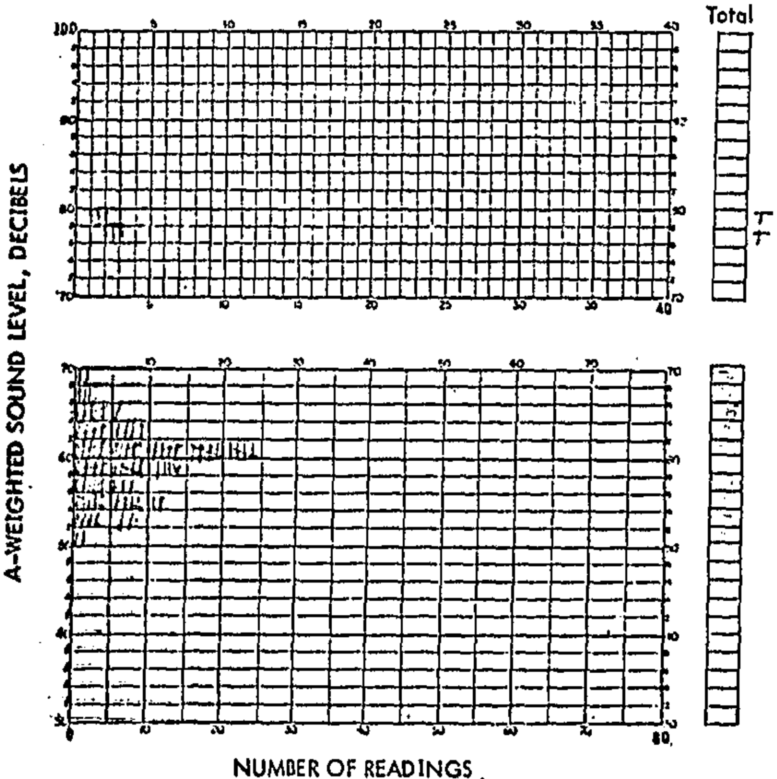



MISCELLANEOUS 39

Traffic Count: Autos ____

Trucks ____ Other ____ Total ____

Comments Low rumble of cars. Canal covered




Code for Noises Above 70 dB

TRANSPORTATION
E____EMER. VEH.
P____SMALL PLANE
J____JET
H____HELICOPTER
R____RAILROAD
T____TRUCK
A____AUTO
B____BUS
M____MOTORCYCLE
W____WATER CRAFT
V____OFF RD. VEH.

MACHINERY
C____CONSTRUCTION EQUIP.
Y____YARD MAINT. EQUIP.
F____FACTORY EQUIP.
h____HOUSEHOLD EQUIP.

OTHER
D____DOG
L____LOUD SPEAKERS

# APPENDIX E

## 24-HOUR DATA

The 24-hour data obtained with the community noise analyzer are presented in this appendix. Note that the summary sheet (Table E-1) indicates that some of the measurements were repeated during different days at the same site. Following the summary is an individual tabulation and 24-hour graph for each site showing hourly levels of $L_{eq}$, $L_{90}$, $L_{50}$, and $L_{10}$, and daily values of $L_{eq}$ and $L_{dn}$.

Table E-1

Summary of 24-Hour Measurements of Noise in Boise, Idaho, January 1977

| Location | Start | | Finish | | $L_{eq}$ (24) (dB) | $L_d$ (dB) (0700-2200) | $L_n$ (dB) (2200-0700) | $L_{dn}$ (dB) | Land Use or Local Noise Source |
|---|---|---|---|---|---|---|---|---|---|
| | Day | Time | Day | Time | | | | | |
| City Hall Roof (SW 1/4) | 1/7 Fri. | 1730 | 1/8 Sat. | 1630 | 61.0 | 60.1 | 62.4 | 68.5 | Road |
| City Hall Roof (SW 1/4) | 1/8 Sat. | 1730 | 1/9 Sun. | 1630 | 59.0 | 56.5 | 61.2 | 67.1 | Road |
| City Hall Roof (SW 1/4) | 1/10 Mon. | 1030 | 1/11 Tues. | 0930 | 62.0 | 63.8 | 58.8 | 66.0 | CBD |
| 7111 McMullens | | 1530 | | 1430 | 56.0 | 57.5 | 51.3 | 59.0 | Residential |
| 2040 Penninger | 1/12 Wed. | 1530 | 1/13 Thurs. | 1430 | 59.0 | 61.1 | 49.1 | 60.0 | Airport NEF 30-NEF 40 Boundary |
| 2800 No. Frye | 1/12 Wed. | 1830 | 1/13 Thurs. | 1730 | 43.0 | 44.1 | 37.0 | 45.0 | Residential |
| 2205 Harrison | 1/12 Wed. | 1730 | 1/13 Thurs. | 1650 | 54.0 | 55.2 | 43.1 | 57.0 | Arterial < 6000 ADT |
| 1814 8th Street | 1/13 Thurs. | 1730 | 1/14 Fri. | 1630 | 56.0 | 58.0 | 47.8 | 58.0 | Arterial < 6000 ADT |
| 217 Redfish Lane | 1/13 Thurs. | 1930 | 1/14 Fri. | 1830 | 50.0 | 52.0 | 40.5 | 52.0 | Residential |
| 1050 Kroll Street | 1/13 Thurs. | 1830 | 1/14 Fri. | 1730 | 50.0 | 51.5 | 42.0 | 52.0 | Residential |
| 1814 8th Street | 1/14 Fri. | 1930 | 1/15 Sat. | 1230 | 52.0 | 53.5 | 50.8 | 58.0 | Arterial < 6000 ADT |
| 1050 Kroll Street | 1/14 Fri. | 1930 | 1/15 Sat. | 1330 | 47.0 | 47.3 | 46.7 | 53.0 | Residential |
| 1790 Hill Road Terrace | 1/18 Tues. | 1830 | 1/19 Wed. | 1830 | 58.0 | 60.0 | 48.7 | 60.0 | Arterial < 6000 ADT |
| 300 Costin | 1/20 Thurs. | 1930 | 1/21 Fri. | 1930 | 53.0 | 54.3 | 45.1 | 55.0 | Residential |

Table E-2

24-HOUR DATA SHEET

Location: City Hall Roof
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: RR

| | Date | Time |
|---|---|---|
| Start | 1-7-77 | 17:30 |
| Finish | 1-8-77 | 16:30 |

All Descriptions in Decibels

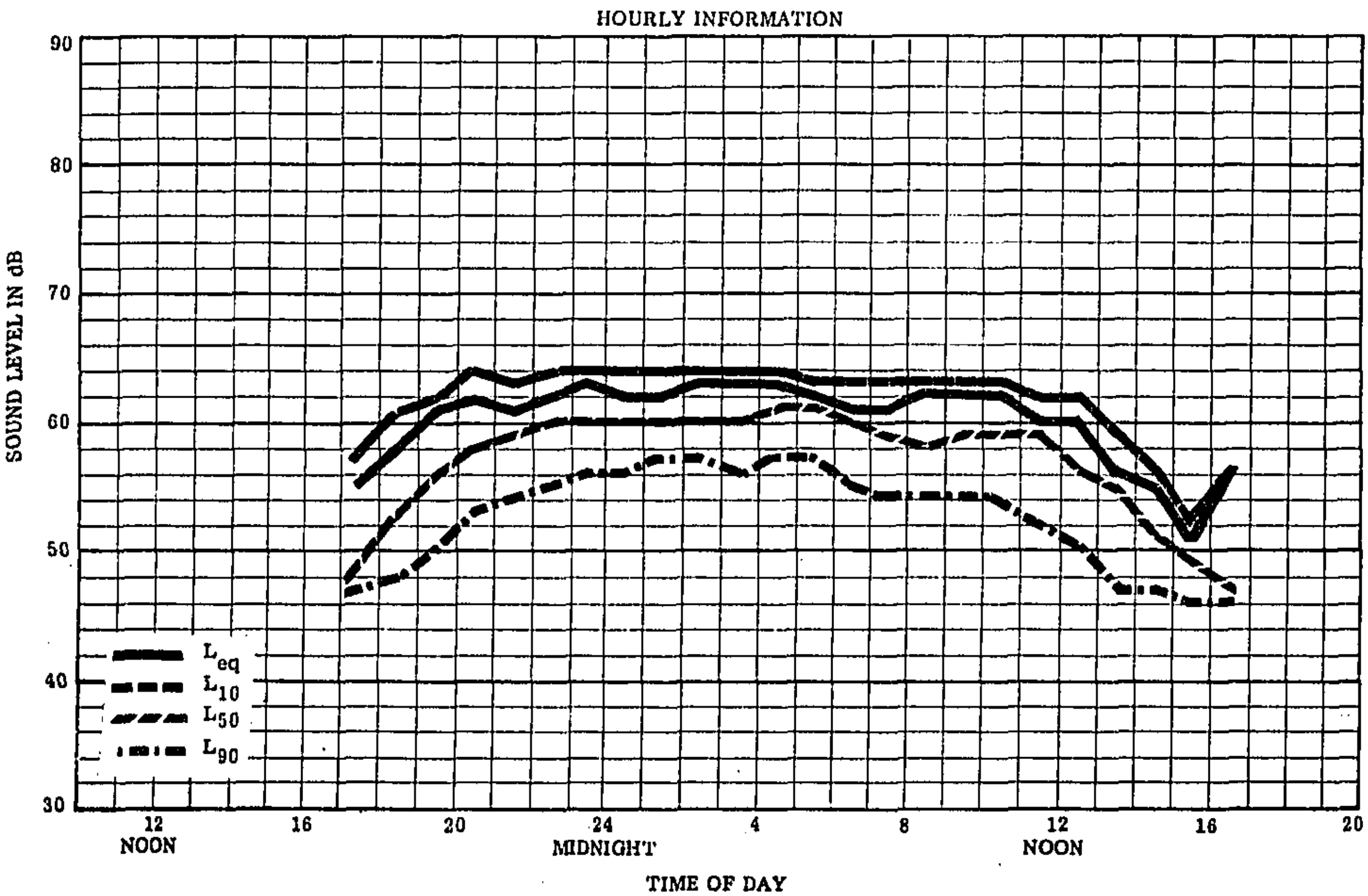
| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1730 | 55 | 57 | 49 | 47 | 0630 | 61 | 63 | 60 | 55 |
| 1830 | 58 | 61 | 53 | 48 | 0730 | 61 | 63 | 59 | 54 |
| 1930 | 61 | 62 | 56 | 50 | 0830 | 62 | 63 | 58 | 54 |
| 2030 | 62 | 64 | 58 | 53 | 0930 | 62 | 63 | 59 | 54 |
| 2130 | 61 | 63 | 59 | 54 | 1030 | 62 | 63 | 59 | 54 |
| 2230 | 62 | 64 | 60 | 55 | 1130 | 60 | 62 | 59 | 52 |
| 2330 | 63 | 64 | 60 | 56 | 1230 | 60 | 62 | 56 | 50 |
| 2430 | 62 | 64 | 60 | 56 | 1330 | 56 | 59 | 55 | 47 |
| 0130 | 62 | 64 | 60 | 57 | 1430 | 55 | 56 | 51 | 47 |
| 0230 | 63 | 64 | 60 | 57 | 1530 | 51 | 52 | 49 | 46 |
| 0330 | 63 | 64 | 60 | 56 | 1630 | 56 | 55 | 47 | 46 |
| 0430 | 63 | 64 | 61 | 57 | | | | | |
| 0530 | 62 | 63 | 61 | 57 | | | | | |

$L_{dn}$ = 69 dB

$L_{eq}$ = 59.0 dB (9-5)

Summary of sound levels at
City Hall - January 7, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 68.5 dB




E-4

Table E-3

24-HOUR DATA SHEET

Location: City Hall Roof
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: R.R.

| | Date | Time |
|---|---|---|
| Start | 1-8-77 | 17:30 |
| Finish | 1-9-77 | 16:30 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1730 | 54 | 57 | 48 | 47 | 0630 | 61 | 62 | 58 | 54 |
| 1830 | 55 | 58 | 49 | 48 | 0730 | 60 | 62 | 57 | 54 |
| 1930 | 55 | 58 | 50 | 48 | 0830 | 60 | 61 | 56 | 52 |
| 2030 | 59 | 61 | 51 | 49 | 0930 | 58 | 61 | 55 | 52 |
| 2130 | 60 | 62 | 55 | 52 | 1030 | 57 | 59 | 54 | 52 |
| 2230 | 60 | 62 | 56 | 50 | 1130 | 54 | 57 | 52 | 49 |
| 2330 | 61 | 63 | 57 | 50 | 1230 | 55 | 56 | 48 | 47 |
| 2430 | 61 | 63 | 59 | 54 | 1330 | 49 | 50 | 45 | 40 |
| 0130 | 62 | 62 | 58 | 53 | 1430 | 47 | 46 | 41 | 40 |
| 0230 | 61 | 63 | 57 | 55 | 1530 | 50 | 49 | 40 | 38 |
| 0330 | 61 | 63 | 58 | 53 | 1630 | 52 | 55 | 41 | 39 |
| 0430 | 61 | 63 | 57 | 52 | | | | | |
| 0530 | 62 | 63 | 59 | 54 | | | | | |

$L_{dn}$ = 67 dB

$L_{eq}$ = 54.2 dB (9-5)

Summary of sound levels at
City Hall - January 8, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 67.1 dB

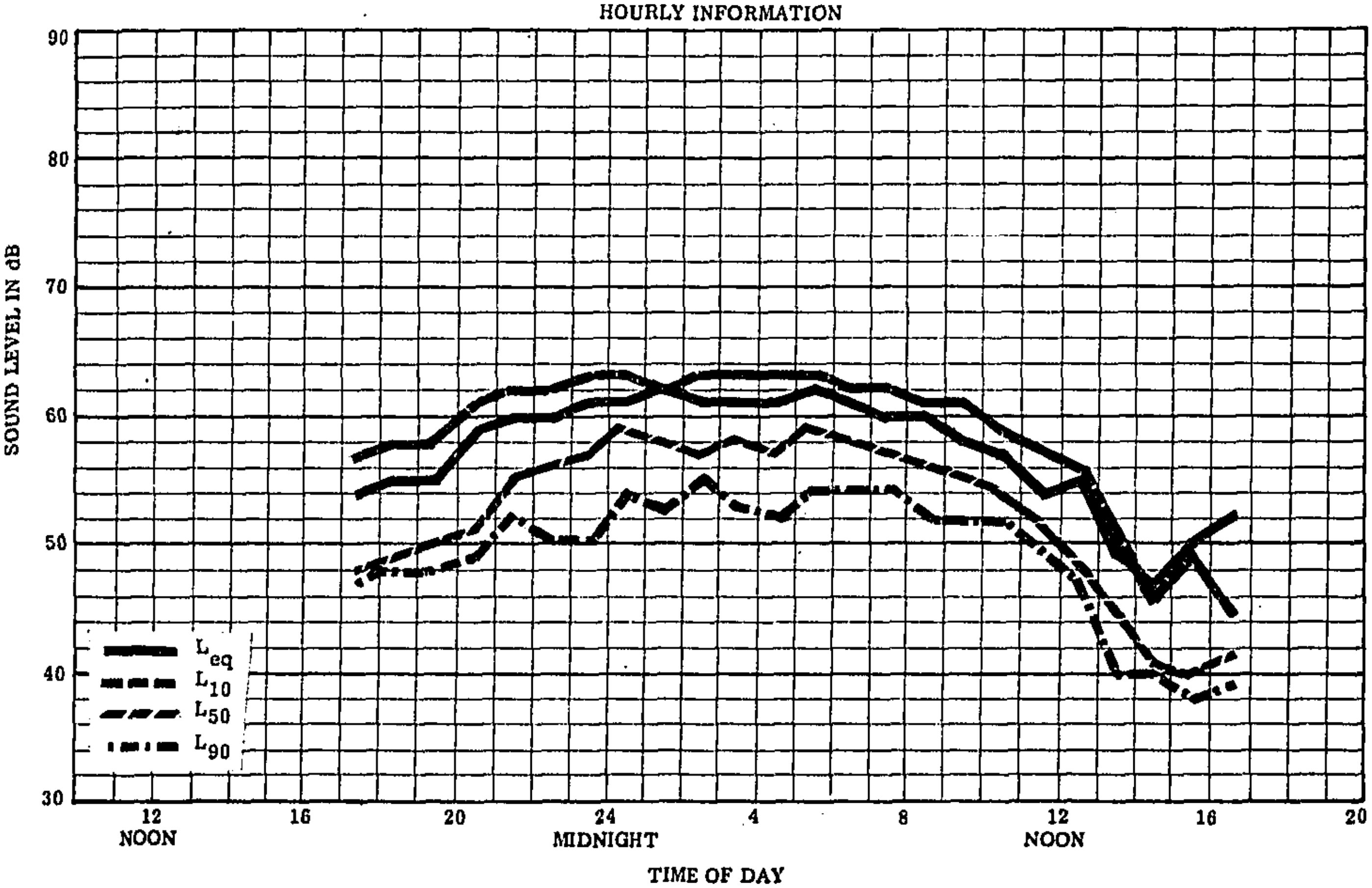


Table E-4

24-HOUR DATA SHEET

Location: City Hall Roof
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: Konheim

| | Date | Time |
|---|---|---|
| Start | 1-10-77 | 09:50 |
| Finish | 1-11-77 | 11:50 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1030 | 64 | 64 | 61 | 57 | 2330 | 61 | 59 | 51 | 47 |
| 1130 | 65 | 65 | 62 | 59 | 2430 | 55 | 58 | 49 | 46 |
| 1230 | 64 | 65 | 62 | 60 | 0130 | 54 | 55 | 47 | 46 |
| 1330 | 65 | 65 | 62 | 60 | 0230 | 52 | 51 | 46 | 45 |
| 1430 | 66 | 66 | 63 | 60 | 0330 | 51 | 51 | 47 | 45 |
| 1530 | 65 | 66 | 63 | 60 | 0430 | 52 | 54 | 47 | 46 |
| 1630 | 65 | 65 | 62 | 59 | 0530 | 57 | 60 | 52 | 47 |
| 1730 | 63 | 64 | 60 | 56 | 0630 | 63 | 71 | 60 | 54 |
| 1830 | 62 | 63 | 59 | 54 | 0730 | 64 | 71 | 60 | 54 |
| 1930 | 61 | 62 | 57 | 52 | 0830 | 64 | 67 | 61 | 58 |
| 2030 | 59 | 62 | 57 | 51 | 0930 | 64 | 63 | 63 | 60 |
| 2130 | 60 | 62 | 56 | 51 | 1030 | 65 | 63 | 63 | 60 |
| 2230 | 58 | 61 | 54 | 49 | 1130 | 66 | 64 | 64 | 60 |

$L_{dn}$ = 66 dB

$L_{eq}$ = 65.3 dB (9-5)

Summary of sound levels at
City Hall - January 10, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 65.7 dB

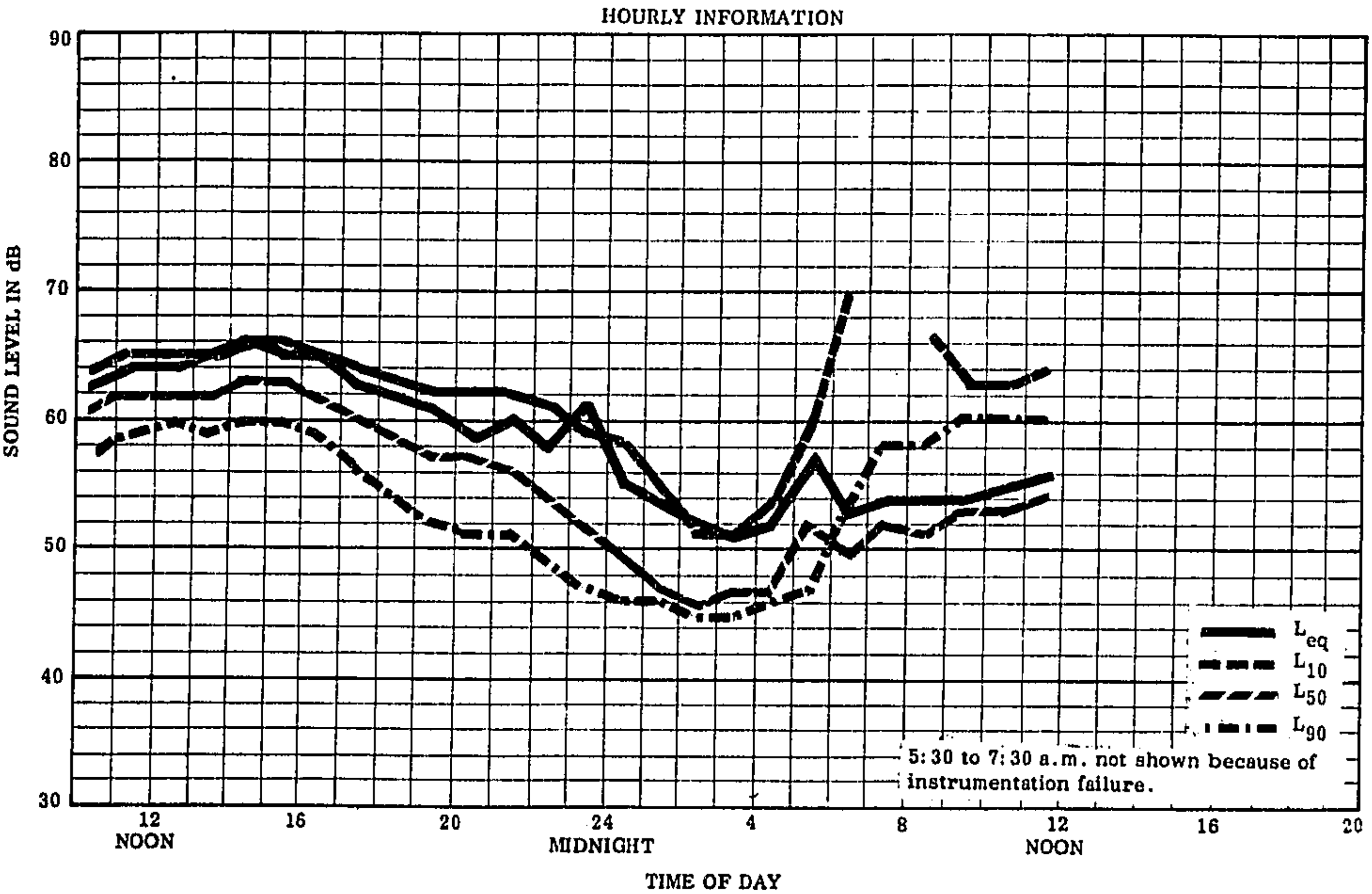


Table E-5

24-HOUR DATA SHEET

Location: 7111 McMullens
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: AK

| | Date | Time |
|---|---|---|
| Start | 15:00 | |
| Finish | 14:45 | |
| | | |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1530 | 59 | 54 | 48 | 45 | 0330 | 49 | 49 | 47 | 46 |
| 1630 | 60 | 53 | 50 | 48 | 0430 | 48 | 48 | 47 | 46 |
| 1730 | 58 | 56 | 49 | 47 | 0530 | 49 | 48 | 46 | 44 |
| 1830 | 59 | 54 | 49 | 47 | 0630 | 47 | 48 | 46 | 43 |
| 1930 | 60 | 56 | 49 | 47 | 0730 | 48 | 49 | 47 | 43 |
| 2030 | 54 | 53 | 48 | 47 | 0830 | 51 | 45 | 47 | 44 |
| 2130 | 62 | 58 | 50 | 48 | 0930 | 52 | 50 | 48 | 46 |
| 2230 | 52 | 53 | 51 | 48 | 1030 | 56 | 56 | 48 | 46 |
| 2330 | 54 | 54 | 50 | 49 | 1130 | 55 | 55 | 48 | 44 |
| 2430 | 51 | 51 | 49 | 47 | 1230 | 57 | 55 | 48 | 47 |
| 0130 | 55 | 51 | 48 | 47 | 1330 | 57 | 53 | 47 | 45 |
| 0230 | 49 | 49 | 48 | 46 | 1430 | 56 | 53 | 48 | 46 |
| | | | | | | | | | |

$L_{dn}$ = 59.3 dB

$L_{eq}$ = 57.1 dB (9-5)

Summary of sound levels at
7111 McMullen Drive

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 59.3 dB

E-10

HOURLY INFORMATION

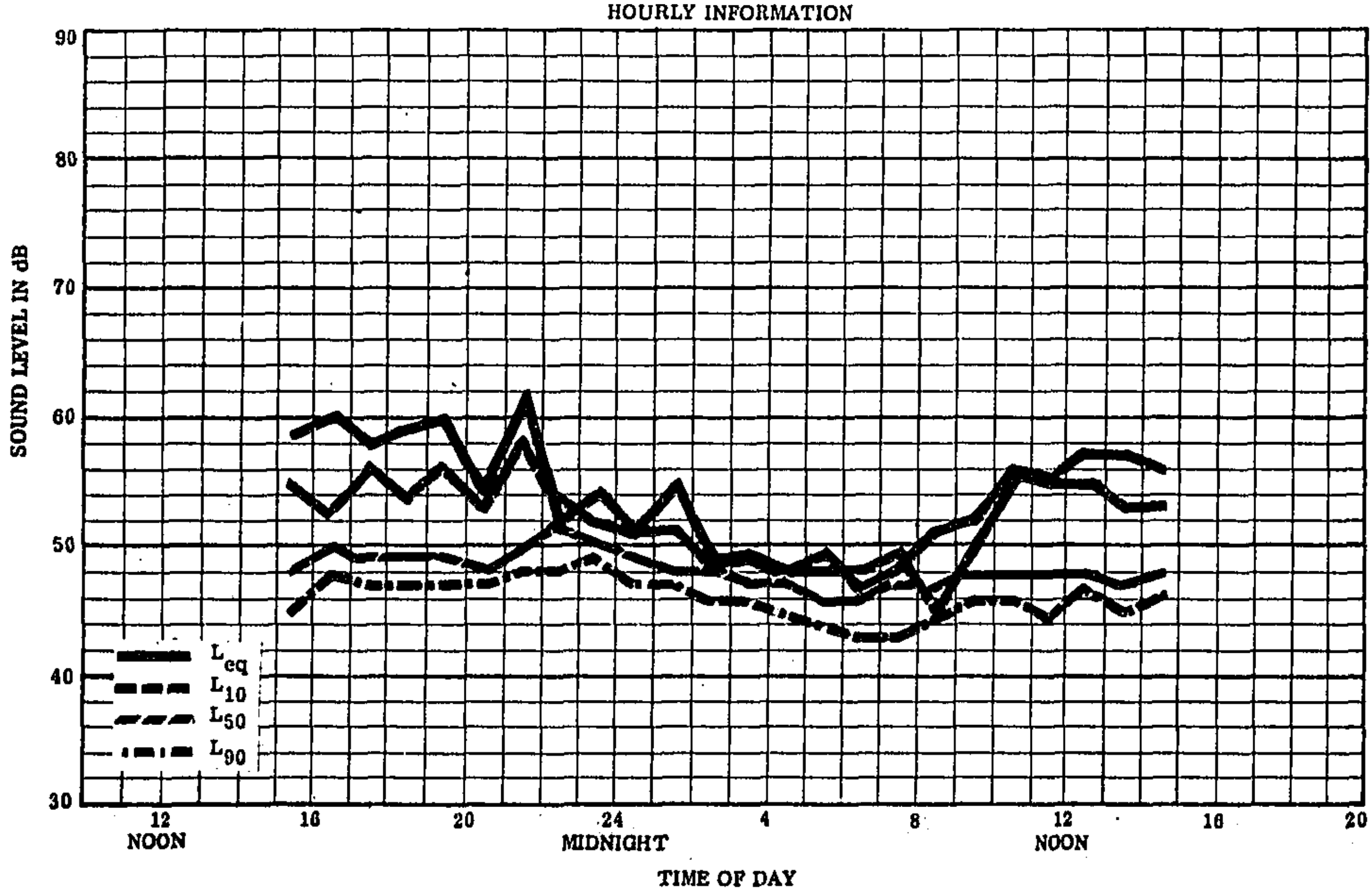


Table E-6

24-HOUR DATA SHEET

Location: 2040 Penninger
Serial Number of Mike: 526575
EPA Property Number of Analyzer: 019156
Operator: R.R.

| | Date | Time |
|---|---|---|
| Start | 1-12-77 | 14:15 |
| Finish | 1-13-77 | 14:50 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1530 | 56 | 47 | 41 | 43 | 0330 | 42 | 41 | 35 | 36 |
| 1630 | 63 | 56 | 43 | 39 | 0430 | 37 | 38 | 35 | 33 |
| 1730 | 64 | 40 | 45 | 39 | 0530 | 37 | 38 | 35 | 33 |
| 1830 | 57 | 49 | 43 | 41 | 0630 | 41 | 42 | 38 | 33 |
| 1930 | 59 | 50 | 41 | 38 | 0730 | 40 | 41 | 39 | 36 |
| 2030 | 56 | 50 | 40 | 39 | 0830 | 49 | 46 | 40 | 37 |
| 2130 | 67 | 45 | 39 | 38 | 0930 | 62 | 55 | 40 | 38 |
| 2230 | 57 | 42 | 37 | 37 | 1030 | 62 | 50 | 39 | 37 |
| 2330 | 49 | 43 | 36 | 35 | 1130 | 58 | 51 | 41 | 38 |
| 2430 | 41 | 42 | 38 | 35 | 1230 | 62 | 56 | 43 | 39 |
| 0130 | 48 | 41 | 38 | 36 | 1330 | 63 | 54 | 41 | 39 |
| 0230 | 46 | 41 | 38 | 36 | 1430 | 47 | 47 | 43 | 41 |
| | | | | | | | | | |

$L_{dn}$ = 60.4 dB

$L_{eq}$ = 60.9 dB (9-5)

Summary of sound levels at
2040 Penninger - January 19, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 60.4 dB

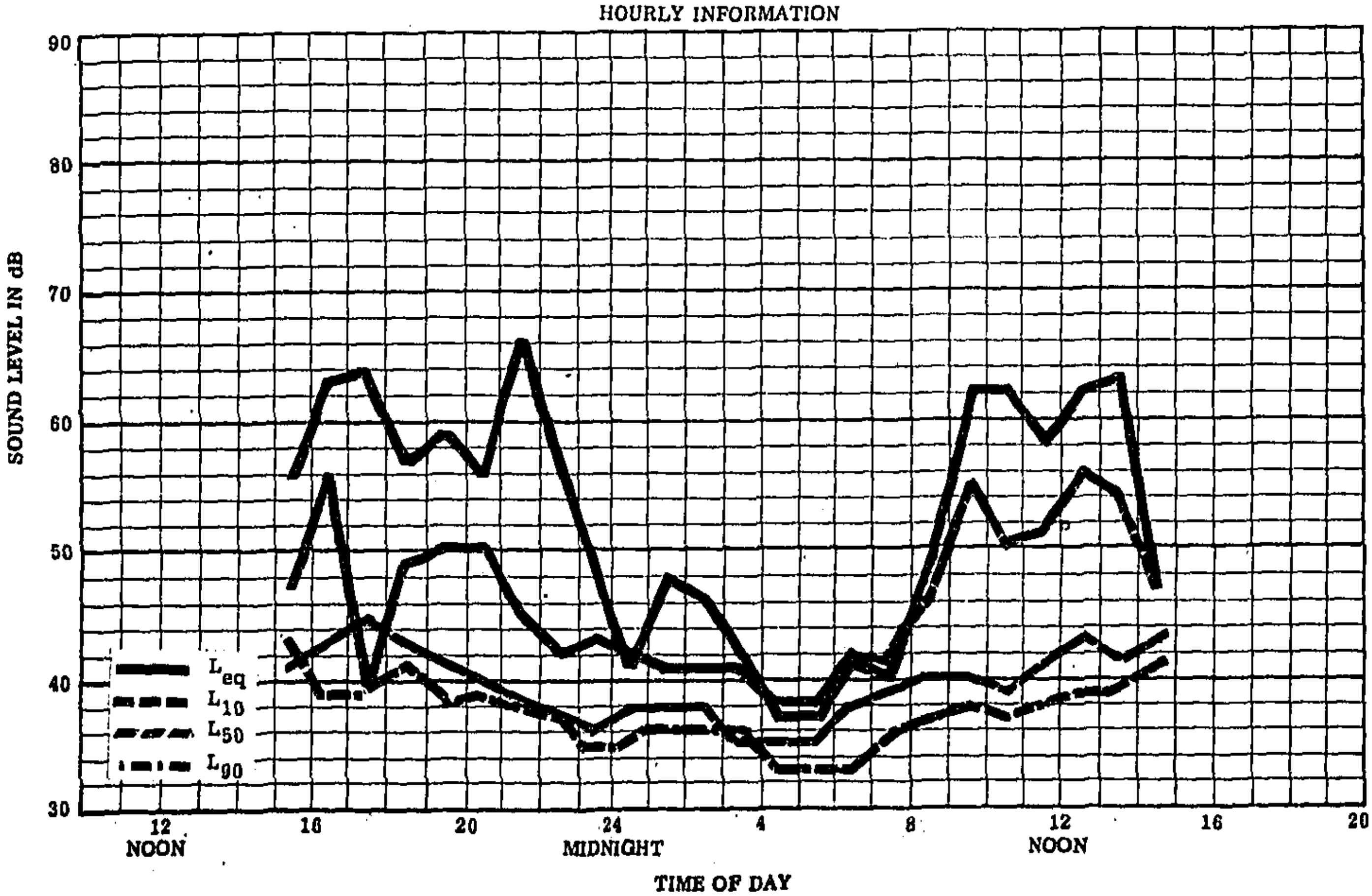


Table E-7

24-HOUR DATA SHEET

Location: 2800 N. Fry
Serial Number of Mike: 442933
EPA Property Number of Analyzer: 063020
Operator: 063020 R.R.

| | Date | Time |
|---|---|---|
| Start | 1-12-77 | 16:55 |
| Finish | 1-13-77 | 17:35 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1830 | 47 | 47 | 36 | 33 | 0530 | 31 | 31 | 30 | 30 |
| 1930 | 41 | 42 | 33 | 31 | 0630 | 35 | 35 | 32 | 30 |
| 2030 | 41 | 43 | 33 | 30 | 0730 | 46 | 53 | 34 | 30 |
| 2130 | 46 | 47 | 31 | 30 | 0830 | 44 | 41 | 36 | 32 |
| 2230 | 38 | 34 | 30 | 30 | 0930 | 44 | 41 | 35 | 33 |
| 2330 | 43 | 38 | 30 | 30 | 1030 | 48 | 45 | 36 | 33 |
| 2430 | 37 | 35 | 32 | 30 | 1130 | 41 | 40 | 35 | 34 |
| 0130 | 34 | 35 | 31 | 30 | 1230 | 42 | 42 | 36 | 34 |
| 0230 | 34 | 33 | 30 | 30 | 1330 | 43 | 42 | 34 | 33 |
| 0330 | 34 | 33 | 30 | 30 | 1430 | 41 | 38 | 33 | 31 |
| 0430 | 32 | 30 | 30 | 30 | 1530 | 40 | 39 | 34 | 31 |
| | | | | | 1630 | 42 | 41 | 33 | 32 |
| | | | | | 1730 | 45 | 44 | 34 | 31 |

$L_{dn}$ = 45.4 dB

$L_{eq}$ = 43.4 dB (9-5)

Table E-8

24-HOUR DATA SHEET

Location: 2205 Harrison
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: R.R.

| | Date | Time |
|---|---|---|
| Start | 1-12-77 | 16:15 |
| Finish | 1-13-77 | 16:35 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1730 | 57 | 59 | 53 | | 0430 | 39 | 32 | 31 | |
| 1830 | 56 | 58 | 53 | | 0530 | 39 | 35 | 31 | |
| 1930 | 54 | 57 | 51 | | 0630 | 41 | 38 | 32 | |
| 2030 | 54 | 56 | 50 | | 0730 | 51 | 53 | 41 | |
| 2130 | 53 | 55 | 47 | | 0830 | 56 | 58 | 53 | |
| 2230 | 52 | 55 | 46 | | 0930 | 56 | 57 | 51 | |
| 2330 | 53 | 55 | 46 | | 1030 | 53 | 56 | 48 | |
| 2430 | 49 | 52 | 39 | | 1130 | 55 | 55 | 48 | |
| 0130 | 47 | 49 | 35 | | 1230 | 55 | 57 | 51 | |
| 0230 | 47 | 43 | 32 | | 1330 | 56 | 58 | 52 | |
| 0330 | 39 | 37 | 31 | | 1430 | 56 | 58 | 51 | |
| | | | | | 1530 | 56 | 58 | 52 | |
| | | | | | 1630 | 56 | 58 | 52 | |

$L_{dn}$ = 56.5 dB

$L_{eq}$ = 55.5 dB (9-5)

Summary of sound levels at
2205 Harrison Blvd. - January 12, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 56.5 dB

HOURLY INFORMATION

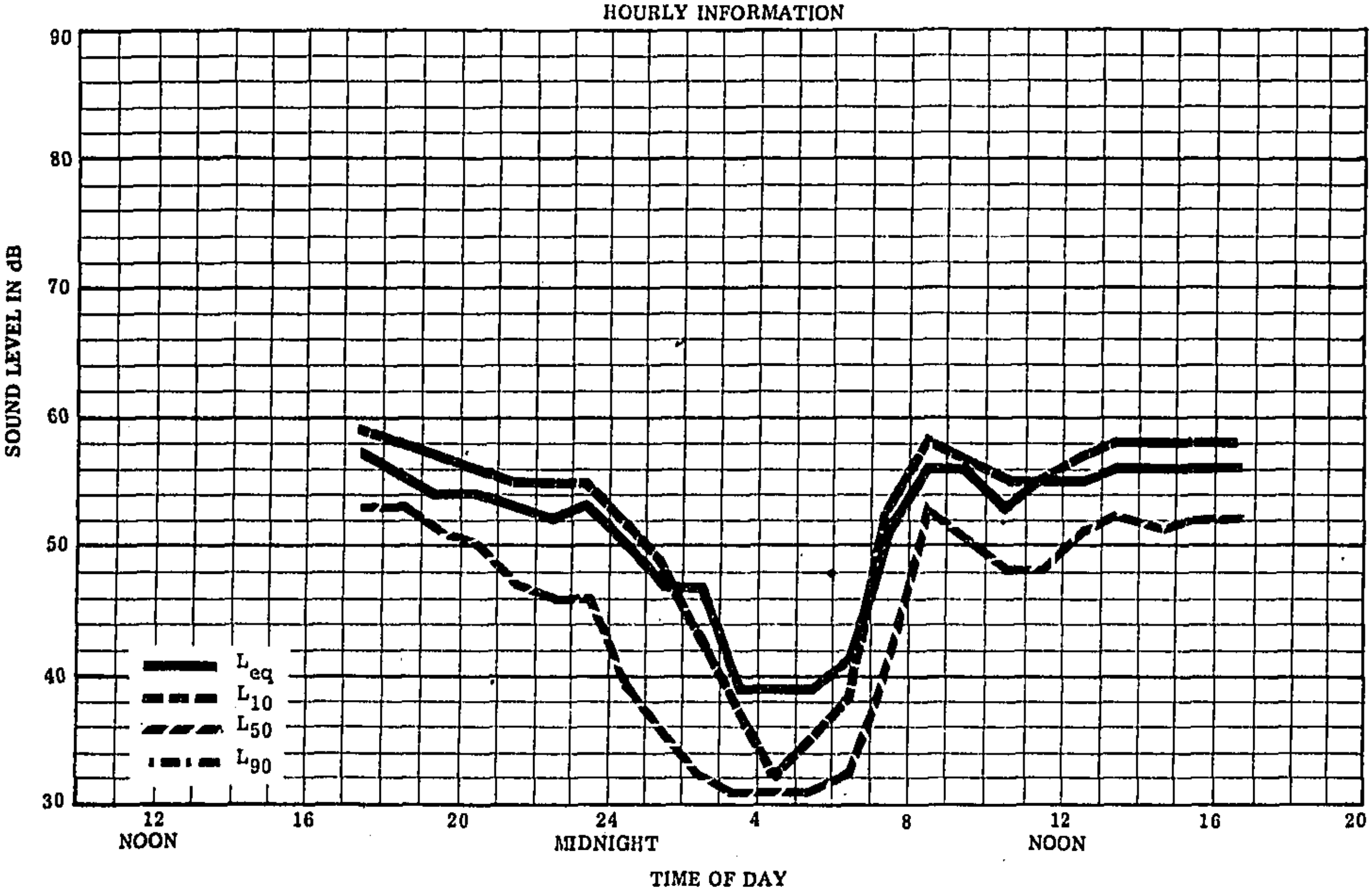


Table E-9

24-HOUR DATA SHEET

Location: 1814 8th Street
Serial Number of Mike: 526575
EPA Property Number of Analyzer: 019156
Operator: R.R.

| | Date | Time |
|---|---|---|
| Start | 1-13-77 | 15:50 |
| Finish | 1-14-77 | 18:30 |
| | | |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1730 | 59 | 60 | 48 | 40 | 0530 | 42 | 34 | 33 | 32 |
| 1830 | 58 | 59 | 50 | 39 | 0630 | 39 | 38 | 35 | 33 |
| 1930 | 53 | 56 | 45 | 37 | 0730 | 48 | 48 | 39 | 37 |
| 2030 | 55 | 56 | 43 | 35 | 0830 | 51 | 53 | 41 | 36 |
| 2130 | 50 | 52 | 38 | 34 | 0930 | 59 | 58 | 46 | 39 |
| 2230 | 51 | 53 | 40 | 35 | 1030 | 53 | 56 | 42 | 39 |
| 2330 | 52 | 54 | 40 | 34 | 1130 | 57 | 56 | 44 | 39 |
| 2430 | 50 | 50 | 35 | 33 | 1230 | 61 | 58 | 43 | 38 |
| 0130 | 48 | 48 | 34 | 33 | 1330 | 59 | 61 | 46 | 38 |
| 0230 | 46 | 43 | 34 | 33 | 1430 | 60 | 64 | 46 | 38 |
| 0330 | 44 | 35 | 33 | 32 | 1530 | 61 | 65 | 48 | 39 |
| 0430 | 39 | 34 | 33 | 32 | 1630 | 62 | 66 | 53 | 42 |
| | | | | | 1730 | 61 | 65 | 52 | 43 |
| | | | | | 1830 | 58 | 61 | 53 | 44 |

$L_{dn}$ = 58 dB

$L_{eq}$ = 59.7 dB (9-5)

Summary of sound levels at
1814 Eighth Street - January 13, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 57.7 dB

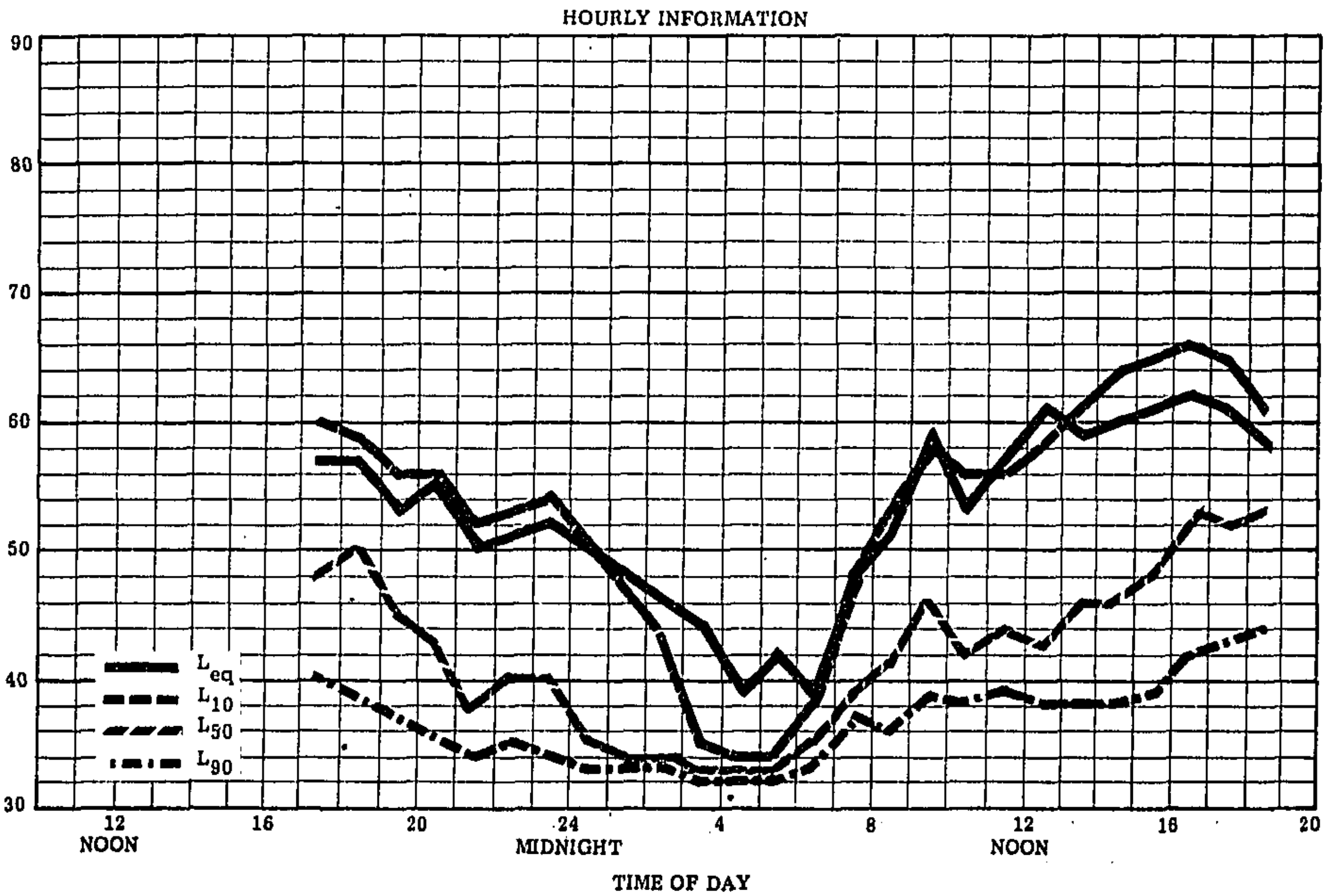


Table E-10

24-HOUR DATA SHEET

Location: 217 Red Fish Lane
Serial Number of Mike: 442933
EPA Property Number of Analyzer: 063020
Operator: RR

| | Date | Time |
|---|---|---|
| Start | 1-13-77 | 18:20 |
| Finish | 1-14-77 | 18:35 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1930 | 44 | 39 | 34 | 32 | 0730 | 43 | 43 | 40 | 37 |
| 2030 | 52 | 42 | 34 | 32 | 0830 | 53 | 48 | 41 | 37 |
| 2130 | 45 | 44 | 34 | 31 | 0930 | 55 | 50 | 43 | 40 |
| 2230 | 45 | 45 | 34 | 31 | 1030 | 51 | 50 | 46 | 41 |
| 2330 | 43 | 35 | 31 | 30 | 1130 | 56 | 50 | 47 | 43 |
| 2430 | 32 | 32 | 31 | 30 | 1230 | 51 | 44 | 45 | 40 |
| 0130 | 34 | 34 | 32 | 31 | 1330 | 51 | 48 | 43 | 39 |
| 0230 | 35 | 36 | 32 | 30 | 1430 | 52 | 49 | 46 | 38 |
| 0330 | 38 | 36 | 33 | 31 | 1530 | 56 | 53 | 41 | 36 |
| 0430 | 35 | 35 | 33 | 30 | 1630 | 53 | 54 | 40 | 36 |
| 0530 | 42 | 40 | 36 | 34 | 1730 | 50 | 53 | 41 | 38 |
| 0630 | 42 | 42 | 37 | 35 | 1830 | 46 | 51 | 38 | 36 |
| | | | | | | | | | |
| | | | | | | | | | |

$L_{dn}$ = 51.5 dB

$L_{eq}$ = 53.6 dB (9-5)

Summary of sound levels at
217 Redfish Lane - January 13, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): ________ dB

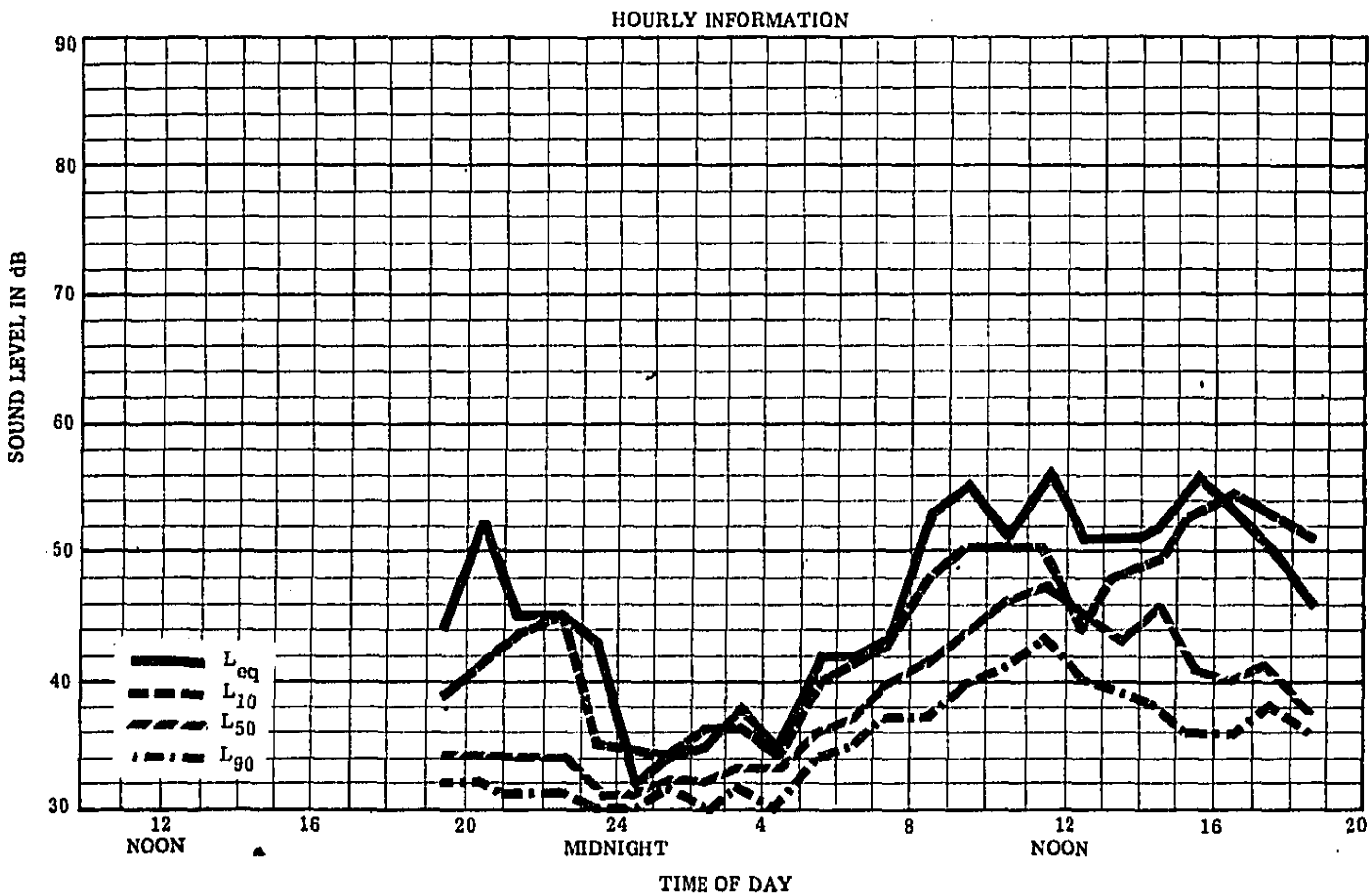


Table E-11

24-HOUR DATA SHEET

Location: 1050 Krall Street
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: R.R.

| | Date | Time |
|---|---|---|
| Start | 1-13-77 | 17:10 |
| Finish | 1-14-77 | 18:35 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1830 | 53 | 47 | 40 | 38 | 0630 | 37 | 37 | 38 | 36 |
| 1930 | 51 | 50 | 38 | 36 | 0730 | 40 | 40 | 40 | 38 |
| 2030 | 42 | 44 | 38 | 36 | 0830 | 43 | 43 | 43 | 41 |
| 2130 | 46 | 45 | 38 | 36 | 0930 | 47 | 49 | 43 | 42 |
| 2230 | 46 | 45 | 43 | 35 | 1030 | 48 | 50 | 42 | 41 |
| 2330 | 47 | 48 | 37 | 35 | 1130 | 49 | 48 | 43 | 41 |
| 2430 | 42 | 42 | 35 | 34 | 1230 | 48 | 48 | 42 | 40 |
| 0130 | 38 | 39 | 36 | 35 | 1330 | 47 | 48 | 40 | 38 |
| 0230 | 38 | 37 | 36 | 35 | 1430 | 47 | 45 | 40 | 38 |
| 0330 | 38 | 37 | 36 | 33 | 1530 | 49 | 46 | 43 | 39 |
| 0430 | 38 | 38 | 35 | 34 | 1630 | 54 | 58 | 43 | 39 |
| 0530 | 37 | 37 | | | 1730 | 60 | 56 | 45 | 42 |
| | | | | | 1830 | | 58 | 42 | 41 |

$L_{dn}$ = 51.7dB

$L_{eq}$ = 49.3 dB (9-5)

Summary of sound levels at
1050 Krall Street - January 13, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 51.7 dB

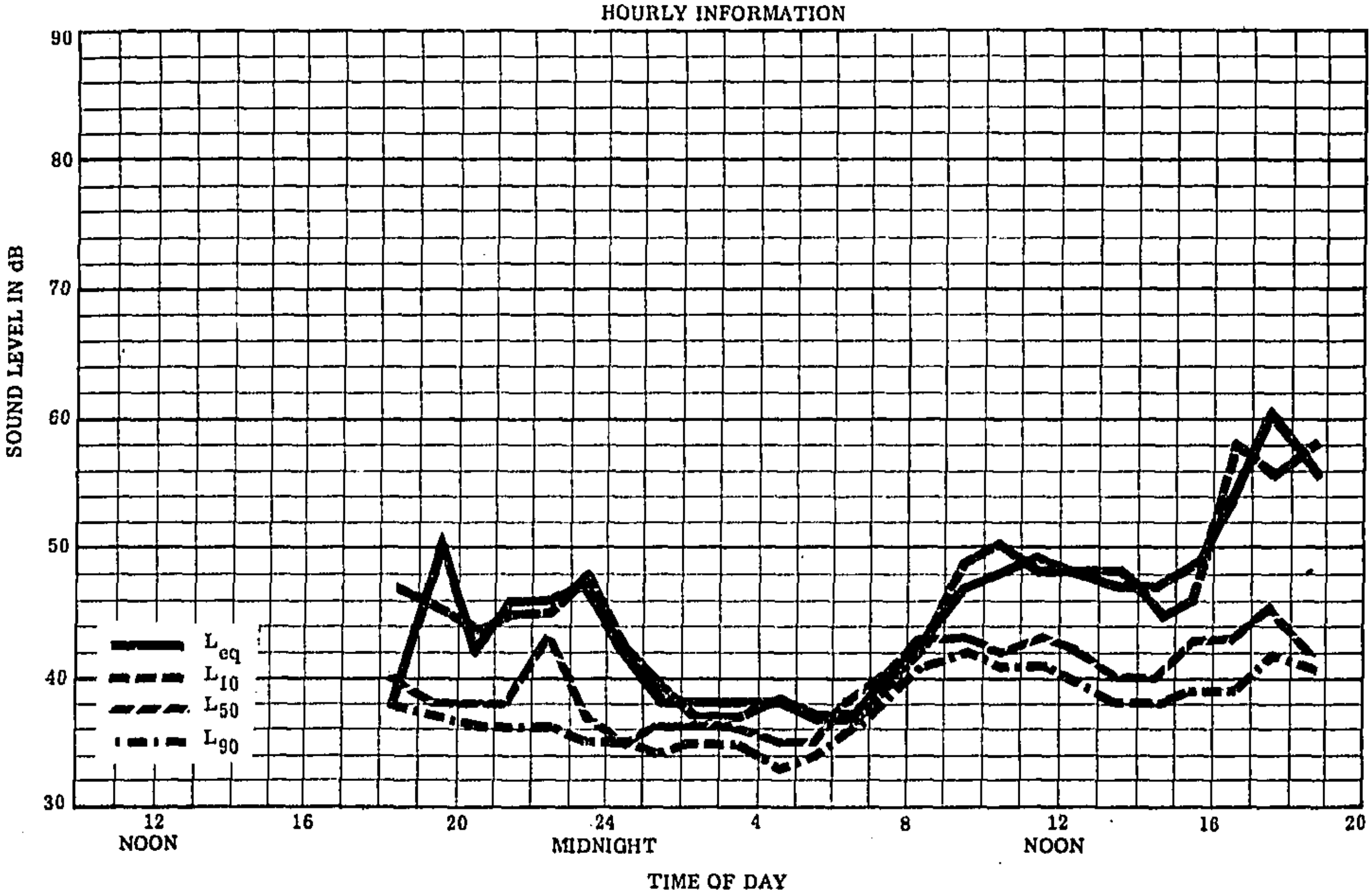


Table E-12

24-HOUR DATA SHEET

Location: 1814 8th Street
Serial Number of Mike: 526575
EPA Property Number of Analyzer: 019156
Operator: R.R.

| | Date | Time |
|---|---|---|
| Start | 1-14-77 | 18:35 |
| Finish | 1-15-77 | 12:10 |
| | | |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1930 | 56 | 58 | 48 | 41 | 0730 | 46 | 43 | 36 | 37 |
| 2030 | 55 | 57 | 46 | 41 | 0830 | 47 | 45 | 38 | 36 |
| 2130 | 54 | 56 | 45 | 40 | 0930 | 53 | 54 | 41 | 38 |
| 2230 | 52 | 56 | 43 | 39 | 1030 | 53 | 53 | 42 | 39 |
| 2330 | 53 | 55 | 43 | 40 | 1130 | 54 | 56 | 44 | 40 |
| 2430 | 51 | 52 | 41 | 39 | 1230 | 55 | 59 | 45 | 40 |
| 0130 | 53 | 55 | 41 | 38 | | | | | |
| 0230 | 52 | 53 | 41 | 39 | | | | | |
| 0330 | 47 | 47 | 39 | 37 | | | | | |
| 0430 | 49 | 42 | 37 | 36 | | | | | |
| 0530 | 50 | 40 | 36 | 35 | | | | | |
| 0630 | 38 | 37 | 36 | 35 | | | | | |
| | | | | | | | | | |



$L_{dn}$ = 58

$L_{eq}$ = 53.8 dB (9-5)

Summary of sound levels at
1814 Eighth Street - January 14, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 58.0 dB

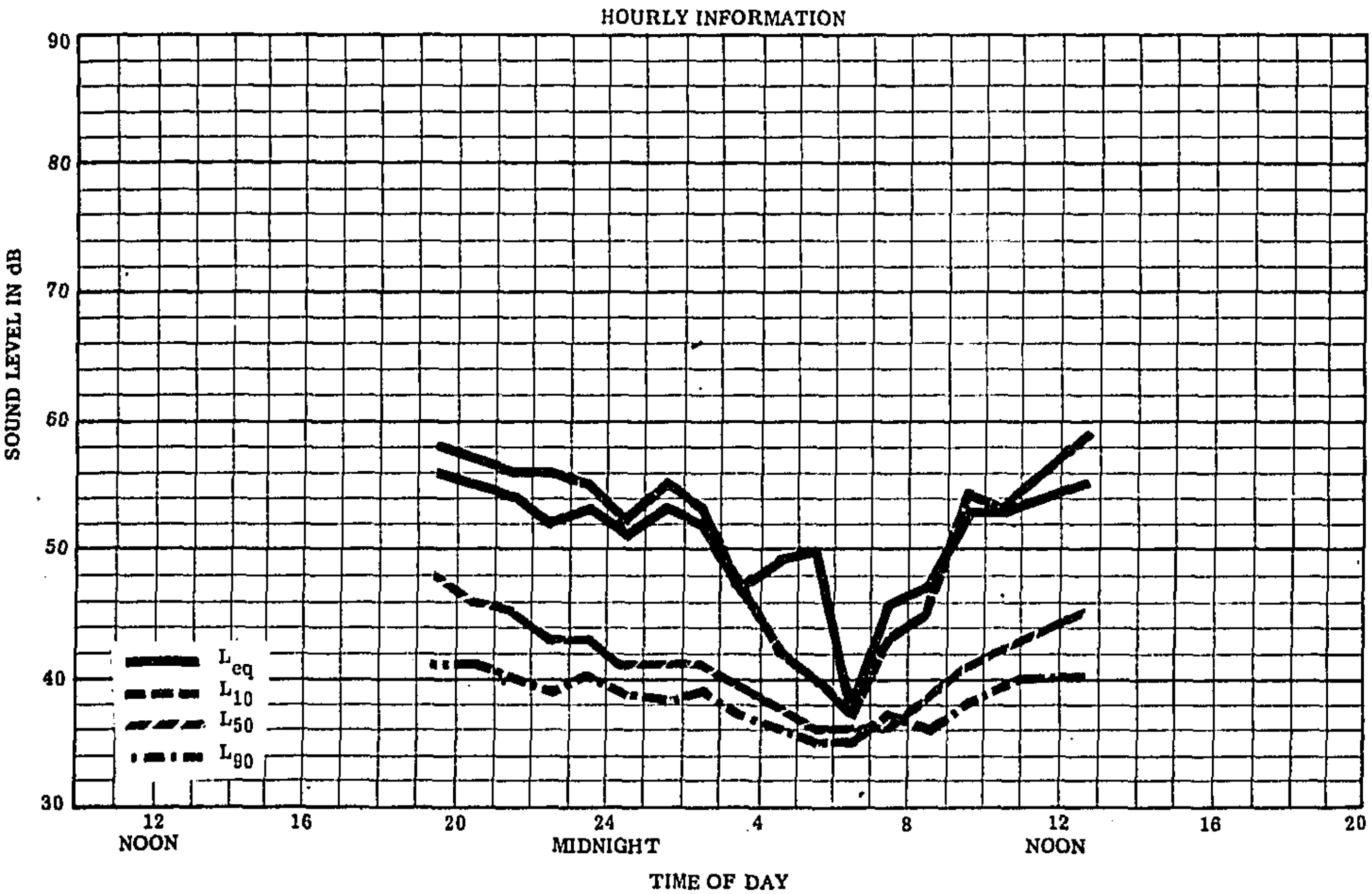


Table E-13

24-HOUR DATA SHEET

Location: 1050 Krall Street
Serial Number of Mike: 506149
EPA Property Number of Analyzer: 063019
Operator: R. R.

| | Date | Time |
|---|---|---|
| Start | 1-14-77 | 18:35 |
| Finish | 1-15-77 | 12:55 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1930 | 50 | 48 | 43 | 42 | 0730 | 40 | 40 | 39 | 39 |
| 2030 | 49 | 48 | 43 | 41 | 0830 | 42 | 42 | 41 | 40 |
| 2130 | 47 | 48 | 42 | 40 | 0930 | 44 | 43 | 44 | 42 |
| 2230 | 45 | 46 | 42 | 40 | 1030 | 48 | 50 | 44 | 42 |
| 2330 | 45 | 45 | 42 | 41 | 1130 | 49 | 51 | 43 | 42 |
| 2430 | 46 | 46 | 42 | 40 | 1230 | 48 | 49 | 42 | 40 |
| 0130 | 48 | 49 | 42 | 40 | 1330 | 47 | 46 | 42 | 40 |
| 0230 | 51 | 54 | 40 | 38 | | | | | |
| 0330 | 45 | 46 | 40 | 37 | | | | | |
| 0430 | 49 | 52 | 37 | 36 | | | | | |
| 0530 | 39 | 39 | 37 | 36 | | | | | |
| 0630 | 38 | 39 | 37 | 36 | | | | | |

$L_{dn}$ = 53.2 dB

Summary of sound levels at
1050 Krall Street - January 14, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 53.2 dB

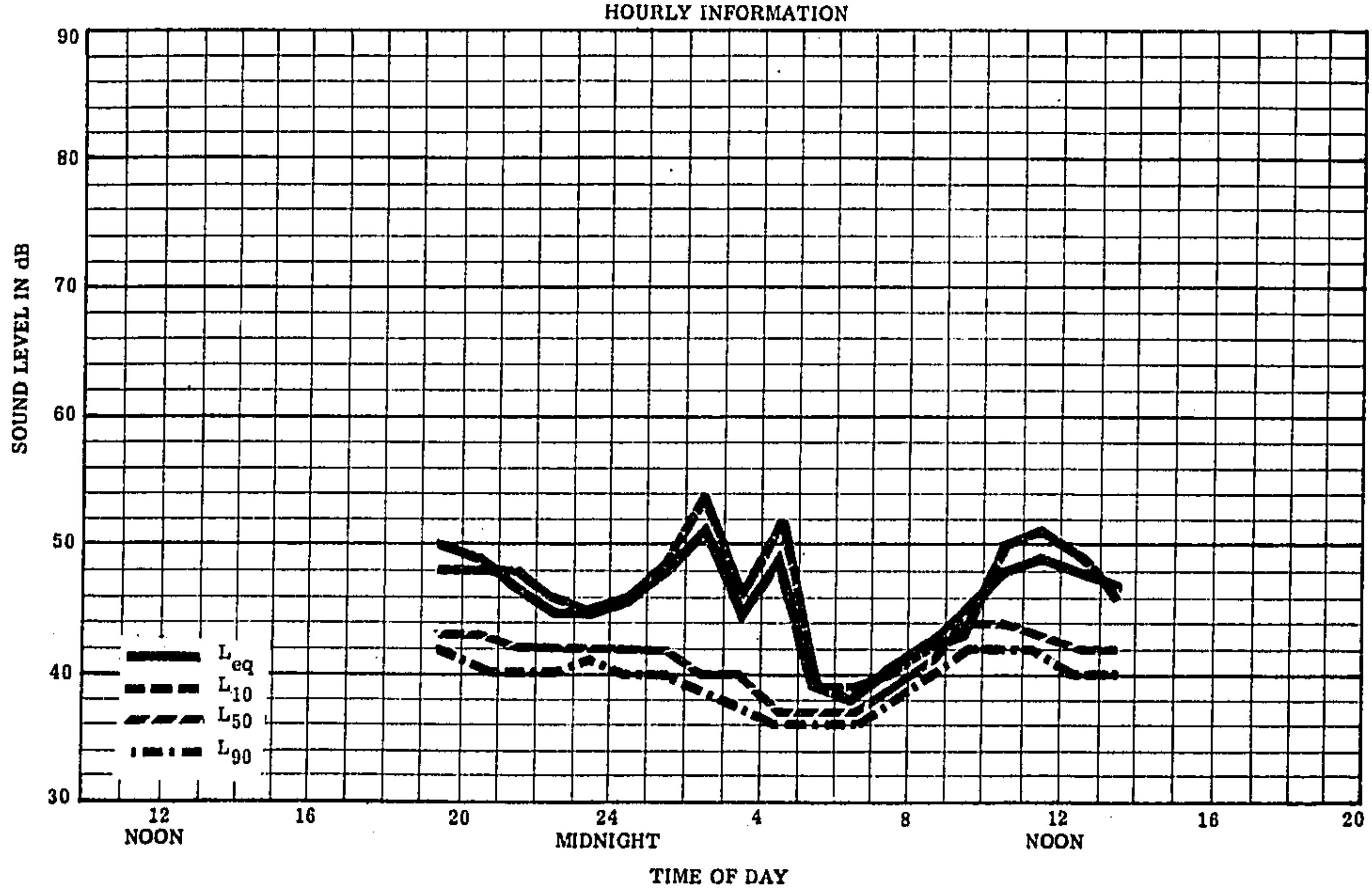


Table E-14

24-HOUR DATA SHEET

Location: 1790 Hill Road Terrace
Serial Number of Mike: 442933
EPA Property Number of Analyzer: 06302
Operator: AGK

| | Date | Time |
|---|---|---|
| Start | 1-18-77 | 17:48 |
| Finish | 1-19-77 | 23:42 |

All Descriptions in Decibels

| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1830 | 59 | 62 | 54 | 45 | 0830 | 60 | 63 | 57 | 50 |
| 1930 | 57 | 61 | 51 | 44 | 0930 | 58 | 63 | 57 | 50 |
| 2030 | 56 | 60 | 47 | 42 | 1030 | 60 | 63 | 50 | 45 |
| 2130 | 56 | 59 | 46 | 41 | 1130 | 58 | 63 | 50 | 45 |
| 2230 | 55 | 58 | 46 | 41 | 1230 | 61 | 63 | 53 | 45 |
| 2330 | 50 | 52 | 37 | 34 | 1330 | 61 | 63 | 53 | 45 |
| 2430 | 46 | 42 | 33 | 32 | 1430 | 60 | 64 | 53 | 44 |
| 0130 | 45 | 38 | 33 | 32 | 1530 | 62 | 65 | 55 | 45 |
| 0230 | 41 | 33 | 32 | 32 | 1630 | 63 | 66 | 58 | 48 |
| 0330 | 39 | 33 | 32 | 32 | 1730 | 63 | 66 | 60 | 54 |
| 0430 | 39 | 34 | 32 | 32 | | | | | |
| 0530 | 43 | 37 | 33 | 33 | | | | | |
| 0630 | 51 | 50 | 40 | 35 | | | | | |
| 0730 | 58 | 62 | 52 | 44 | | | | | |

$L_{dn}$ = 59.6 dB

$L_{eq}$ = 60.7 dB (9-5)

Summary of sound levels at
1790 Hill Road Terrace - January 18, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 59.6 dB

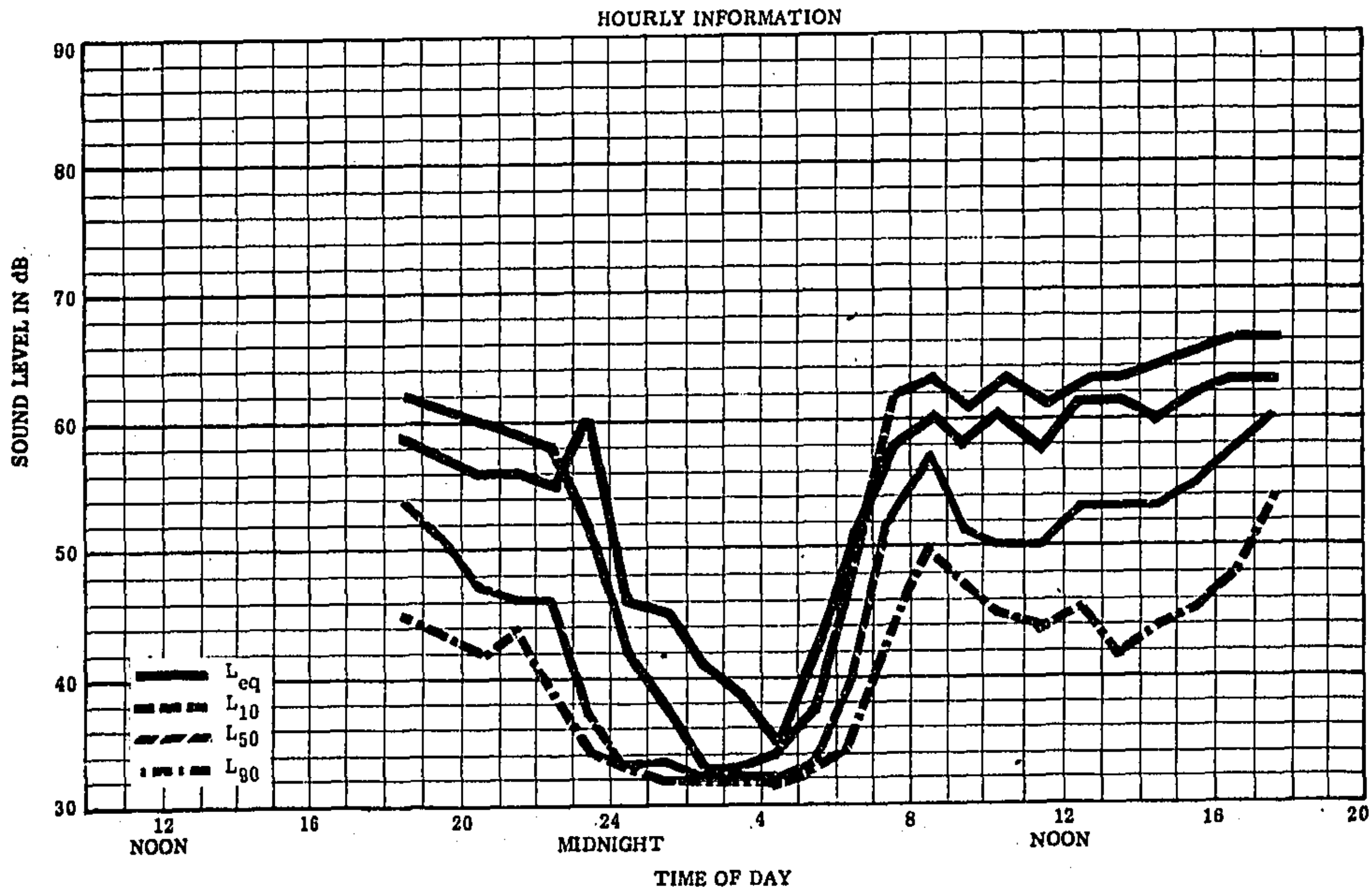


Table E-15

24-HOUR DATA SHEET

Location: 300 Costin Street
Serial Number of Mike: 442933
EPA Property Number of Analyzer: 063020
Operator: Konheim

| | Date | Time |
|---|---|---|
| Start | 1-20-77 | 1908 |
| Finish | 1-21-77 | 2010 |

All Descriptions in Decibels

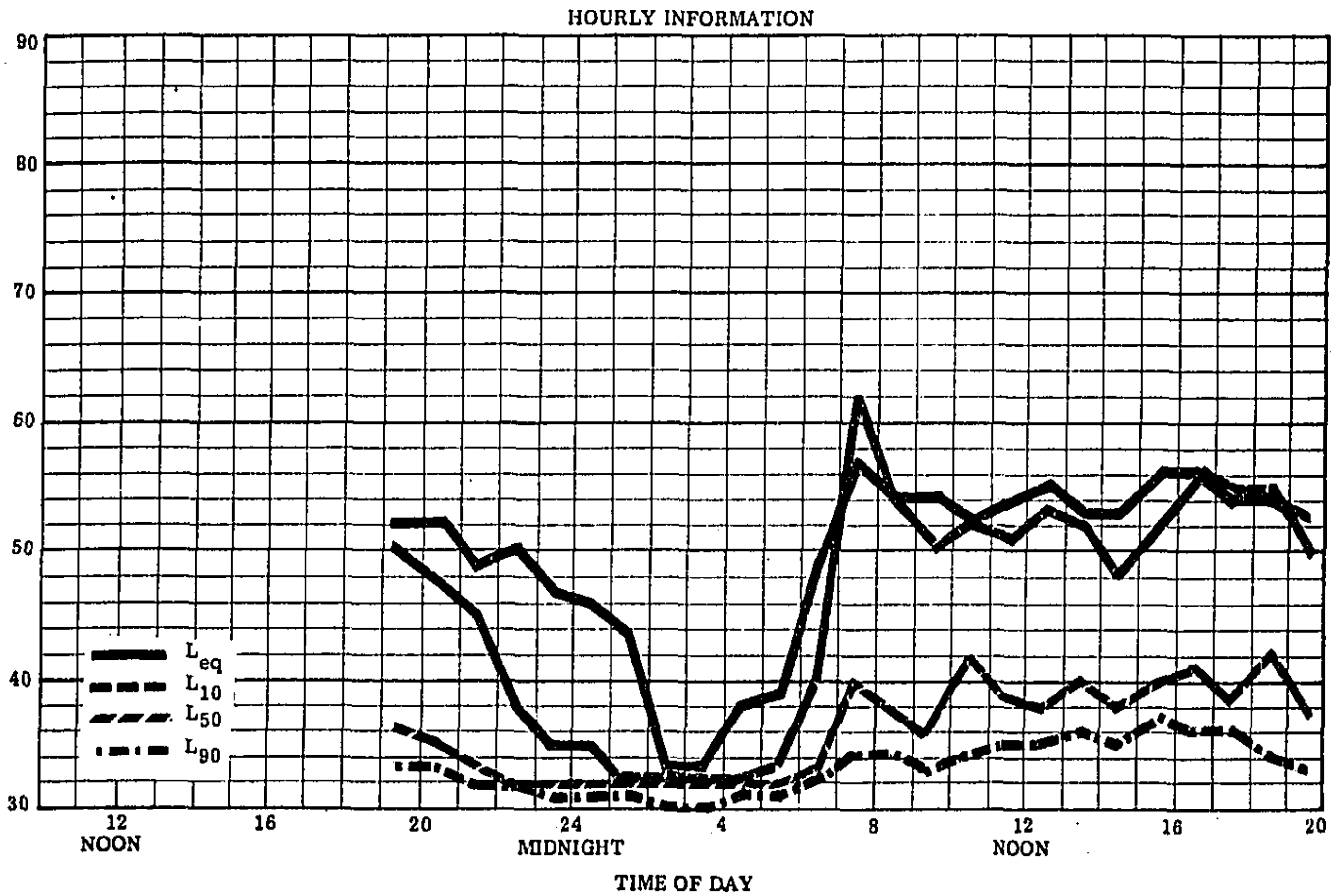
| Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ | Hour | $L_{eq}$ | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1930 | 52 | 50 | 36 | 33 | 0730 | 59 | 62 | 40 | 34 |
| 2030 | 52 | 48 | 35 | 33 | 0830 | 54 | 54 | 38 | 34 |
| 2130 | 49 | 45 | 33 | 32 | 0930 | 54 | 54 | 38 | 34 |
| 2230 | 50 | 38 | 32 | 32 | 1030 | 52 | 52 | 42 | 34 |
| 2330 | 47 | 35 | 32 | 31 | 1130 | 54 | 51 | 39 | 35 |
| 2430 | 46 | 35 | 32 | 31 | 1230 | 55 | 53 | 38 | 35 |
| 0130 | 43 | 32 | 32 | 31 | 1330 | 53 | 52 | 40 | 36 |
| 0230 | 33 | 32 | 32 | 30 | 1430 | 53 | 48 | 38 | 35 |
| 0330 | 33 | 32 | 32 | 30 | 1530 | 56 | 52 | 40 | 37 |
| 0430 | 38 | 32 | 32 | 31 | 1630 | 56 | 56 | 41 | 36 |
| 0530 | 39 | 33 | 32 | 31 | 1730 | 54 | 55 | 39 | 36 |
| 0630 | 48 | 40 | 33 | 32 | 1830 | 54 | 55 | 42 | 34 |
| | | | | | 1930 | 53 | 50 | 37 | 33 |

$L_{dn}$ = 54.7 dB

$L_{eq}$ = 54.3 dB (9-5)

Summary of sound levels at
300 Cosin Street - January 20, 1977

DAY-NIGHT AVERAGE LEVEL
($L_{dn}$): 54.7 dB



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