TRANSPORT and ROAD
RESEARCH LABORATORY

Department of the Environment

TRRL REPORT LR 479

A DATA LOGGING SYSTEM FOR THE MEASUREMENT OF ROAD TRAFFIC NOISE

by

M. Cheeseman and P.M. Nelson

Environmental Effects Division
Transport Systems Department
Transport and Road Research Laboratory
Crowthorne, Berkshire
1972

CONTENTS

A DATA LOGGING SYSTEM FOR THE MEASUREMENT OF ROAD TRAFFIC NOISE

ABSTRACT

The TRRL noise logging equipment is a ten microphone system designed to accumulate information automatically about the temporal distribution of noise over a selected area. It is capable of operating continuously for 24 hours or more. This paper describes the components of the logger and discusses its performance in the field. The accuracy of the system depends upon the rate of data acquisition. At the rate currently in use, the standard error associated with estimates of the L_{10} and L_{90} indices is typically ± 1.0 dBA at sites alongside busy roads. This compares favourably with the precision offered by the more widely used tape recording method.

The results of an experiment carried out in Birmingham are reported. Using the TRRL equipment it was found that 360 microphone-hours of data could be comfortably collected and analysed in two weeks, involving a total staff effort of approximately 180 man-hours. At sites closer to the Laboratory the staff requirement can be approximately halved.

A computerised noise mapping technique has been adapted to display the Birmingham data. In its present form, however, a considerable amount of data pre-processing is required and for this reason the method is not recommended.

Finally, modifications to the system are proposed. A mini-computer will be used to control high speed scanning of the microphone outputs, and will also analyse the data on-site.

1. INTRODUCTION

The Wilson Committee reported in 1963 that traffic was the most widespread cause of noise disturbance(1). At present sufficient research work has been carried out to give interim guidance to those involved with immediate problems of design(2). However, further research is required on a substantial scale:- to study the propagation of traffic noise in complex situations, to assess the relative benefits of various noise palliatives, and to quantify the adverse effects of traffic noise on individuals and communities. Research into these problems requires considerable amounts of traffic noise data collected over large areas.

Scholes and Vulkan have reviewed the methods available for the measurement of traffic noise(3). These usually involve tape recording the sound levels at a microphone for a period ranging from two to ten minutes every hour for a twenty-four hour period. Subsequently the tapes have to be played to a statistical analyser in the laboratory.

To collect data from a large area, several microphones and recorders have to be used, or alternatively the single microphone must be moved around. Whichever of these procedures is adopted the result is a large amount of magnetic tape for analysis. Even when this has been done the statistical analyser output needs some ordering and calculation before the recordings can be reduced to meaningful criteria. Above all the total time during which tape recording measurements are made at any one microphone position seldom exceeds 10 per cent of the total investigation time. Therefore much information is lost and care must be taken in relating the sample statistics to the true parameters of the noise climate.

This Report describes a traffic noise logging system, assembled at the Transport and Road Research Laboratory, that overcomes some of the shortcomings of the conventional system.

2. THE TRRL TRAFFIC NOISE DATA LOGGING SYSTEM

2.1 The logging equipment

The TRRL noise logging system is designed to accumulate information automatically about the temporal variation of noise over a wide area. This is achieved by the use of ten microphones connected to a common automatic data logger. Fig. 1 shows a block diagram of the salient features of the measuring equipment.

On-site noise is detected by ten outdoor microphone systems. Each system comprises a condenser microphone fitted with an electrostatic calibrator, rain cover, heating element, preamplifier and windscreen. The microphone is connected by a short lead to a weatherproof box containing an A-weighted amplifier, power supply and calibration oscillator. This arrangement converts sound pressures into electrical signals which may be transmitted through cables up to half a mile in length.

Each microphone can be calibrated by feeding a constant amplitude voltage from the calibration oscillator to the electrostatic calibrator. This produces a constant amplitude force on the microphone diaphragm which simulates a sound pressure level of 90 dB at a frequency of 1000 Hz.

The signal-carrying cable from each microphone system is connected to the central processor which comprises a ten channel amplifier-rectifier unit, a digital logger and a paper tape punch. The amplifier-rectifier converts the transmitted signals for each microphone to DC voltages directly proportional to A-weighted sound level. The rectifier time constant is designed so that the DC level corresponds to the output of a conventional sound level meter on "fast" response. The equipment is usually set to measure sound levels in the range 40-90 dB(A), although the ranges 50-100 dB(A) and 60-110 dB(A) are available if higher than normal noise levels are anticipated. On the 40-90 dB(A) setting electrical noise in the system is usually under 30 dB(A). The central processor also contains a system control module which allows either the remote calibration of any microphone or two way voice communication between any microphone and the central processor.

A scanner selects the rectifier outputs and presents them sequentially at a pre-selected time interval to a digital voltmeter. The scanning rate that has been adopted is one channel every two seconds, although rates of 1, 2 and 10 channels per second are available if more detailed measurements are required.

The voltmeter reading together with a channel identification number is punched on paper tape using a fast punch. At the scan rate of one channel every two seconds a standard eight inch reel of paper tape is filled in eight hours.

The equipment has been installed in a caravan. This serves as a store for all the equipment and provides accommodation for a staff of two during measurements.

2.2 The method of data analysis

A computer program to analyse the paper tape records has been written in Fortran IV language, for use on the Laboratory's ICL System 4-70 computer. Fig. 2 is a simplified flowchart of the program.

First the program checks the integrity of the basic data and discards any incorrectly punched records. The program then divides the raw data into hourly blocks, each of which will contain 180 samples from each channel when the scan rate is 1 channel every 2 seconds.

Depending on the composition of the data the program analyses the hourly data blocks as follows:-

1. The mean and standard deviation of the recorded data is determined and these parameters are used to generate a normal distribution. A comparison between the normal curve and the observed distribution is then made using the standard chi-square test (one tailed test at 0.05 level of significance). If the chi-square test indicates that the observed data can be fitted to a normal distribution the fundamental noise units L_{10}, L_{50}, L_{90} - the levels exceeded for 10 per cent, 50 per cent and 90 per cent of the time respectively - are estimated from the equation of the normal curve.

2. For data where the chi-square test signifies a poor fit between the observed distribution and the normal curve, a frequency table of noise levels is constructed and L_{10}, L_{50} and L_{90} are estimated from the corresponding frequency polygon.

3. The equipment has an operating range of 50 dBA. When the upper limit of this range is set to 90 dBA, observed levels less than 40 dBA, the lower limit, are considered unreliable and are censored by the program. If more than 10 per cent of the sample are censored in this way the L_{90} level is estimated from Fisher's tables of the truncated normal distribution[4].

4. The program provides a complete printed record of the collected data together with hourly estimates of L_{10}, L_{50}, L_{90}, TNI, L_{eq} and L_{NP} at each microphone site:

$$TNI = 4(L_{10} - L_{90}) + L_{90} - 30,$$

$$L_{eq} = 10 \log_{10} \left(\frac{1}{100} \Sigma f_i . 10^{L_i/10} \right)$$

L_i is the median sound level of the i th interval

f_i is the percentage time that a sound level is in the i th interval.

or for Gaussian noise,

$$L_{eq} = L_{50} + \frac{(L_{10}-L_{90})^2}{56}$$

and $L_{NP} = L_{eq} + (L_{10} - L_{90})$

If required the program will produce a histogram and frequency table of the noise levels.

2.3 **Statistical accuracy of the system**

Both the TRRL computer program and the conventional procedures derive indices of subjective response such as L_{10} from the frequency distribution of 'A' weighted sound level. These procedures imply that subjectively the precise time history of sound level variation is unimportant and that sound level is a quasi-random variable. The accuracy of determining the distribution of such a variable depends on the shape of the distribution and the number of independent measurements made. Previous experience has shown that the sound level distributions arising at sites exposed to busy traffic approximate very closely to Gaussian distributions[3]. Consequently the statistics of sampling sound levels may be deduced from the statistics of sampling a Gaussian distribution and this is the procedure adopted here.

The Gaussian distribution is defined by[5]:

$$y = \frac{1}{\sigma\sqrt{2\pi}} \cdot e^{\frac{-(x-\bar{x})^2}{2\sigma^2}}$$

where y is the probability density of the value x in the infinite population of possible values

$\bar{x}$ is the mean value for the infinite population

σ is the standard deviation of the population about the mean

It can be seen that the distribution is fully specified once $\bar{x}$ and σ are known. Further the standard deviation of the population, σ, specifies the standard errors of distribution parameters deduced from a limited sample of n members of the population. Thus for a collection of n measurements of sound level the standard errors of L_{50} and the sample standard deviation are given by:[5]

$$SE(L_{50}) = \frac{1.25\sigma}{\sqrt{n}}$$

$$SE(\sigma s) = \frac{\sigma}{\sqrt{2n}}$$

where L_{50} is the sample median level

and σs is the sample standard deviation

and σ may be estimated from

$$\sigma = \sqrt{\frac{n}{n-1}} \cdot \sigma s$$

In Table 1 the indices calculated from the observed level distributions are listed together with their formulae in terms of L_{50} and σ_s and their standard errors. All the standard errors are proportional to $\frac{\sigma s}{\sqrt{n-1}}$

For traffic noise σs is unlikely to fall outside the range $2 \leqslant \sigma s \leqslant 8$. The TRRL system has usually been operated to sample each microphone every 20 seconds so that for an hourly sample n will be 180. Table 2 lists the noise indices and their range of standard error for $2 \leqslant \sigma s \leqslant 8$ and $n = 180$.

TABLE 1

Standard errors of derived indices

Index	Formula	Standard error
L_{10}	$L_{50} + 1.28\sigma$	$1.54\sigma s/\sqrt{n-1}$
L_{50}	L_{50}	$1.25\sigma s/\sqrt{n-1}$
L_{90}	$L_{50} - 1.28\sigma$	$1.54\sigma s/\sqrt{n-1}$
Noise climate	2.56σ	$1.81\sigma s/\sqrt{n-1}$
TNI	$L_{50} + 8.96\sigma + 30$	$6.46\sigma s/\sqrt{n-1}$
L_{NP}	$L_{50} + 2.56\sigma + 0.12\sigma^2$	$2.34\sigma s/\sqrt{n-1}$

TABLE 2

Expected range of standard errors

Index	Range of standard error calculated from statistics theory	Maximum value of the standard error including 0.5 dBA calibration slip error
L_{10}	0.23 – 0.92	1.0
L_{50}	0.19 – 0.75	0.9
L_{90}	0.23 – 0.92	1.0
Noise climate	0.27 – 1.08	1.2
TNI	0.97 – 3.9	3.9
L_{NP}	0.35 – 1.4	1.5

So far only the standard error arising from the statistics of sampling a random distribution has been considered. With the TRRL apparatus an additional error factor may arise from calibration slip of the microphones and amplifiers between calibration checks. In use calibration checks are made every four hours and it is unusual (less than once in twenty times) for the slip in any one channel to exceed 2 dBA. Taking 0.5 dBA as representing the standard error due to slip in one hour, and this is possibly an over-estimate, the final column of table 2 shows the maximum value of the standard error of the TRRL system.

The values listed in the table are appropriate to indices derived from one hour's measurement and the standard error of indices derived from averaging measurements over several hours will have lower standard errors. The two such indices in current use are L_{10} averaged over 18 hours and TNI averaged over 24 hours. The maximum value standard errors of the 18 hour L_{10} and 24 hour TNI derived using the TRRL system are 0.3 and 0.8 respectively. In the L_{10} determination the errors due to calibration slip and sampling statistics take equal weight but the error in the TNI determination is dominated by error arising from the sampling statistics.

3. APPLICATION OF THE DATA LOGGING SYSTEM TO THE MEASUREMENT OF TRAFFIC NOISE AT A SITE IN BIRMINGHAM

3.1 Site description

The main object of this investigation was to provide the Statistical Research Unit in Sociology of Keele University with measurements of traffic noise in an urban environment as part of a study into the effect of road traffic noise on the housing market. The site was chosen by the Keele research team. Their requirements were:

1. that the site should be as homogeneous as possible in every respect except that of noise climate;

2. that ideally the site would be an estate of identical houses. These would most conveniently be arranged alongside parallel roads, one of which would be a heavily trafficked urban road;

3. that information from about five hundred houses would be necessary to give a valid statistical analysis of the data.

A site was found north of the centre of Birmingham which satisfied these conditions and was also reasonably convenient for the Keele team.

A plan and photograph of the site showing the roadway and housing configuration, is shown in Fig. 3 and Plate 1 respectively. The main road through the site is a busy dual carriageway which joins two important radial roads leading into the city centre. All the houses are two-storey and most are arranged in terraces of four or six, with a small number of pairs of semi-detached houses, usually situated at the ends of a road.

The main road runs roughly east to west with an uphill gradient of approximately 2 per cent. The vehicle flow on this road was typically 26000 vehicles per day consisting of 20 per cent heavy lorries. Traffic flows on the minor roads were low, consisting mainly of local traffic.

The land rises to the north-east with a gradient of 9 per cent giving a gradual elevation of the housing level above the roadway on the northern side of the main road and a gradual depression of the housing level below that of the roadway on the southern side.

3.2 Factors governing the layout of the microphones on site

The primary interest of the sociologists was noise levels at residential facades and it was necessary to ensure that the measurement scheme adopted would provide a very reliable assessment of sound level variation along the various facade lines. Inspection of the site suggested that most variation would occur along the main road. At the West end of the site the traffic behaviour was influenced by a roundabout while towards the East end a slight embankment on the North side of the road could provide some screening for the housing on that side. Consequently more than a third of all measurements were made at facades along this road and over two thirds of all measurements on the site were facade measurements. However, the results were also to be used to test the computerised mapping of noise contours and some measurements were made in gardens behind the houses.

The microphone systems required a 240 volt a.c. supply and so the exact position of any microphone depended on the willingness of householders to allow not only access to their land but also the use of some electric power. The householders who permitted this were paid a small ground rental and in general the site population were happy to co-operate.

The first measurements were made in a 24 hour pilot survey at the West end of the site. This indicated that eight at random of the ten channels would function reliably over a 24 hour period. Subsequent experience confirmed this, the trouble usually arising from microphone failure probably due to damp but possibly due to rough handling or failures of the amplifier calibration circuitry. Based on the experience of the pilot experiment the remainder of the site was divided into eight zones of roughly equal size. Fig. 3 shows the nine zones and the positions of the microphones in each. It was estimated that by deploying about seven to eight microphones in each zone sufficiently detailed coverage would be obtained for both the sociological investigation and the trial of computerised mapping.

3.3 Organisation and Execution of measurements

Prior to the experiment the site was visited to secure the co-operation of the selected householders in supplying electricity for the microphones and allowing access to their property. A suitable position and supply of mains electricity was also arranged for the caravan which served as a base during the experiment.

For the experiment, all equipment was transported to the site in the caravan. The microphones were set out in their pre-arranged positions and allowed to warm up. During the warming-up period signal cables were connected between each microphone and the central processor. Once the microphones had been installed and connected, calibration checks and adjustments were made on the rectifier-amplifiers and the outdoor microphone systems. Setting out the microphones and calibrating occupied two staff for about four hours.

Measurements were started "on the hour". After four hours, scanning was interrupted and each microphone and rectifier-amplifier calibration re-checked. This was repeated after each subsequent four-hour period. Apart from changing paper tapes at eight-hourly intervals and calibrating, no further staff effort was required until the 24-hour run was completed and the equipment cleared away. This took two staff two hours.

It was found that, given satisfactory weather conditions, noise measurements in two zones could be completed in one week constituting, on average, measurements at fifteen microphone sites and a total record of 360 microphone-hours.

The whole process of arranging electrical power and microphone sites, travelling to the site, setting up, recording for twenty four hours, clearing away, and editing and processing the paper tape covered two weeks and involved a total staff effort of approximately 180 man-hours. This estimate includes 96 man-hours on site while the equipment was operating. However, during this period, because the equipment needs little attention the site operators were free to get on with other work, or rest.

4. RESULTS AND DISCUSSION

To assess the accuracy of the system and check sampling statistics in Birmingham, measurements at two positions were made on two different days. Fig. 4 shows how the hourly L_{10} and L_{90} values compared at site 37, one of the two sites. The results at the other site, site 21, were very similar. At site 37 the average difference between L_{10} and L_{90} was 16 dBA, indicating that the standard deviation, σ of the sound level distribution was 6.3 dBA. Table 1 lists the standard error of L_{10} and L_{90} as $1.54\sigma s/\sqrt{n\text{-}1}$ which could have been written $1.54\sigma/\sqrt{n}$. Consequently for σ of 6.3 dBA and n = 180, the standard error of L_{10} and L_{90} from statistics alone must be 0.72 dBA. The mean range of repeat pairs of L_{10} and L_{90} values shown in Fig. 4 is 0.92 dBA corresponding to a standard error of 0.82 dBA for the L_{10} and L_{90} values[5]. The standard error due to calibration slip and any other factors not considered is given by:-

$$\text{Standard error} = \sqrt{0.82^2 - 0.72^2}$$

$$= 0.38 \text{ dBA}$$

The corresponding value for site 21 is 0.81 dBA.

An r.m.s. average of these two values is 0.64 dBA. This is somewhat higher than the 0.5 dBA considered in section 2.3 as being the standard error due to calibration slip. Slight day to day variation in traffic flow and composition, the principal noise generator, could account for this difference.

Overall, the results suggest that at the Birmingham site the errors were controlled by the sampling and not by calibration slip, traffice flow variation or any other factors.

Table 3 shows the values of four noise indices for each microphone site. The site numbers in the table correspond with the site numbers shown on Fig. 3. The L_{10} and L_{90} values listed are arithmetic averages of the hourly estimates over the 18 hour period 0600 - 2400 hours, while the TNI and L_{NP} values are the arithmetic averages over a 24 hour period. L_{10} averaged over the 18 hour period is the statistic based on Scholes's work that was recently advanced by the Noise Advisory Council as a measure of traffic noise nuisance (2, 6). It can be seen from the table that the general trend is for all four indices to increase together.

TABLE 3

Table of results for the Birmingham experiment

Site No.	18 hr L_{10} dB(A)	18 hr L_{90} dB(A)	24 hr TNI	24 hr L_{NP}	Zone No.
1	57.4	51.1	46.3	61.8	1
2	58.2	52.2	47.2	62.1	
3	74.1	62.9	81.8	85.1	
4	73.7	61.2	81.3	83.6	
5	61.1	52.6	58.1	66.3	
6	61.4	55.2	50.6	64.8	
7	74.1	59.7	87.2	84.1	
8	73.7	58.3	89.5	85.0	2
9	56.3	46.8	55.1	61.6	
10	73.0	57.9	88.2	83.8	
11	65.8	50.0	80.9	72.3	
12	55.6	45.6	56.9	65.0	
13	57.4	45.4	63.3	67.3	
14	57.5	48.2	55.5	61.4	3
15	73.3	58.7	87.0	83.0	
16	72.9	58.4	86.4	82.2	
17	73.2	58.8	86.5	82.5	
18	72.5	58.3	85.9	79.8	
19	54.8	45.4	53.1	58.5	
20	57.3	46.5	59.6	56.5	
21	70.8	57.7	86.4	83.5	
22	70.1	56.9	79.9	82.5	4
23	69.1	55.1	81.1	82.3	
24	56.0	47.5	51.5	62.5	
25	68.1	54.4	79.2	80.2	
26	72.4	58.8	84.4	84.0	
27	55.5	46.6	53.8	64.4	
28	52.8	41.7	50.1	66.3	
29	71.1	58.1	80.3	81.4	5
30	72.1	58.6	82.6	82.5	
31	71.4	58.3	80.6	81.4	
32	64.5	50.7	75.7	71.3	
33	57.4	47.2	58.0	63.0	
34	55.8	43.6	62.4	62.6	
35	50.6	42.9	43.5	54.2	
36	51.9	46.3	55.0	63.6	
37	73.1	57.2	90.7	85.9	6
38	71.9	56.3	88.4	83.9	
39	52.3	41.8	65.3	64.4	
40	72.6	59.1	84.8	84.2	
41	57.8	46.7	61.2	65.4	
42	55.9	42.2	66.0	67.1	
43	56.9	41.6	72.6	65.5	
44	58.0	46.8	61.5	60.6	7
45	73.1	57.7	89.3	84.7	
46	71.6	57.0	85.4	82.5	
47	73.1	59.4	79.5	84.5	
48	57.8	48.9	54.8	62.6	
49	61.8	51.1	64.4	67.3	
50	55.1	43.8	58.9	61.3	
51	61.0	49.1	67.1	69.4	8
52	55.7	44.1	61.4	62.5	
53	60.7	48.4	69.4	69.3	
54	55.8	44.8	59.1	63.4	
55	53.5	39.1	62.7	64.5	9
56	55.3	38.3	67.2	67.7	
57	60.8	38.6	81.7	73.2	
58	52.2	41.0	50.8	58.7	

5. CONTOURING TRAFFIC NOISE INDICES

It was expected that the Birmingham site investigations would furnish sufficiently detailed noise measurements to enable the development of a computerised noise mapping technique. A computer drawn map has the advantage of being entirely reproducible for a given set of data points since it relies upon fixed regression and surface fit algorithms to produce the contour lines. The Laboratory has purchased a general purpose contouring program (GPCP)[7] and has implemented this in the ICL system 4-70 computer.

This section describes the problems involved in contouring traffic noise indices in urban areas, the input format finally adapted with GPCP, and the results obtained.

5.1 Adapting GPCP to contour traffic noise indices

Each contouring problem presents unique difficulties of surface representation. A particular method may contour successfully one type of data but may badly misrepresent other types. General purpose programs such as GPCP have user-accessible controls which allow a wide range of applications. The main features of the Birmingham traffic noise data that dictate the contouring program format are:-

1. More than 50% of the microphone sites are at house facades so that the distribution of sites is not especially suited for contouring,

2. In the site there are several field discontinuities. These occur at buildings and at noise sources,

3 The data are not exact and small local fluctuations in level can arise due to experimental error. The trend of measured levels must therefore be regarded as being more significant than the actual measured levels.

When preparing the data for contouring using GPCP two important points must be recognised. These are:-

1. GPCP is an "exact fit" technique,

2. the GPCP surface approximation algorithm behaves poorly at discontinuities.

To overcome these problems, firstly the site was divided into four homogeneous sections each bounded by expected field discontinuities. Secondly, within each section, a curvilinear regression was performed on the control points to produce a set of equations describing the variation in level in the section. This process averaged out the localised variations in level. Using these equations more data points were generated to create a balanced distribution of control points. The four data sets were then processed independently in one computer "run" and the resulting contour maps superimposed under computer control. The contour map obtained using this technique for the 18 hour L_{10} index is shown superimposed on the map of the site in Fig. 5.

As a means of summarising and visually displaying a large quantity of traffic noise data, the contour map is very effective. The attenuation down side roads leading from the main road can readily be seen. Also noticeable is the reduction of facade levels on the North side of the road where the housing is partially shielded by an embankment. Reliable estimates of the noise criteria may also be made for any point within the site, and the Keele sociologists have been supplied with 18 hour L_{10}, 24 hour TNI and 24 hour L_{NP} data for every house in the district.

In its present form, however, GPCP is not readily applicable to contouring traffic noise indices in urban areas. The program will be more useful when the generation of trend surfaces is included. It would also be useful if the program could accept the co-ordinates of discontinuities and adapt the interpolation process to recognise these, rather than that the data should be re-organised into zones of continuity. The present technique requires rather too much user interpretation and modification to be described as a truly machine mapping of noise.

6. FUTURE DEVELOPMENT OF THE SYSTEM

The measurement of traffic noise using the data logger is, at present, a two stage process. Firstly punched paper tape records of the noise levels at the microphones are obtained, and secondly the records are processed using the Laboratory's ICL system 4-70 computer. A delay between acquisition and analysis of data is therefore incurred.

Experience in using the equipment has shown that on-site data analysis would offer two advantages over the present arrangement. They are:

1. the results would indicate any equipment faults, and could also be used to re-deploy the microphones more effectively,

2. in large site investigations, unusual day to day variation of noise could be detected and an experiment prolonged if necessary.

A system is being considered in which the present logger would be replaced by a mini-computer. The computer would be programmed to control the rate of data acquisition and the scanning sequence of the microphone channels, and to make the noise level analysis on site.

Since computers can execute input/output instructions and manipulate data very rapidly, high speed scanning of the microphone signals can be achieved if desired. At the high sampling rates envisaged it seems likely that calibration slip will become the dominant source of error.

7. ACKNOWLEDGEMENTS

This paper was prepared in the Environmental Effects Division of the Transport Systems Department. Acknowledgement is made to the Birmingham, Walsall and Aldridge engineers and to the residents of the Queslett Road area who assisted the site work by allowing electric power to be drawn from their supplies.

8. REFERENCES

1. WILSON, SIR ALAN (Chairman). Noise - Final Report of the Committee on the Problem of Noise. Cmnd 2056, HMSO, London, 1963.

2. SCHOLES W E and SARGENT J W. Designing against noise from road traffic. Building Research Station. Current paper CP 20/71.

3. SCHOLES W E and VULKAN G H. A note on the objective measurement of road traffic noise. Applied Acoustics, 2(3), 1967, 185-197.

4. FISHER R A. The truncated normal distribution. British Association for the Advancement of Science, Mathematical Tables, 2, 1931.

5. MORONEY M J. Facts from Figures. Pelican Books, A236, 1953.

6. WALKER P. Hansard, 4 July 1971.

7. Calcomp Applications Software. GPCP - A general purpose contouring program. User's manual, April 1971. California Computer Products Inc; Anaheim, California.

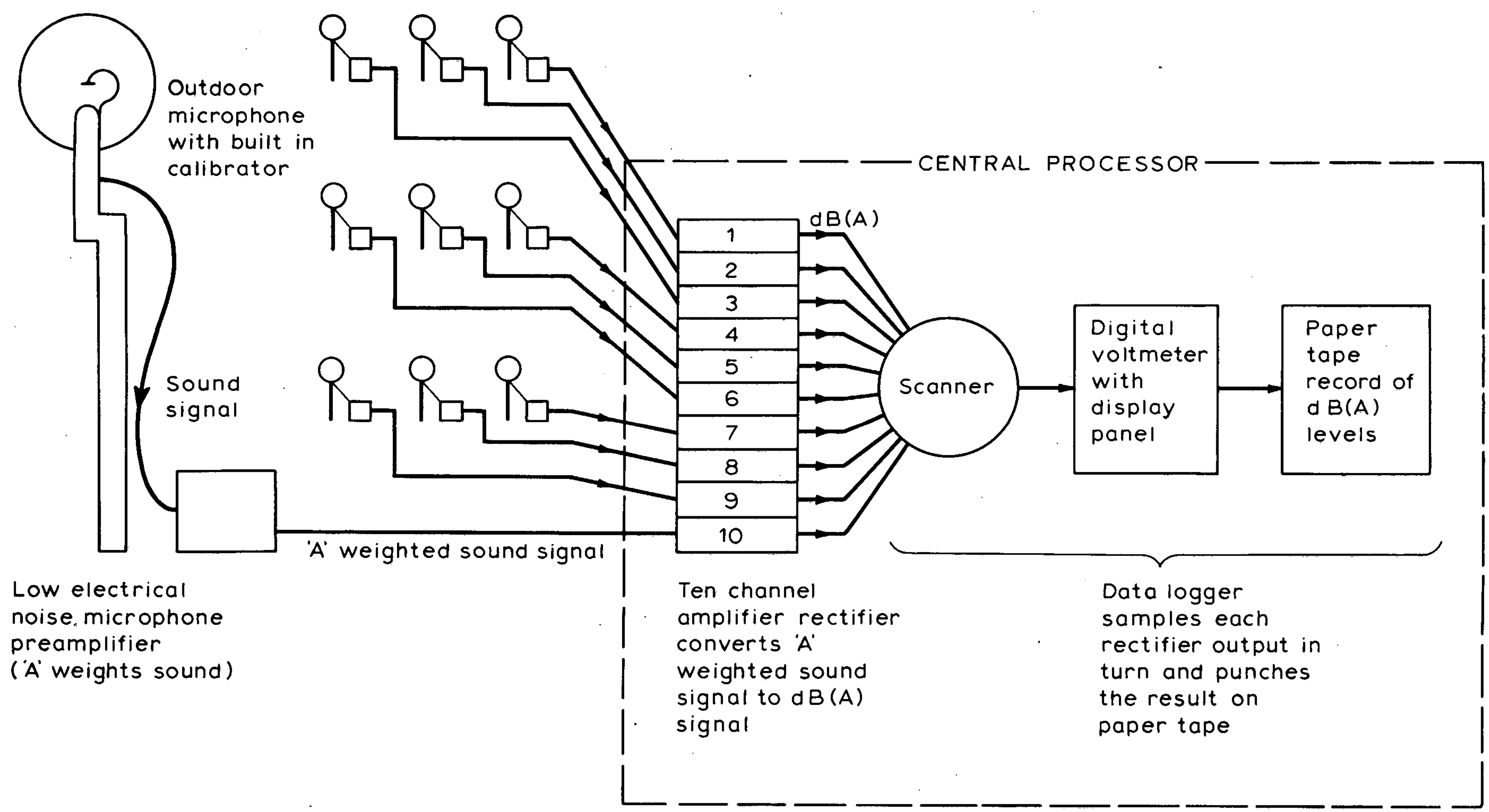

Fig. 1. EQUIPMENT FOR MEASURING AND RECORDING TRAFFIC NOISE

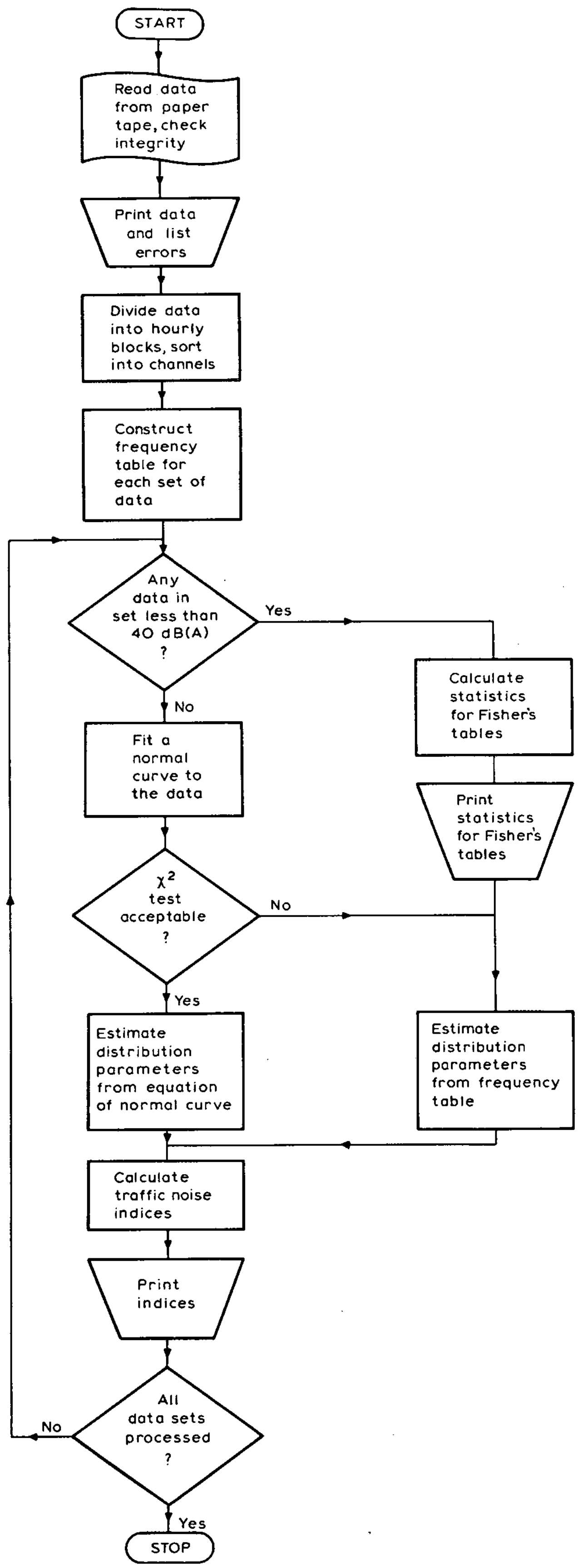

Fig. 2 SIMPLIFIED FLOWCHART OF THE COMPUTER PROGRAM TO ANALYSE TRAFFIC NOISE DATA

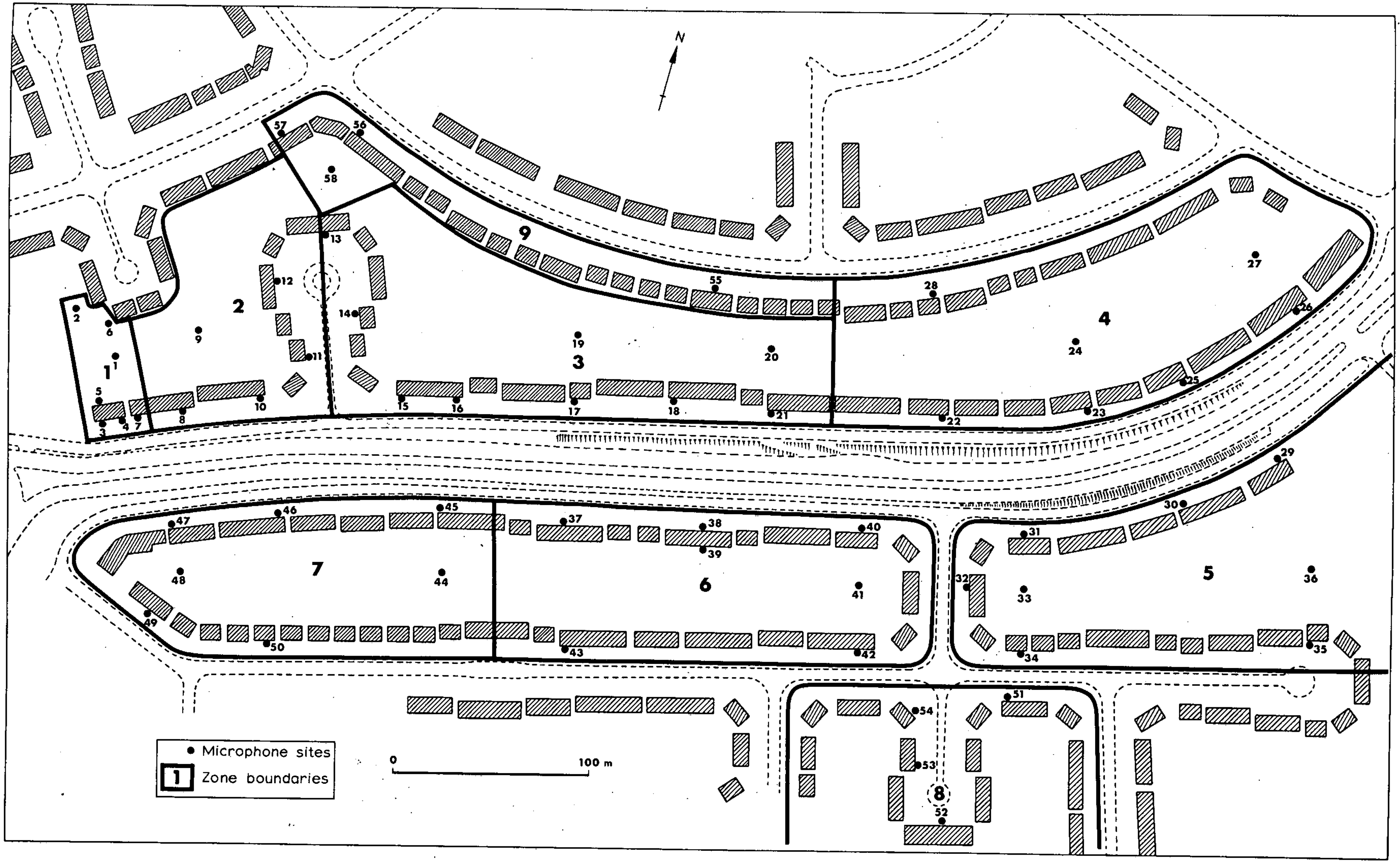

Fig. 3 PLAN OF THE BIRMINGHAM SITE

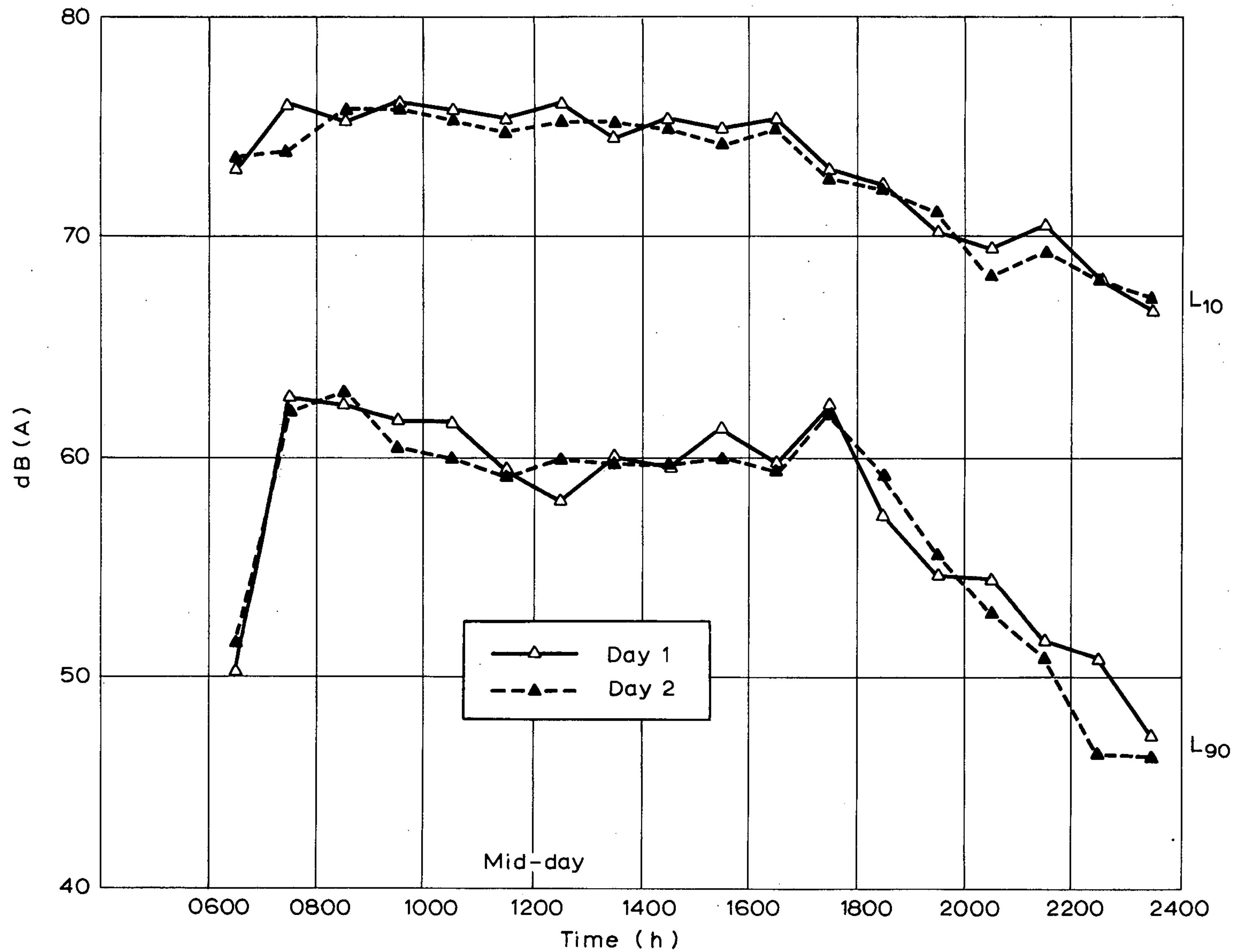

Fig. 4. HOURLY VALUES OF L_{10} AND L_{90} OBTAINED AT SITE 37 ON SEPARATE DAYS

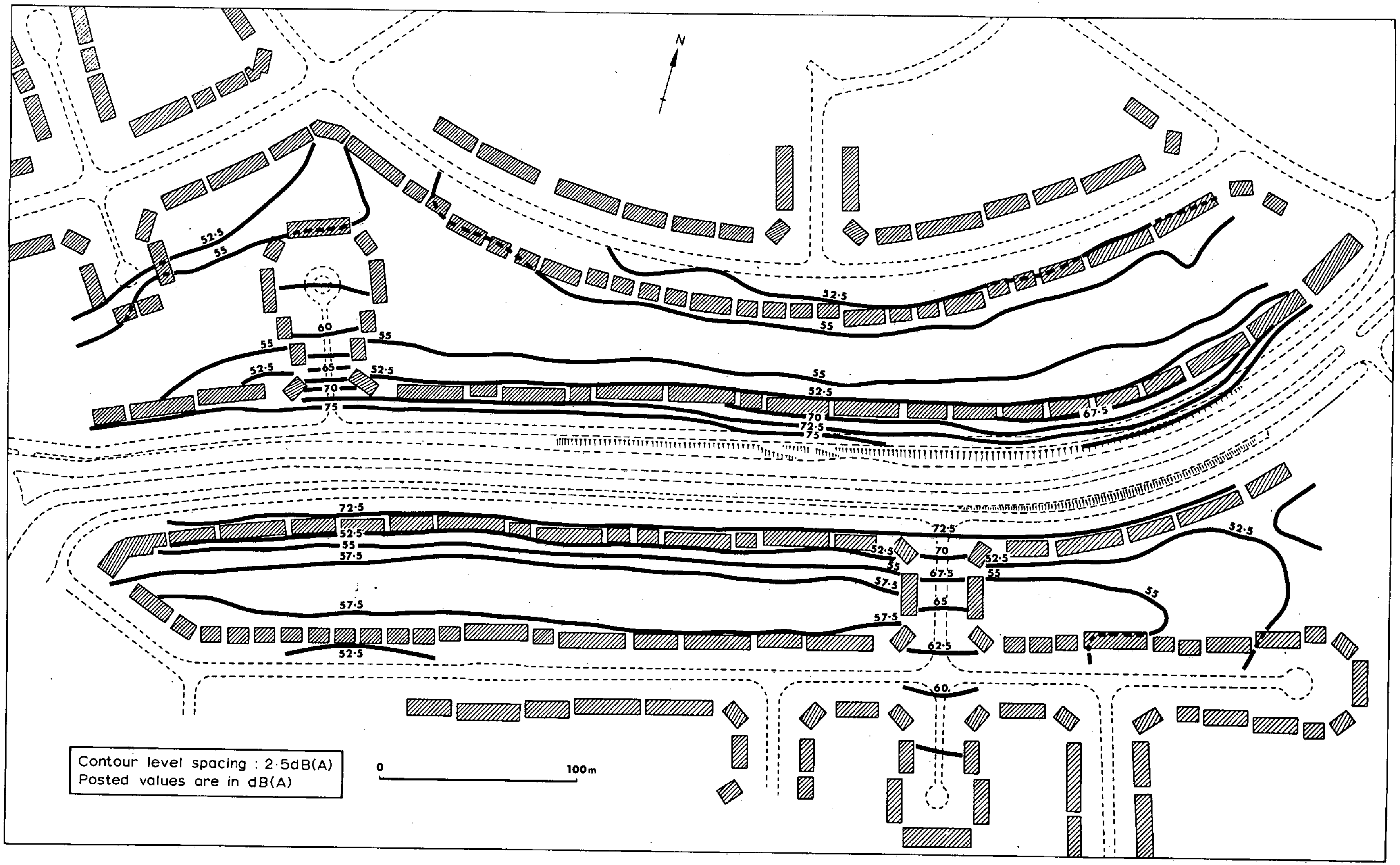

Fig. 5 PLAN OF THE BIRMINGHAM SITE SHOWING CONTOURS OF L_{10} (18h average)

Neg No R 1193/72/9

PLATE 1

Aerial photograph of the Birmingham site

(961) Dd.891796 3M 7/72 HP Ltd. So'ton G.1915
PRINTED IN ENGLAND

ABSTRACT

A data logging system for the measurement of road traffic noise: M CHEESEMAN and P M NELSON: Department of the Environment, TRRL Report LR 479: Crowthorne, 1972 (Transport and Road Research Laboratory). The TRRL noise logging equipment is a ten microphone system designed to accumulate information automatically about the temporal distribution of noise over a selected area. It is capable of operating continuously for 24 hours or more. This paper describes the components of the logger and discusses its performance in the field. The accuracy of the system depends upon the rate of data acquisition. At the rate currently in use, the standard error associated with estimates of the L_{10} and L_{90} indices is typically ± 1.0 dBA at sites alongside busy roads. This compares favourably with the precision offered by the more widely used tape recording method.

The results of an experiment carried out in Birmingham are reported. Using the TRRL equipment it was found that 360 microphone-hours of data could be comfortably collected and analysed in two weeks, involving a total staff effort of approximately 180 man-hours. At sites closer to the Laboratory the staff requirement can be approximately halved.

A computerised noise mapping technique has been adapted to display the Birmingham data. In its present form, however, a considerable amount of data pre-processing is required and for this reason the method is not recommended.

Finally, modifications to the system are proposed. A mini-computer will be used to control high speed scanning of the microphone outputs, and will also analyse the data on-site.

ABSTRACT

A data logging system for the measurement of road traffic noise: M CHEESEMAN and P M NELSON: Department of the Environment, TRRL Report LR 479: Crowthorne, 1972 (Transport and Road Research Laboratory). The TRRL noise logging equipment is a ten microphone system designed to accumulate information automatically about the temporal distribution of noise over a selected area. It is capable of operating continuously for 24 hours or more. This paper describes the components of the logger and discusses its performance in the field. The accuracy of the system depends upon the rate of data acquisition. At the rate currently in use, the standard error associated with estimates of the L_{10} and L_{90} indices is typically ± 1.0 dBA at sites alongside busy roads. This compares favourably with the precision offered by the more widely used tape recording method.

The results of an experiment carried out in Birmingham are reported. Using the TRRL equipment it was found that 360 microphone-hours of data could be comfortably collected and analysed in two weeks, involving a total staff effort of approximately 180 man-hours. At sites closer to the Laboratory the staff requirement can be approximately halved.

A computerised noise mapping technique has been adapted to display the Birmingham data. In its present form, however, a considerable amount of data pre-processing is required and for this reason the method is not recommended.

Finally, modifications to the system are proposed. A mini-computer will be used to control high speed scanning of the microphone outputs, and will also analyse the data on-site.