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# Pacific Highway Upgrade Yelgun to Chinderah

## Environmental Impact Statement

JULY 1998

### WORKING PAPER No. 3

### Noise Assessment



COMMONWEALTH DEPARTMENT OF  
TRANSPORT AND  
REGIONAL DEVELOPMENT

SINCLAIR KNIGHT MERZ





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WP 3

**PACIFIC HIGHWAY UPGRADE  
YELGUN TO CHINDERAH  
NOISE AND VIBRATION ASSESSMENT**



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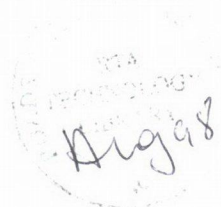
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## 1. INTRODUCTION

### 1.1 Background

The Roads and Traffic Authority (RTA) is proposing to upgrade the Pacific Highway between Yelgun and Chinderah, on the far north coast of New South Wales. The upgrade would be undertaken as part of the Pacific Highway Upgrading Program.

The proposal is for the construction and operation of a new dual carriageway which is located, for the most part, east of the existing highway and travels generally in a north-south direction. The proposal would start just north of Yelgun and continue through to an interchange with the existing highway, at the northern end of Oak Avenue near Chinderah. The total length of the proposal is approximately 28.5 km.

The proposal has been planned in conjunction with the Proposed Pacific Highway Upgrade, Brunswick River to Yelgun. A separate Environmental Impact Statement (EIS) is being prepared for that project.

The proposed upgrade of this section of the highway is part of the Pacific Highway Upgrading Program, which is a joint NSW State/Commonwealth Government initiative. The Program has committed some \$2.2 billion for upgrading the Pacific Highway between Hexham and the Queensland border over ten years commencing July 1996.

The proposal is within the Byron and Tweed local government areas (LGA) and is subject to the provisions of the Byron Local Environmental Plan, 1988 and the Tweed Local Environmental Plan 1987. Under the provisions of those environmental planning instruments the proposal does not require consent and will be considered under Part 5 of the Environmental Planning and Assessment Act, 1979, as amended (EP&A Act).

This Working Paper is one of a series that documents the detailed investigations carried out to assess the environmental impact of the proposal. These Working Papers accompany the Environmental Impact Statement (EIS) which has been prepared by Sinclair Knight Merz, on behalf of the RTA.

The EIS and accompanying Working Papers are being placed on exhibition for a period of at least 30 days, during which time all interested parties are invited to make submissions on the proposal. Following the exhibition period, the RTA will review submissions and address the issues raised. All copies of the submissions and the RTA's consideration of them will be forwarded to the Department of Urban Affairs



and Planning. The proposal requires the approval of the Minister for Urban Affairs and Planning. If and when that approval is obtained the proposal, and DUAP conditions will be considered by the Chief Executive of the RTA, for ultimate determination.

## **1.2 The Proposal**

The upgrading of this section of the highway has been the subject of a number of strategic transport planning studies. This particular proposal arose directly from a land use and transport strategy study undertaken in 1996 by the Department of Urban Affairs and Planning (DUAP) and the RTA. That study identified the need for upgrading the highway between the Brunswick River and Yelgun, and identified an investigation corridor for the section between Yelgun and Chinderah.

The preferred route for the proposal, which is the subject of the EIS and was the subject of the detailed investigations described in this Working Paper, was selected following extensive investigation of the corridor defined by the DUAP/RTA study and analysis of several alignment options. The proposal is shown on Figure 1.1.

The preferred route commences just north of Yelgun and at this location it is confined between the Billinudgel Nature Reserve, the existing highway and the Main Northern Railway. The proposal crosses underneath the existing highway just north of Jones Road and from there it is located on the eastern side of the existing highway. From Jones Road the existing highway starts to swing away to the north-west, while the proposal travels generally in a north-south direction.

In the southern section the proposal has been located to minimise property impacts, particularly impacts on agriculture and on natural areas of high conservation value. Relocation of about 700 m of the Pottsville-Mooball Road would be necessary to avoid sensitive vegetation in Burringbar Creek. The proposal crosses underneath the Pottsville-Mooball Road at Sleepy Hollow and travels north to a grade separated diamond interchange at Cudgera Creek Road. The local road would be raised over a short stretch to pass over the proposal.

Between Cudgera Creek Road and Clothiers Creek Road the proposal has been located to minimise impacts on agricultural activity, particularly on existing and future cane land, and on rural residential properties.

The interchange at Clothiers Creek Road is a modified trumpet design, located to take advantage of better ground conditions in that vicinity. As for Cudgera Creek Road, the interchange would be grade separated and allow for connections with the local road network.



The proposal would pass under Eviron Road travelling between Tweed Council's Botanic Gardens and Cemetery. From Eviron Road it hugs the lower western slopes of the Duranbah Ridge to minimise impacts on cane farms.

There would be a tunnel of approximately 150 m under Cudgen Road, to avoid a major cut in this location and to preserve the scenic qualities of the area. The proposal then travels north to an interchange at Oak Avenue.

The proposal will be within a road corridor of variable width, typically varying from 50 to 100 m (and wider in the larger cuttings). The corridor has been defined to allow for the road itself as well as landscaping and other environmental mitigation measures including noise mitigation measures, erosion and sedimentation control, and fauna crossings. Figure 1.2 shows a typical cross-section for the proposal. The concept design also includes details of proposed measures to maintain local drainage networks and to maintain access for agricultural properties.

The description and assessment of the proposal is based on a concept design. For the purposes of this EIS, the design illustrates the general configuration of the proposal and includes the location of interchanges, areas requiring cut and fill, local road realignments and a preliminary road profile.

Detailed design of the proposal would be undertaken when and if the RTA makes a decision that the proposal is to proceed. The detailed design stage would use the concept designs and the information provided in this EIS including the recommended environmental safeguards and mitigation measures. It would also need to take into account issues raised during the exhibition period and the RTA's determination, including any conditions imposed as part of that determination. The more detailed engineering investigation of the proposal would then be undertaken so that construction could commence.

### **1.3 Environmental Impacts and Mitigation Measures**

The purpose of the environmental assessment was to identify impacts associated with the proposal, and establish their significance. An important part of the process has been to identify the mitigation and environmental measures that need to be incorporated into the project to ensure that the environment can be adequately protected.

The potential environmental impacts of the proposal are described in each Working Paper, and are described cumulatively in the EIS document. Each Working Paper, and the EIS document also identifies any further additional environmental approvals and/or licences that would be required to enable the project to proceed.



The environmental mitigation and management measures, together with statutory requirements are collated in the form of an outline Environmental Management Plan (EMP) in the EIS document.

#### **1.4 Noise and Vibration**

This Working Paper presents an assessment of the impact of traffic noise and construction noise and vibration arising from the proposal.

Noise levels along the proposed route have been measured to determine the existing ambient environment including the contribution from current traffic noise. Traffic noise levels from the operation of the proposal have been predicted approximately 10 years after opening for the year 2012, mitigation measures have been designed and the noise impact upon the community identified.

The Environment Protection Authority (EPA) has developed new draft traffic noise guidelines which have been agreed between the RTA and EPA. These new draft guidelines have been used as the basis for the assessment of road traffic noise.

These new draft guidelines have been used as the basis for assessment of traffic noise, along with an assessment of short term intrusive noise levels in terms of sleep disturbance. This is to address the often cited concerns regarding heavy vehicle noise particularly at night time.

Construction noise and vibration has been assessed according to the guidelines contained in the 1994 EPA Environmental Noise Control Manual (ENCM).



## **2. SITE DESCRIPTION, PROPOSAL DESIGN AND PROJECTED TRAFFIC FLOWS**

This section of the report includes a general discussion of the existing area, identifies the nearest residences and other sensitive receiver, discusses the salient design issues which affect traffic noise and presents the traffic flow data.

A more detailed description of the proposal can be found in the EIS.

### **2.1 Site Description**

The proposal is shown in Figures 1.1 and 1.2. The term upgrade is used since it refers to the overall upgrade program for the Pacific Highway between Sydney and the Queensland border. This term should not be confused with classifications within the new draft EPA guidelines.

The proposal would closely follow the existing alignment between the Yelgun Interchange and Halls Road at which point it deviates significantly from the existing highway and follows the alignment of the Pottsville – Mooball Road. Sleepy Hollow golf course is located to the west although this is currently not operational. A full grade separated interchange would be provided at Cudgera Creek Road and Clothiers Creek Road. The Tweed Cemetery and Botanic Gardens are located at Eviron Road and Duranbah Public School is located on Duranbah Road. A new interchange is located at the northern end at Oak Avenue.

Travelling from south to north the following areas (Table 2-1) which are near to or front the road alignment have been identified. These refer to general areas and may not include all street names. The noise measurement locations (N1 – N26) in each of these areas are also shown in Figure 1.1



**TABLE 2-1: ADJACENT AREAS**

Section	Area	
	West of Proposal	East of Proposal
Yelgun to Clothiers Creek Rd	Isolated residences along Pacific Hwy in Yelgun and Crabbes Creek (N4,N6,N8). Isolated residences along Pottsville Rd, Samuel Marshall Cl, Sleepy Hollow Rd, Cudgera Creek Rd,. (N9,N13) Sleepy Hollow Golf Course	Isolated residences along Pacific Hwy, Jones Rd, Wooyung Rd, Hulls Rd. (N1,N2,N3,N5,N7) Isolated residences along Pottsville Rd, Warwick Park Rd, Cudgera Creek Rd (N10,N11,N12)
Cudgera Creek Rd to Clothiers Creek Rd	Isolated residences along Reserve Creek Rd, Round Mountain Rd & Clothiers Creek Rd. (N14,N19)	Isolated residences along Kanes Rd & Wilman Rd. (N15,N16,N17)
Clothiers Creek Rd to Northern Interchange	Isolated residences along Eviron Rd, Cudgen Rd. (N24)	Isolated residences along Eviron Rd (N20) Tweed Cemetery (N21) Duranbah Public School (N23). Isolated residences along Duranbah Rd. (N22,N25,N26)

## 2.2 Proposal Design

The proposal would be constructed as a dual carriageway road comprising two 3.5m traffic lanes and paved shoulder lanes separated by a varying width median. Full grade separated sections would be provided at Yelgun, Cudgera Creek Road, Clothiers Creek Road and Oak Avenue. The road surface is proposed as either a dense graded asphaltic concrete or a hessian dragged concrete with options for a speed limit of 100 km/h or 110 km/h. The road surface of the ramps is proposed as a dense graded asphaltic concrete with a typical speed of 80 km/h.

The existing highway would be reconstructed in short sections between Yelgun and Hulls Road and in the vicinity of the northern interchange. At the southern end the proposal is designed to be compatible with the proposed Pacific Highway Upgrade, Brunswick to Yelgun (currently under investigation).

Travelling from the south along the existing highway current posted speed limits are 100 km/h from Yelgun to the north of Hulls Road and along Oak Avenue. Between Yelgun and Hulls Road there are relatively steep gradients and numerous curves where speeds of 75 kmh or 85 kmh are recommended. The road surface is currently a chipseal surface with a short section of dense graded asphaltic concrete between Crabbes Creek and Hulls Road. Once the proposal is opened it is possible that the speed limit on the existing highway to the south of Mooball would be reduced to 80 km/h for both safety and environmental benefits.



### 2.3 Existing and Projected Traffic Flow

Tables 2-2, 2-3 and 2-4 below summarises the traffic flow data provided by Sinclair Knight Merz. These have been provided for the existing situation and 10 years after operating (2012). The information is summarised in the 15 hours from 7.00 am to 10.00 pm and the 9 hours from 10.00 pm to 7.00 am to be used with the new draft EPA guidelines.

**TABLE 2-2 EXISTING TRAFFIC VOLUMES ON THE PACIFIC HIGHWAY**

Section	Direction	15 hr		9 hr	
		Light	Heavy	Light	Heavy
South of Wooyung Road	NB	3611	401	307	188
	SB	3750	463	377	119
North of Wooyung Road	NB	2336	445	192	185
	SB	2603	495	227	102
South of Murwillumbah	NB	3382	461	331	194
	SB	3566	629	337	124
North of Cudgen Road	NB	4575	683	462	95
	SB	4544	739	430	121

On the local roads which would intersect with or be affected by the proposal, existing and year 2012 daily traffic flow volumes (with and without the proposal) are summarised in Table 2-3 as follows

**TABLE 2-3 EXISTING AND FUTURE AADT TRAFFIC ON LOCAL ROADS**

Section	Existing	Year 2012	
		Without	With
Pottsville – Mooball Rd	880	756	335
Cudgera Ck Rd (east of Pacific Highway)	622	1177	1456
Cudgera Ck Rd (west of Tweed Coast Rd)	1210	1589	3286
Clothiers Ck Rd (east of Eviron Rd)	274	347	473
Clothiers Ck Rd (west of Tweed Coast Rd)	1738	2278	1956



**TABLE 2-4: PROJECTED TRAFFIC VOLUMES YEAR 2012**

Section or Ramp	Direction	15 hr		9 hr	
		Light	Heavy	Light	Heavy
REALIGNED EXISTING HIGHWAY					
South of Wooyung Rd	NB	1989	221	207	93
	SB	2043	227	195	45
North of Wooyung Rd	NB	1173	223	96	93
	SB	1205	229	104	47
South of Murwillumbah	NB	1961	267	192	112
	SB	1939	342	183	67
North of Cudgen Rd	NB	4815	719	486	99
	SB	4782	778	459	100
NEW HIGHWAY					
Yelgun to Cudgera Creek Rd	NB	5992	665	387	317
	SB	5953	735	477	195
Cudgera Creek Rd to Clothiers Creek Rd	NB	6264	696	637	314
	SB	6414	712	588	196
Clothiers Creek Rd to Northern Interchange	NB	6415	712	648	319
	SB	6586	731	582	194
Cudgera Creek Rd Interchange	NB On	980	52	102	11
	SB On	579	30	60	7
	NB Off	565	30	73	8
	SB Off	957	50	124	14
Clothiers Creek Road Interchange	NB On	397	21	41	5
	SB On	283	15	29	3
	NB Off	276	15	36	4
	SB Off	388	20	50	6
Northern Interchange	NB On	4682	737	450	96
	SB On	135	7	13	1
	NB Off	134	7	13	1
	SB Off	4703	690	473	98



## 2.4 Cudgen Road Tunnel

The Cudgen Road Tunnel would require fans located below the tunnel roof to provide the necessary ventilation. It is proposed that fans would be situated near to each end of the tunnel and at the centre for both the northbound and southbound carriageways. Noise generated by the operation of these fans would be required to meet more stringent criteria than those for traffic noise.

Although background noise levels would increase once the proposal is open to traffic it is proposed to design the fans to meet noise level goals contained within the EPA, ENCM and ensure that  $L_{A10}$  noise levels from the fans do not exceed the existing background  $L_{A90}$  noise levels by more than 5 dBA. In addition the EPA recommended acceptable planning levels for rural areas would also be satisfied.

The fan selection has not been made at this time however general data based on a typical fan selection have been used to assess the potential impact. Since the fans would be housed within the tunnel and the portal is approximately 300 m from the nearest residence and well shielded the fans are predicted to be inaudible and no impact is expected.



### 3. EXISTING NOISE ENVIRONMENT

The existing noise environment along the proposed corridor has been measured. Traffic noise goals are based on the results of these measurements. Figure 1.1 shows the proposal and noise measurement locations.

#### 3.1 Measurement Locations

##### 3.1.1 Residential

Measurements of the existing ambient noise level have been made at 24 residences along the proposal. Measurements were also made at the Durambah Public School and Tweed Cemetery. The locations were representative of groups of residences likely to be affected by traffic noise from the proposal.

Noise level measurements were generally taken at a height of 1.2m, and 1m from the ground floor facades facing the proposal. At locations N1 to N8 measurements were made at building facades that are presently affected to some degree by traffic noise from the existing highway. At locations N9 to N26 some locations were affected by traffic noise on the local road network.

The residential measurement locations, dates of measurement and the figure number containing the relevant graphs are summarised in Table 3-1 as follows:



**TABLE 3-1 : NOISE MEASUREMENT LOCATIONS**

Ref	Location Description	Measurement Dates	Fig. No.
N1	Lot 13, Yelgun Ridge, Yelgun	27/2/98 – 11/3/98	2
N2	Lot 1, (Clothier) Pacific Highway, Yelgun	27/2/98 – 3/3/98	3
N3	Lot 1, (Pike), Pacific Highway, Yelgun	7/3/98 – 11/3/98	4
N4	Lot 5, ( Gallagher) Pacific Highway, Yelgun	3/3/98 – 7/3/98	5
N5	"Isherwood" Wooyung Road, Yelgun <sup>(1)</sup>	7/3/98 – 11/3/98	6
N6	Lot 6, (Alexander) Crabbes Creek	3/3/98 – 7/3/98	7
N7	"Tweedale" Hulls Road, Mooball	27/2/98 – 3/3/98	8
N8	Lot 3, (Bale) Pacific Highway, Mooball	27/2/98 – 11/3/98	9
N9	"Cowell Park" Mooball Road <sup>(2)</sup>	7/3/98 – 11/3/98	10
N10	Cnr. Warwick Park and Pottsville Road	26/2/98 – 3/3/98	11
N11	"Frosty Hollow" Pottsville Road	3/3/98 – 7/3/98	12
N12	Lot 6, (Edwards) 765 Pottsville Road	7/3/98 – 11/3/98	13
N13	Lot 2 (Everingham) Cudgera Creek Road <sup>(2)</sup>	27/2/98 – 11/3/98	14
N14	44 (Miller) Kanes Road, Round Mountain	3/3/98 – 7/3/98	15
N15	Lot 14 ( McGrath) Kanes Road	26/2/98 – 3/3/98	16
N16	Lot 5 (Sheehan) Wilman Road, Round Mountain <sup>(1)</sup>	7/3/98 – 11/3/98	17
N17	Lot 3 (Mary) Round Mountain Road	3/3/98 – 7/3/98	18
N18	Lot 72 (Jackson) Clothiers Creek Road <sup>(2)</sup>	26/2/98 – 3/3/98	19
N19	Lot 3 (Howarth) Clothiers Creek Road	26/2/98 – 11/3/98	20
N20	(Kane) Eviron Road, Duranbah <sup>(2)</sup>	7/3/98 – 11/3/98	21
N21	Tweed Valley Cemetery, Eviron Road	3/3/98 – 7/3/98	22
N22	"Dunarra" (Peate) 240 Duranbah Road	7/3/98 – 11/3/98	23
N23	Duranbah Public School <sup>(2)</sup>	26/2/98 – 3/3/98	24
N24	"Nyari" (McConnell) Cudgen Road, Duranbah <sup>(2)</sup>	3/3/98 – 7/3/98	25
N25	"Poinciana Place" (Campbell), Cudgen Road	26/2/98 – 3/3/98	26
N26	RMB 63, (Salisbury) Cudgen Road, Duranbah <sup>(2)</sup>	26/2/98 – 11/3/98	27

Notes 1) Total acquisition of this residence/property is proposed by the RTA.

2) Free field location

### 3.2 Measurement Procedure

The measurement of existing ambient noise was carried out between 29 October 1997 and 7 November 1997 over a period of 8 days at 5 locations and over a period of 4–5 days at 21 locations. The weather conditions during this period did include some thunderstorms but were dry for the most part. This period was during the school term when normal levels of traffic are present. The measurement results are therefore considered suitable for assessment purposes.

The noise measurement equipment used for these measurements consisted of Environmental Noise Loggers set to A-Weighted, fast time weighting continuously monitoring over 15 minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift occurred.

The logger determines  $L_{A1}$ ,  $L_{A10}$ ,  $L_{A90}$ , and  $L_{Aeq}$  levels of the existing noise environment. The  $L_{A1}$ ,  $L_{A10}$  and  $L_{A90}$  levels are the levels exceeded for 1%, 10% and 90% of the sample time respectively. The  $L_{A1}$  is indicative of maximum noise levels due to individual noise events such as the occasional passby of a heavy vehicle. The  $L_{A90}$  level is normally taken as the background noise level. The  $L_{Aeq}$  level is the Equivalent Continuous Sound Level and contains the same sound energy over the sampling period as the actual noise environment with its fluctuating sound levels. The  $L_{Aeq}$  is used as standard descriptor for traffic noise.

### 3.3 Measurement Results

Before presenting the results of the existing noise measurements, there is a need for a discussion of the appropriate descriptors. The new draft EPA guidelines (discussed in detail in Section 4) are based on the following descriptors:

- \*  $L_{Aeq,15hr}$  based on the daytime period 7.00 am– 10.00 pm.
- \*  $L_{Aeq,9hr}$  based on the night-time period 10.00 pm– 7.00 am.

These  $L_{Aeq}$  levels can either be measured over the time period indicated or calculated from 15 minute periods, as occurred during this project. The detailed noise measurement results using 15 minute periods are shown graphically in Figures 2 to 27.

The ambient noise level is taken to be the total noise at receivers that would normally occur at a location excluding extraneous noises. The average results excluding extraneous noise are rounded to the nearest 0.5 dBA. At the school and the Cemetery the results are shown as a typical range. The results are summarised in Table 3-2.



TABLE 3-2: MEASURED NOISE LEVELS

Ref	Location	Measured Noise Levels (dBA)	
		L <sub>Aeq,15hr</sub>	L <sub>Aeq,9hr</sub>
N1	Lot 13, Yelgun Ridge	54.0	50.5
N2	Lot 1, (Clothier) Pacific Hwy	61.5	57.0
N3	Lot 1, (Pike), Pacific Hwy	59.0	54.0
N4	Lot 5, (Gallagher) Pacific Hwy	49.0	48.0
N5	"Isherwood" Wooyung Rd	54.5	48.0
N6	Lot 6, (Alexander) Pacific Hwy	62.5	59.0
N7	"Tweedale" Hulls Rd	52.0	49.0
N8	Lot 3, (Bale) Pacific Hwy	50.0	46.0
N9	"Cowell Park" Mooball Rd <sup>(2)</sup>	51.0	41.0
N10	Cnr. Warwick Park and Pottsville Rd	53.0	46.0
N11	"Frosty Hollow" Pottsville Rd	45.5	40.5
N12	Lot 6, (Edwards) 765 Pottsville Rd	49.0	41.0
N13	Lot 2 (Everingham) Cudgera Creek Rd <sup>(2)</sup>	57.5	51.0
N14	44 (Miller) Kanes Road	49.5	47.0
N15	Lot 14 (McGrath) Kanes Rd	53.0	47.0
N16	Lot 5 Wilman Road	50.0	42.5
N17	Lot 3 (Mary) Round Mountain Rd	57.0	46.0
N18	Lot 72 (Jackson) Clothiers Creek Rd <sup>(2)</sup>	56.5	49.5
N19	Lot 3 (Howarth) Clothiers Creek Rd	51.0	47.0
N20	(Kane) Eviron Road <sup>(2)</sup>	52.0	44.5
N21	Tweed Valley Cemetery, Eviron Rd <sup>(1) (2)</sup>	50-55	-
N22	"Dunarra" 240 Duranbah Rd	53.0	38.0
N23	Duranbah Public School <sup>(1) (2)</sup>	48-53	-
N24	"Nyari" Cudgen Rd <sup>(2)</sup>	53.5	44.5
N25	"Poinciana Place", Cudgen Rd	53.0	46.0
N26	RMB 63, Cudgen Road <sup>(2)</sup>	50.5	44.0

Notes: 1) L<sub>Aeq,1hr</sub> values for daytime only

2) Free field location

#### 4. NOISE ASSESSMENT CRITERIA

This section of the report summarises Wilkinson Murray's understanding and interpretation of the new draft EPA guidelines. This includes noise at residences, school classrooms and playground, the Cemetery and both passive and active recreation areas. Noise from individual noisy events such as heavy vehicle passbys are assessed separately.

##### 4.1 EPA Traffic Noise Guidelines for Residences

The EPA has recently proposed new traffic noise guidelines which have been agreed between the RTA and EPA. These guidelines have just been formally released and are significantly more stringent than the previous Noise Control Guideline detailed in the ENCM. The guidelines are non mandatory and suggest that *"in some instances the criteria may only be achievable through long-term strategies such as improved planning, design and construction of adjoining land use developments, reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles, greater use of public transport and alternative methods of freight haulage"*.

Those residents who currently experience little or no road traffic noise are likely to be more affected by noise from traffic on a new road alignment than those residents who currently experience some road traffic noise where noise from traffic on a realigned or upgraded road may make little or no changes. In interpreting the new draft EPA guidelines for this project, a pragmatic approach has been adopted.

This approach has meant that at those residences where noise levels increase significantly to above the guidelines the RTA would be committed to providing noise mitigation subject to technical practicability and cost effectiveness.

The guidelines generally refer to future road capacity, however no quantitative definition of capacity is provided. Since the proposal is for a dual carriageway with 2 lanes in each direction, then capacity is not expected to be reached for over 20 years. Predictions have been based on the Year 2012, which represents a scenario 10 years after opening where reliable traffic data are available and allows for reasonable traffic growth.

For freeways or arterial roads (which the Pacific Highway would be classified as), the EPA has three assessment categories which are summarised as follows:



\* ***New Road.***

In addition to this being a completely new road development, this also includes a substantial realignment of an existing road. The criteria relating to new roads (to be applied 10 years after opening) are as follows:

- \*  $L_{Aeq,15hr}$  (7.00 am – 10.00 pm) = 55 dBA
- \*  $L_{Aeq,9hr}$  (10.00 pm – 7.00 am) = 50 dBA.

The guidelines also state: *"The new road should be designed so as not to increase existing noise levels by more than 0.5 dBA."*

\* ***Road Upgrade.***

This refers to minor realignment of an existing road which does not involve any change in traffic capacity, ie. straightening out curves or the inclusion of traffic control measures. The criteria relating to a road upgrade is as follows:

- \*  $L_{Aeq,15hr}$  (7.00 am – 10.00 pm) = 60 dBA
- \*  $L_{Aeq,9hr}$  (10.00 pm – 7.00 am) = 55 dBA.

If these goals are already exceeded then the guidelines state *"it is highly desirable that no increase in noise levels occur"*. It is considered that allowing for prediction accuracy that an allowable goal is an increase of 0.5 dBA or less, which would not be noticeable. It is considered this increase should apply at opening.

\* ***Road Redevelopment.***

This includes the upgrade of an existing alignment which will include an increase in capacity. The criteria relating to a road redevelopment is:

- \*  $L_{Aeq,15hr}$  (7.00 am – 10.00 pm) = 60 dBA
- \*  $L_{Aeq,9hr}$  (10.00 pm – 7.00 am) = 55 dBA.

If these goals are already exceeded, the guidelines state *"in all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dBA"*. It is considered this increase should apply 10 years after opening

The EPA has advised that the proposal is far enough from the existing highway along the entire length that the "new road" guidelines should apply at all residences. This working paper adopts the EPA goals. As recommended by the EPA it then predicts and discusses changes in noise levels at individual residences.

At some residences which are close to existing local roads (excluding Cudgera Creek Road and Clothiers Creek Road), ambient noise levels are above the EPA goals, but it is considered that this is not solely due to traffic noise from local roads but would include domestic or other rural sources. The assessment procedure has therefore been simplified and ignores the unknown contribution of traffic noise from the minor local roads and designs the proposal alone to meet the goals of  $L_{Aeq,15hr} = 55$  dBA and  $L_{Aeq,9hr} = 50$  dBA for the Year 2012. The traffic noise from the proposal is likely to dominate in most cases.

Since the existing highway would be realigned and remain open to traffic the noise predictions at each location in the southern section include the contribution of traffic noise from both the proposal and the realigned existing highway. Similarly at the interchanges the contribution from the main carriageway, ramps and local roads are included.

The "new road" classification or the "new road" criteria may not be the most appropriate for the residences in the section between Yelgun and Hulls Road where many of the residences currently experience noise levels above the EPA criteria.

It is considered that if noise levels are predicted to reduce at a residence as a result of the proposal then the EPA goals should be met. In applying the "new road" classification and criteria in all areas it is possible that a reduction in noise levels immediately after opening would not meet the EPA goals in the future.

Where the criteria are already exceeded the EPA goal would be Ambient + 0.5 dBA. The EPA consider this plus 0.5 dBA would apply to the future assessment Year. For the future assessment Year the increase in noise as a result of traffic growth alone is predicted as approximately 1 dBA. Even at residences where the proposal is marginally further away than the existing highway the EPA goals would not be met. This issue needs to be carefully considered when assessing compliance with the EPA guidelines.



## 4.2 EPA Noise Guidelines for the School, Cemetery, Botanic Gardens and Golf Courses

### 4.2.1 School

For schools, the draft EPA guidelines recommend an internal noise level criterion of  $L_{Aeq,1hr} = 45$  dBA for an existing school classroom. It is assumed this applies to a typical worst case hour during normal school times. For building facades which contain openable windows an equivalent external goal would be 55 dBA. For fixed windows or facades with no windows the appropriate external level would depend on the building and window construction but would be at least 70 dBA and possibly 75 dBA. The guidelines also recommend a criterion of  $L_{Aeq,1hr} = 55$  dBA for school playgrounds.

Although not stated in the EPA guidelines if existing traffic noise results in internal levels above the EPA guidelines then it would be appropriate not to increase noise levels or in cases where existing levels are not significantly above the guidelines to apply the "new road" guidelines applicable to the residential receivers and limit increases in noise level to 0.5 dBA.

The Duranbah Public School has openable windows in the facade which faces the proposal and the school playground is located adjacent to the school access road and is set back approximately 15–20 m from Duranbah Road.

### 4.2.2 Cemetery

No guidelines specific to cemeteries are provided by the EPA. The closest guidelines would be those for passive recreation areas which require a  $L_{Aeq,1hr}$  level of 55 dBA. Given that a peaceful environment would be desirable at the Cemetery which would be conducive to contemplation and allow services to be held it is considered that a goal of  $L_{Aeq,1hr}$  of 50 dBA during the daytime would be appropriate if it can be achieved. This level is equivalent to the criterion for outside a church and is 5 dBA more stringent than the EPA criterion for passive recreation areas.

### 4.2.3 Botanic Gardens

The EPA provided guidelines for passive recreation areas for which a criterion of  $L_{Aeq,1hr}$  of 55 dBA would apply.

#### 4.2.4 Golf Course

The EPA provided guidelines for active recreation areas such as golf courses for which a criterion of  $L_{Aeq,1hr}$  of 60 dBA would apply. The Sleepy Hollow Golf Course is currently not operational and its future is uncertain, however this goal has been adopted for assessment purposes.

### 4.3 Summary of EPA Noise Level Goals

Since the measurements were carried out at representative residences, the noise level goals derived would apply to regions in the vicinity of the measurement location. Based on the temporal traffic flows including the percentage of heavy vehicles and the existing ambient noise levels, the most stringent goal is the night time period of  $L_{Aeq,9hr}$ . If this goal is achieved then the daytime goal would automatically be satisfied. The noise level goals at the various locations, based on the EPA correspondence in relation to its guidelines, are shown below:

*	Residences	$L_{Aeq,9hr} = 50 \text{ dBA or Ambient} + 0.5 \text{ dBA}$
*	School	
	classrooms	$L_{Aeq,1hr} = 45 \text{ dBA}$
	playground	$L_{Aeq,1hr} = 55 \text{ dBA}$
*	Cemetery	$L_{Aeq,1hr} = 55 \text{ dBA (RTA would try to achieve 50 dBA)}$
*	Botanic Gardens	$L_{Aeq,1hr} = 55 \text{ dBA}$
*	Golf Course	$L_{Aeq,1hr} = 60 \text{ dBA}$



#### 4.4 Heavy Vehicle Noise Events

While not a quantitative part of the EPA guidelines, the potential for sleep disturbance from short term maximum noise levels generated by heavy vehicles at night time has been assessed. Previous surveys have identified some noise impact may occur from short term noise events at night and so an assessment is included here for completeness. These events generally relate to heavy vehicle movements on steep grades or near intersections, where engine braking or numerous gear changes occur. These are mostly a function of individual driver behaviour or vehicle condition over which the RTA, at present, have little effective control. This area is being targeted by the RTA for significant improvement.

Since almost all the heavy vehicle movements would be likely to be through traffic, and the grades associated with the proposal are significantly reduced, then it is unlikely that engine braking would be required with the exception of the few heavy vehicles which may use the interchanges.

The EPA in its draft guidelines suggest there is no definitive research which allows them to establish criteria for sleep disturbance, however, it makes the following statements:

"Maximum internal noise levels below 50–55 dBA are unlikely to cause awakening reaction."

"One or two noise events per night, with maximum internal noise levels of 65–70 dBA, are not likely to significantly impact health and well being".

Assuming a minimum sound level reduction from outside to inside through an open window of 10 dBA these internal levels would relate to external facade levels of 60–65 dBA and 75–80 dBA respectively.

## 5. TRAFFIC NOISE ASSESSMENT AND MITIGATION OPTIONS

This section of the report presents the predicted noise levels and assesses the potential impact if the proposal was designed and constructed with no noise mitigation measures. It then discusses the options for mitigation and recommends a noise mitigation scheme which the RTA would need to implement to meet the new draft EPA guidelines. The scheme is considered to be the most cost effective and practicable.

### 5.1 Traffic Noise Prediction Method

Noise levels have been predicted using the Environmental Noise Model (ENM). Traffic noise is generated continuously by each light and heavy vehicle as it passes along the road alignment. This would be represented by a line noise source. The ENM model allows the road alignment to be modelled as an equivalent line source by incorporating a number of point sources along the centreline of each carriageway. Each point source would represent an amount of noise generated by either a light vehicle or heavy vehicle. These points would be interspaced equally along the centrelines.

The sound power level at each point source is dependent on the following factors for both light and heavy vehicles.

- \* Traffic flow volumes in the 15 hour and 9 hour periods.
- \* Vehicle speed.
- \* Spacing between source points.
- \* Road surface.
- \* Road gradient.
- \* Reflections from buildings/barriers.
- \* Building facade reflection (normally 2.5 dBA).

To maintain prediction accuracy the spacing between each point source is dependent on the distance to the nearest residence from the road and should be less than three times the distance between the road and receiver.

The ENM algorithm which incorporates the surrounding topographic data and locations of receivers then takes into consideration the following factors to predict noise levels at the receiver.



- \* Geometric spreading.
- \* Ground attenuation.
- \* Air absorption.
- \* Shielding due to natural topography or purpose built barriers.

Wilkinson Murray consider the ENM algorithm, when compared with the CORTN and FHWA noise prediction procedures, improves the prediction of noise for greater distances (>100 m) from the road alignment where the topography is not flat due to its better predictions for shielding and ground attenuation. The ENM algorithm was compared to the CORTN noise prediction procedure at smaller distances (<100 m) for a straight length of road and gave good agreement.

The sound power level spectrum associated with light and heavy vehicles at 100 km/h on a flat dense graded asphaltic concrete surface are summarised in Table 5-1. The data is based on a review of several sources including the CORTN and FHWA noise prediction procedures and Australian Design Rules.

Australian Design Rule 28/01 sets maximum permissible noise levels for heavy vehicles being registered for the first time. These sound power levels depend upon net engine power and range from 106 dBA for engines less than 75 kW to 112 dBA for engines greater than 270 kW. This noise level is representative of a high engine rpm scenario and includes engine, exhaust and tyre noise although speeds are not as high as 100 km/h. The largest engine category has been used as a basis to determine maximum noise levels however this has been increased to reflect the speed change.

**TABLE 5-1: VEHICLE SOUND POWER LEVELS**

Frequency – (Hz)	Octave Band Sound Power Level (dB)							
	63	125	250	500	1K	2K	4K	8K
Light vehicle	103.8	102.8	99.8	97.8	95.8	96.8	92.8	88.8
Heavy vehicle	113.4	113.4	112.4	110.4	106.4	106.4	101.4	93.4

These are equivalent to a sound power level of 102.5 dBA for light vehicles and 113 dBA for heavy vehicles. Although noise from the engine, exhaust and pavement surface / tyre interface is generated at different source heights for modelling purposes at the proposed speeds the average source heights are taken as 0.6m for light vehicles and 1.5m for heavy vehicles.

For the existing highway south of Hulls Road adjustments are generally made for a chipseal surface (+3.5 dBA for light vehicles and +1.5 dBA for heavy vehicles at 100 km/h) although short sections include a dense graded asphaltic concrete. In addition, adjustments are made for a lower average speed of 80 km/h in the areas with sharp curves which are sign posted as 75 or 85 km/h. Adjustments are made for



facade reflection (+2.5 dBA) and a flow correction based on a 30 m spacing between each vehicle type. Light and heavy vehicles have been interspaced at equal intervals to provide a 15m spacing between each source point and modelled for both the northbound and southbound carriageways.

For the realigned existing highway adjustments are made as above, however, additional sections of dense graded asphaltic concrete are included and the speed is reduced in all sections to 80 km/h.

For the proposal adjustments are made for a hessian dragged concrete surface (which includes a -1 dBA correction for light vehicles and a -1.5 dBA correction for heavy vehicles at 100 km/h). Adjustments are made for facade reflection (+ 2.5 dBA) and a flow correction based on a 50 m spacing between each vehicle type. Light and heavy vehicles have been interspaced at equal intervals to provide a 25m spacing between each source point.

The ramps have also been included at an assumed speed of 80 km/h. Gradient corrections are included for both uphill and downhill traffic to reflect the noise from both braking and acceleration.

Gradient corrections have been provided to heavy vehicles only by incorporating the following correction to the spectrum between 63 Hz and 1 kHz only. These are shown in Table 5-2 below. This reflects the change in engine and exhaust noise emission but not tyre noise. This data is based on the CORTN and FHWA noise prediction procedures.

**TABLE 5-2: CORRECTION FOR GRADIENT**

Gradient (%)	0.0- 1.0	1.1- 1.5	1.6- 2.0	2.1- 2.5	2.6- 3.0	3.1- 3.5	3.6- 4.5	4.6- 5.5	5.6- 6.5	6.6- 7.5
Correct'n (dB)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0

## 5.2 Calibration of Prediction Model

Since the residences to the south of Hulls Road, where measurements were undertaken are currently affected by traffic noise it was considered appropriate to check the accuracy of the prediction model by comparing the measured noise levels to the predicted noise levels for the existing situation. The results are shown in Table 5-3.

The EPA goal in this Table is the higher value of the criterion or the increase above ambient level.



**TABLE 5-3 : COMPARISON OF MEASURED AND PREDICTED EXISTING NIGHT TIME  $L_{Aeq,9hr}$  NOISE LEVELS**

Ref.	Location Description	Measured Existing (dBA)	Predicted Existing (dBA)	Difference (dBA)	EPA Goal (dBA)
N1	Lot 13, Yelgun Ridge	50.5	50.0	-0.5	50.5
N2	Lot 1, (Clothier) Pacific Hwy	57.0	57.0	0	57.5
N3	Lot 1, (Pike) Pacific Hwy	54.0	54.5	+0.5	55.0
N3-A	Lot 4, (Cole) Pacific Hwy	-	27.0	-	50.0
N4	Lot 5, (Gallagher) Pacific Hwy	48.0	49.5	+1.5	50.0
N4-A	Lot 5, (Foster) Pacific Hwy	-	47.0	-	50.0
N5	"Isherwood" Wooyung Rd	48.0	49.0	+1.0	50.0
N6	Lot 6, (Alexander) Pac Hwy	59.0	59.5	+0.5	60.0
N6-A	Lot 5, (Breust) Pacific Hwy	-	52.0	-	52.5
N7	"Tweedale" Hulls Rd	49.0	43.0	-6.0	50.0
N7-A	Lot 5, (Aboud) Hulls Rd	-	43.5	-	50.0
N7-B	"Benwerrin", Pottsville Rd	-	40.5	-	50.0
N8-A	Cnr Hulls Rd & Pacific Hwy	-	59.5	-	60.0

These results show excellent correlation between the predicted and measured results with the predicted levels being between 0.5 dBA lower and 1.5 dBA higher than the measured levels. At the measurement locations where the larger differences were noted the following factors need to be considered.

Some of the measurement locations were not true facade positions or the distances from the existing highway is such that the 2.5 dBA facade reflection correction included in the prediction model is probably too high.

At "Tweedale" on Hulls Road the predicted noise levels were 6 dBA lower than the measured levels, however this location is approximately 700 m from the existing highway and only 40 m from Hulls Road. The contribution from any traffic noise from Hulls Road was not included in the prediction model. This would account for this difference.

Given these factors it is considered that the prediction model provides excellent correlation to the measured levels, the existing noise levels were predicted at a number of additional residences (as shown in Table 5-3). Assessment against the EPA guidelines was based on a comparison of predicted existing noise levels versus predicted future noise levels.



### 5.3 Prediction and Assessment of Traffic Noise Levels (no mitigation)

#### 5.3.1 Prediction of Traffic Noise Levels

$L_{Aeq,9hr}$  noise levels were predicted at the residences without any noise mitigation measures incorporated into the road design. Where noise levels were not measured, the goals have been based on nearby locations with similar acoustic environments. The results are summarised in the Table 5-4 below at the relevant receivers for both opening and the Year 2012. The assessment of the future noise level against the EPA goal is shown in the last column. For convenience, the noise level goals derived from Table 4-1 are repeated.

To allow residents to determine whether noise levels will increase or decrease immediately after opening the change in noise level immediately after opening is presented in Table 5-4. This is based on the difference between predicted noise levels with and without the proposal. The values in this column should not be used for comparison with the EPA goals. Since the residences at "Isherwood", the old house near the gate on part of "Cowell Park" and Lot 5 (Sheehan) Wilman Rd would be acquired by the RTA, predictions have not been completed at these locations.

Noise level contours are shown in Figure 28.

**TABLE 5-4: PREDICTED  $L_{Aeq,9hr}$  NOISE LEVELS (NO MITIGATION)**

Ref.	Location Description	EPA Goal (dBA)	$L_{Aeq,9hr}$ (dBA)		Change in traffic noise level at opening <sup>(1)</sup>	Meet EPA Goal
			Opening	2012		
N1	Lot 13, Yelgun Ridge	50.5	49.5	50.5	-0.5	✓
N2	Lot 1, (Clothier) Pacific Hwy	57.5	56.0	57.0	-1.0	✓
N3	Lot 1, (Pike) Pacific Hwy	55.0	58.0	59.0	+3.5	x
N3-A	Lot 4, (Cole) Pacific Hwy	50.0	28.5	29.5	+1.5	✓
N4	Lot 5, (Gallagher) Pac Hwy	50.0	46.0	47.0	-3.5	✓
N4-A	Lot 5, (Foster) Pacific Hwy	50.0	52.5	53.5	+5.5	x
N6	Lot 6, (Alexander) Pac Hwy	60.0	59.5	60.5	0	✓
N6-A	Lot 5, (Breust) Pacific Hwy	52.5	50.0	51.0	-2.0	✓
N7	"Tweedale" Hulls Rd	50.0	44.5	45.5	+1.5	✓
N7-A	Lot 5, (Aboud) Hulls Rd	50.0	46.0	47.0	+2.5	✓
N7-B	"Benwerrin" Pottsville Rd	50.0	47.5	48.5	+7.0	✓
N8-A	Cnr Hulls Rd & Pacific Hwy	60.0	57.0	58.0	-2.5	✓
N8	Lot 3, (Bale) Pacific Hwy <sup>(1)</sup>	50.0	44	45	-	✓
N9-A	"Cowell Park" Mooball Rd	50.0	43.5	44.5	-	✓
N10	Warwick Park and Pottsville <sup>(1)</sup>	50.0	46	47	-	✓



Ref.	Location Description	EPA Goal (dBA)	L <sub>Aeq,9hr</sub> (dBA)		Change in traffic noise level at opening <sup>(1)</sup>	Meet EPA Goal
			Opening	2012		
N10-A	7 Samuel Marshall Close	50.0	48.0	49.0	-	✓
N10-B	Lot 2 (Clingan) Pottsville Rd <sup>(1)</sup>	50.0	56	57	-	x
N11-B	Golf Course <sup>(1) (2)(3)</sup>	60	55	56	-	✓
N11	"Frosty Hollow" Pottsville Rd	50.0	45.0	46.0	-	✓
N12-A	641 Pottsville Rd	50.0	46.0	47.0	-	✓
N12	765 Pottsville Rd <sup>(1)</sup>	50.0	34	35	-	✓
N12-B	(Leybourne) Pottsville Rd	50.0	34.5	35.5	-	✓
N12-C	(Thong) Cudgera Creek Rd <sup>(1)</sup>	50.0	39	40	-	✓
N13-A	Lot 3 Cudgera Creek Rd	50.0	52.0	53.0	-	x
N13	Lot 2 Cudgera Creek Rd	51.5	52.5	55.0	+1.5	x
N14-A	1793 Reserve Creek Rd	50.0	47.5	48.5	-	✓
N14	44 Kanes Road <sup>(1)</sup>	50.0	39	40	-	✓
N14-B	(Morley) Cudgera Ck Rd	50.0	42.5	43.5	-	✓
N15-A	(Kane) Kanes Rd	50.0	52	53	-	x
N15-B	(Porter) Kanes Rd <sup>(1)</sup>	50.0	41.0	42.0	-	✓
N15	Lot 14 ( McGrath) Kanes Rd <sup>(1)</sup>	50.0	39	40	-	✓
N16-A	83 (Easton) Wilman Rd	50.0	48.5	49.5	-	✓
N17	Lot 3 Round Mountain Rd	50.0	46.0	47.0	-	✓
N18	Lot 72 Clothiers Creek Rd	50.0	43.5	44.5	-	✓
N19-A	1094 Clothiers Creek Rd	50.0	54.5	55.5	-	x
N19	Lot 3 Clothiers Creek Rd	50.0	50.5	51.5	+3.5	x
N20	(Kane) Eviron Road	50.0	52.5	53.5	-	x
N21	Tweed Valley Cemetery <sup>(2) (4)</sup>	50.0	56.0	57.0	-	x
N21-A	Botanic Gardens <sup>(1) (2) (5)</sup>	55.0	54	55	-	✓
N22-A	Lot 4 Eviron Rd	50.0	51.0	52.0	-	x
N22	"Dunarra" 240 Duranbah Rd	50.0	46.0	47.0	-	✓
N23-A	152 Duranbah Rd	50.0	48.5	49.5	-	✓
N23	Duranbah Public School <sup>(2)</sup>	55.0	54.5	55.5	-	x
N24	"Nyari" Cudgen Rd	50.0	43.0	44.0	-	✓
N25	Poinciana Place, Cudgen Rd <sup>(1)</sup>	50.0	42	43	-	✓
N25-A	241 Cudgen Rd	50.0	48.5	49.5	-	✓
N26	RMB 63, Cudgen Road	50.0	44.0	45.0	-	✓

Notes: 1) Levels estimated from contours.

2) L<sub>Aeq,1hr</sub> for daytime only

3) Taken at western end of club house

4) Taken at T junction within cemetery

5) Taken at edge of buffer zone shown on preliminary sketches provided by Council



### 5.3.2 Assessment of Traffic Noise Levels

The EPA noise level goal of 50 dBA is predicted to be met at almost all the residences along the proposal. Marginal exceedances of up to approximately 7 dBA are predicted at 10 residences as indicated in Table 5-4. These generally occur at residences near the proposed interchanges at Cudgera Creek Road and Clothiers Creek Road along the existing highway to the south of Hulls Road and also at Kanes Road and Eviron Road. At most of these locations traffic noise from local roads is already present however the future noise environment would be dominated by the proposal.

In the area to the south of Hulls Road where traffic noise from the existing highway is present the noise level goals are predicted to reduce at almost all the residences. Exceedances of up to 4 dBA are predicted at Lot 1 (Pike) and Lot 5 (Foster).

The EPA noise level goal at the Sleepy Hollow Golf Course would be exceeded within 40 m from the edge of the carriageway, approximately 30 m from the boundary. This is a very small percentage of the golf course and no impact would therefore be expected. As previously mentioned this golf course is currently not operational and its future is uncertain.

The EPA noise level goal at the Botanic Gardens would be exceeded within 65 m from the edge of the carriageway, approximately 50 m from the boundary. This is a small percentage of the total gardens and is at the edge of the buffer zone indicated on the preliminary sketches provided by Council. Negligible impact would therefore be expected

The noise level goal within Tweed Cemetery would be exceeded within 240 m from the edge of carriageway, approximately 220 m from the boundary. This would result in much of the Cemetery being exposed to noise levels above the goal and significant impact would be expected in the closer areas.

The EPA goal for the classrooms and playground at Duranbah Public School are marginally exceeded (0.5 dBA). The existing environment at these locations is similar to that predicted from the proposal, therefore only minor impact would be expected. The RTA would enter into negotiations with the school to determine an appropriate noise mitigation strategy subject to monitoring results, practicability and cost effectiveness.

The future noise levels are discussed in each of the different areas along the proposal below.



At those isolated residences south of Hulls Road and to the east of the proposal increases in noise levels of up to 5.5 dBA are predicted. This increase would be clearly noticeable and moderate impact would be expected. At most residences where increases of up to 3 dBA are predicted it is expected that residents may soon get accustomed to the change in traffic noise.

At those isolated residences south of Hulls Road and to the west of the proposal reductions in noise levels of up to 6 dBA are predicted. This would provide significant benefit to those residents.

At those isolated residences along Pottsville – Mooball Road, Samuel Marshall Close and Sleepy Hollow Road the noise level goals are met at all residences. Noise levels are predicted as typically 45–50 dBA which are higher than the existing noise generated from local traffic. At the Clingan residence it would be possible to relocate the building to a part of the property where the goals would be achieved.

At those isolated residences along Reserve Creek Road the noise level goals are met at all residences. Noise levels are predicted as typically 40–48 dBA which are higher than the existing noise generated from local traffic.

At those isolated residences along Round Mountain Road and Kanes Road the noise level goals are met at all residences. Noise levels are predicted as typically 40–45 dBA. These levels (40–45 dBA) are generally lower than existing noise levels.

At those isolated residences along Wilman Road the noise level goals are met at all residences. Noise levels are predicted as typically less than 45 dBA with the exception of the closest residence where a level of 49.5 dBA is predicted. These levels (40–45 dBA) are generally similar to existing noise levels.

At those isolated residences along Eviron Road. the noise level goals are met at almost all residences with the exception of the Kane residence and Lot 4 (Meharg) Eviron Rd. Noise levels are predicted as typically 40–45 dBA with the exception of the closest residences where levels of up to 53.5 dBA are predicted. These levels (40–45 dBA) are generally similar to existing noise levels.

At those isolated residences along Duranbah Road the noise level goals are met at all residences. Noise levels are predicted as typically 40–45 dBA with the exception of the closest residences where levels of 47–50 dBA are predicted. These levels (40–45 dBA) are higher than existing levels.

At those isolated residences along Cudgen Road the noise level goals are met at all residences. Noise levels are predicted as typically 40–45 dBA with the exception of

the closest residences where levels of 47–50 dBA are predicted. These levels (40–45 dBA) are generally similar to existing noise levels.

Although this assessment has indicated that the EPA guidelines would generally be achieved at the majority of residences, many of those currently experience little or no road traffic noise and therefore very noticeable increases in noise levels are predicted. This would result in the future noise environment being dominated by road traffic noise and significant impact would be likely immediately after opening. It is expected that many residents would soon get accustomed to the traffic noise.

## 5.4 Noise Mitigation Options

### 5.4.1 General Noise Mitigation Option

A number of techniques can be employed to lessen the impact of road traffic noise from freeways. The decision depends on practicability, construction, community requirements and cost effectiveness. The principle ones are summarised below:

- \* *Control of traffic speed.*

Theoretically on high speed roads such as divided carriageways, halving the average speed can lead to a 5 – 6 dBA reduction in the  $L_{Aeq}$  noise level. In practise however, these reductions are hard to achieve and may also negate the original purpose of the development in providing shorter travel times.

- \* *Quieter road surfaces.*

Quieter road surfaces are now widely used in Australian urban freeway developments. They reduce the amount of noise generated by vehicle tyres rolling over the road surface and provide good sound absorption in the frequency range of 400 Hz – 2 kHz. For this development, open graded asphaltic concrete would reduce road traffic noise levels by an average of 2–3 dBA over the life of the road.

- \* *Provide shielding.*

By providing shielding to the closest residences either by placing the road in cut, erecting noise barrier walls or constructing earth mounds (or a combination of both), noise levels can be reduced at the nearest residences. For a barrier to be effective it must have sufficient mass to attenuate the noise and should be positioned either close to the road or the location to be protected. This is because the barrier performance improves with increasing path difference between the shortest path over the top of the barrier (between



source and the receiver) and the direct line between the two. The barrier should break the line of sight between the source and receiver and should be free from gaps which reduce the effectiveness of the barrier.

\* *Modifying road alignment.*

The road alignment for most road developments is determined by available land, the required areas to be serviced and safety issues such as minimum bend radius. Generally in urban areas access corridors are selected many years before the road is to be built and limited opportunity exists to dramatically alter its alignment. This is not necessarily the situation in rural areas.

\* *Building Design and Planning Controls.*

Land rezoning can limit the encroachment of residential areas on roadway corridors if done prior to houses being built. The opportunity to use zoning as a noise control measure only exists in practise when a rural zoning is changed to either commercial or industrial, rather than residential. If land is zoned residential however, noise amelioration can be achieved through the application of local government planning controls on both urban design and building design in the approvals process

\* *Reducing vehicle noise emissions.*

The Government can reduce vehicle noise emission over a long period of time by gradually tightening the Australian Design Rules (ADR) for vehicles. The effectiveness of this method is limited at high traffic speeds where tyre and aerodynamically generated noise tends to dominate. The largest impact from this method is likely to be in the area of heavy vehicle noise emission.

\* *Noise control treatment to individual residences.*

It is possible to provide noise control treatment to individual residences. The provision of localised barriers surrounding residences is discussed above. This section refers to alteration of building design to incorporate upgrade of the building fabric particularly glazing and the provision of ventilation. Treatment to the building fabric would not provide any reduction in noise level to outdoor areas.

#### 5.4.2 Project Specific Noise Mitigation Options

The results presented above in Section 5.3 indicate that the EPA noise level goals are generally met at most residences, however, noise levels are predicted to exceed the goals at 10 isolated residences. The use of an open graded asphaltic concrete surface on its own would not be sufficient to reduce noise levels to below the EPA criteria and is not considered cost effective given the high maintenance costs.

During the route selection phase the road alignment in some areas, particularly around Taggets Hill and Kanes Road was selected to minimise noise impacts at a greater number of residences.

Following the review of the effectiveness of the various noise control options, a hessian dragged concrete surface was considered the most appropriate, however a dense graded asphaltic concrete may be required in some sections due to ground conditions. The use of noise barriers was not considered cost effective since there are only 10 isolated residences where predicted noise levels would exceed the EPA criteria. It is therefore proposed that the RTA would enter into negotiations with the affected residents identified in this working paper to determine the most appropriate form of noise mitigation.

At the Tweed Cemetery a noise barrier in the form of a landscaped earth mound with a 1–2m timber fence on top (total height of 3m above road level) is proposed, extending from the end of the Eviron Road cut for approximately 350 m (Chainage 72250 to 72600). The degree of noise reduction in those areas of the Cemetery where the noise level goal is exceeded is predicted as between 4–8 dBA depending on the precise position. The resulting noise levels within the Cemetery would generally meet the goal of  $L_{Aeq,1hr} = 50$  dBA.

The RTA would implement a post construction noise monitoring programme to confirm these predictions and ensure that the noise mitigation measures are achieving the design aims.

#### 5.5 Impact of Change in Speed Limit or Pavement Surface

Predictions have been completed to assess the impact of increasing the posted speed limit from 100 km/h to 110 km/h. Irrespective of this speed change heavy vehicles would still be speed limited to 100 km/h and this speed is therefore used for predictions. Other research into the typical speeds of light vehicles would suggest that the change in speed limit by 10 km/h would not increase the typical speed by the full 10 km/h. However, Wilkinson Murray generally adopt the posted speed limit as the typical speed of light vehicles for noise level predictions.



Since the night time period is the most critical in relation to meeting EPA guidelines then it is the component of truck noise which dominates the  $L_{Aeq}$  noise levels at the residences and this does not change. The increase in noise level from a light vehicle is calculated as 0.6 dBA. When combined with the heavy vehicle component (which remains unchanged) the overall night time noise levels diminish to less than 0.1 dBA. For the daytime period the increase is predicted as less than 0.3 dBA. The effect of this change in speed is considered to be not noticeable.

The predicted change in noise levels resulting from a change in road surface from a hessian dragged concrete to a dense graded asphaltic concrete would be an increase of approximately 1 dBA. The noise levels at 5 residences (Lot 13 Yelgun Ridge, Lot 1 Clothier, 83 Wilman Road (Easton), 152 Duranbah Road and 241 Cudgen Road) which currently are predicted to just meet the EPA goals would just exceed the goals. If the dense graded asphaltic concrete is required the RTA would enter into negotiations with the affected residents identified in this working paper to determine the most appropriate form of noise mitigation

## 5.6 Heavy Vehicle $L_{Amax}$ Predictions at Residences

The sound power level of 113 dBA given in Table 5-1 for the larger heavy vehicles has been used to determine the maximum noise level at residences adjacent to the proposal. While many of the smaller heavy vehicles would generate lower levels, occasionally passing heavy vehicles, particularly those in poor repair, would generate higher noise levels.

The use of engine compression brakes have also been considered. A 1993 Austroads study "Review of Noise Generated by Heavy Vehicle Exhaust/Engine Brakes" indicated the maximum noise level varied for the two different trucks measured and between those with and without mufflers. The without muffler was representative of a vehicle with a defective muffler. These results showed a maximum sound power level of 109.5 dBA at 50 km/h and 113.5 dBA at 70 km/h for the louder heavy vehicle and only 99 dBA at 50 km/h for the quieter heavy vehicle. The use of engine brakes also includes a significant change in character of noise that is considered more annoying.

The heavy vehicle without a muffler had a sound power level as high as 130 dBA but this would be an unusual event and is not considered relevant in this assessment.

In predicting the maximum noise levels at residences from the proposal, it is assumed that the "proposed" scheme of noise mitigation measures would be implemented. The noise levels are summarised in Table 5-5.

**TABLE 5-5: PREDICTED MAXIMUM NOISE LEVELS**

Road Section	General Area	Predicted Maximum Noise Levels (dBA)
Yelgun to Hulls Road	Isolated residences along Pacific Hwy in Yelgun and Crabbes Creek and along Jones Rd, Wooyung Rd, Hulls Rd. (N1 to N8)	45-62
Hulls Road to Cudgera Creek Road	Isolated residences along Pottsville - Mooball Rd, Samuel Marshall Cl, Warwick Park Rd Sleepy Hollow Rd, Cudgera Creek Rd,. (N9 to N13)	43-58 ramps 56-62
Cudgera Creek Road to Clothiers Creek Road	Isolated residences along Reserve Creek Rd, Kanes Rd, Wilman Rd Round Mountain Rd & Clothiers Creek Rd (N14 to N19)	47-67 ramps 52-60
Clothiers Creek Road to Oak Avenue	Isolated residences along Eviron Rd, Duranbah Rd Cudgen Rd. (N20 to N26) Tweed Cemetery (N21) Duranbah Public School (N23)	49-64 62 58

In general the predicted noise levels are below 60-65 dBA. The single residence where maximum noise levels are predicted to be above 60-65 dBA has already been identified as requiring some form of mitigation since noise levels also exceed the EPA guidelines.

At many residences to the south of Hulls Road area which are close to the existing highway maximum noise levels from the proposal would reduce significantly. However, as the existing highway would remain open it is possible that an occasional heavy vehicle would generate maximum noise levels slightly lower than currently experienced as a result of the reduction in speed.

The most affected residences are in areas near the interchanges where the use of engine brakes may occur. These factors would indicate some sleep disturbance is possible especially immediately after opening before residents become accustomed to the changed environment.



## 6. NOISE LEVEL EFFECTS ON EXISTING ROADS

The EPA has guidelines for traffic noise on the local road network. The criteria for local roads which are affected by other developments are an  $L_{Aeq,1hr}$  of 55 dBA for the daytime and  $L_{Aeq,1hr}$  of 50 dBA for the nighttime. In either case the guidelines state that "noise levels should not be increased by more than 2 dBA". It is stated that the guidelines should be achieved where feasible.

Cudgera Creek Road and Clothiers Creek Road both have full interchanges and therefore changes in traffic flow to both the east and west of the proposal would occur. Based on the traffic flows summarised in Section 2 the changes in noise level as a direct result of the proposal are summarised as follows:

*	Pottsville – Mooball Rd	-3.5 dBA
*	Cudgera Ck Rd (east of existing highway)	+1.0 dBA
*	Cudgera Ck Rd (west of Tweed Coast Rd)	+3.0 dBA
*	Clothiers Ck Rd (east of Eviron Rd)	+1.5 dBA
*	Clothiers Ck Rd (west of Tweed Coast Rd)	-0.5 dBA

With the exception of Cudgera Creek Road between the Tweed Coast Road and the proposal the noise levels would either reduce or increase by up to 1.5 dBA. These increases would meet the EPA guidelines for local roads. An increase of 1 dBA would be considered as not noticeable and negligible impact would therefore be expected. An increase of 1.5 dBA would be considered as barely noticeable and marginal impact would therefore be expected.

Along this section of Cudgera Creek Road the predicted increase of 3 dBA would result in exceedances of the EPA guidelines at any residence within approximately 150 m of the alignment. This increase would be noticeable and minor impact would be expected.

The RTA propose to monitor existing noise levels along Cudgera Creek Road before and after opening to determine changes in noise levels and compliance with EPA guidelines. The RTA would negotiate with affected residents to provide noise mitigation subject to monitoring results, practicability and cost effectiveness.

On the realigned existing highway, traffic flows at opening are predicted to reduce by typically 55% to 80% to the south of Murwillumbah. This would result in noise level reductions at all residences between Mooball and Murwillumbah of between 4–7 dBA. This would be clearly noticeable and improve the amenity for these residents. To the north of Murwillumbah traffic flows would reduce by approximately 40%.

At any residences which would be affected by noise from both the proposal and realigned highway the EPA requires that all traffic noise sources are considered. These traffic flow changes on the realigned highway along with the physical realignment of certain sections have all been incorporated in the noise levels predicted in Section 5.

The Pottsville – Mooball Road would be slightly realigned in one short section and run directly adjacent to the proposal to the west. Traffic flows on this road would reduce to approximately 50%. Overall the change in traffic noise from local traffic is insignificant in comparison with traffic noise from the proposal.



## 7. IMPACTS OF CONSTRUCTION NOISE AND VIBRATION

In this section, the impact of noise from the construction of the proposal is assessed. The guidelines for assessment are those established by the EPA in the ENCM.

### 7.1 Construction Methodology

It is anticipated at this stage that the proposal would be constructed under a design and construct tender and therefore detailed information regarding the construction programme is unavailable. Therefore, this assessment is based on the general type of construction activity likely to occur. A detailed construction noise assessment would be required when the future contractor applies for a Pollution Control Approval (Environment Protection Licence per POEO Act after 1 September 1998) from the EPA.

The project duration is expected to be approximately 36 months. The proposed activities are summarised as follows:

- \* Earthworks and drainage (30 months)
- \* Tunnel at Cudgen Road (12 months)
- \* Bridgeworks at Cudgera Creek, Clothiers Creek (4–6 months each).
- \* Culvert to south of northern interchange (6 months)
- \* Bridgeworks at Yelgun, Wooyung Rd, Hulls Rd, Pottsville – Mooball Rd, Sleepy Hollow Rd, Cudgera Ck Rd, Kaners Rd, Round Mountain Rd, Clothiers Ck Rd and Eviron Rd. (4–6 months)
- \* Road pavement, pavement furniture and landscaping (6 months).

These activities would overlap within the 36 month period.

The preliminary geotechnical investigation indicated that the rock in most sections of cut could be removed with mechanical ripping and minor hydraulic hammering. In each of the six largest cuts, Hulls Road, Cowell Park, two within Taggets Hill, Clothiers Creek Road, Eviron Road and the tunnel at Cudgen Road some blasting would be required in the deepest parts.

This investigation also indicated that in some areas the ground conditions are poor and either pre-loading or in some cases ground modifications would be required before the final fill formation would be stable. These would occur within the following chainage sections.

*	Preloading	56100–57750, 66350–68100, 68550–69200, 72300–73350 74900–75550, 75900–76150
	Ground Modification	68100–68550, 69200–69600, 70000–70800, 73500–74600

The current design would generate a very small quantity of excess fill. This would be subject to the final earthworks balance and would probably be used on the project for additional landscaping. This earthworks balance includes an allowance to provide noise bunds where appropriate.

The earthworks and drainage phase is expected to have the longest duration and to generate the highest construction noise levels. Extensive cut and fill operations would be required in many sections of the alignment with extensive cut at depths of typically 10–20 m but up to 30 m and fill heights of typically 5–10 m but up to 20 m being required.

Extensive cut would be required at Hulls Road, Cowell Park, two within Taggets Hill, Clothiers Creek Road, Eviron Road and the tunnel at Cudgen Road.

Extensive fill would be required between Wooyung Road and Hulls Road, on the "Benwerrin" and "Cowell Park" properties, around Sleepy Hollow, between the cuts within Taggets Hill, around the Cudgera Creek Road interchange and generally from Christies Creek to the northern interchange (with the exception of the cuts at Clothiers Creek Road, Eviron Road and Cudgen Road).

A variety of earth moving equipment would be used to remove material from cut sections of the alignment and emplace material into fill sections. This includes the movement by truck of significant quantities of material from the Eviron Road cut towards the northern interchange.

The preloading will require the emplacement of fill in stages to allow for settlement over the construction period. The ground modifications may require the use of driven piling activities in these areas.

Surface preparation would involve compaction with vibratory rollers and road surface finishing would involve numerous concrete pours. This process would be shorter in duration and generally produce lower noise levels than the earthworks phase. Road surface finishing and road furniture installation are likely to be progressive activities with machinery being immediately adjacent to any nearby residence for a period of only one to two weeks.



The construction of bridges and grade separations is expected to involve the use of plant such as concrete trucks, concrete pumps, generators, compressors, pneumatic hammers, hydraulic hammers, mobile cranes and bored or driven type piling machines. Unlike earthworks and surface preparation, the noise from bridge works is expected to be largely stationary.

## 7.2 Construction Noise Guidelines

The guidelines for assessment of construction noise as specified in the EPA's ENCM Chapter 171 are as follows:

For periods of 4 weeks or less, the  $L_{A10}$  level should not exceed the background ( $L_{A90}$ ) level by more than 20 dBA.

For periods greater than 4 weeks and less than 26 weeks, the  $L_{A10}$  level should not exceed the background ( $L_{A90}$ ) level by more than 10 dBA.

Although not clearly stated by the EPA it is considered that for periods greater than 26 weeks, the EPA would expect that the  $L_{A10}$  level should not exceed the background ( $L_{A90}$ ) level by more than 5 dBA. However, in general, road construction activities are continually moving and not in any one area for more than 26 weeks.

In addition, the EPA specifies the following time restrictions for construction activities.

- \* Monday to Friday 7.00 am to 6.00 pm
- \* Saturday 7.00 am to 1.00 pm if construction noise is inaudible on residential premises otherwise 8.00 am to 1.00 pm.

No construction work is to take place on Sundays or Public Holidays.

The EPA also recommends that all possible steps should be taken to reduce noise levels of construction site equipment so as to minimise the impact of construction noise.

The noise generated by construction equipment would rise and fall as construction progresses along the route. The equipment may therefore be assumed to have a moving acoustic centre, which for most of the construction period would not be immediately adjacent to a single residence. Although the total contract duration would be in excess of 26 weeks the normal duration of the particular road building



operations adjacent to a given receiver makes it appropriate to assess construction noise levels against the short term and medium term guidelines indicated above.

Table 7-1 following shows the applicable noise level guidelines for residences along the proposed route for the various construction durations. These are based on the minimum repeatable background noise levels shown in the attached Figures 2-27.

**TABLE 7-1: CONSTRUCTION NOISE LEVEL GOALS**

Ref (Fig 1)	Location Description	Measured Background L <sub>A90</sub> Level	L <sub>A10</sub> (dBA) (<4 Wks)	L <sub>A10</sub> (dBA) (4-26 Wks)	L <sub>A10</sub> (dBA) (>26 Wks)
N1	Lot 13, Yelgun Ridge	41	61	51	
N2	Lot 1, (Clothier) Pacific Hwy	47	67	57	
N3	Lot 1, (Pike), Pacific Hwy	43	63	53	48
N4	Lot 5, (Gallagher) Pacific Hwy	38	58	48	
N5	"Isherwood" Wooyung Rd	43	63	53	48
N6	Lot 6, (Alexander) Crabbes Creek	39	59	49	44
N7	"Tweedale" Hulls Rd	42	62	52	47
N8	Lot 3, (Bale) Pacific Hwy	33	53	43	
N9	"Cowell Park" Mooball Rd	35	55	45	
N10	Warwick Park and Pottsville Rd	32	52	42	37
N11	"Frosty Hollow" Pottsville Rd <sup>(1)</sup>	28	50	40	35
N12	(Edwards) 765 Pottsville Rd	34	54	44	
N13	Lot 2 (Ever'ham) Cudgera Ck Rd	33	53	43	38
N14	44 Kanes Road	31	51	41	
N15	Lot 14 (McGrath) Kanes Rd	35	55	45	
N16	Lot 5 Wilman Road	32	52	42	
N17	Lot 3 (Mary) Round Mountain Rd	36	56	46	41
N18	Lot 72 (Jackson) Clothiers Ck Rd	38	58	48	43
N19	Lot 3 (Howarth) Clothiers Ck Rd	33	53	43	38
N20	(Kane) Eviron Road	35	55	45	40
N21	Tweed Cemetery, Eviron Rd	36	56	46	
N22	"Dunarra" 240 Duranbah Rd	34	54	44	
N23	Duranbah Public School	35	55	45	
N24	"Nyari" Cudgen Rd	35	55	45	
N25	Poinciana Place, Cudgen Rd	37	57	47	
N26	RMB 63, Cudgen Road	36	56	46	

Notes 1) If background levels are less than 30 dBA the EPA assume 30 dBA

In all areas especially those close to the existing highway or local roads the existing L<sub>A10</sub> noise levels are already higher than the medium term goals shown in Table 7-1. This would suggest that these goals may not be appropriate at all locations.



### 7.3 Predicted Noise Levels During Construction

Table 7-2 contains the maximum Sound Power Levels ( $L_{WA}$ ) of plant likely to be used for the various phases of construction. Noise levels have been predicted by grouping together typical types of noise sources for a particular section and construction phase and by taking into account relevant acoustic factors such as distance attenuation, shielding effects and ground effects.

**TABLE 7-2: TYPICAL MAXIMUM SOUND POWER LEVELS FROM CONSTRUCTION PLANT**

DRAINAGE	$L_{WA}$ (dBA)	PAVING AND ASPHALTING	$L_{WA}$ (dBA)
Backhoe	110	Generator	111
Excavator	112	Backhoe	110
Dump Truck	110	Asphalt Paver	114
<b>EARTHWORKS</b>	<b><math>L_{WA}</math> (dBA)</b>	Pneumatic Tyred Roller	111
Compactor	112	Concrete Truck	110
Bulldozer (D10)	116	Concrete Vibrator	105
Scraper (Cat 627)	117	Concrete Batch Plant	111
Scraper (Cat 631)	113	Concrete Saw	114
Excavator	112	<b>BRIDGEWORKS</b>	<b><math>L_{WA}</math> (dBA)</b>
Vibrating Roller	113	Crane (Mobile)	110
Water cart	107	Bored Piling Rig	114
Grader	111	Concrete Pump	107
Haul Truck	112	Concrete Truck	110
Front End Loader	114	Compressor	105
Impact Piling Rig	121	Generator	111
		Pneumatic hammer	113

#### 7.3.1 Noise Levels from Earthworks

Noise levels have been predicted at a number of indicative distances between the centre of earthworks operations and the typical residential receiver locations. Up to four pieces of construction plant are considered to be working simultaneously for these noise predictions producing a typical maximum sound power level of 118 dBA. This would increase to a typical maximum sound power level of 121 dBA during ground modification activities where driven piles would be required.

The closest residences would be located approximately 50 m away from the noise sources but more typical distances would be between 100 and 300 m from the centre of operations.



Residences near sections of the proposal which would require extensive fill or cut operations may be exposed to construction noise levels for extended periods of time. Adjacent to cut sections, some shielding would be provided as earthworks progress, with a typical noise reduction of 10 dBA. Near fill operations, however, this would not be the case.

The  $L_{A10}$  noise levels expected at various distances from the earthworks are given in Table 7-3.

**TABLE 7-3: EXPECTED NOISE LEVELS DUE TO EARTHWORKS**

Distance from Centre of Operations	$L_{A10}$ (dBA) Earthworks
50	65-75
100	59-69
200	52-62
300	48-58

A summary of the typical highest  $L_{A10}$  noise levels at the various residences along the proposal are summarised in Table 7-6 in Section 7.3.4.

These predicted construction noise levels exceed the EPA guidelines at the closest residences along the whole alignment. These include the two new sections of the realigned highway near Yelgun. Construction noise levels from the proposal would be marginally lower at the few residences to the west of the proposal (N4) which are closer to the realigned highway than to the proposal. Some impact would therefore be expected along the entire proposal however significant impact would be expected in areas where fairly extensive cut and fill would be required for longer durations or where noise levels are predicted to be above 70 dBA. This would apply particularly at residences near the Clothiers Creek Road interchange, the Eviron Road cut and at the Cudgen Road Tunnel.

The ground modification activities would result in noise levels up to 3 dBA higher than those predicted in Table 7-6. This activity would also have impulsive characteristics which would be more annoying. This would potentially affect residences near the Clothiers Creek Road interchange and along Duranbah Road.

### 7.3.2 Noise Levels from Paving

The paving operations would on the whole be significantly quieter than the earthworks and would in general affect each particular residence for a period of 1-2 weeks only. Assuming that a concrete truck and concrete vibrators are all being used simultaneously or the concrete cutting is occurring an  $L_{A10}$  sound power level



of 113 dBA is expected. The expected noise levels at different distances due to the paving are given in Table 7-4.

**TABLE 7-4: EXPECTED NOISE LEVELS DUE TO PAVING**

Distance from Centre of Operations	Paving $L_{A10}$ (dBA)	
	Shielded	Unshielded
50	60	70
100	54	64
200	47	57
300	43	53

A summary of the typical highest  $L_{A10}$  noise levels at the various residences along the proposal are summarised in Table 7-6 in Section 7.3.4.

These predicted noise levels still exceed the EPA guidelines and construction noise levels would be clearly audible. However, given this operation would only occur in any one area for a short period the impact is likely to be limited. The use of a hessian dragged concrete pavement requires the use of concrete cutters at the required time during the curing process. This may require this activity to occur during the evening or night time. This has the potential to cause significant annoyance.

### 7.3.3 Noise from Bridgeworks

The construction of overpasses and bridges at various locations along the proposal is expected to involve the use of equipment and plant such as concrete trucks, concrete pumps, generators, compressors, pneumatic hammers, mobile cranes and piling machines. All of these would vary in number and position for the different bridges.

In general terms, it would be reasonable to assume that the noise generated by the construction of bridges would last for longer periods of time than the earthworks and paving construction and the noise levels are likely to be marginally quieter than those predicted for the bulk earthworks. A  $L_{A10}$  sound power level of 116 dBA has been assumed. The expected noise levels at different distances due to bridgeworks are summarised in Table 7-5.

**TABLE 7-5: EXPECTED NOISE LEVELS DUE TO BRIDGEWORKS**

Distance from Centre of Operations	L <sub>A10</sub> (dBA) Bridgeworks
50	73
100	67
200	60
300	56

A summary of the typical highest L<sub>A10</sub> noise levels at the various residences along the proposal are summarised in Table 7-6 in Section 7.3.4.

These predicted construction noise levels would exceed the EPA guidelines at the closest residences to the bridges along the whole alignment. Some impact would therefore be expected.

#### 7.3.4 Summary of Construction Noise Levels

Predicted construction noise levels for various activities are shown in Table 7-6.

**TABLE 7-6: PREDICTED CONSTRUCTION L<sub>A10</sub> NOISE LEVELS**

Ref.	Location Description	EPA Goal	Initial Earthw'ks	Bulk Earthw'ks	Paving	Bridge works
N1	Lot 13, Yelgun Ridge	51	60	50	45	–
N2	Lot 1, (Clothier) Pacific Hwy	57	69	67	62	–
N3	Lot 1, (Pike) Pacific Hwy	53	60	50	45	52
N3-A	Lot 4, (Cole) Pacific Hwy	48	45	45	40	43
N4	Lot 5, (Gallagher) Pac Hwy	48	61	46	41	–
N4-A	Lot 5, (Foster) Pacific Hwy	48	61	60	55	52
N6	Lot 6, (Alexander) Pac Hwy	49	66	65	60	–
N6-A	Lot 5, (Breust) Pacific Hwy	49	59	48	43	55
N7-A	Lot 5, (Aboud) Hulls Rd	52	61	56	51	55
N7-B	"Benwerrin" Pottsville Rd	52	58	58	53	–
N8-A	Cnr Hulls Rd & Pacific Hwy	49	69	55	50	66
N9-A	"Cowell Park" Mooball Rd	45	58	50	53	–
N10	Warwick Park and Pottsville Rd	42	61	60	55	56
N10-A	7 Samuel Marshall Close	42	67	66	61	63
N11	"Frosty Hollow" Pottsville Rd	40	60	60	55	58
N12-A	641 Pottsville Rd	44	61	58	53	–
N12-B	(Leybourne) Pottsville Rd	44	62	51	46	–
N12-C	(Thong) Cudgera Creek Rd	43	50	50	45	–
N13-A	Lot 3 Cudgera Creek Rd	43	63	63	58	56



Ref.	Location Description	EPA Goal	Initial Earthw'ks	Bulk Earthw'ks	Paving	Bridge works
N14-A	1793 Reserve Creek Rd	41	59	59	54	-
N14-B	(Morley) Cudgera Ck Rd	41	62	49	44	-
N15-A	(Kane) Kanes Rd <sup>(2)</sup>	45	64	63	58	59
N15	Lot 14 ( McGrath) Kanes Rd	45	52	52	47	-
N16-A	83 Wilman Rd	42	62	62	57	-
N17	Lot 3 Round Mountain Rd	46	57	57	52	53
N18	Lot 72 Clothiers Creek Rd	48	50	50	45	-
N19-A	1094 Clothiers Creek Rd	43	75	72	67	69
N20	(Kane) Eviron Road	45	74	64	59	70
N22-A	Lot 4 Eviron Rd	44	62	62	57	-
N22	"Dunarra" 240 Duranbah Rd	44	62	62	57	-
N23-A	152 Duranbah Rd	45	62	62	57	-
N23	Duranbah Public School	45	62	62	57	-
N24	"Nyari" Cudgen Rd	45	60	60	55	-
N25-A	241 Cudgen Rd	47	61	61	56	-
N26	RMB 63, Cudgen Road	46	54	54	49	-

#### 7.4 Control of Construction Noise

Since the assessment above indicates a potential noise impact from some construction activities, consideration may need to be given to noise control where these are practicable. However, it is difficult to consider such control measures in detail in view of the lack of details regarding construction methods and timing. This report recommends a strategy which would need to be implemented to minimise construction noise impact.

Following determination of the proposal the RTA would probably engage a Design and Construct Contractor. The Contractor would need to prepare an Environmental Management Plan (EMP), which would incorporate a Noise Management Strategy, and a Community Consultation Programme.

This Noise Management Strategy would consider the methodology proposed by the Contractor and the relative phasing of different construction activities in different areas.

These documents would be submitted to the EPA prior to the Contractor obtaining the necessary Approval / Licence. The Approval / Licence issued by the EPA is likely to contain limits for construction hours and possibly noise levels.

During the more detailed construction noise assessment, such controls can be considered. These could include:

- \* Use of quietest plant available which is regularly maintained and fitted with appropriate mufflers.
- \* Possible restrictions in construction hours (beyond EPA requirements), where noise impacts are likely.
- \* Notification of residents prior to noisy or vibration generating activities.
- \* Noise and Vibration monitoring to ensure best practice is being implemented.
- \* Temporary noise barriers.

It is possible that during the construction phase that some activities (eg tunnelling, concrete joint cutting) may be required beyond the EPA recommended construction hours. The appropriate contact with the EPA and community consultation would be undertaken prior to these activities. These procedures are outlined in the RTA document "Consultation Procedure for Roadworks Undertaken Outside of Normal Working Hours".

## 7.5 Blasting

In each of the six large cuts at Hulls Road, Cowell Park, two within Taggets Hill, Clothiers Creek Road, Eviron Road and the tunnel at Cudgen Road some blasting would be required in the deepest parts. The nearest residence to each of these potential blasting sections vary from 100 m at Eviron Road to 300 m at Cowell Park. In all cases shielding would be provided by the cut.

The EPA has guidelines for the assessment of blast vibration and overpressure in its ENCM (Chapter 154). These are considered to relate to potential annoyance to humans within residences and are summarised as follows.

The time of day, airblast overpressure noise level and ground vibration peak particle velocity limits are suggested for those mining, quarrying and related operations which involve the repeated use of explosives. The criteria are specified for guidance only and may be varied according to local site conditions.

More stringent controls are also included which might be applicable when blasting cannot be done during normal working hours.

Blasting operations would in most cases be confined to the periods Mondays to Saturdays, 9.00 am – 3.00 pm. For this time period, the following criteria apply:



- \* Blast overpressure (dB Linear) – 115 dBL
- \* Ground vibration peak particle velocity – 5 mm/s.

For up to 5% of blasts, these limits can increase to 120 dBL and 10 mm/s.

The EPA suggests that appropriate damage criteria are airblast overpressure 120 dBL and peak particle velocity 10 mm/s.

Even though it is possible to design each blast in such a manner to meet the comfort guidelines, a compromise would need to be achieved between the total number of blasts and the vibration and overpressure levels from each blast. The EPA guidelines generally relate to large quarries or mines where repeated blasting will occur for many years. The blasting during the construction phase would only occur for a short duration and only include relatively few separate blasts.

Since building damage is unlikely at vibration levels below 10–15 mm/s, it is proposed that 10 mm/s is an appropriate guideline for residences in reasonable structural condition. It is recommended that structures within 150 m and other sensitive structures are inspected to assess their structural integrity prior to adopting this limit. Based on the limited number of blasts a blast overpressure limit of 125 dBL is recommended.

Conventional blasting techniques would be appropriate for blasts in excess of 150 m from residences. It is recommended that a decked loading blast design may be required for blasts where there are closer residences (Hulls Road and Eviron Road). All blasts should incorporate sufficient delays to minimise the maximum instantaneous charge (MIC). Chapter 154 of the EPA ENCM provides many recommendations for the control of blast vibration and airblast overpressure. These would be adopted by the Blasting Contractor

## 7.6 Vibration

In addition to blasting, vibration may be generated as a result of piling for bridgeworks, tunnelling and vibratory rolling during the earthworks phase.

In general the bridgeworks would be bored piles which generate little vibration, however, some sheet piles may be required. Depending on ground conditions, these sheet piles may be impact driven or vibratory driven. Both these activities result in higher levels of vibration but are likely to occur in limited areas and for short periods only. In a similar manner, vibratory rolling close to residences would only occur for short periods in each location. Tunnelling activities are unlikely to result in annoying levels of vibration given the distance to the nearest residences.



Vibration is considered both in respect of potential damage to buildings and potential annoyance to residents. In many cases, it is the residents fear of building damage that enhances the potential annoyance. The most common form of vibration measurement is the peak particle velocity (ppv) in mm/s. In respect of building damage, a vibration level limit and frequency is normally specified, however, in respect of potential annoyance to residents, a combination of vibration level, frequency and duration is more appropriate. This is normally termed as a dose value.

The RTA, as part of its environmental procedures (Standard G5), recommend a ppv vibration limit of 2 mm/s at the property boundary. This is considered to be very conservative with respect to building damage but a useful guideline with respect to potential annoyance.

There is no current Australian Standard for assessing building damage due to vibration except from blasting (AS 2187 Explosives:), however, there are a number of international standards that are commonly used and considered appropriate.

The standard which, until now, has most commonly been used is the German Standard DIN 4150 Part 3 1986 "Vibration in Buildings – Effects on Structures". This Standard is generally felt to be fairly conservative and vibration levels significantly higher than those in the table have been recorded without damage to buildings.

A more recent British Standard, BS 7385 1993, "Evaluation and Measurement for Vibration in Buildings", also gives guidance. The following peak particle velocities apply to residences for continuous vibration.

7.5–10 mm/s @ 4–15 Hz, 10–25 mm/s @ 15–40 Hz and 25 mm/s @ > 40 Hz.

At the typical distances to almost all the residences, these limits are predicted to be achieved for all activities and damage to buildings is unlikely. It is recommended that structures within 50 m and other sensitive structures are inspected to assess their structural integrity prior to adopting these limits.

The EPA provides guidelines with respect to annoyance to residents which is based on British Standard BS 6472 1984 (Chapter 174 of the ENCM). This Standard has now been updated to BS 6472 1992 and is considered to be the most appropriate document for establishing guidelines. In addition, Australian Standard AS 2670 "Evaluation of Human Exposure to Whole Body Vibration" is also based on the old British Standard but with some minor variations relating to intermittent vibration.



With respect to annoyance to residents the typical distances to residences from the bridgeworks are far enough that no impact would be expected. During the earthworks phase, vibratory rolling and some impact piling (in limited areas) would be required but typical distances to all of the residences from the proposal and realigned highway are far enough that this activity would be unlikely to result in significant annoyance. At residences within approximately 50 m vibration may be perceptible, however the duration of this activity would be short and negligible impact would be expected.

These vibration generating activities may cause some annoyance, however, they are only temporary and residents should be informed in advance to allay any fears about potential building damage. This should form part of the community consultation programme.

## 8. SUMMARY AND CONCLUSIONS

The proposal alignment, realigned existing highway alignment and location of residences is shown in Figure 1.1. Isolated residences are generally located along the existing highway and many of the local roads including Pottsville – Mooball Road, Cudgera Creek Road, Reserve Creek Road, Kaners Road, Round Mountain Road, Clothiers Creek Road, Eviron Road, Dunbarah Road and Cudgen Road.

The conclusions of the Noise and Vibration Impact Assessment are summarised below.

### 8.1 Road Traffic Noise

Predictions of noise levels without any noise mitigation measures indicated the noise level goals within the new draft EPA guidelines would be met at almost all the residences. Exceedances of the guidelines of up to 7 dBA were predicted at 10 residences along the alignment assuming a hessian dragged concrete pavement surface. This increases to 15 residences assuming a dense graded asphaltic concrete. This does not include the residences which would be acquired by the RTA. Affected residences generally occur near the interchanges at Cudgera Creek Road and Clothiers Creek Road and along Eviron Road and Duranbah Road. Two residences to the south of Hulls Road on the existing highway would also be affected.

The EPA goal for the classrooms and playground at Duranbah Public School are marginally exceeded (0.5 dBA). The existing environment at these locations is similar to that predicted from the proposal, therefore only minor impact would be expected.

The cost effectiveness of various noise mitigation options was considered and the following noise mitigation measures would be implemented.

- \* Use of a hessian dragged or dense graded asphaltic concrete pavement for the main carriageway.
- \* Use of a dense graded asphaltic concrete for the ramps.
- \* The construction of roadside mound and barriers in the vicinity of Tweed Cemetery.
- \* Negotiation with individual residents at residences where EPA guidelines are predicted to be exceeded for suitable property treatments..
- \* Negotiations with the school to determine an appropriate noise mitigation strategy subject to monitoring results practicability and cost effectiveness.



At many of the isolated residences although the EPA guidelines would be complied with, some residents currently experience relatively low levels of traffic noise, therefore some impact would be expected immediately after opening. It is expected that residents may soon get accustomed to the traffic noise.

At the 10 residences where the EPA guidelines are exceeded the RTA would enter into negotiations with residents with the objective of acoustically treating parts of the property or agreeing to alternative mitigation measures.

Opening of the proposal would have an effect on traffic flows on other roads in the area. With the exception of Cudgera Creek Road to the east of the interchange the changes in traffic flow on local roads are predicted to either reduce or only increase slightly. The changes would be not noticeable to barely noticeable and negligible impact would be expected.

Along Cudgera Creek Road to the east of the interchange the changes in noise level as a result of the proposal would increase noise levels by 3 dBA. This would exceed EPA guidelines by 1 dBA at all residences within 150 m. This predicted increase would be noticeable and minor impact would be expected. It is proposed to conduct noise monitoring at representative sites before and after opening before discussing a noise mitigation strategy with potentially affected residents.

Approximately 10 residences in the area to the south of Hulls Road which are currently exposed to relatively high noise levels from the existing highway would receive a reduction in noise levels of typically up to 6 dBA. This reduction would be very noticeable and significant benefit would be expected

## **8.2 Construction Noise and Vibration**

As is common for major road projects of this type, there is likely to be an impact from noise associated with construction activities. The impact would depend upon the stage of construction (earthworks being noisiest), the distance to the affected residences or other noise sensitive uses, any intervening shielding and the duration of the construction in the vicinity of the location. Nevertheless, any noise impact from construction would be temporary.

The practicality of construction noise control measures cannot be clearly determined at this time. A further construction noise impact assessment would be required when construction methods are fully known and practical control measures can, at that time, be identified. This would be required before the necessary Approval / Licence can be sought from the EPA.

Blasting would be required within the deepest parts of each of the six major cuts and the tunnel at Cudgen Road. The nearest residence to each cut are set back between 100 m and 300 m. It would be possible to design the blasts in each cut to comply with EPA guidelines. This may require the use of decked loading blast design for blasts within 150 m.

It is recommended that since blasting would only be temporary during the construction phase that the higher limits suggested in this working paper for overpressure and vibration are adopted. This compromise would reduce the total number of blasts required to win the necessary material.

During the earthwork phase, driven piles would be required in four sections where there are poor ground conditions, tunnelling activities would be required at Cudgen Road and vibratory rolling would be required but typical distances to almost all residences from the main carriageways are far enough that these activities would be unlikely to result in significant annoyance. At any residences within 50 m of vibratory rolling some vibration may be perceptible, however the duration of this activity would be short and negligible impact would be expected.

It is recommended that residences within 50m of vibratory rolling or piling activities and 150 m of blasting activities or any other sensitive structures are inspected prior to these activities to determine their structural integrity and establish appropriate criteria.

#### Quality Assurance

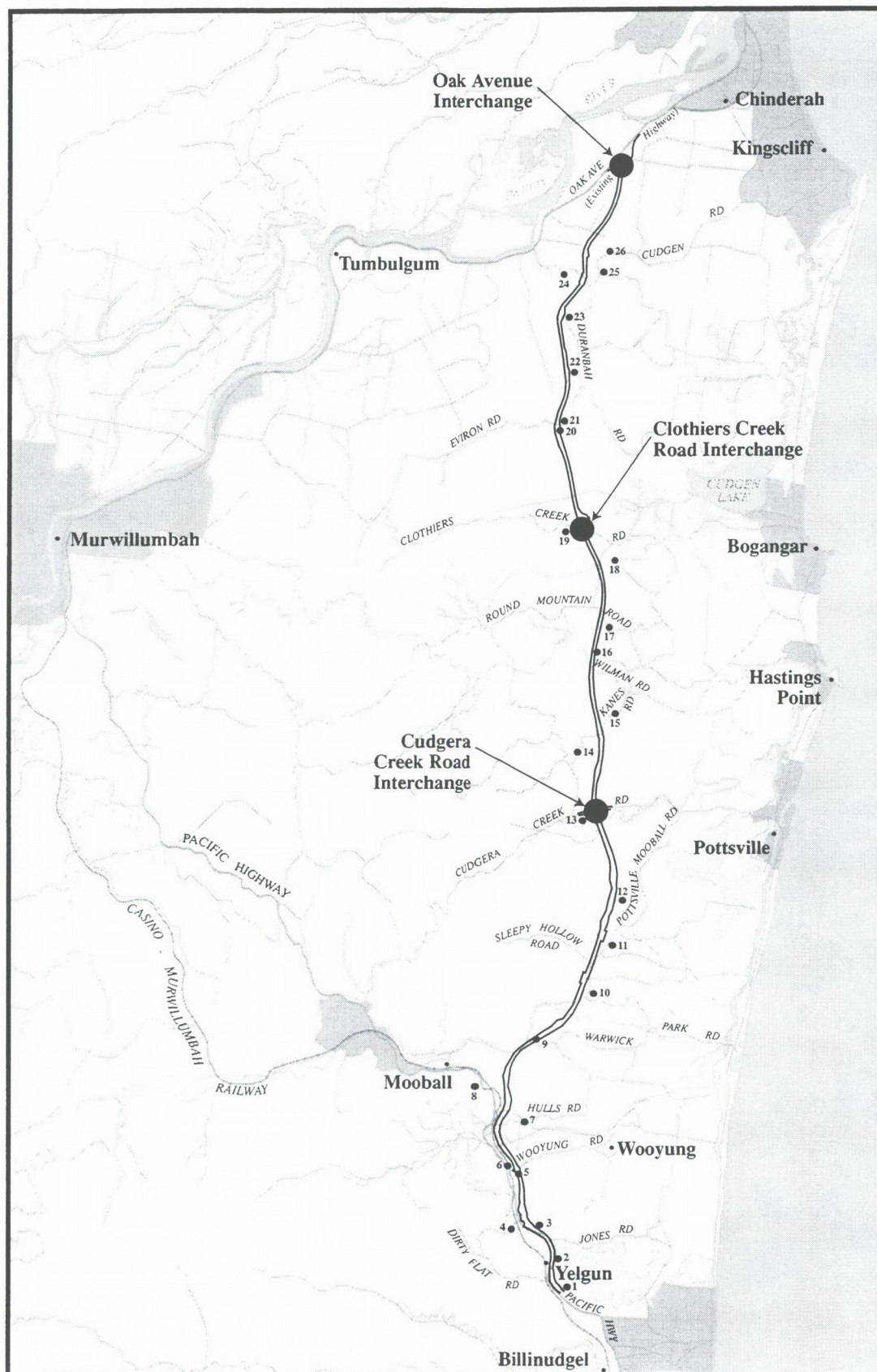
Wilkinson Murray Pty Limited is committed to and has implemented AS/NZS ISO 9001 : 1994 "Quality Systems – Model for quality assurance in design, development, production, installation and servicing". This management system has been externally certified and Certificate of Approval No 543 has been issued.

#### AAAC

This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Revision	Date	Status	Prepared by:	Checked by:
A	20 June 1998	Draft	Neil Gross	Barry Murray
B	17 July 1998	Final	Neil Gross	George Jenner





- Legend
- Proposed Road Corridor
  - Interchanges
  - Noise Locations

Figure 1.1  
PREFERRED  
ROUTE  
ALIGNMENT

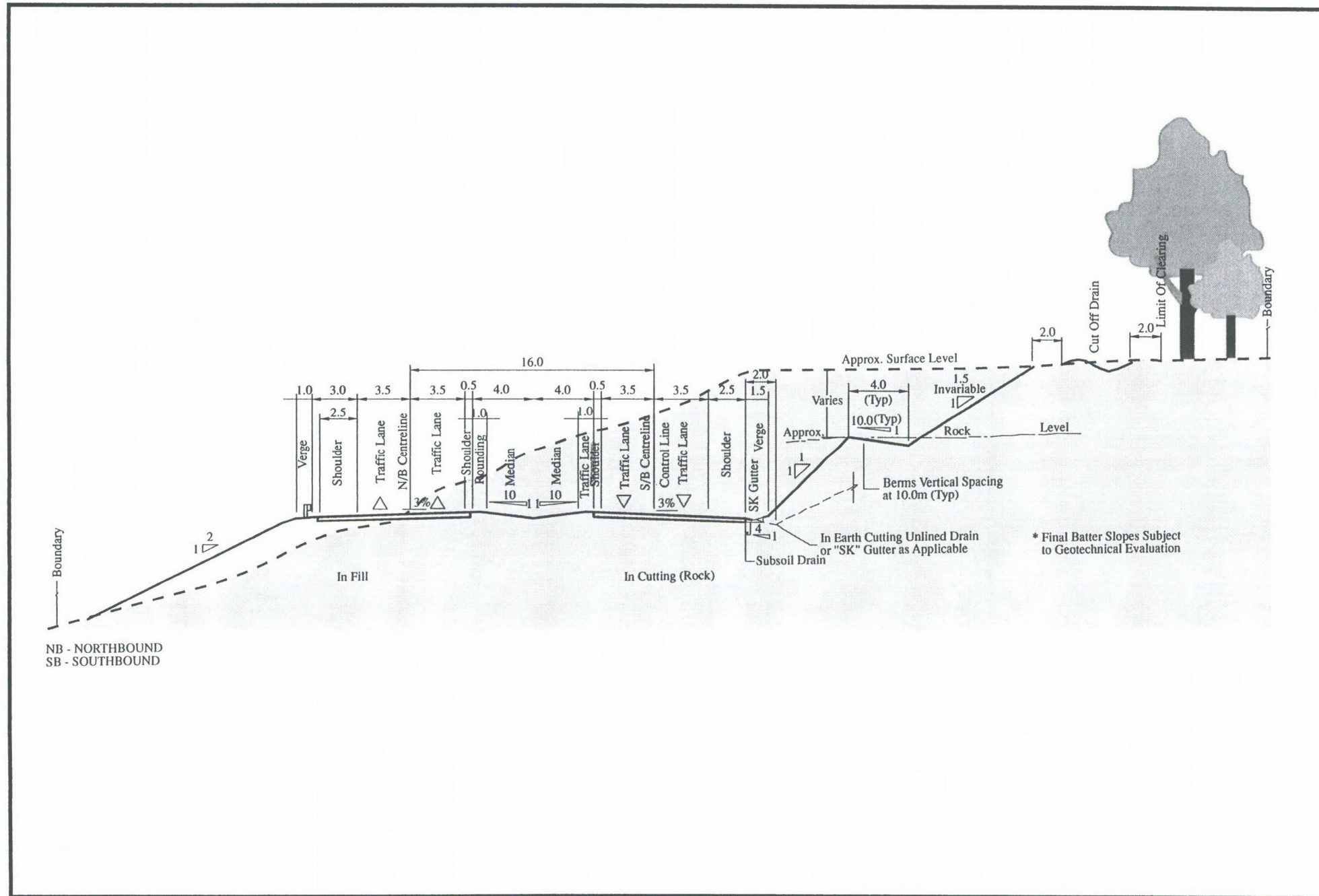
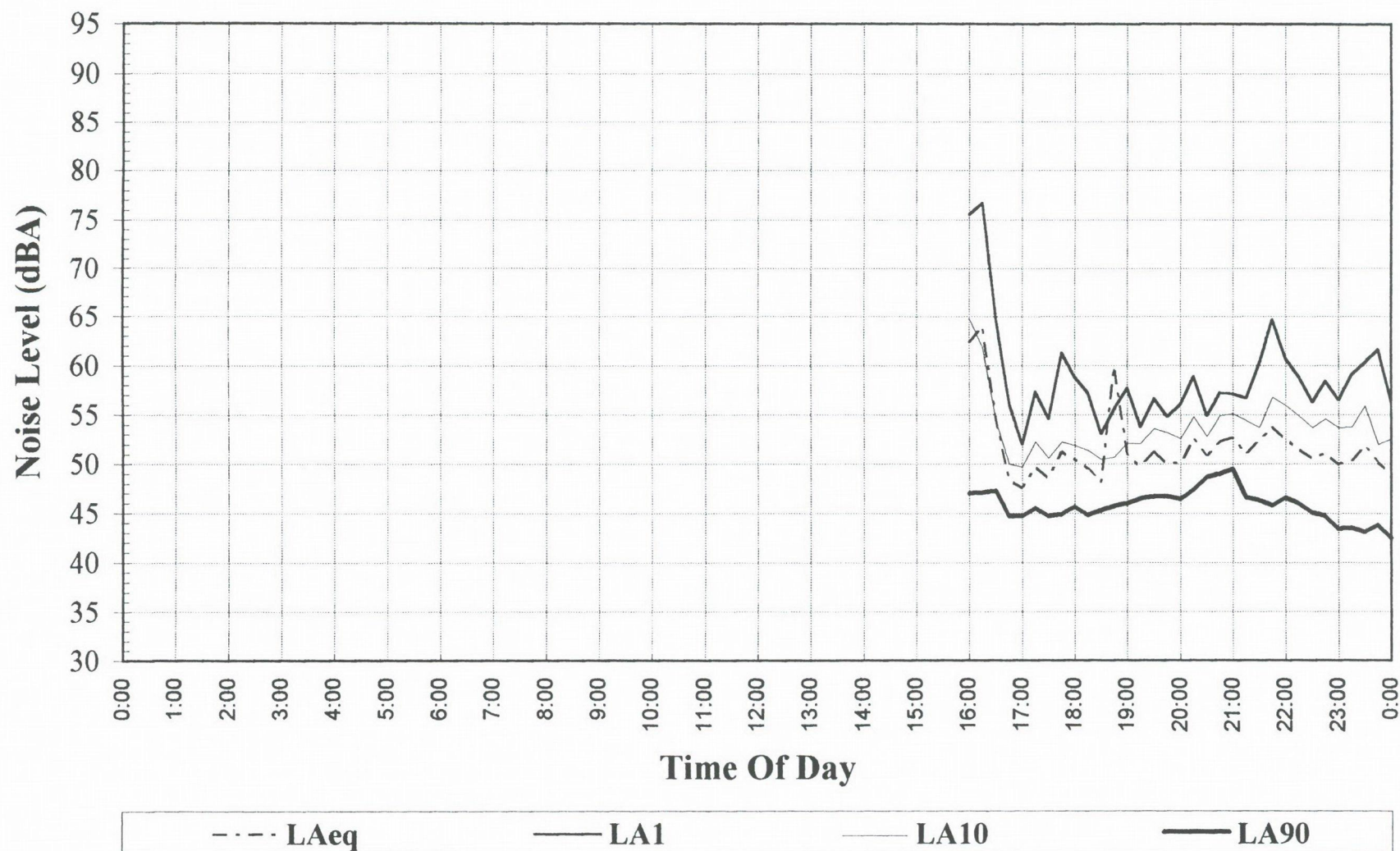


Figure 1.2  
TYPICAL CROSS SECTION



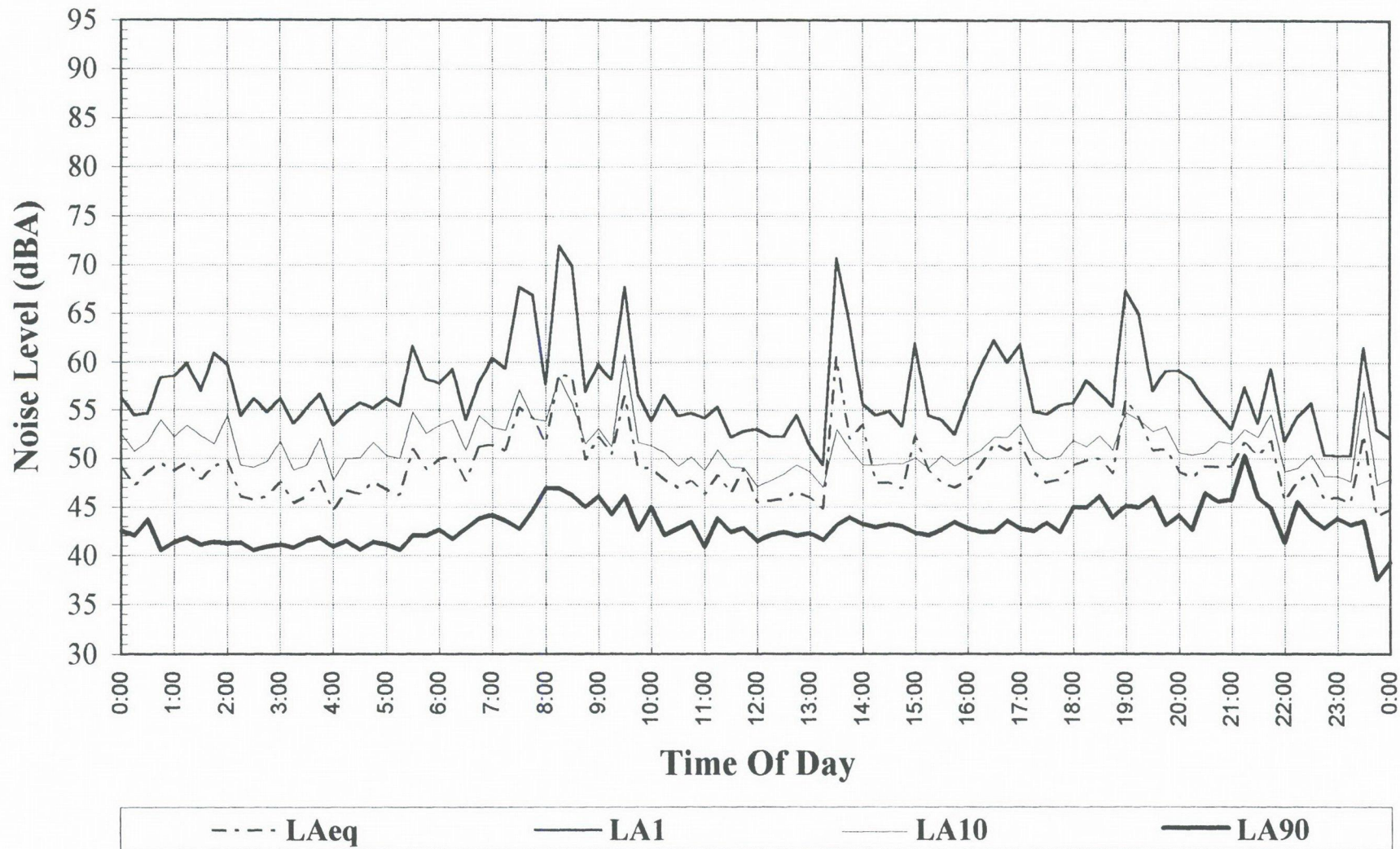
## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

Friday, 27 February, 1998



## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

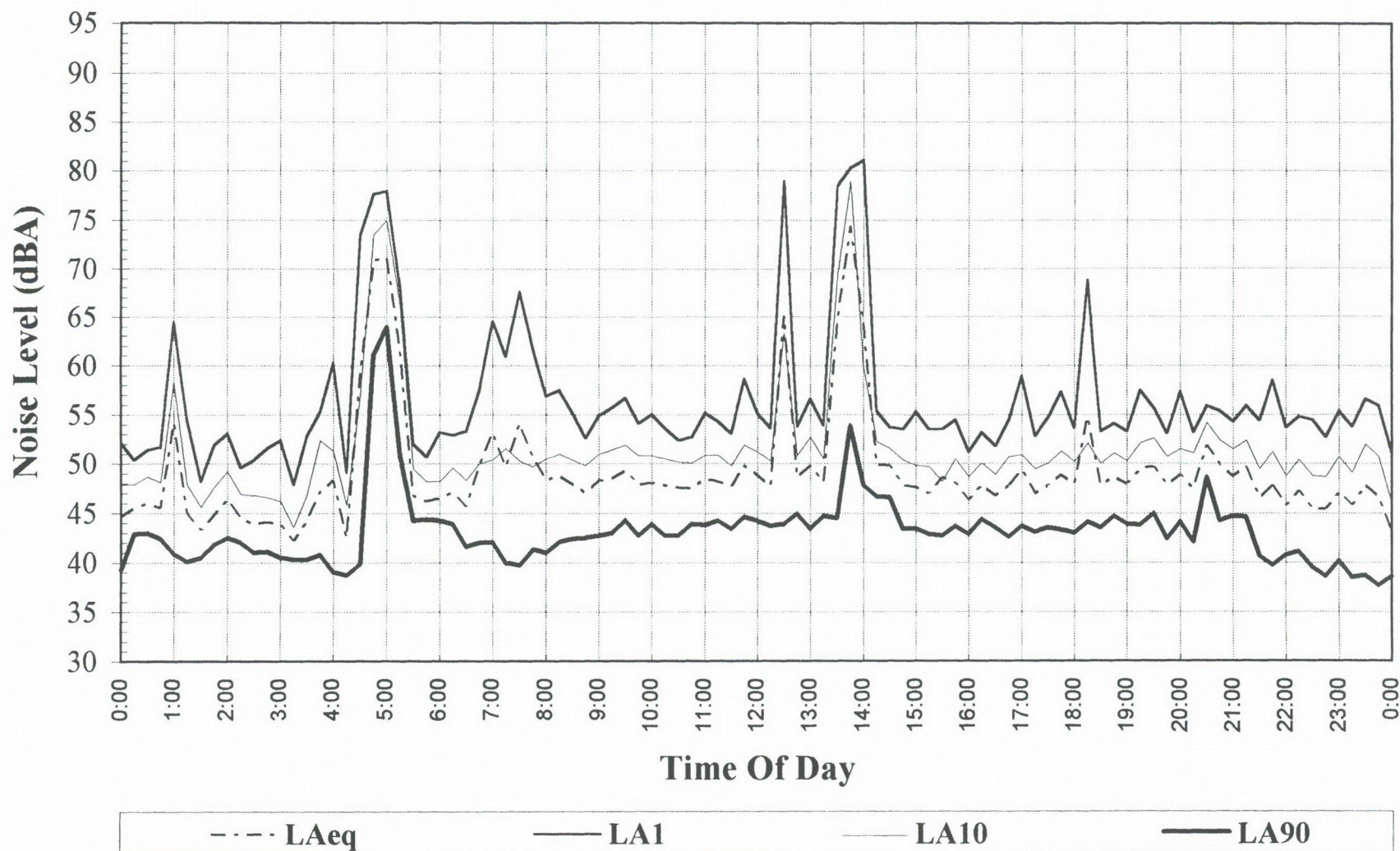
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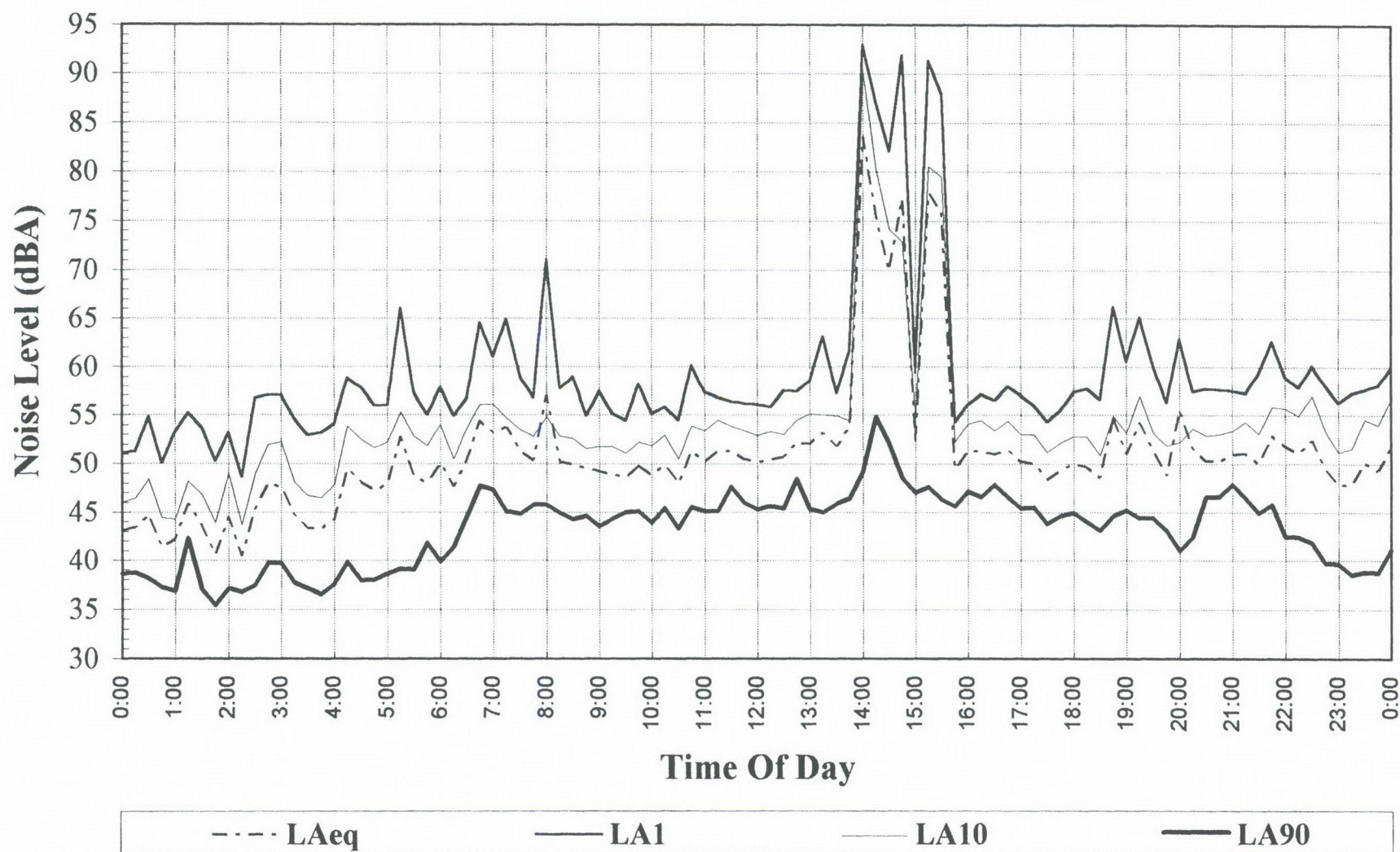
# Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

Sunday, 1 March, 1998



## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

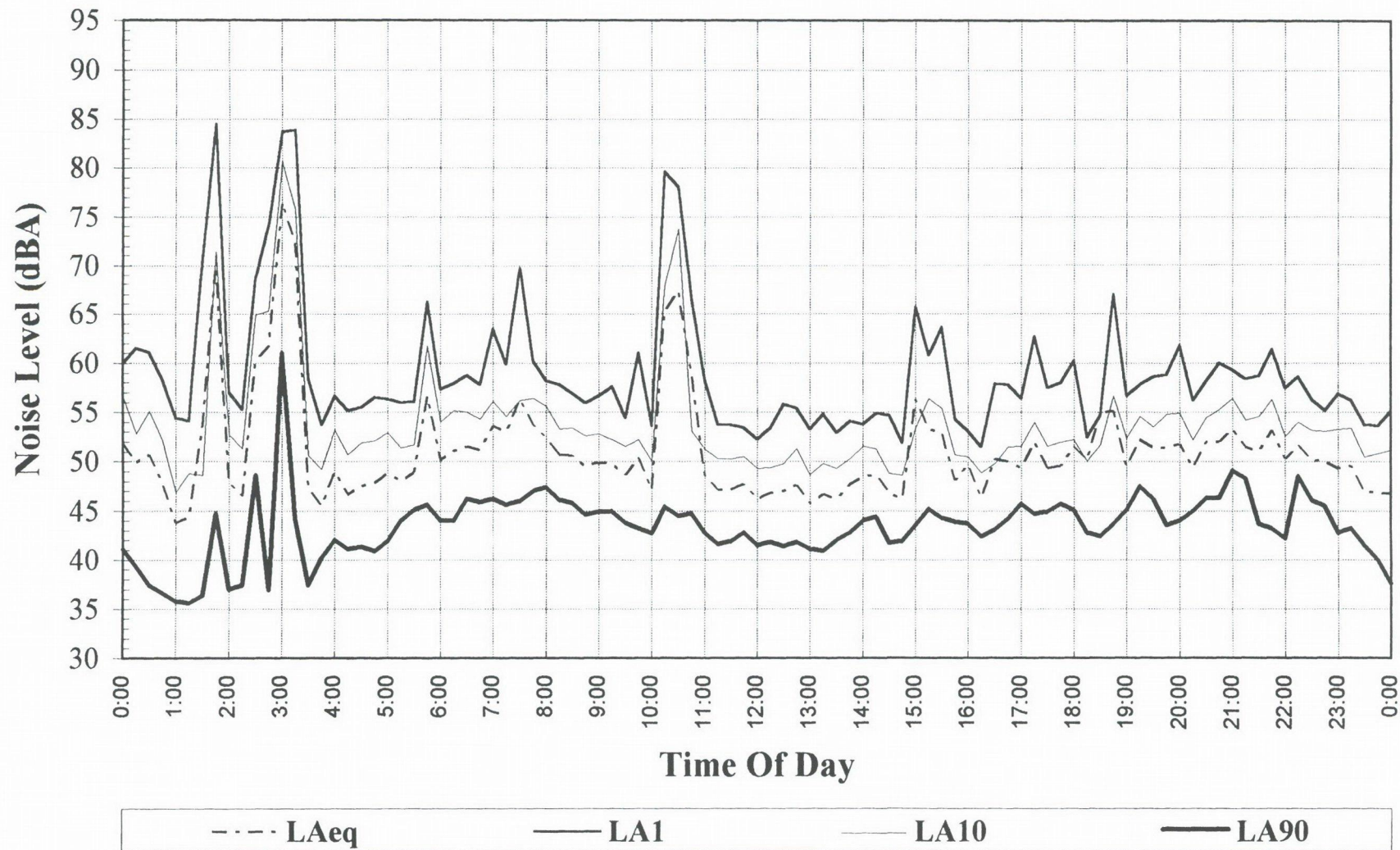
Monday, 2 March, 1998





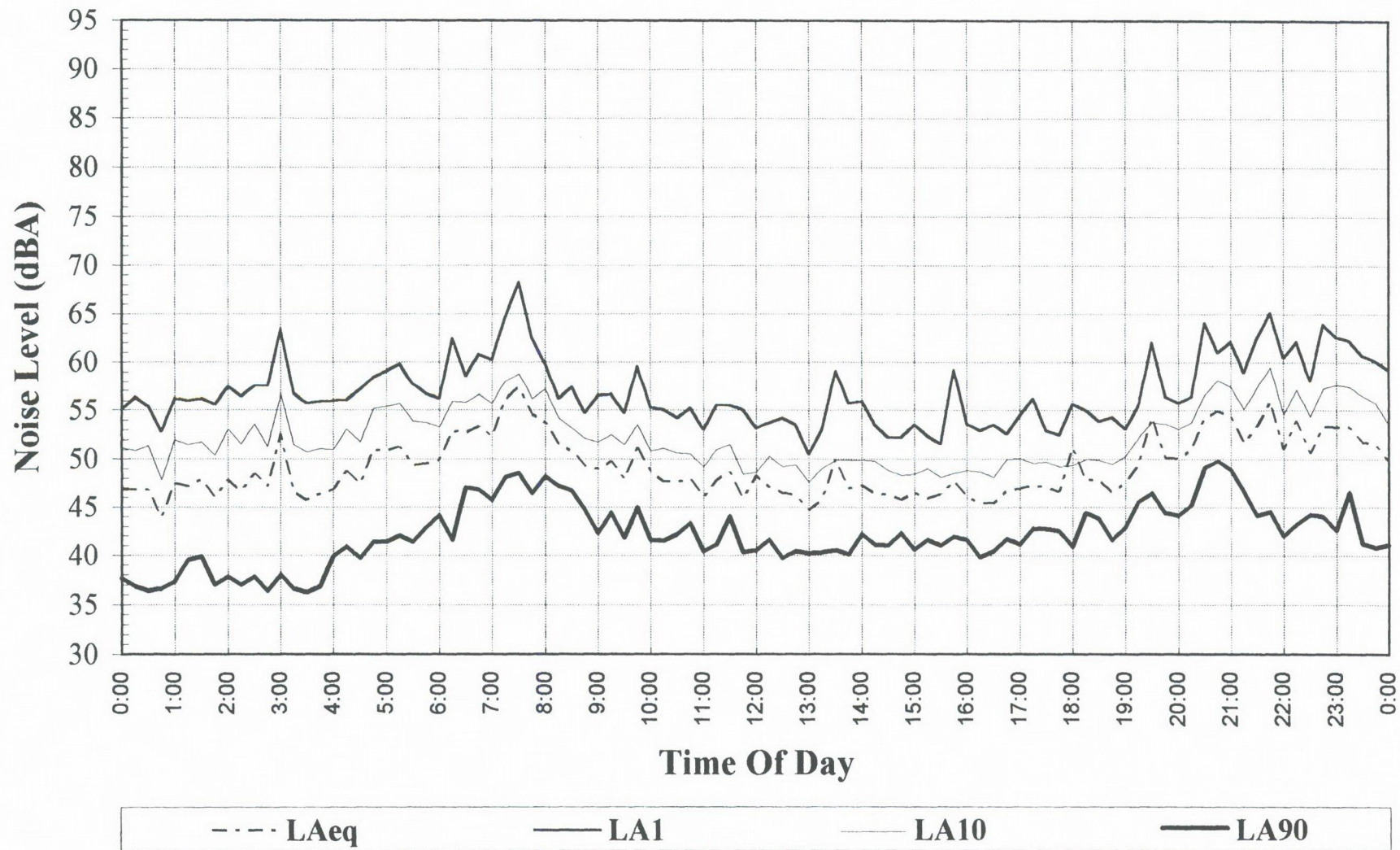
## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

Tuesday, 3 March, 1998



## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

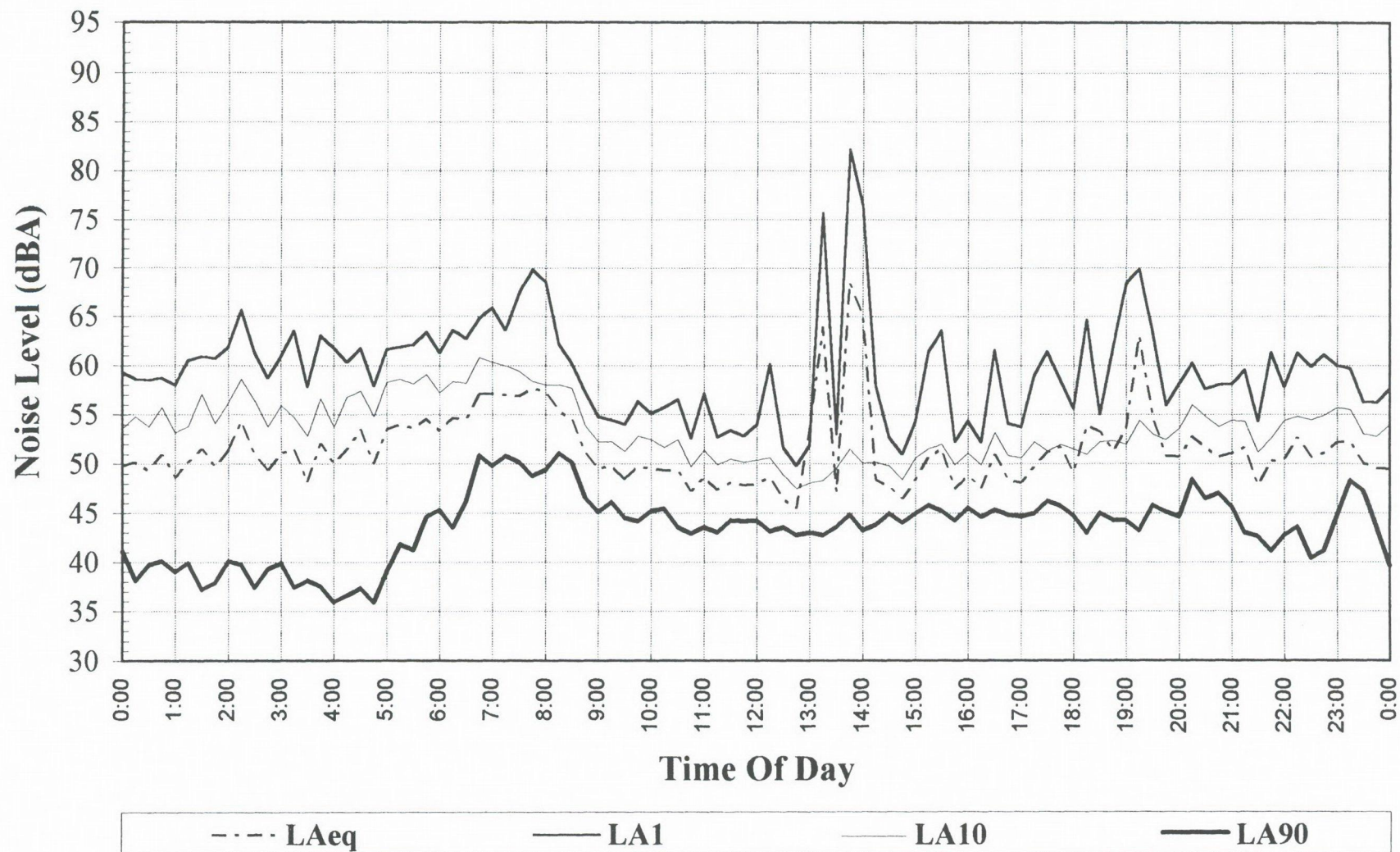
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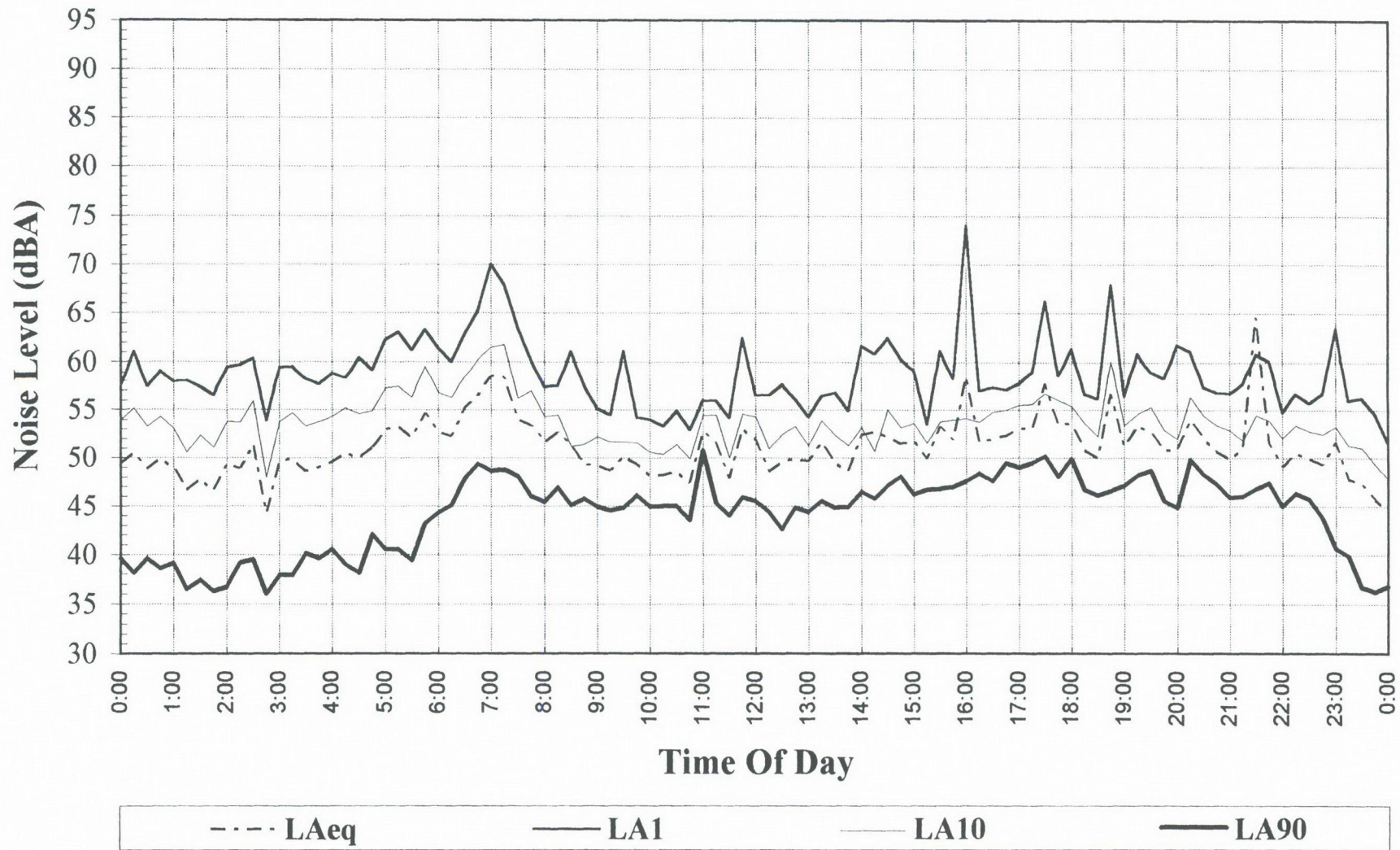
## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

Thursday, 5 March, 1998



## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

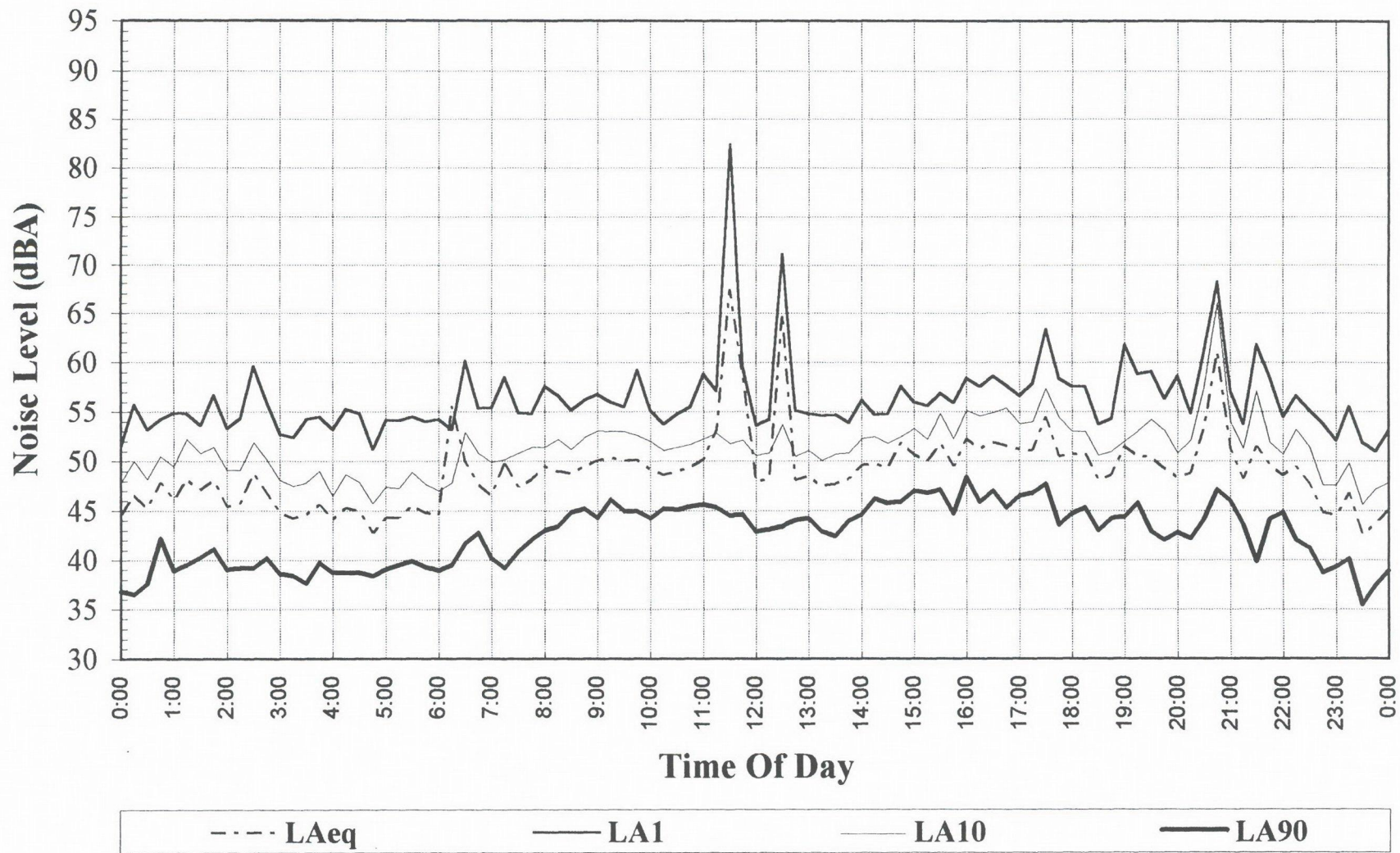
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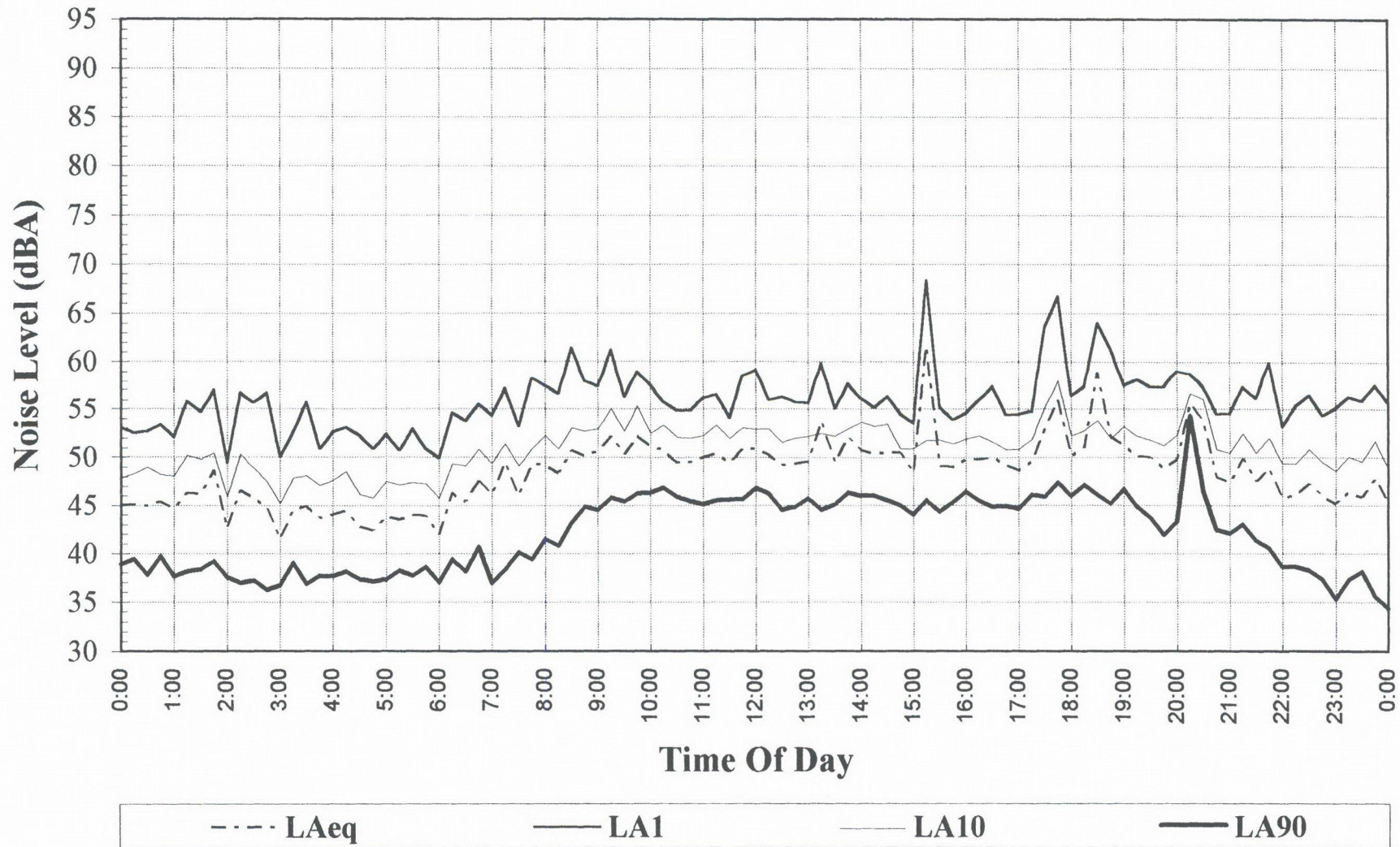
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Saturday, 7 March, 1998



## Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

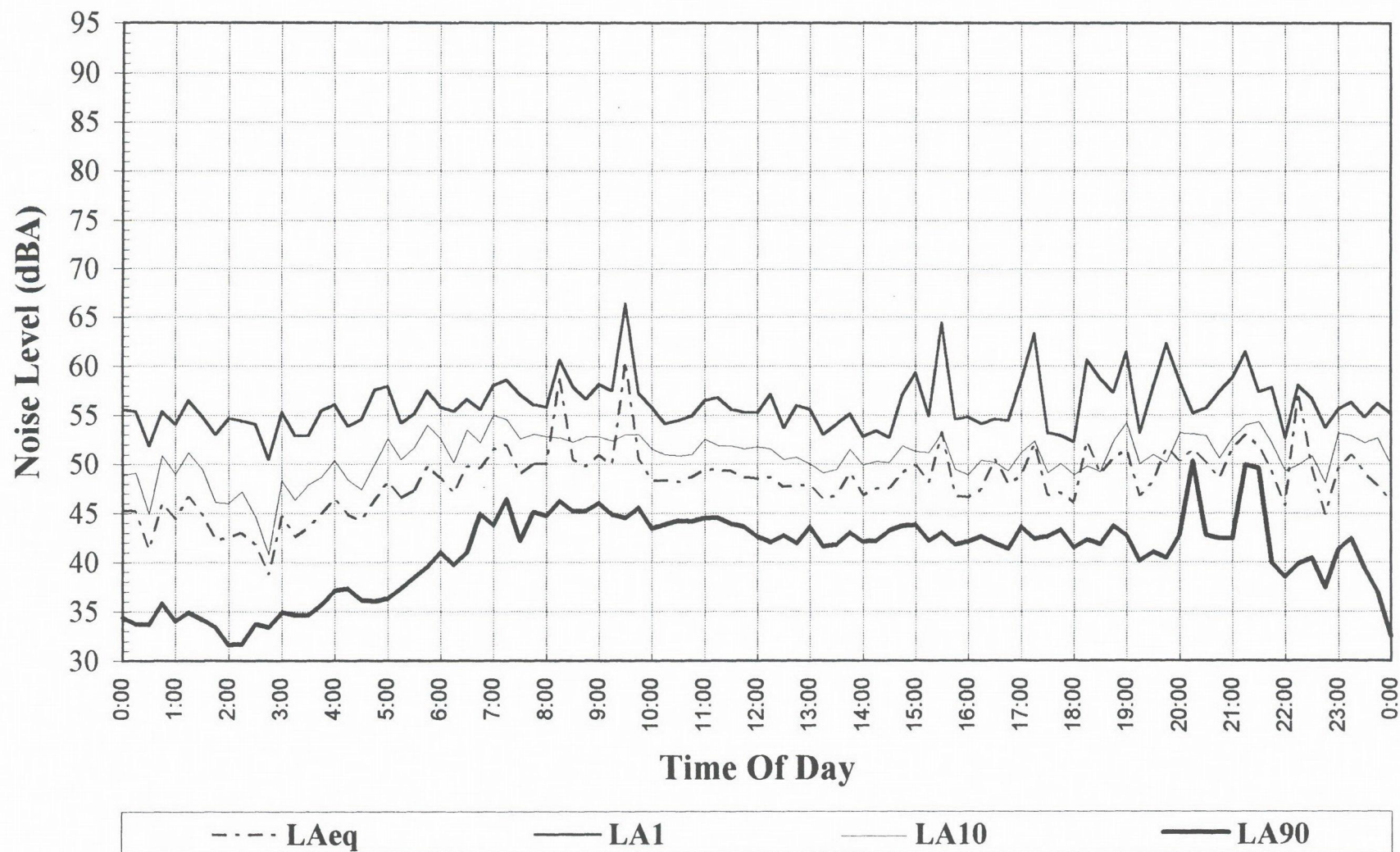
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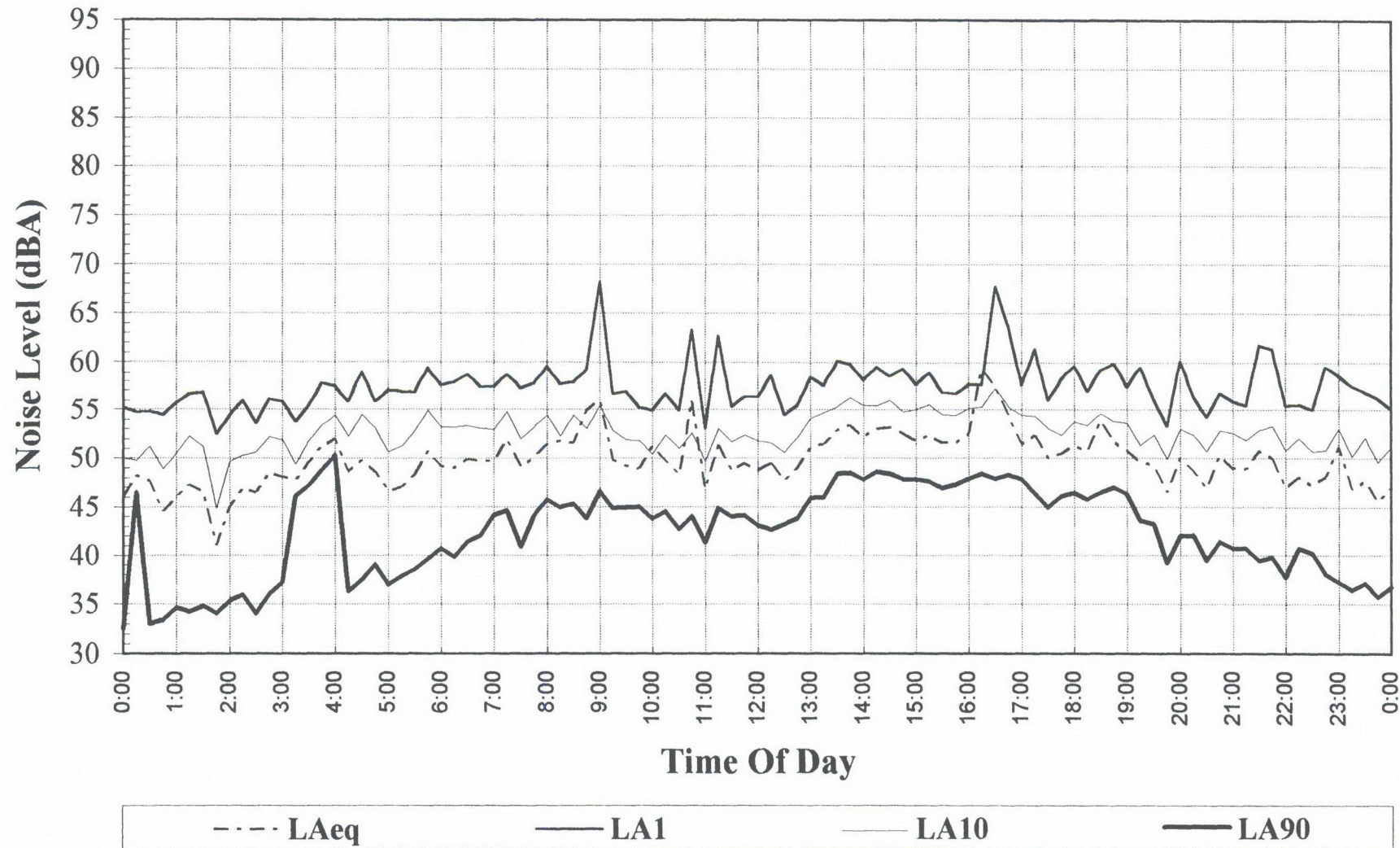
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Monday, 9 March, 1998



# Noise Levels at Location 1 - Lot 13, Yelgun Ridge, Yelgun

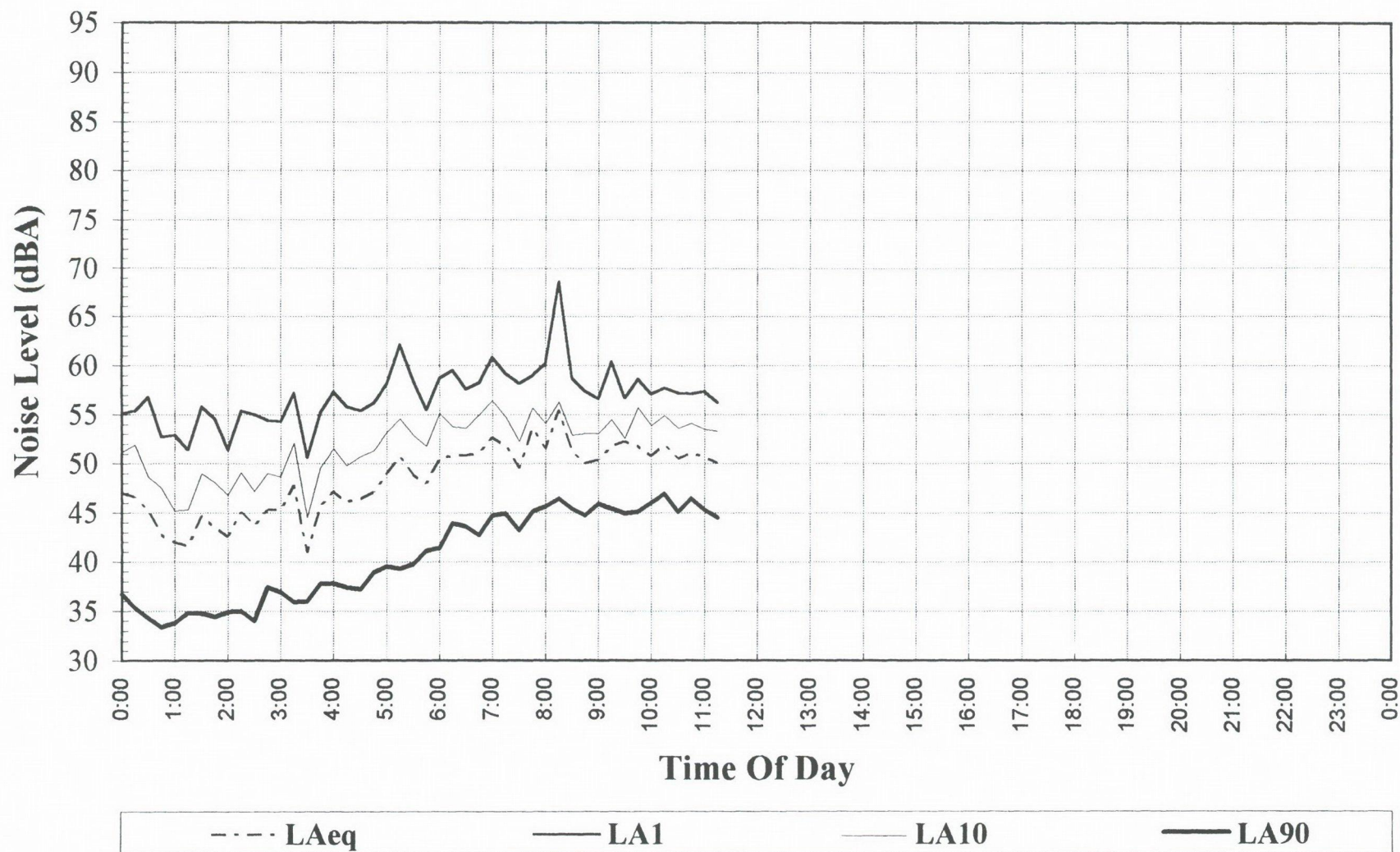
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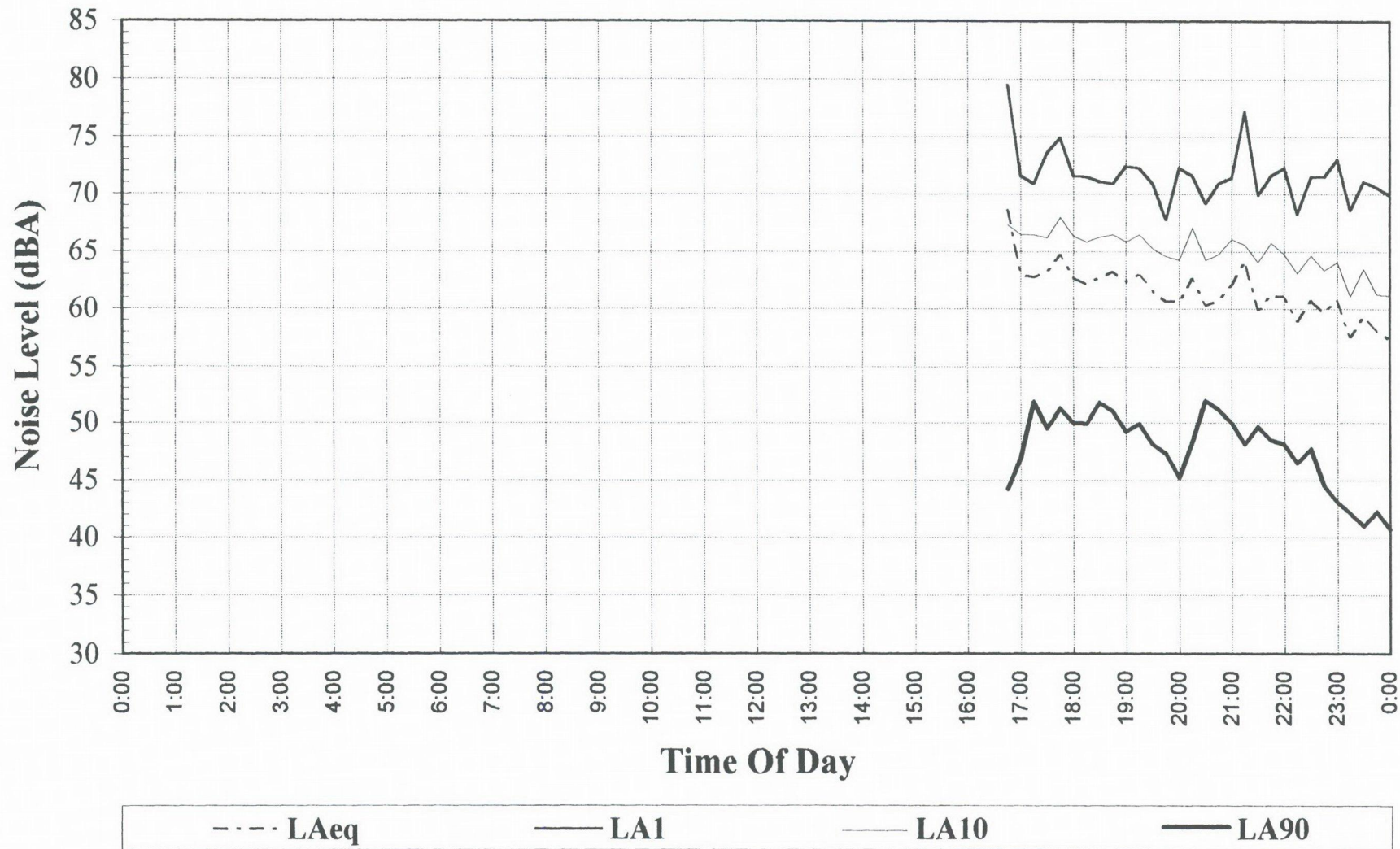
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Wednesday, 11 March, 1998



## Noise Levels at Location 2 - Lot 1, Clothier Residence, Yelgun

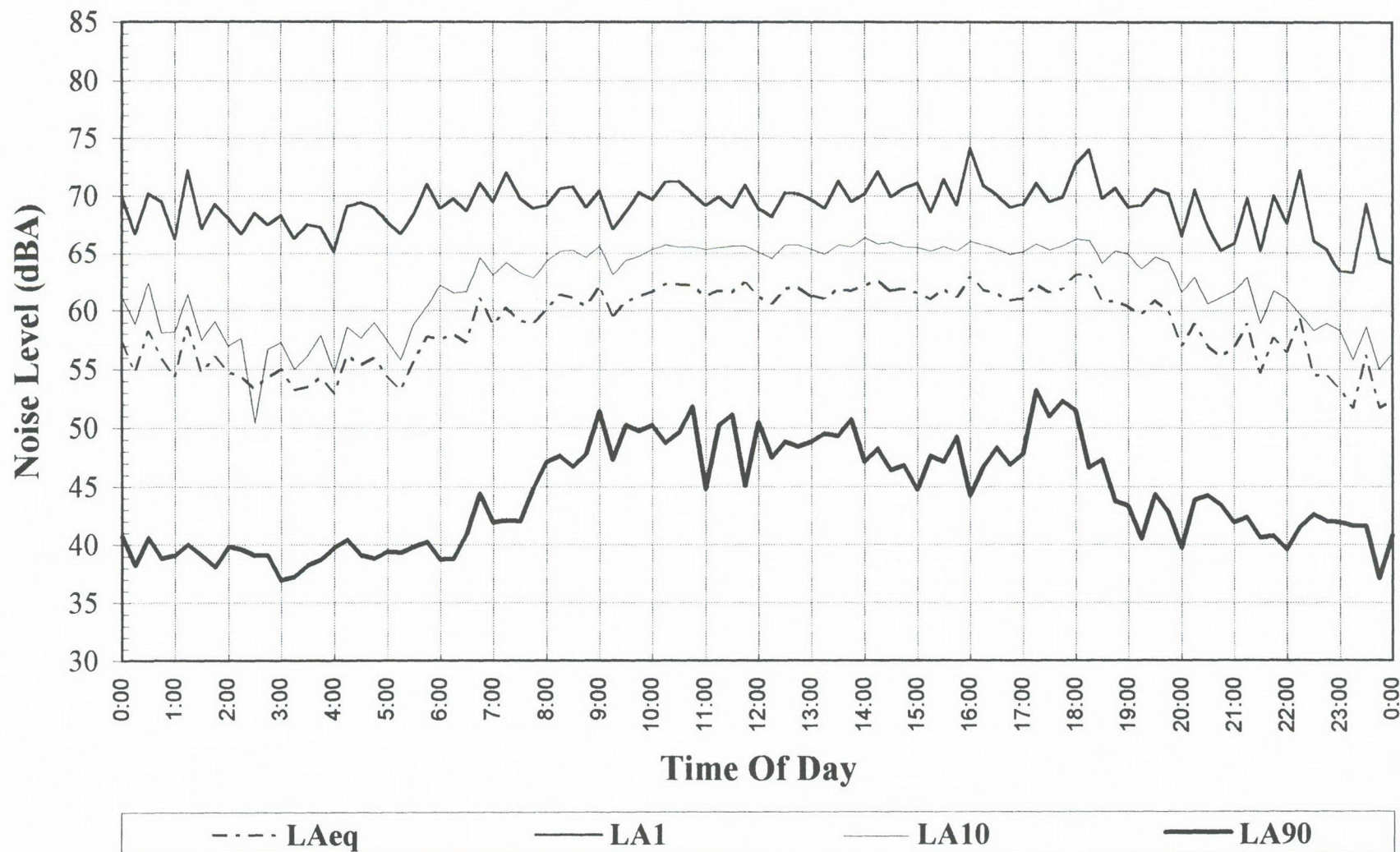
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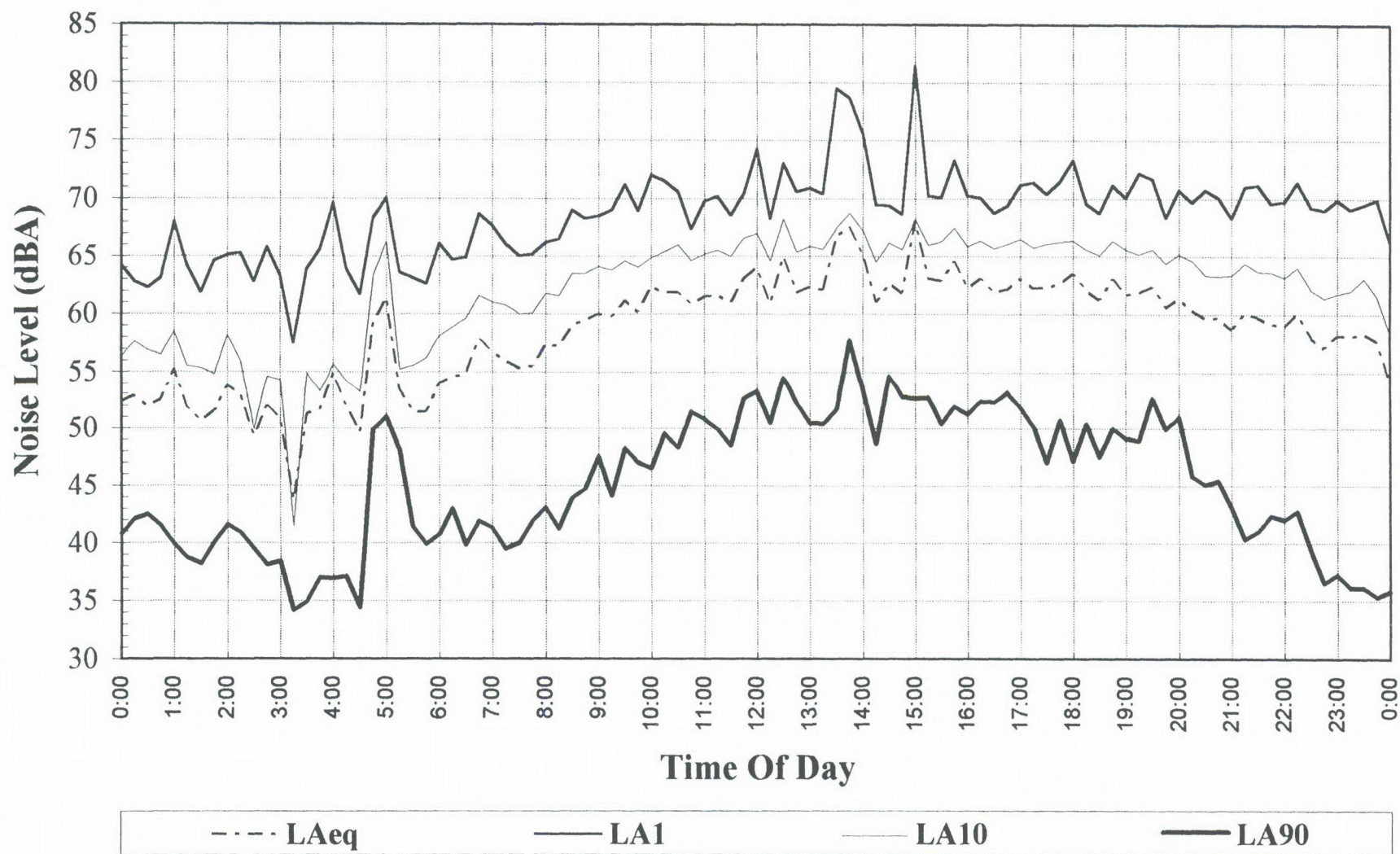
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Saturday, 28 February, 1998



## Noise Levels at Location 2 - Lot 1, Clothier Residence, Yelgun

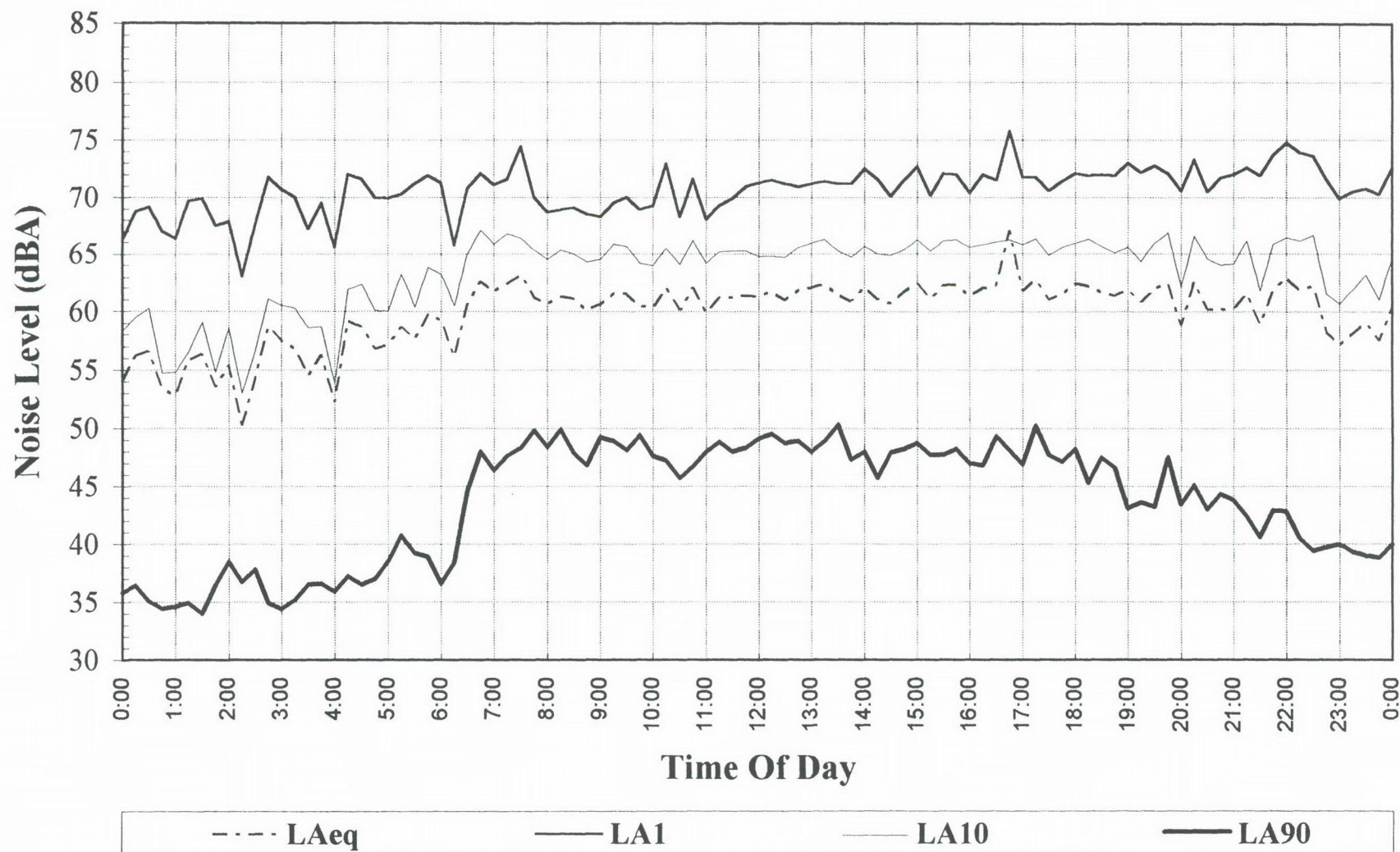
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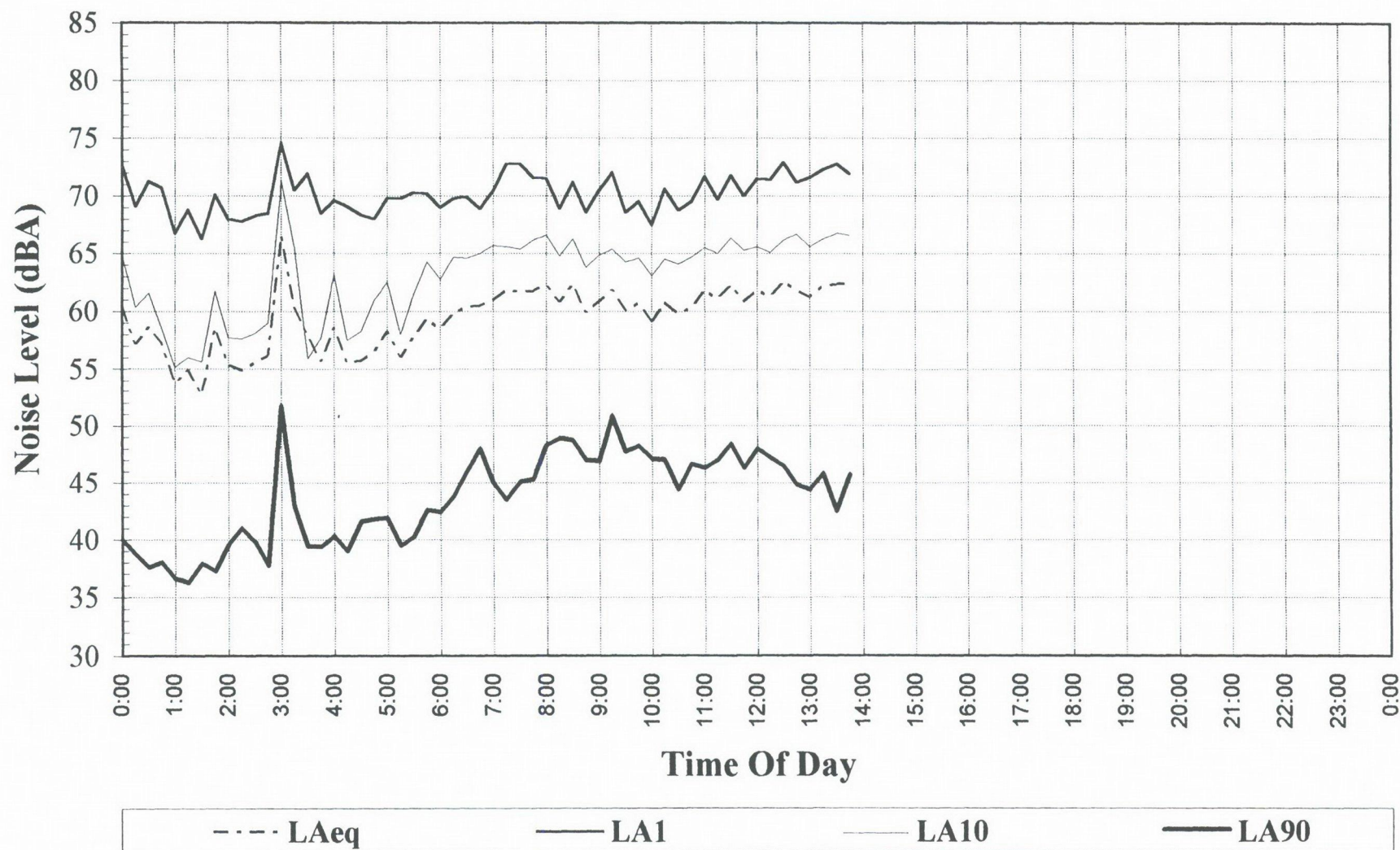
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Monday, 2 March, 1998



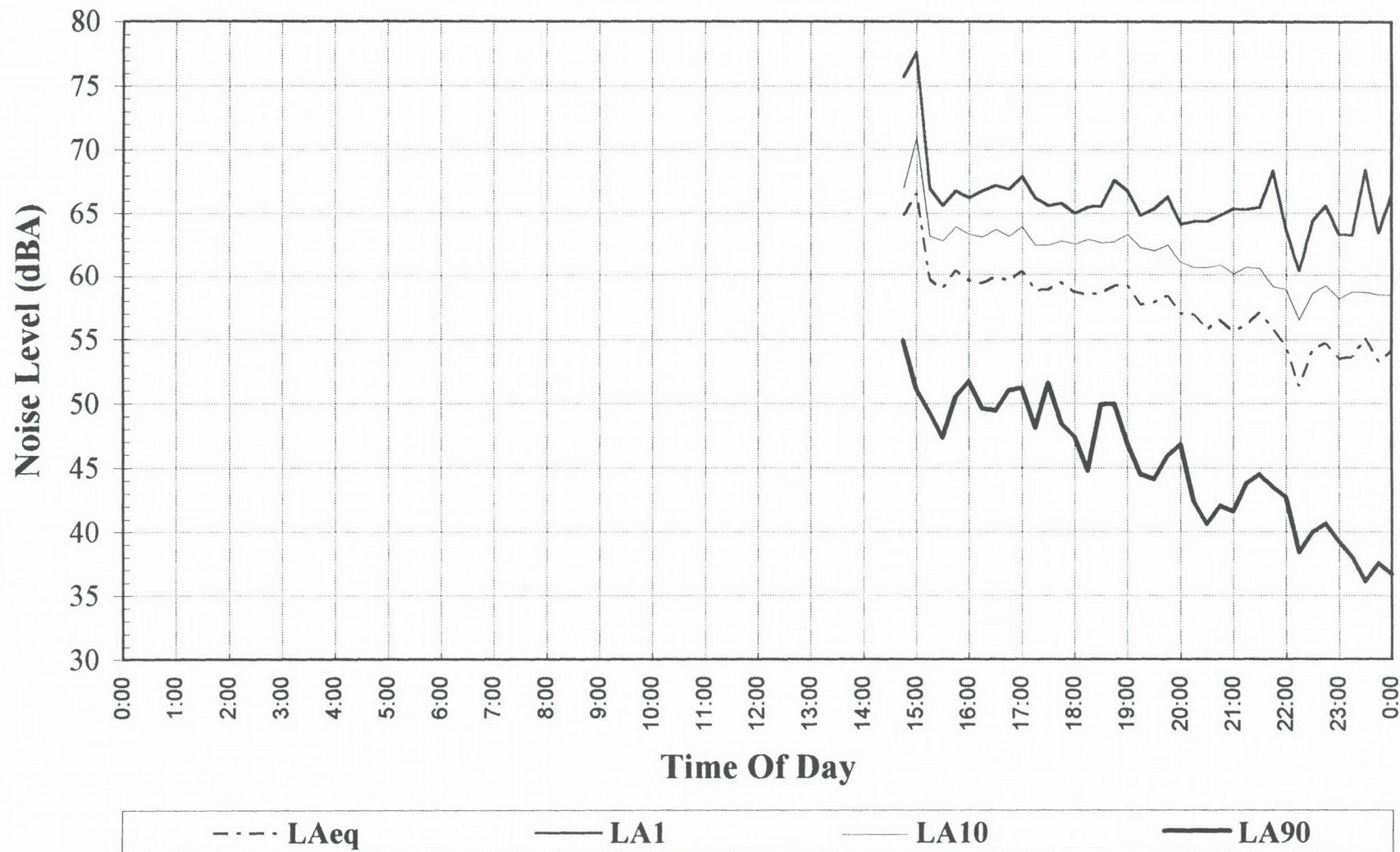
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Tuesday, 3 March, 1998



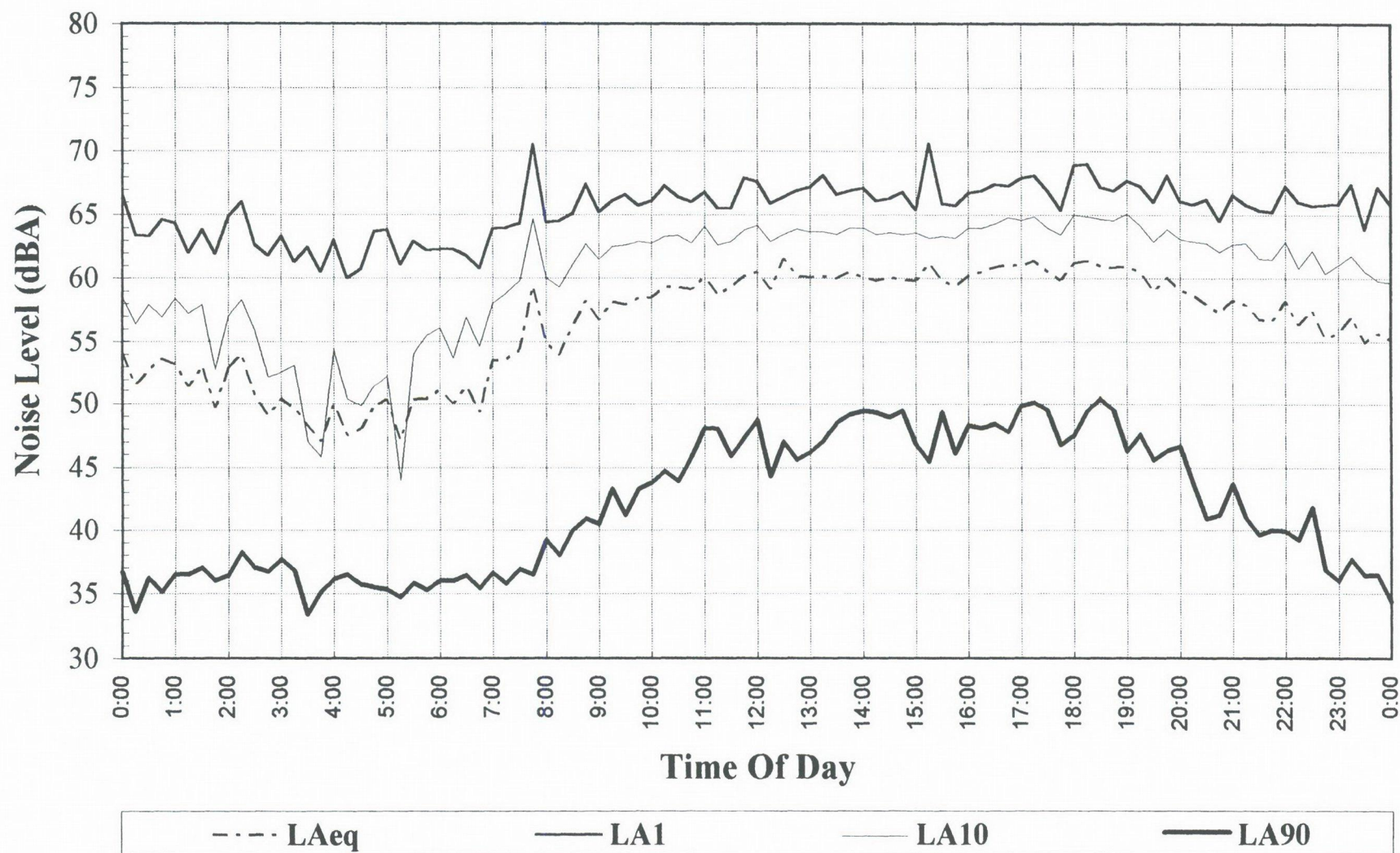


**Noise Levels at Location 3 - Lot 1(Pike), Pacific Hwy, Yelgun**  
**Saturday, 7 March, 1998**



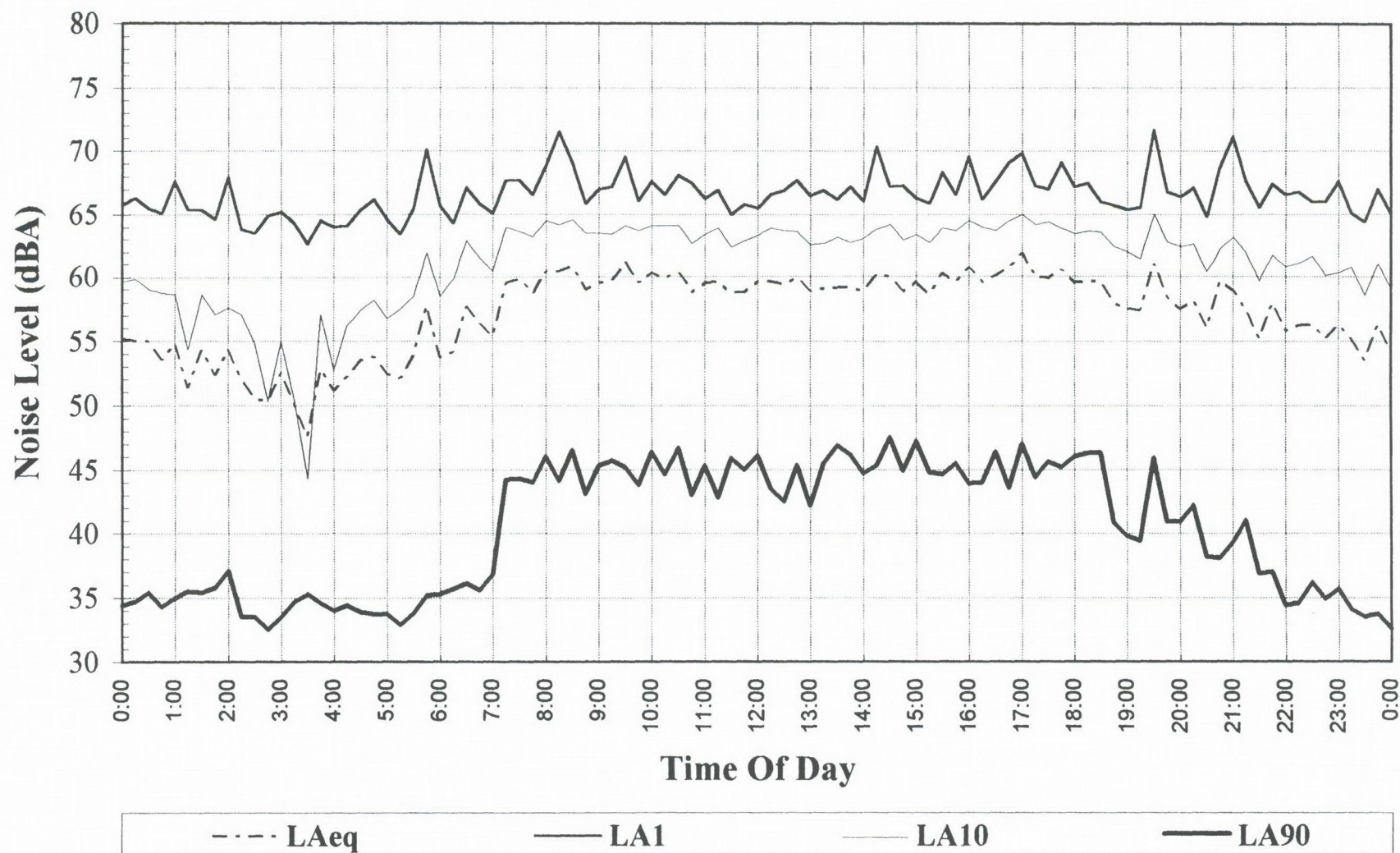
## Noise Levels at Location 3 - Lot 1(Pike), Pacific Hwy, Yelgun

Sunday, 8 March, 1998



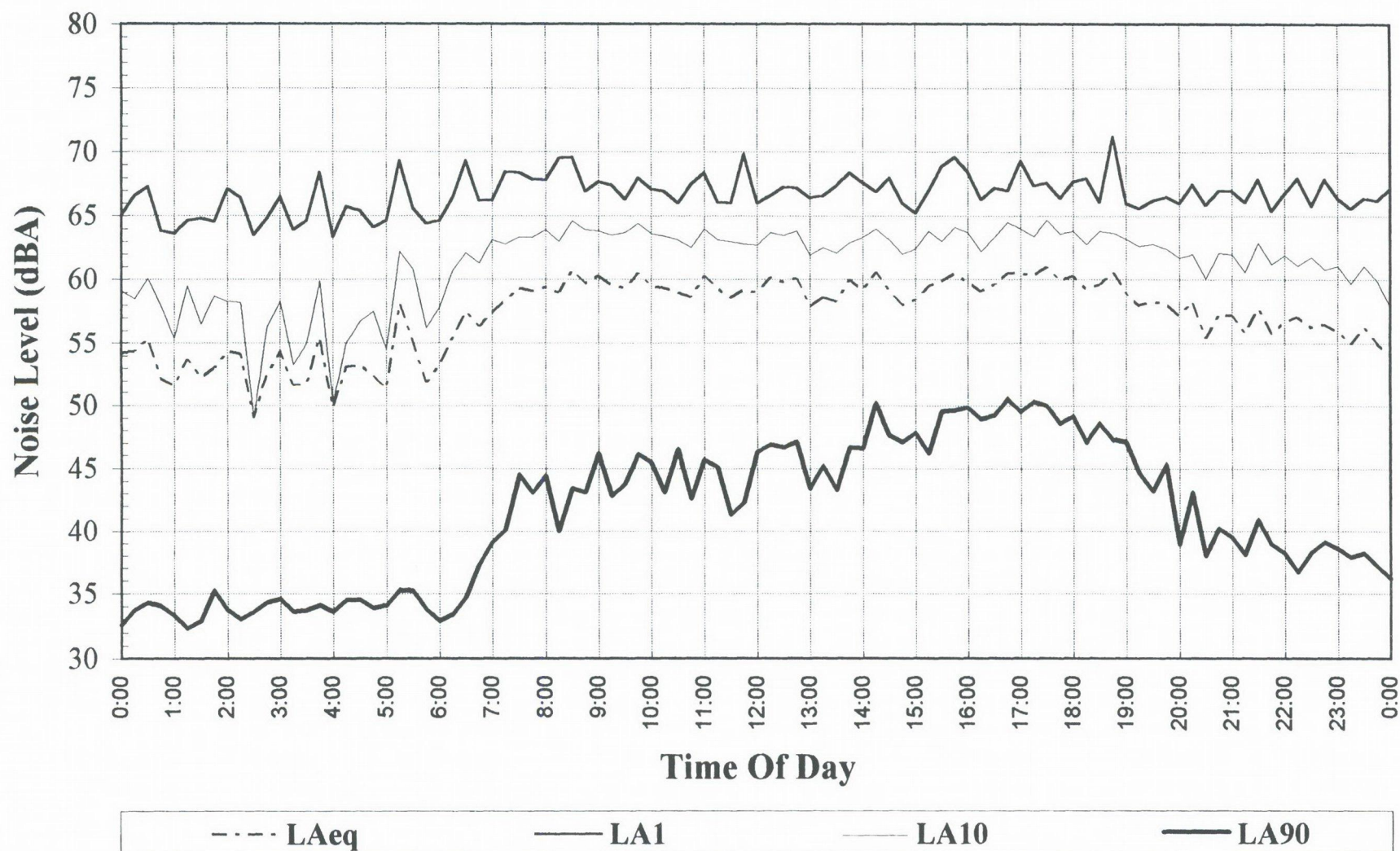


**Noise Levels at Location 3 - Lot 1(Pike), Pacific Hwy, Yelgun**  
**Monday, 9 March, 1998**



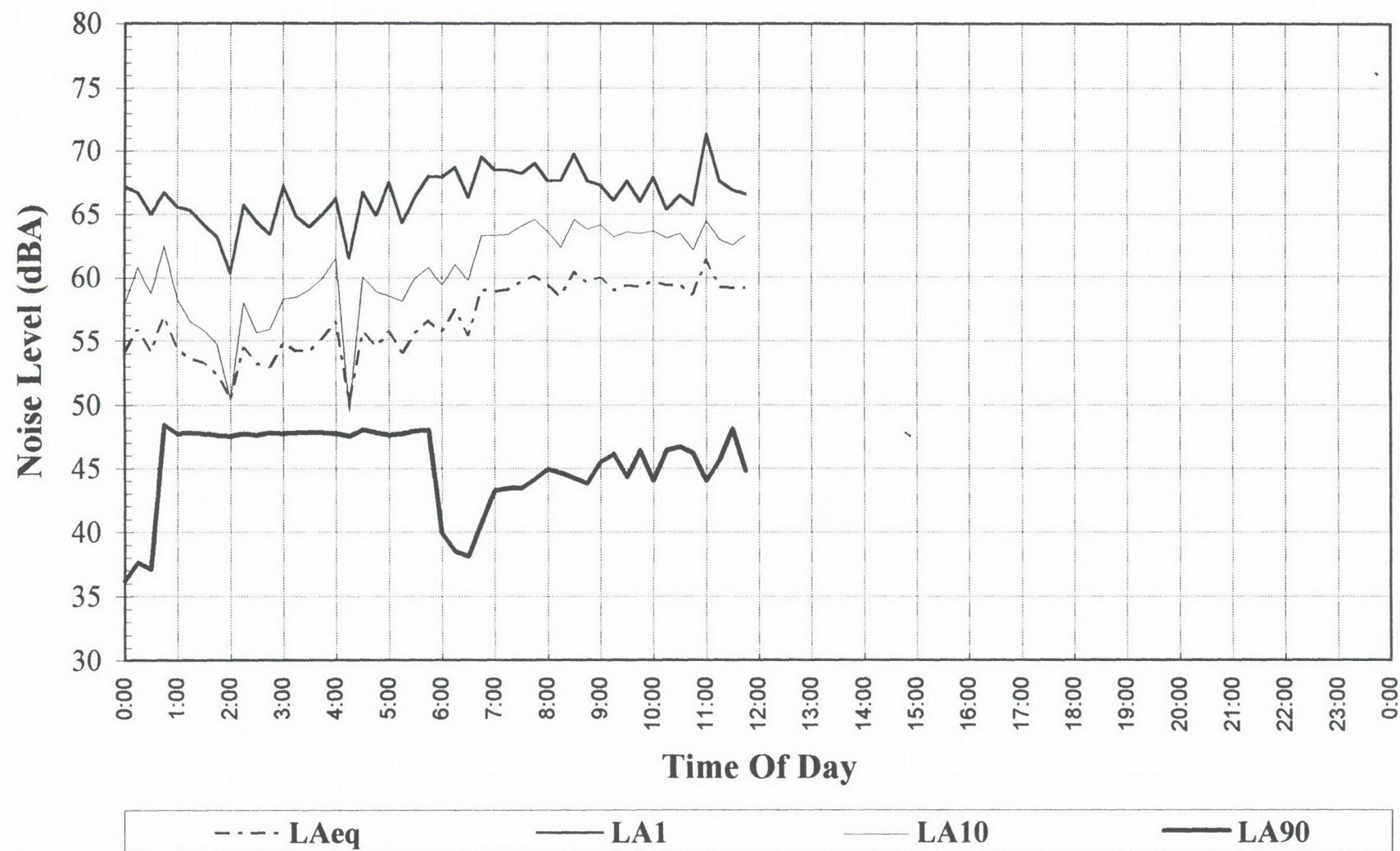
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Tuesday, 10 March, 1998



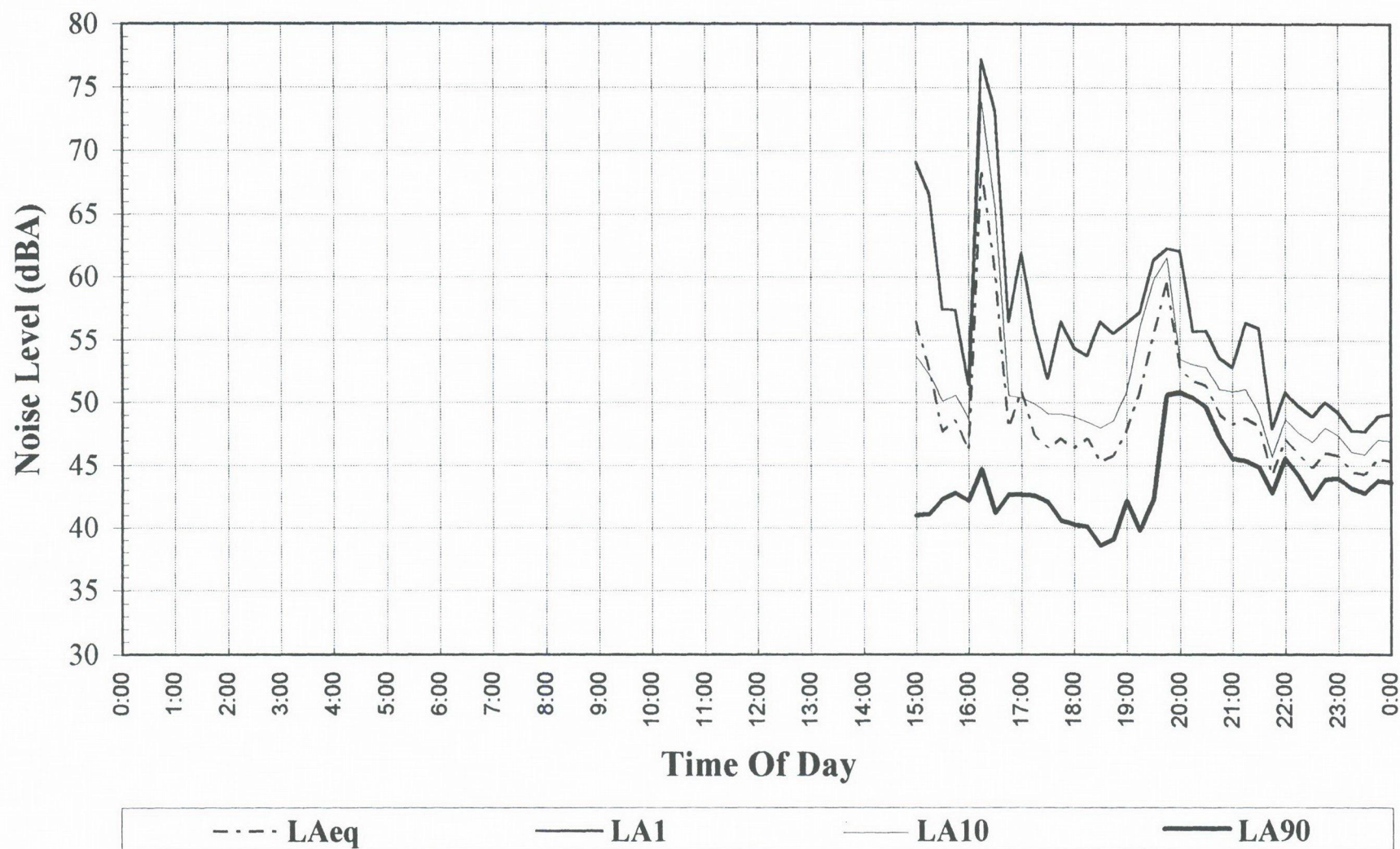


**Noise Levels at Location 3 - Lot 1(Pike), Pacific Hwy, Yelgun**  
**Wednesday, 11 March, 1998**



## Noise Levels at Location 4 - Lot 5 (Gallagher), Pacific Hwy, Yelgun

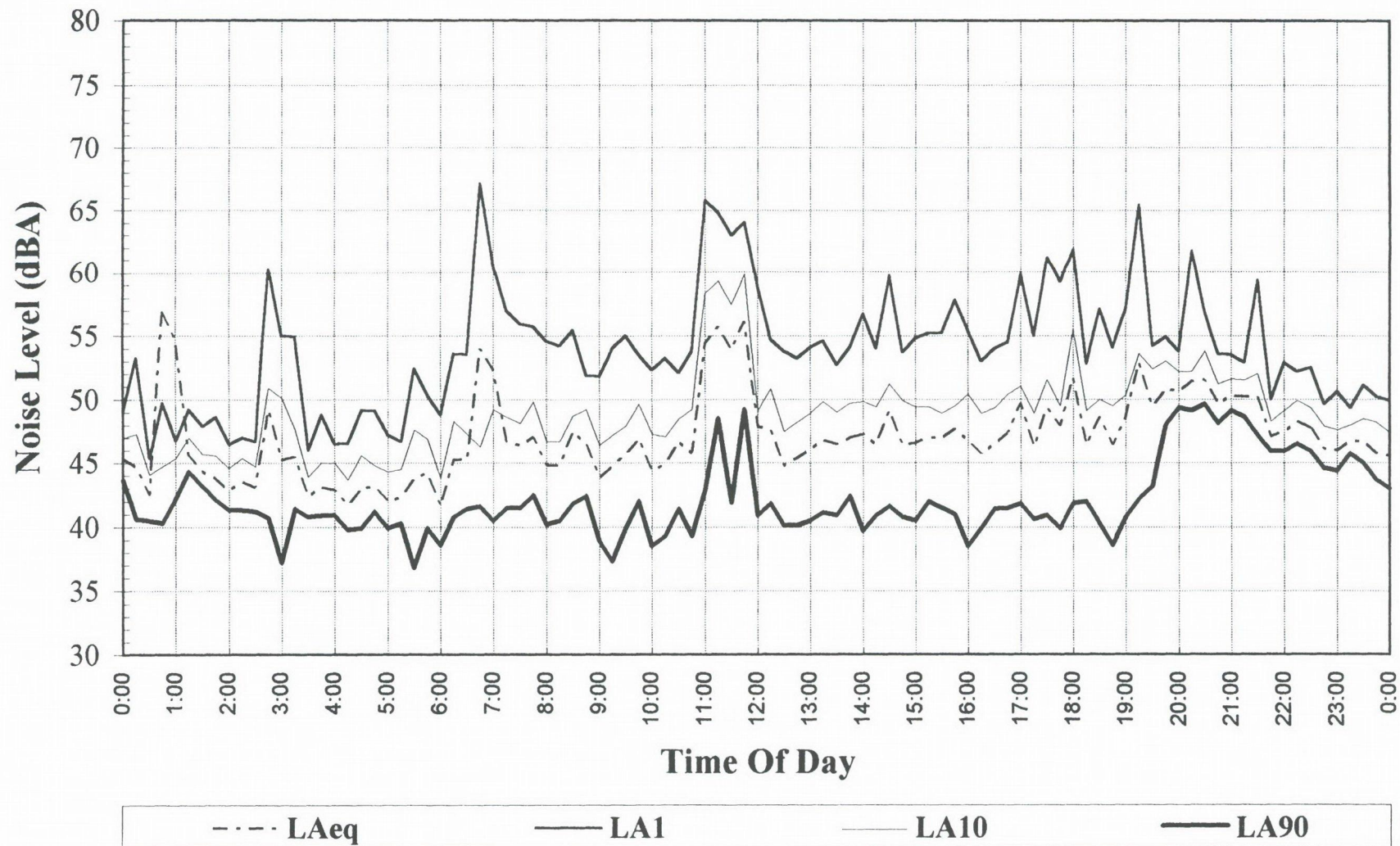
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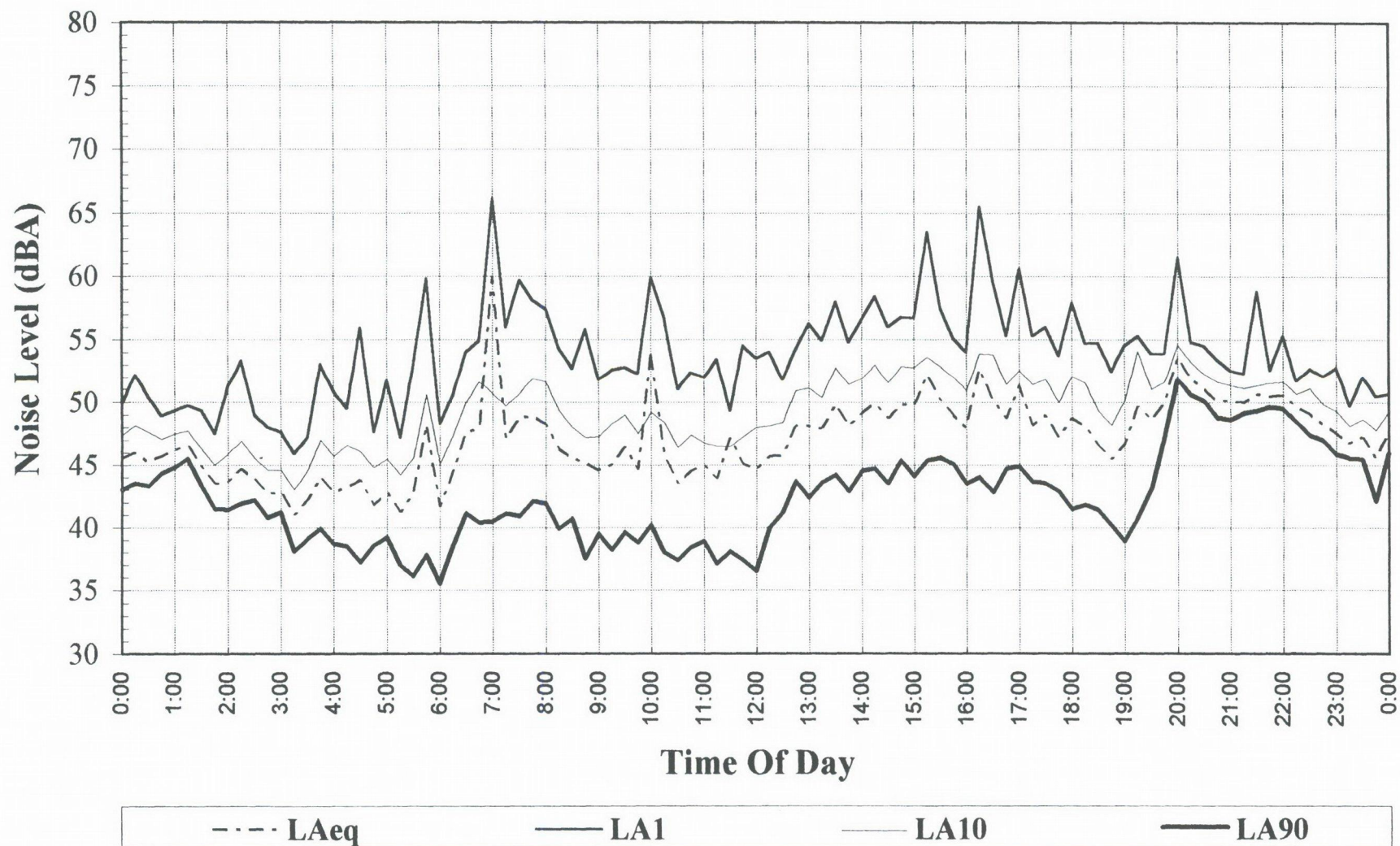
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Wednesday, 4 March, 1998



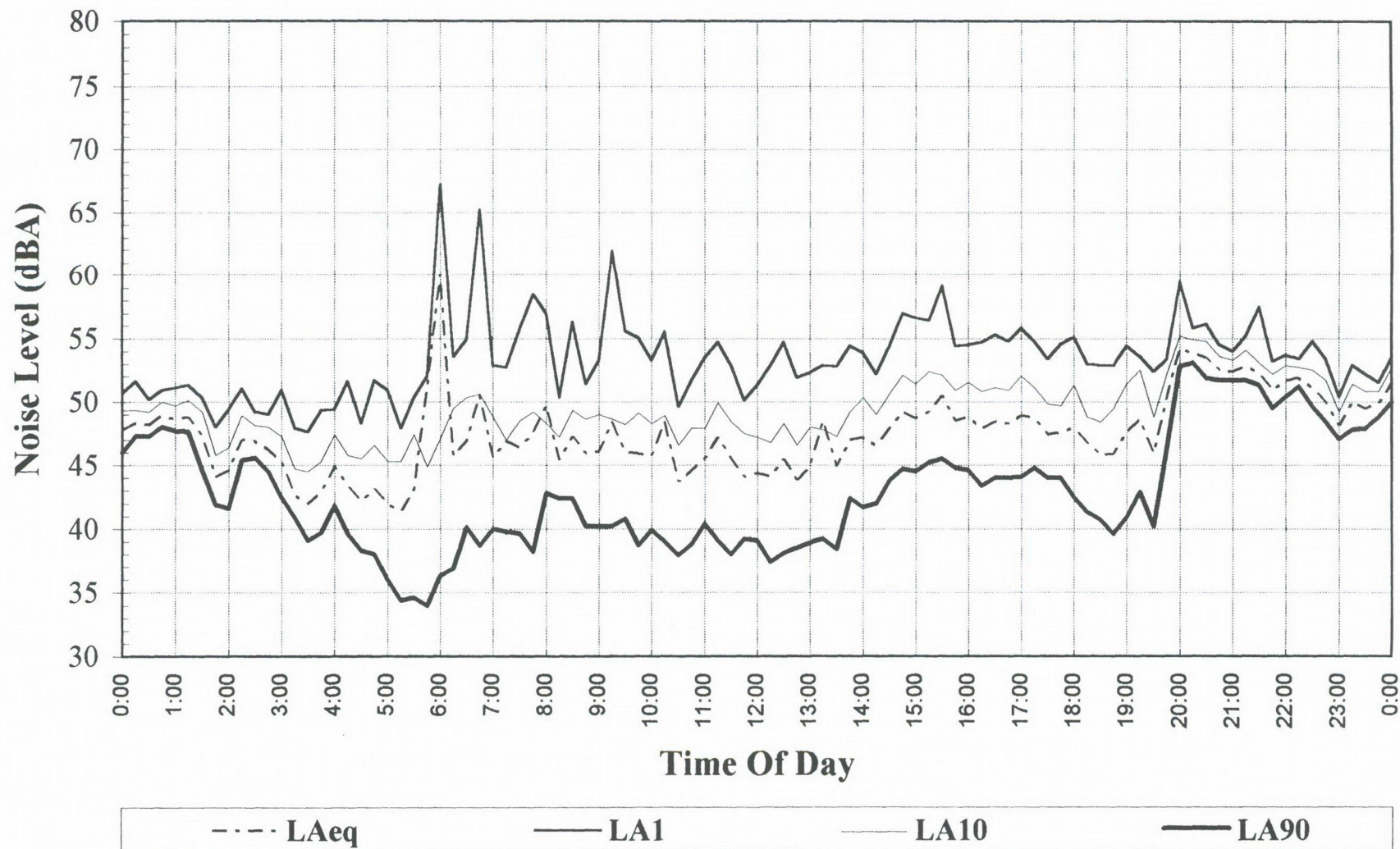
# Noise Levels at Location 4 - Lot 5 (Gallagher), Pacific Hwy, Yelgun

Thursday, 5 March, 1998



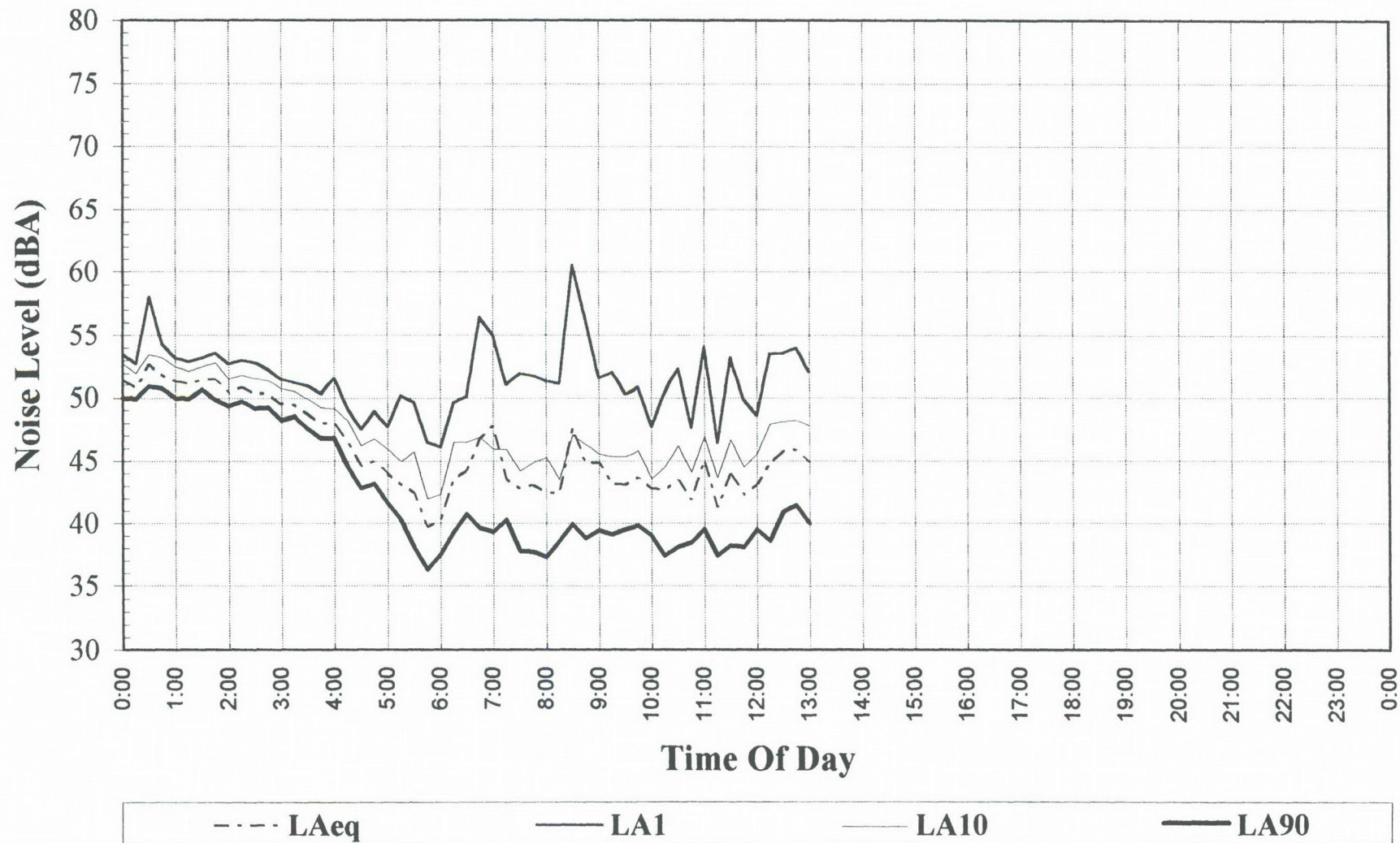


**Noise Levels at Location 4 - Lot 5 (Gallagher), Pacific Hwy, Yelgun**  
**Friday, 6 March, 1998**



## Noise Levels at Location 4 - Lot 5 (Gallagher), Pacific Hwy, Yelgun

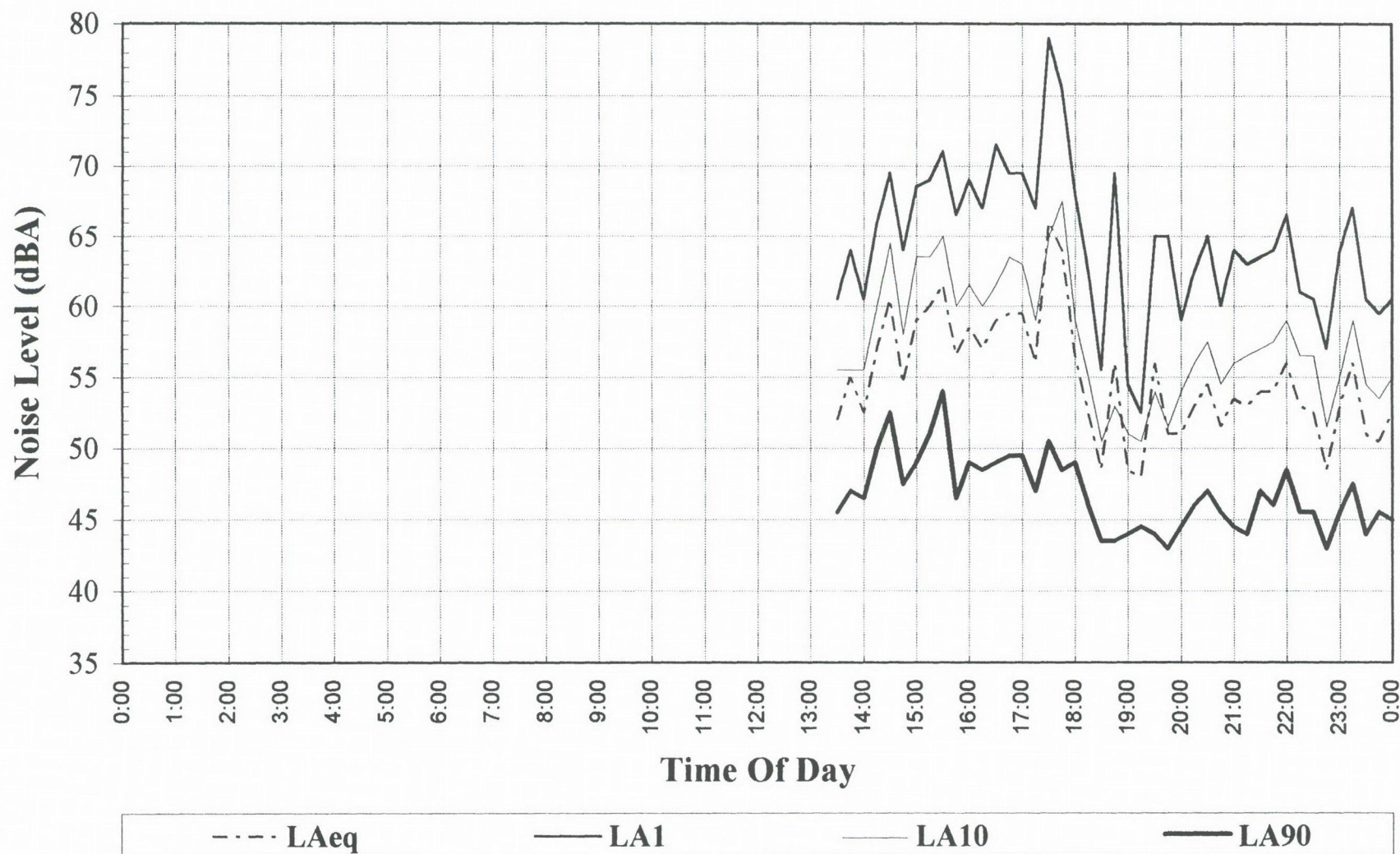
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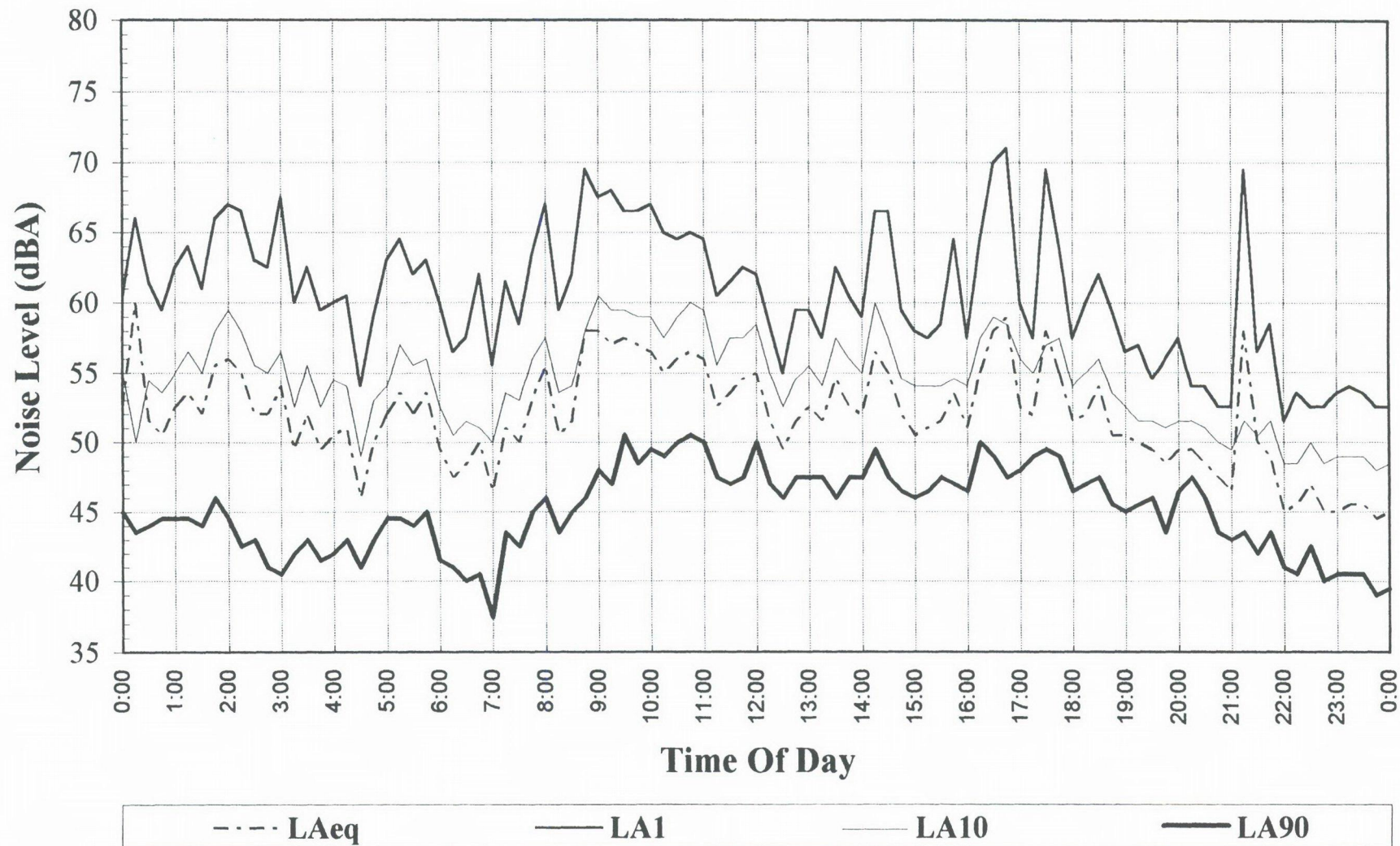
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Saturday, 7 March, 1998



## Noise Levels at Location 5 - Isherwood, Wooyung Road, Yelgun

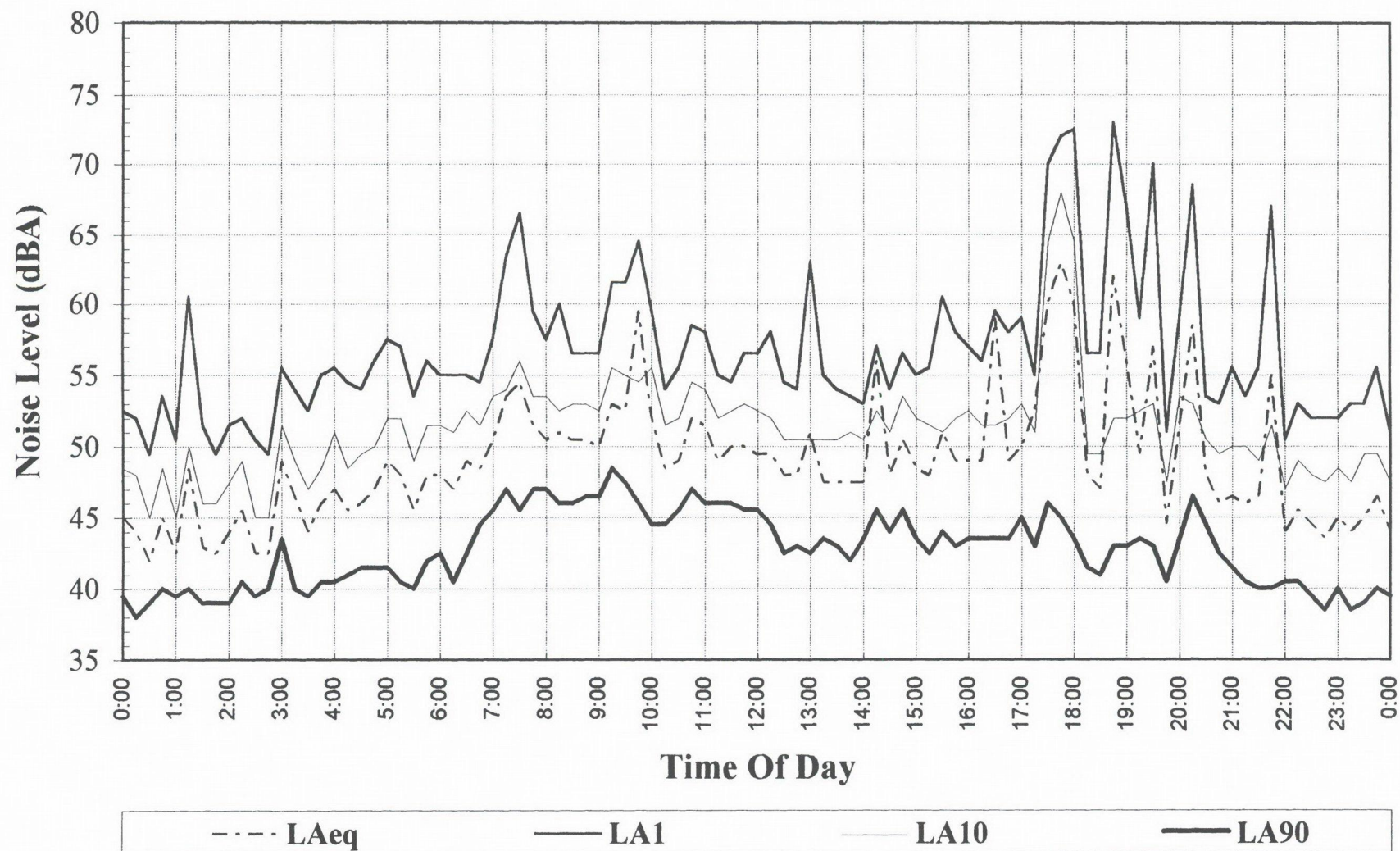
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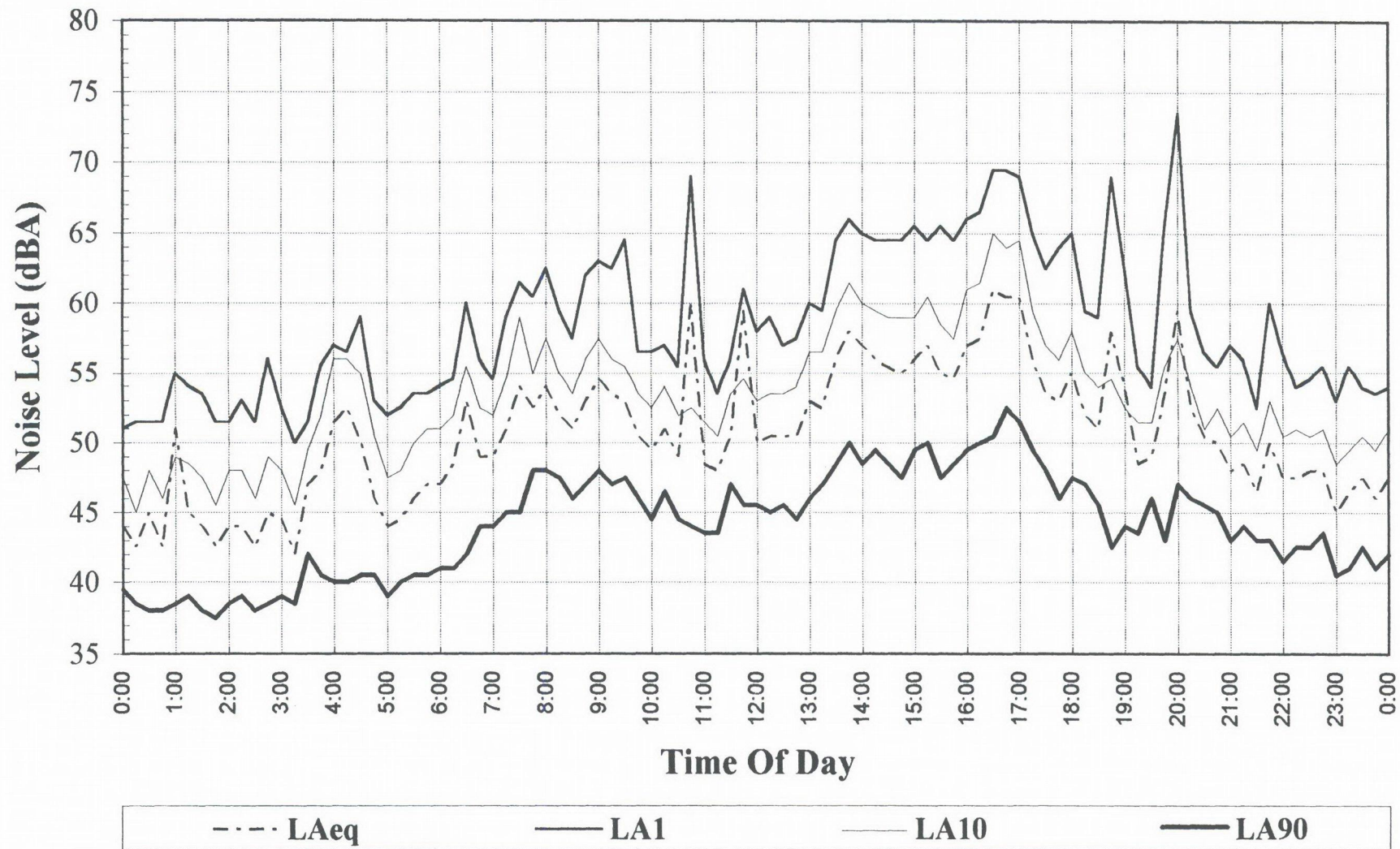
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Monday, 9 March, 1998



## Noise Levels at Location 5 - Isherwood, Wooyung Road, Yelgun

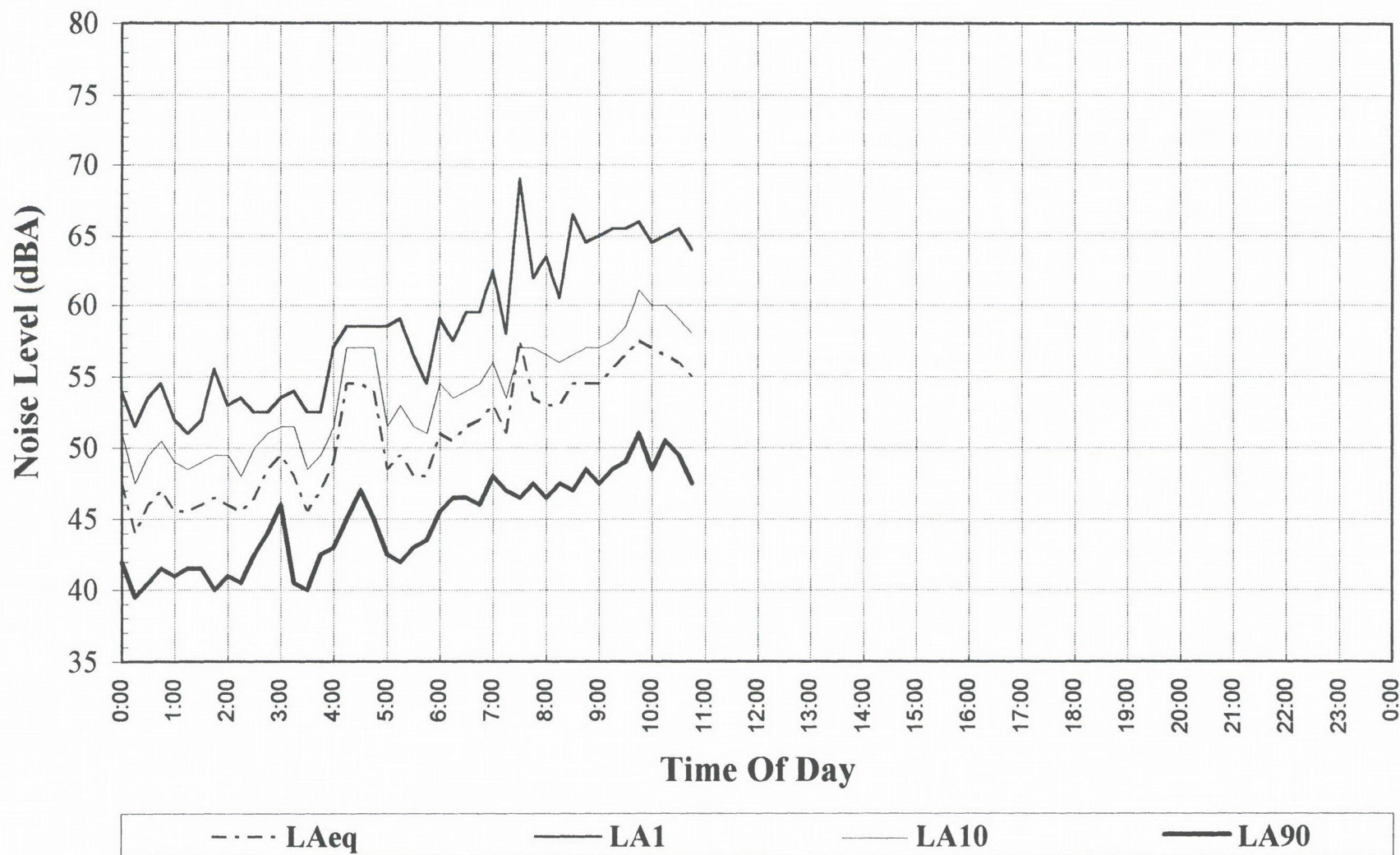
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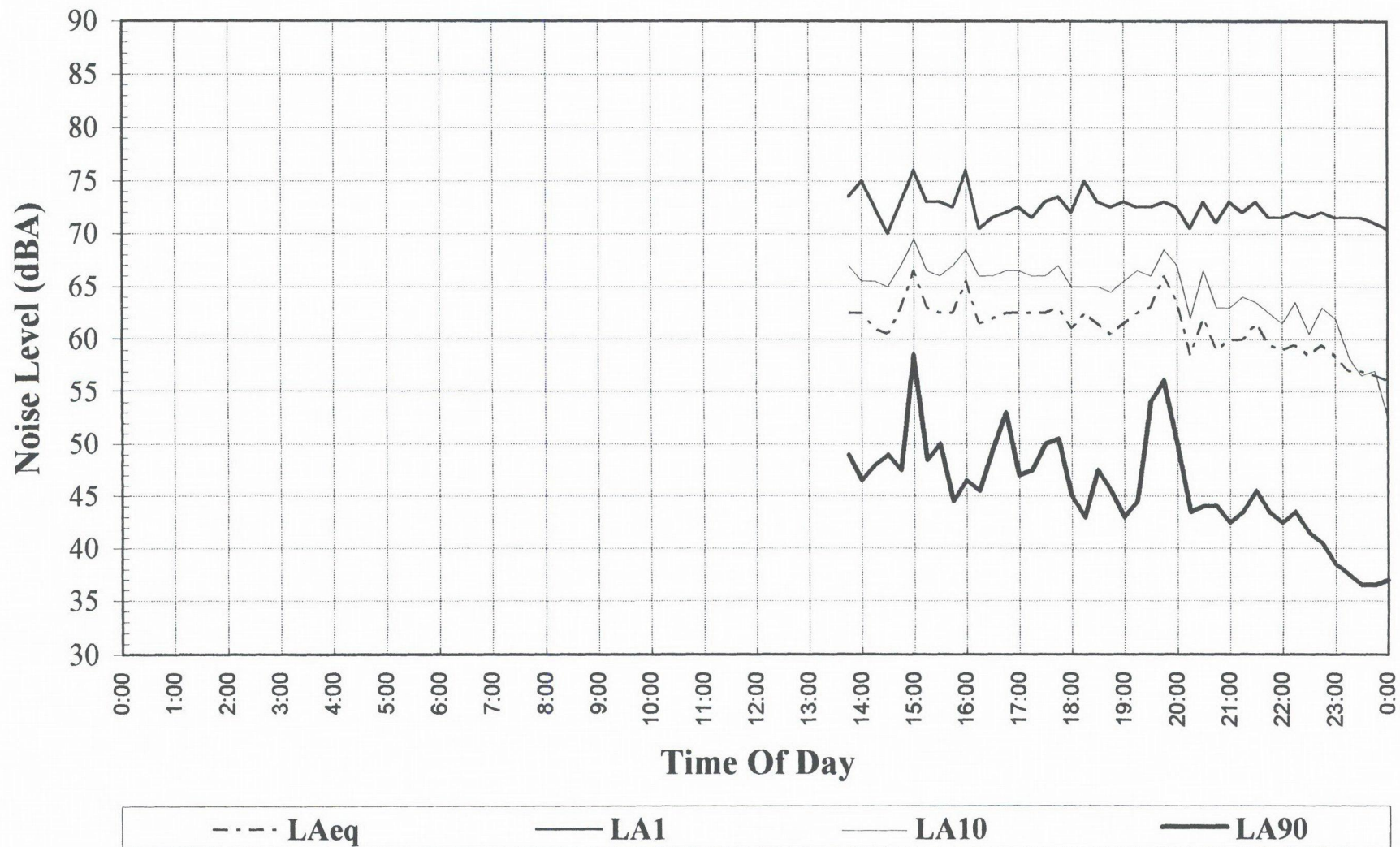
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Wednesday, 11 March, 1998



## Noise Levels at Location 6 - Lot 6 (Alexander), Crabbes Creek

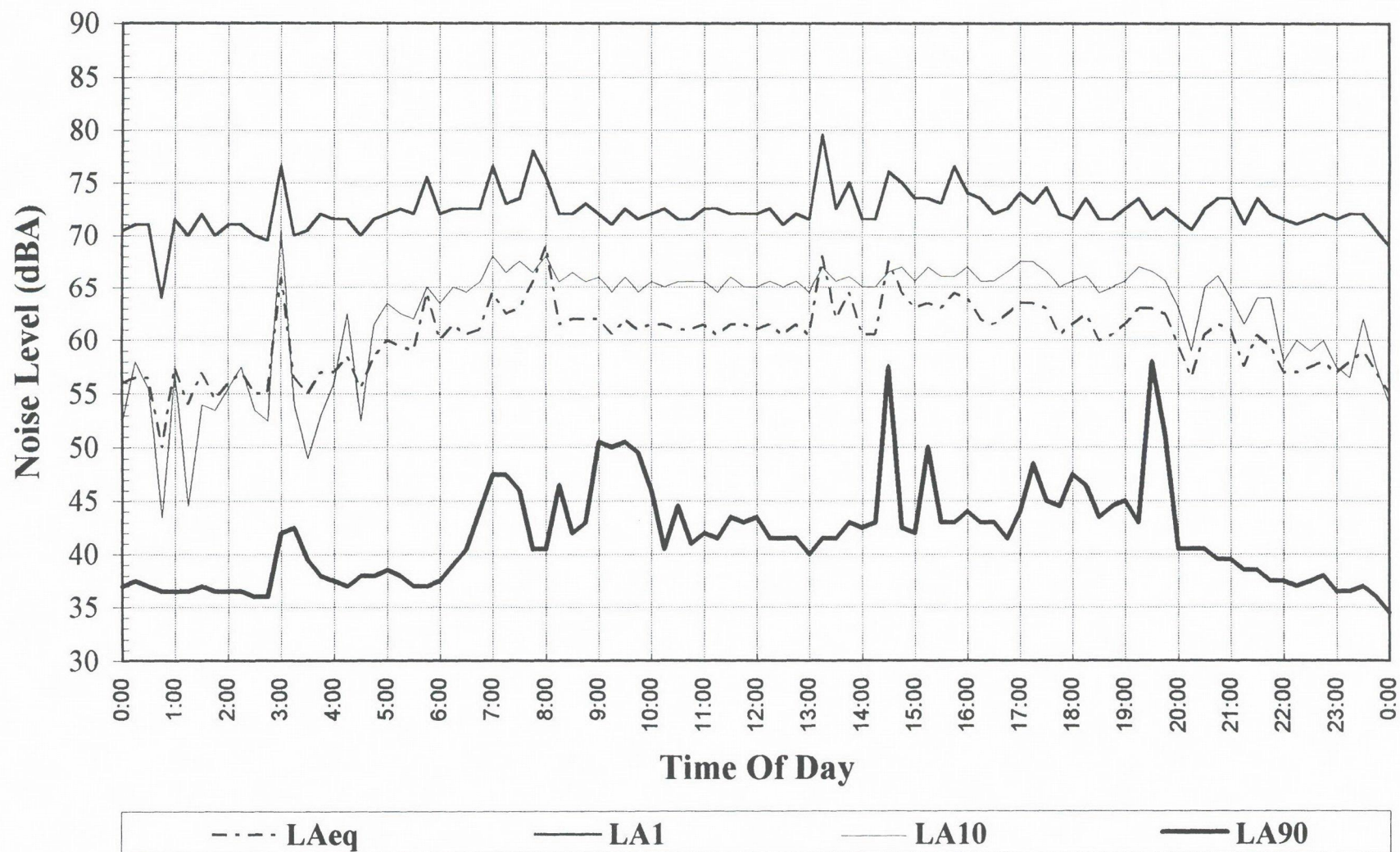
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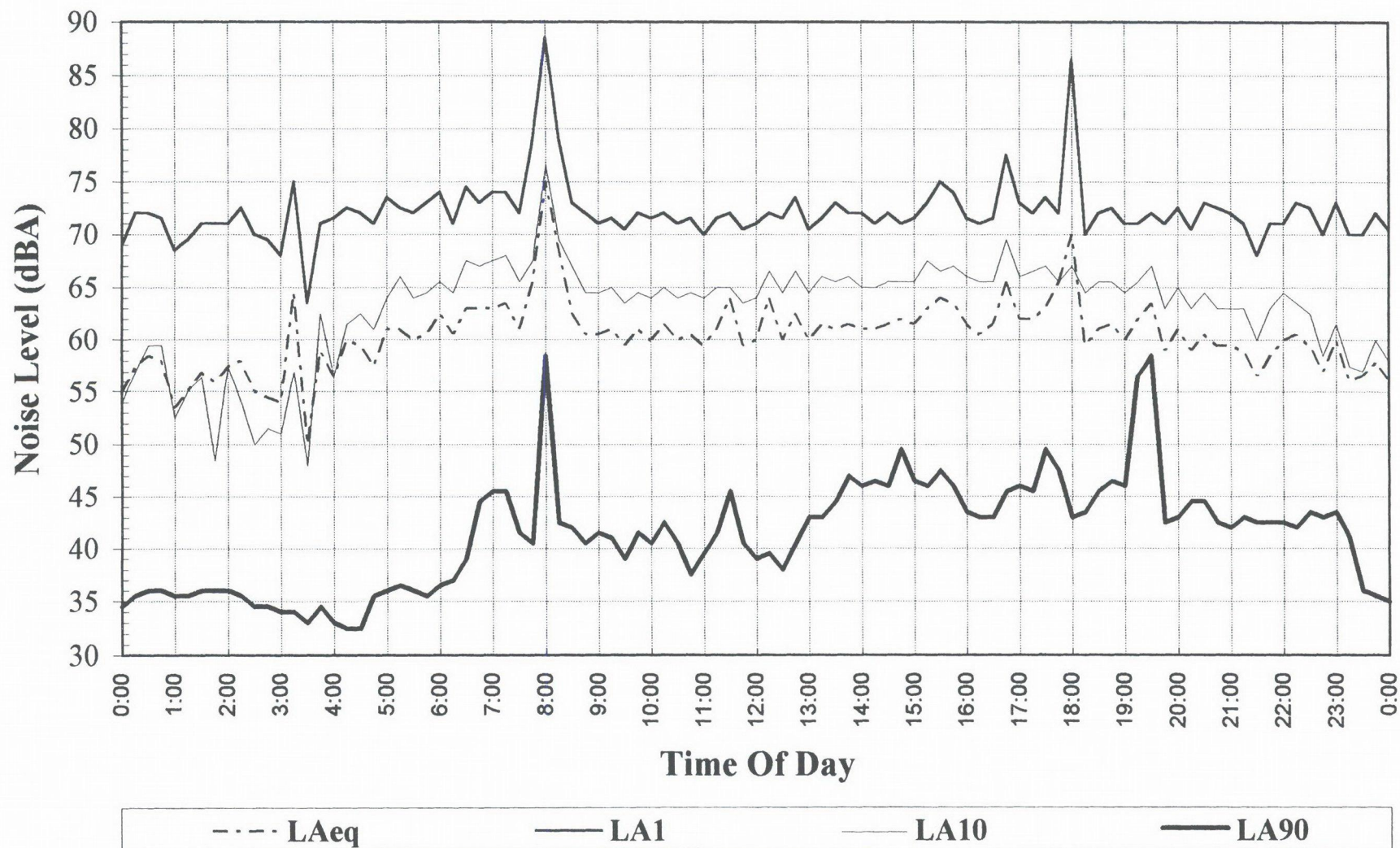
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Wednesday, 4 March, 1998



## Noise Levels at Location 6 - Lot 6 (Alexander), Crabbes Creek

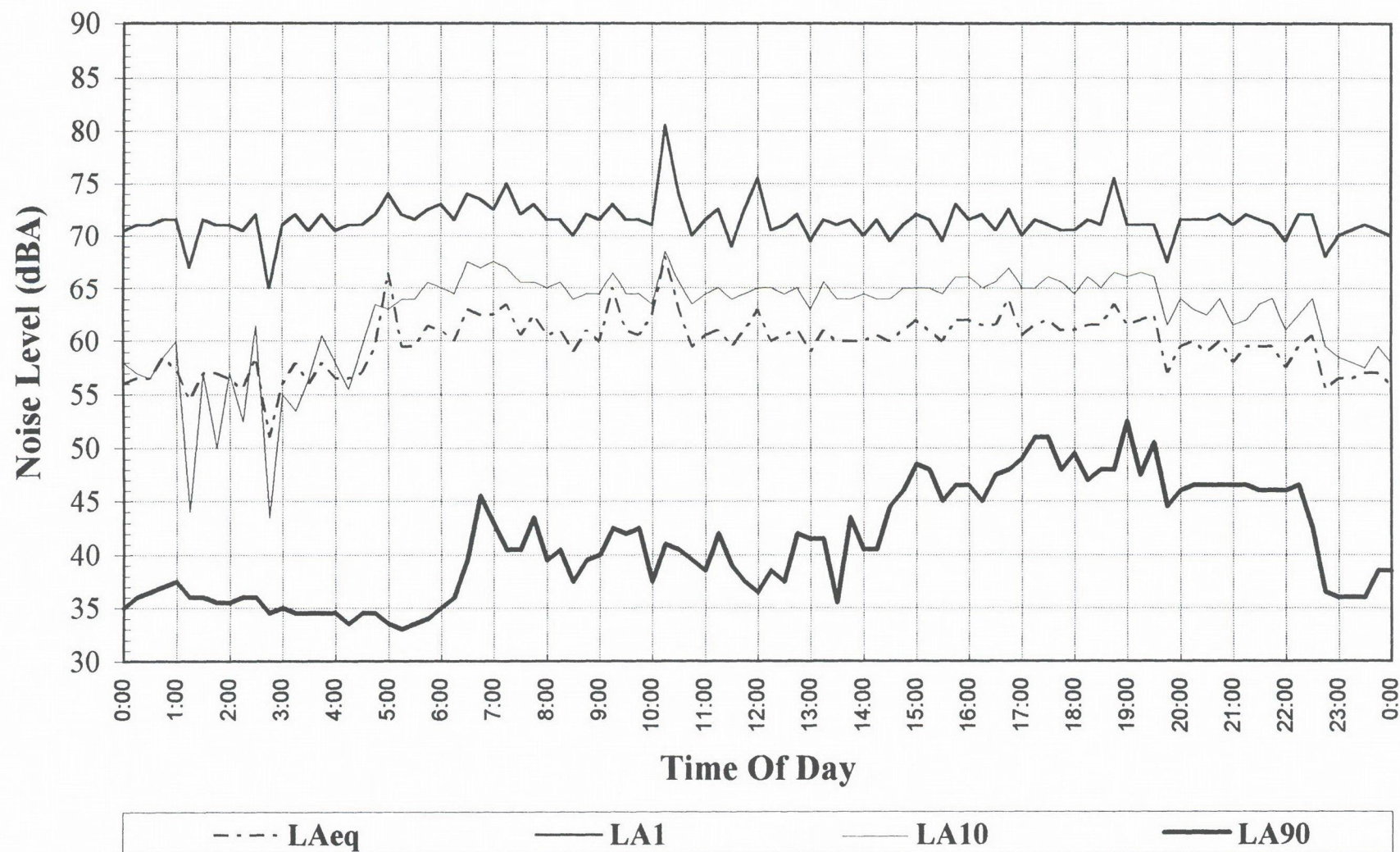
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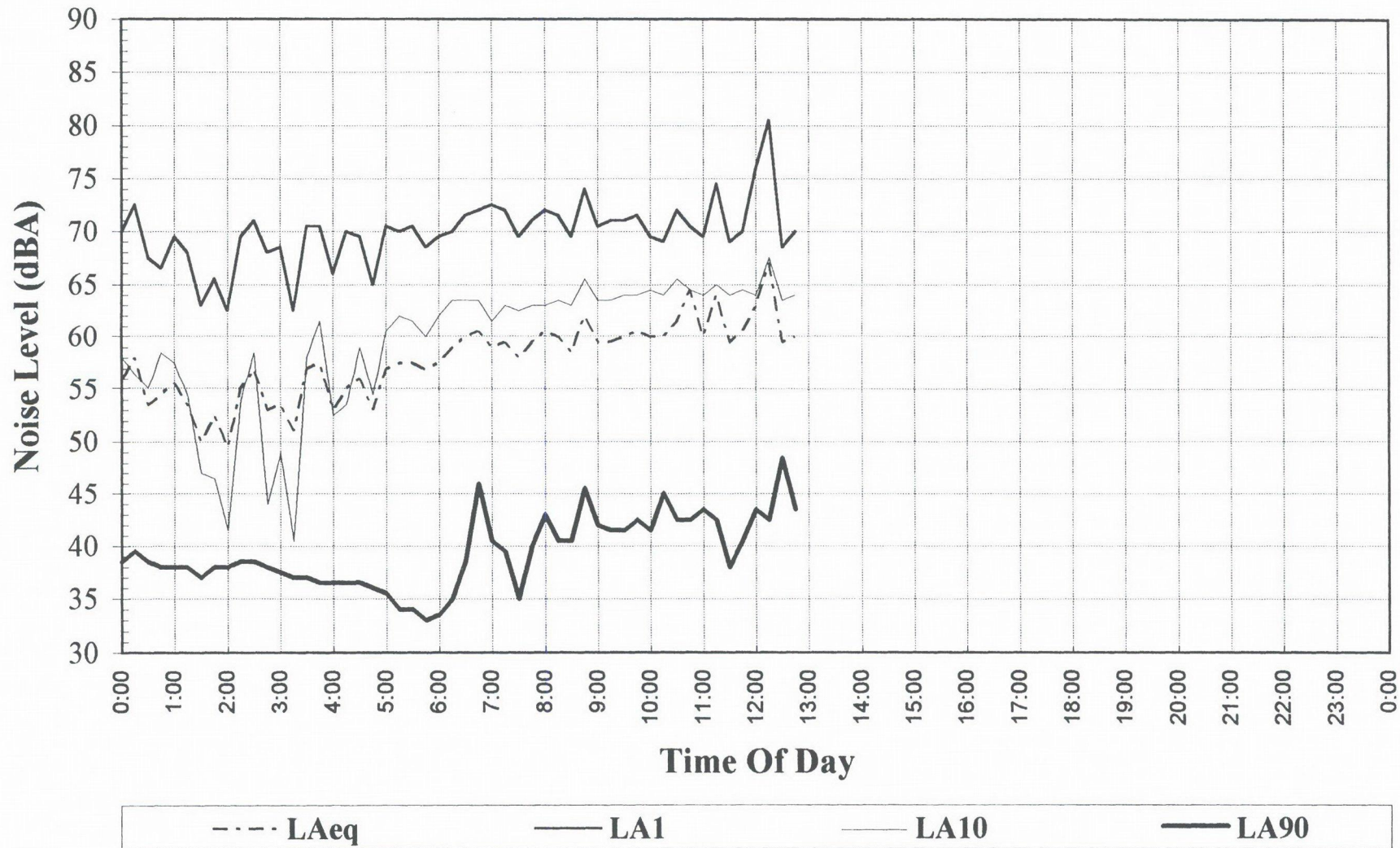
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Friday, 6 March, 1998



## Noise Levels at Location 6 - Lot 6 (Alexander), Crabbes Creek

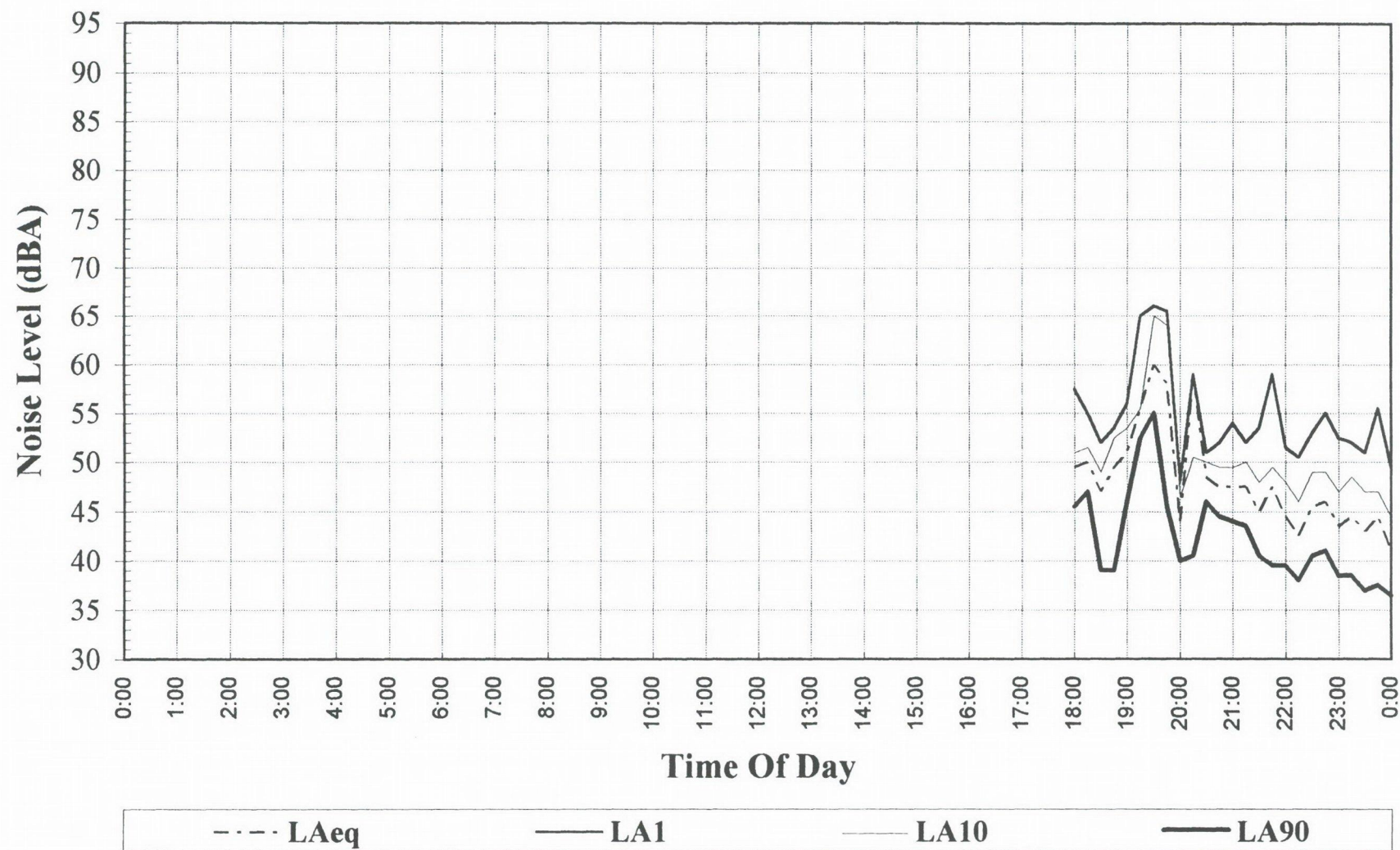
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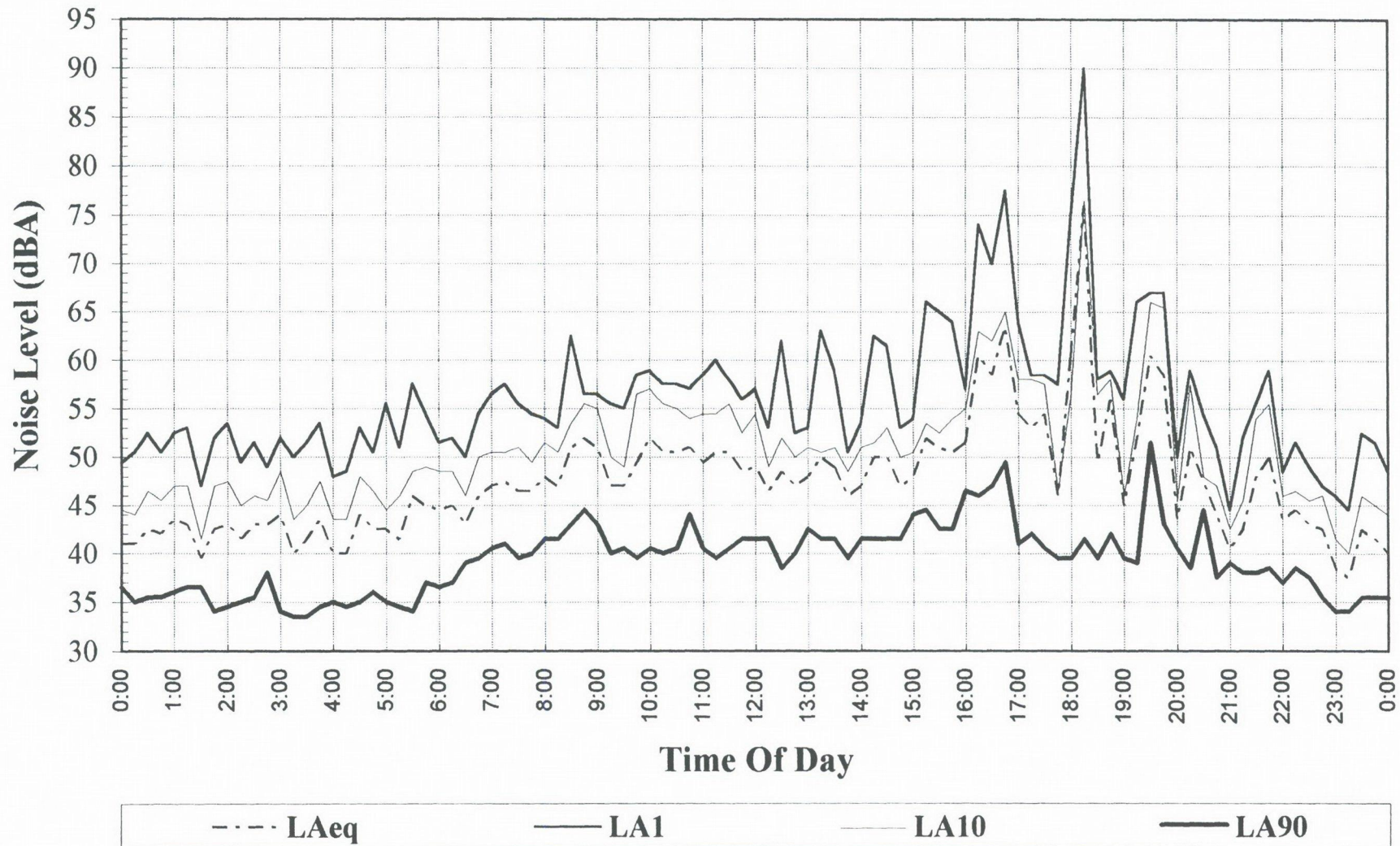
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Friday, 27 February, 1998



## Noise Levels at Location 7 - "Tweeddale", Hulls Road, Mooball

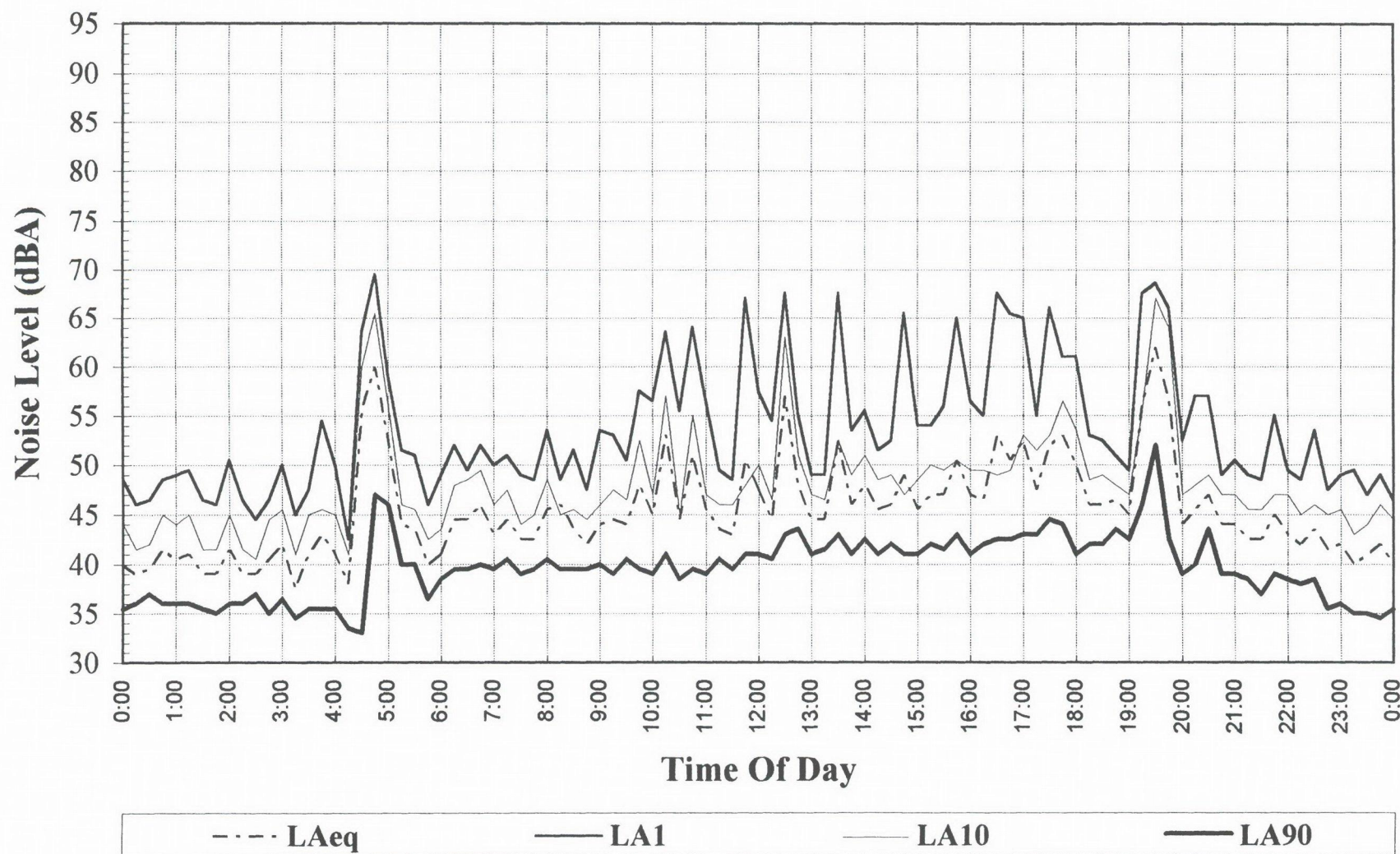
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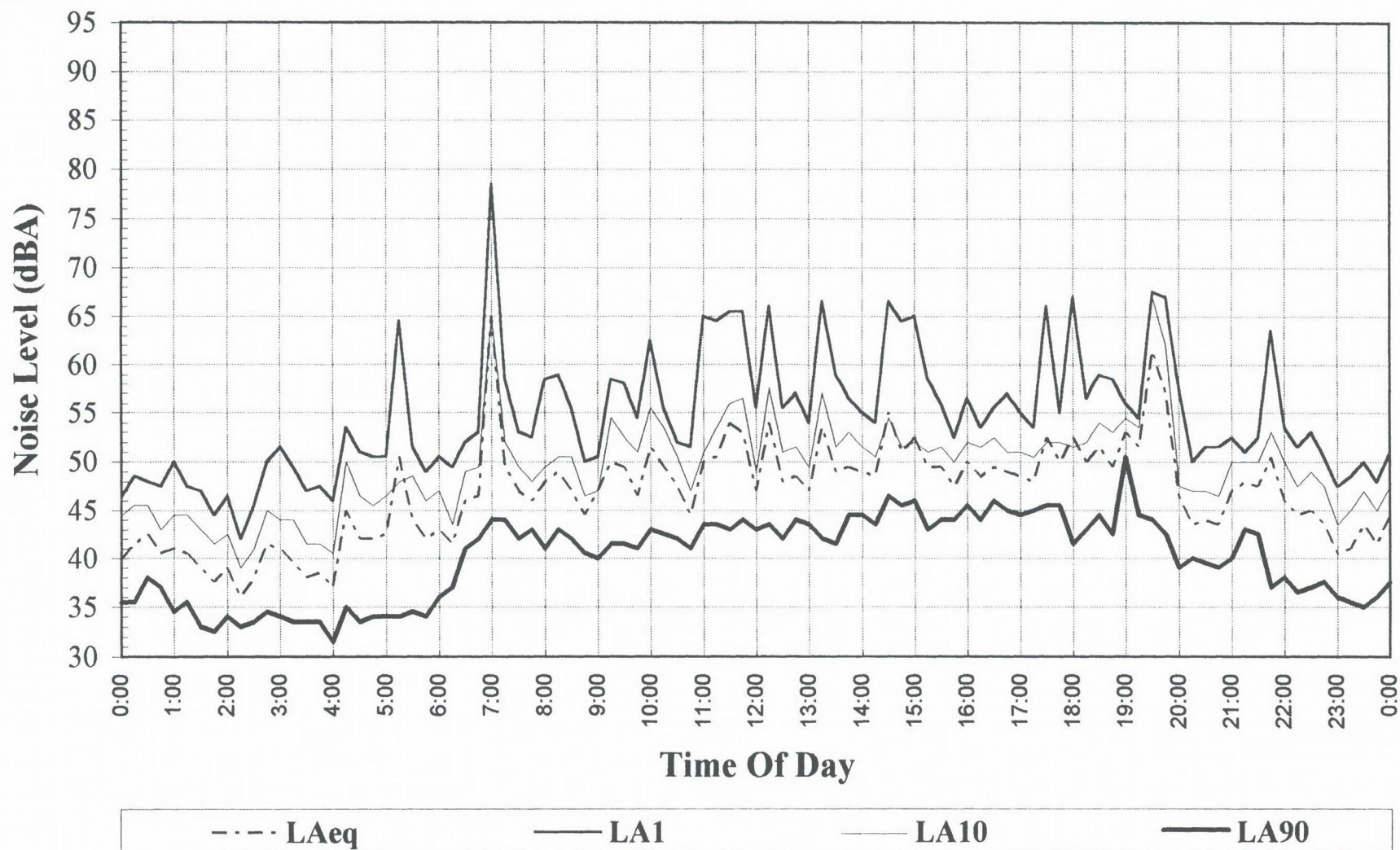
# Noise Levels at Location 7 - "Tweeddale", Halls Road, Mooball

Sunday, 1 March, 1998



# Noise Levels at Location 7 - "Tweeddale", Halls Road, Mooball

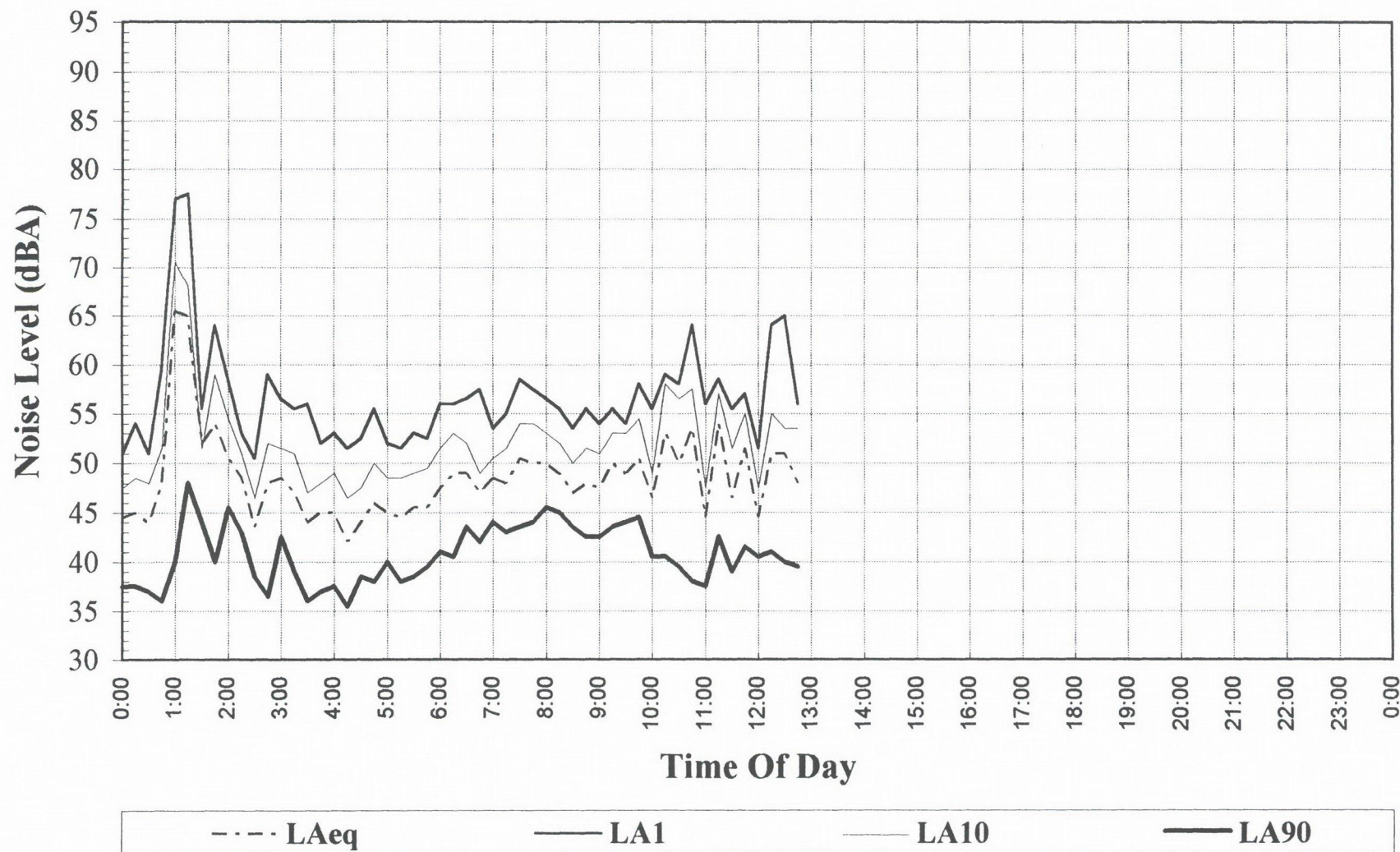
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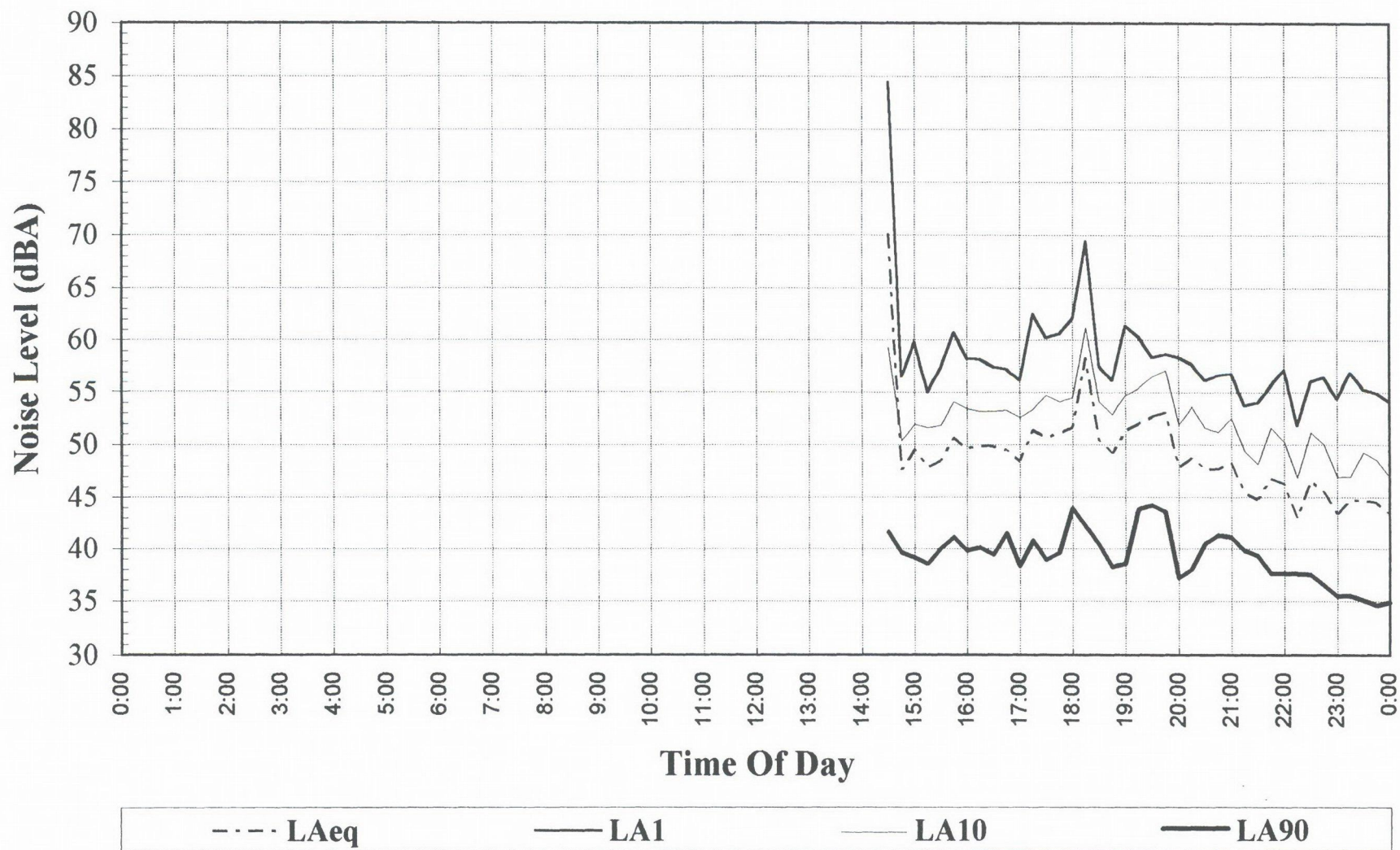
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Tuesday, 3 March, 1998



## Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

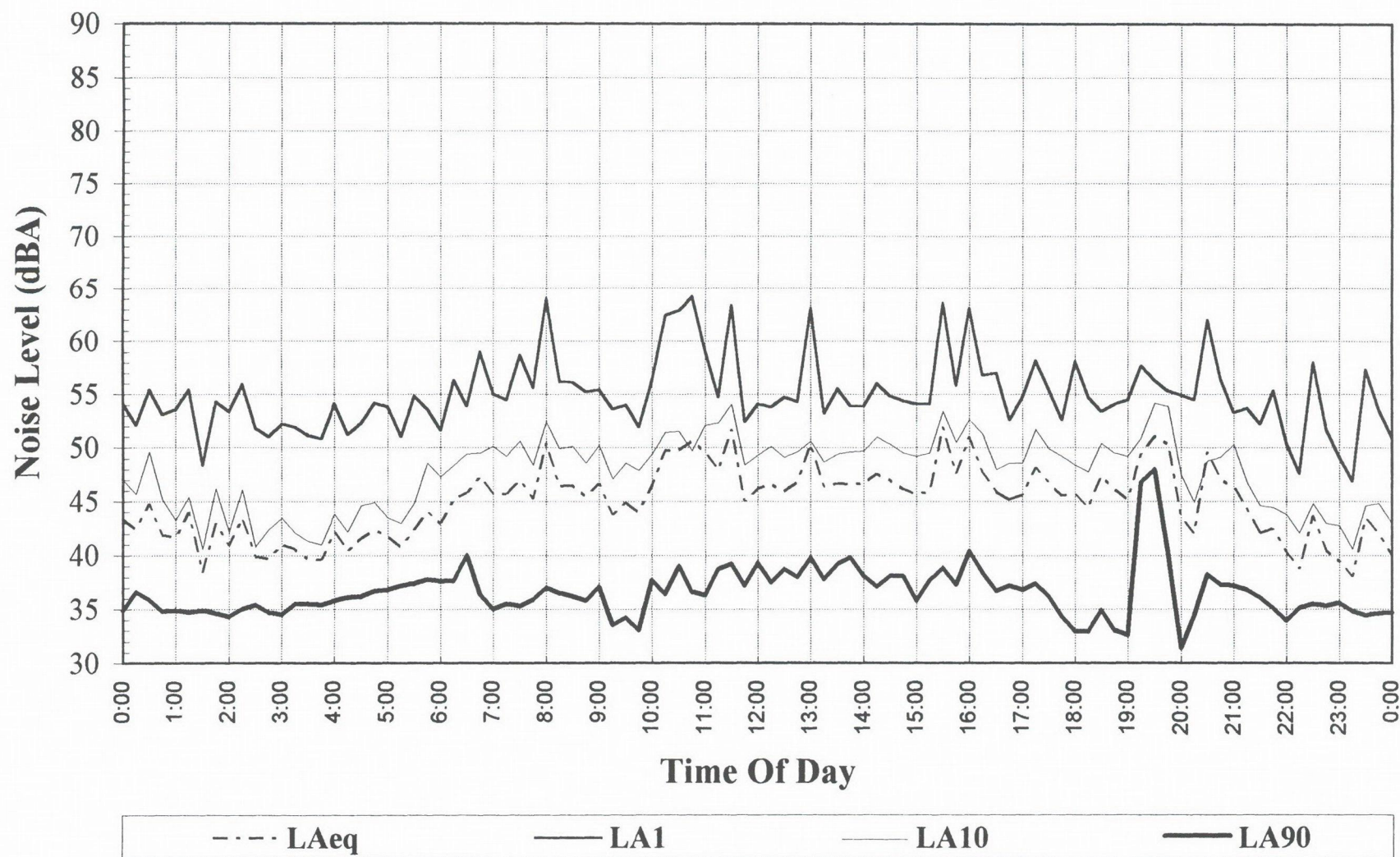
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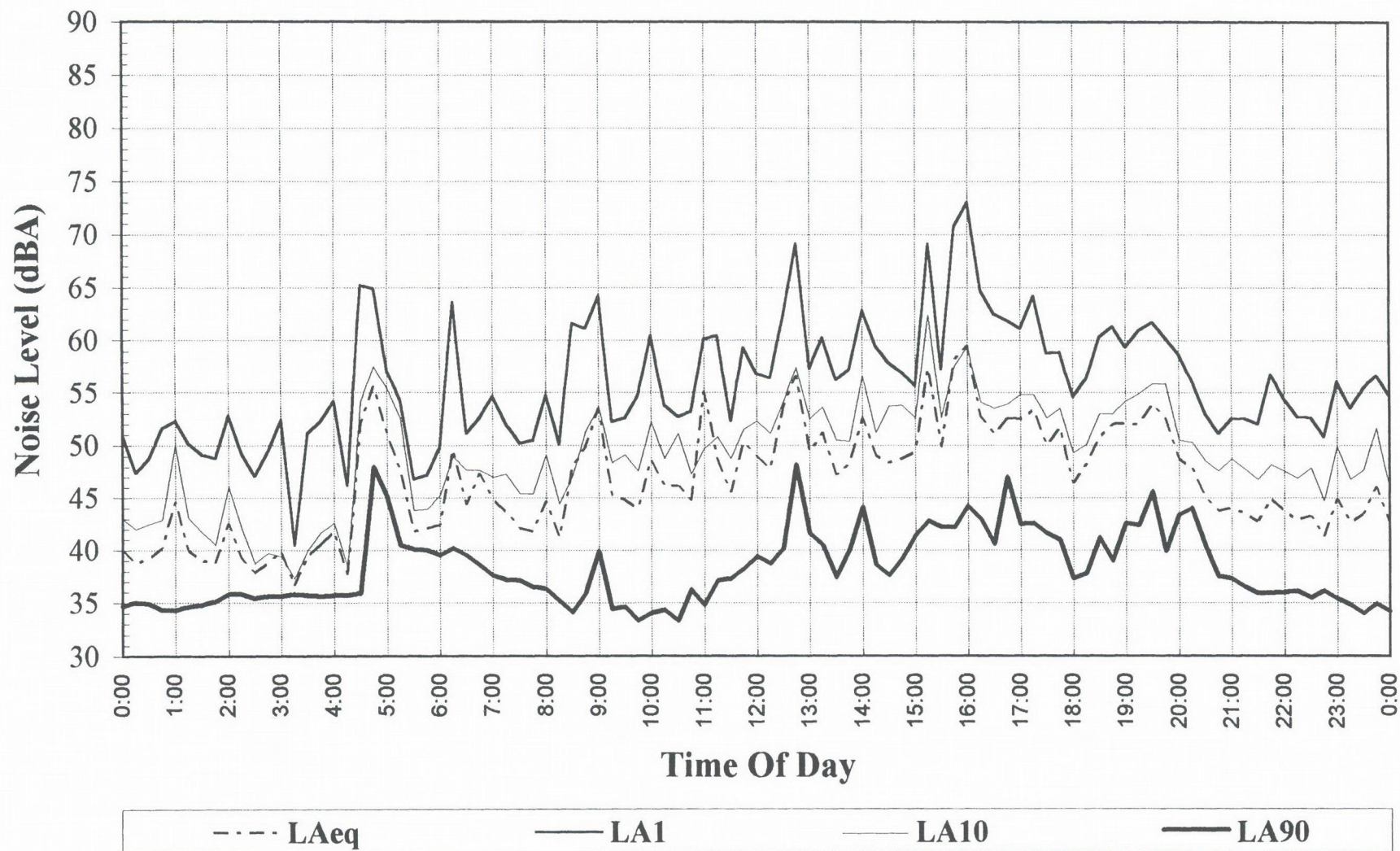
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Saturday, 28 February, 1998



## Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

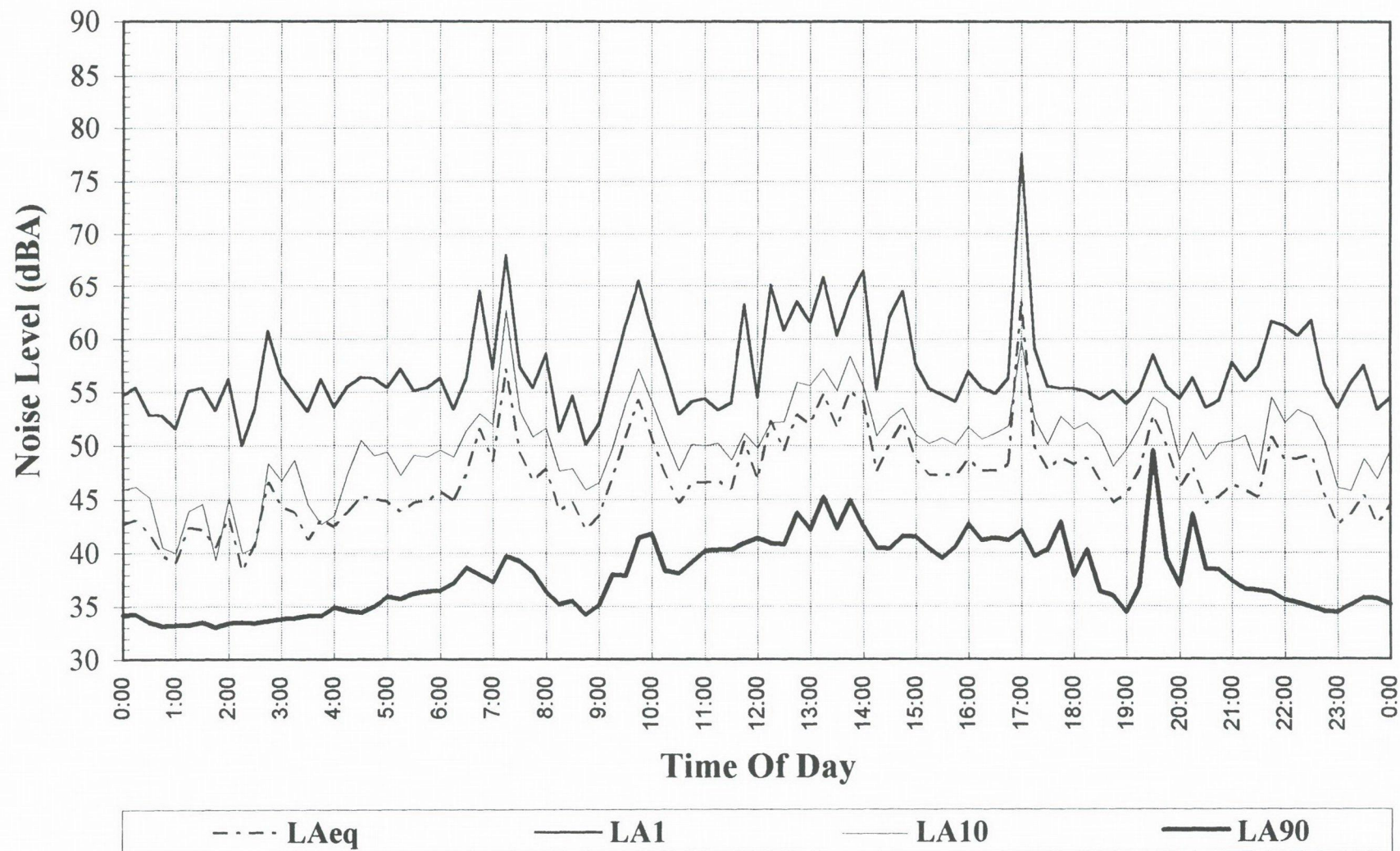
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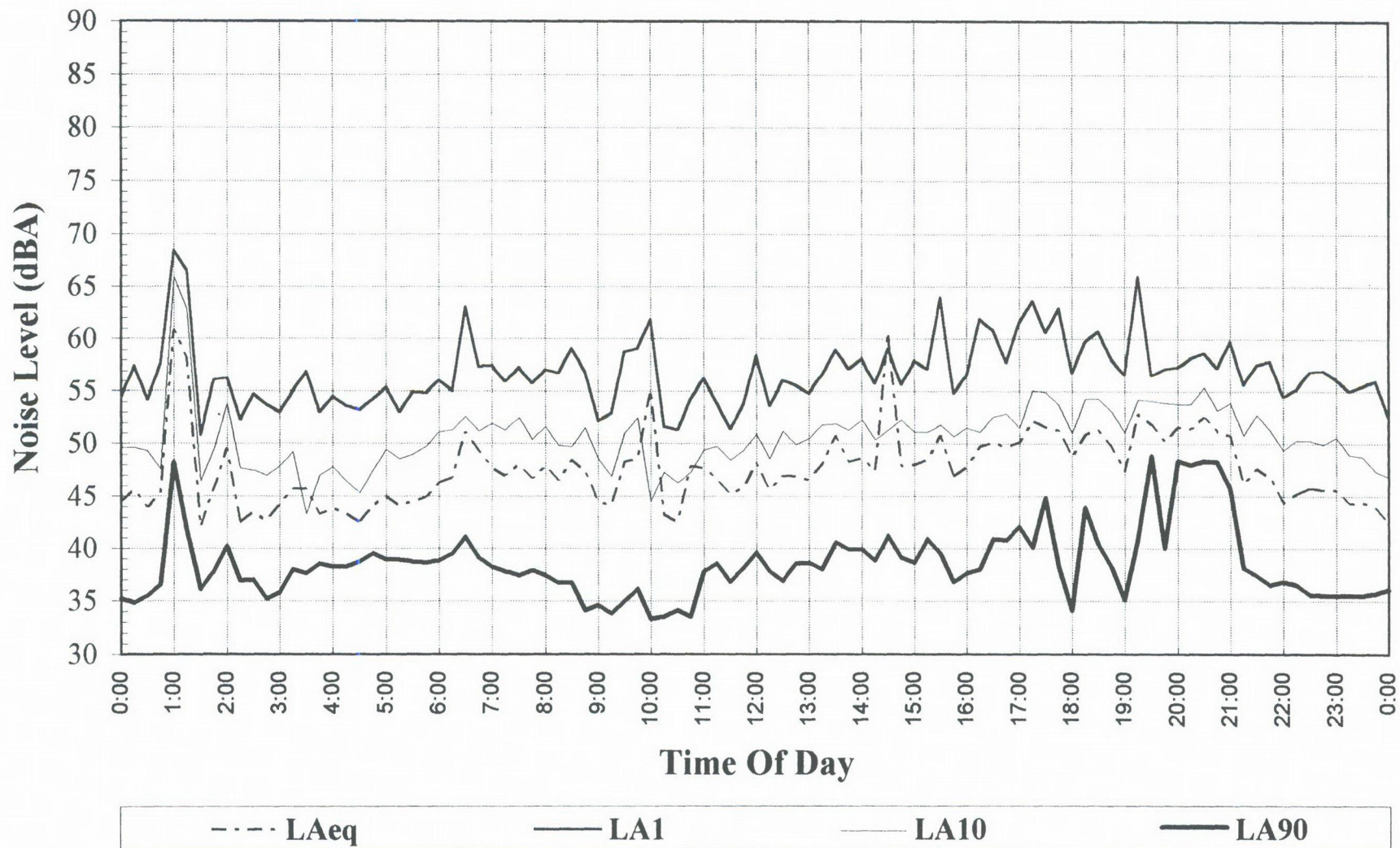
# Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

Monday, 2 March, 1998



## Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

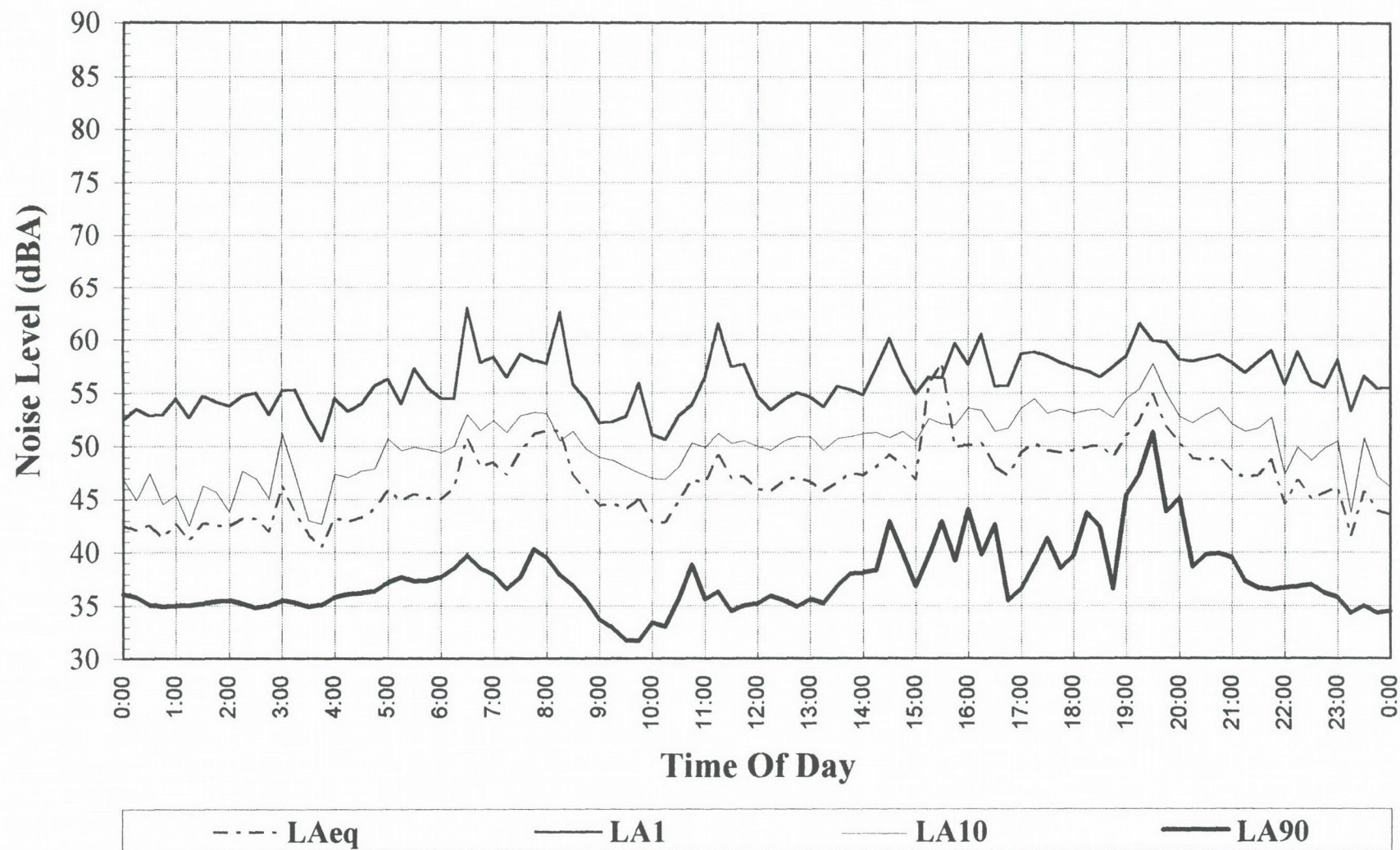
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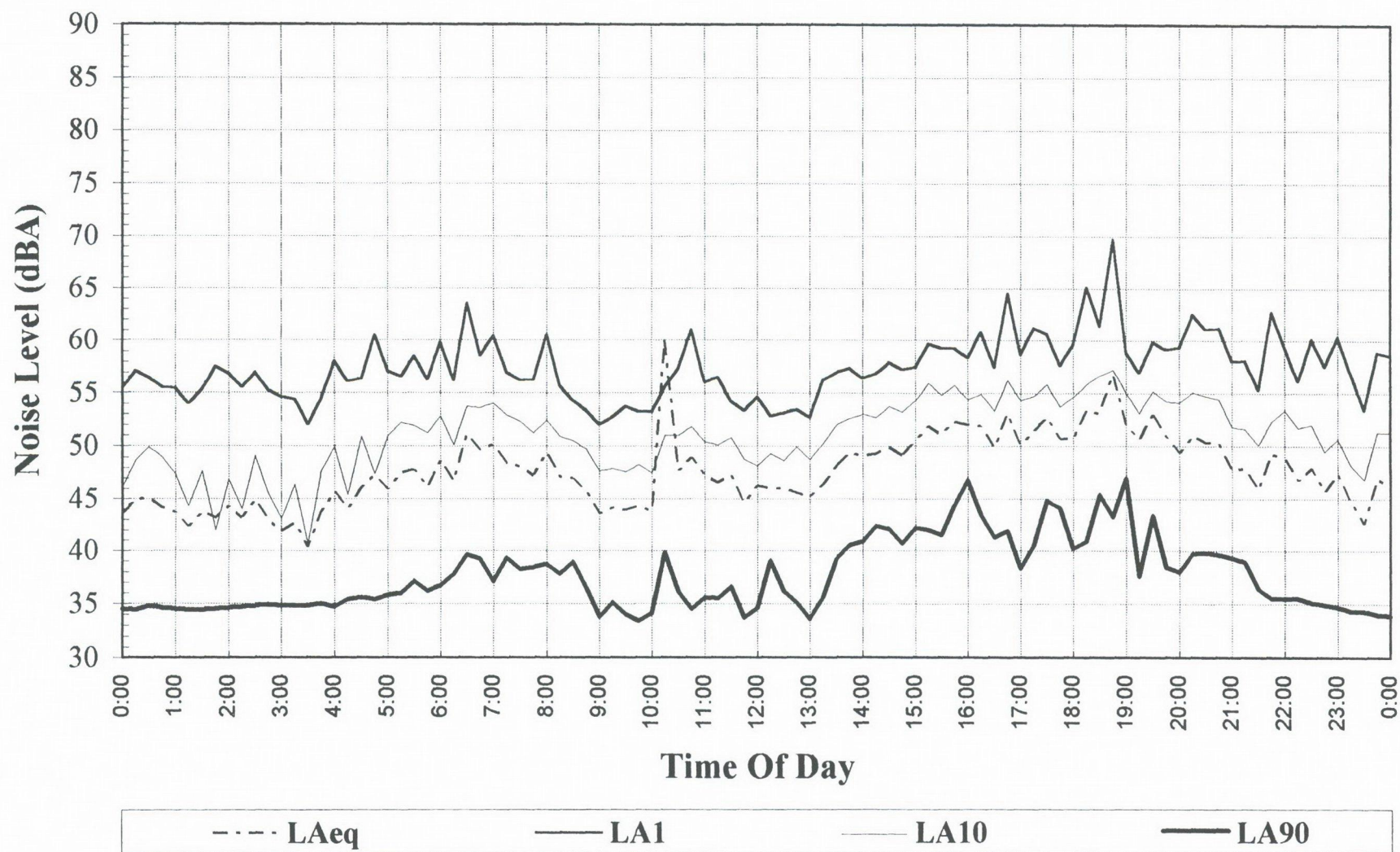
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Wednesday, 4 March, 1998



## Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

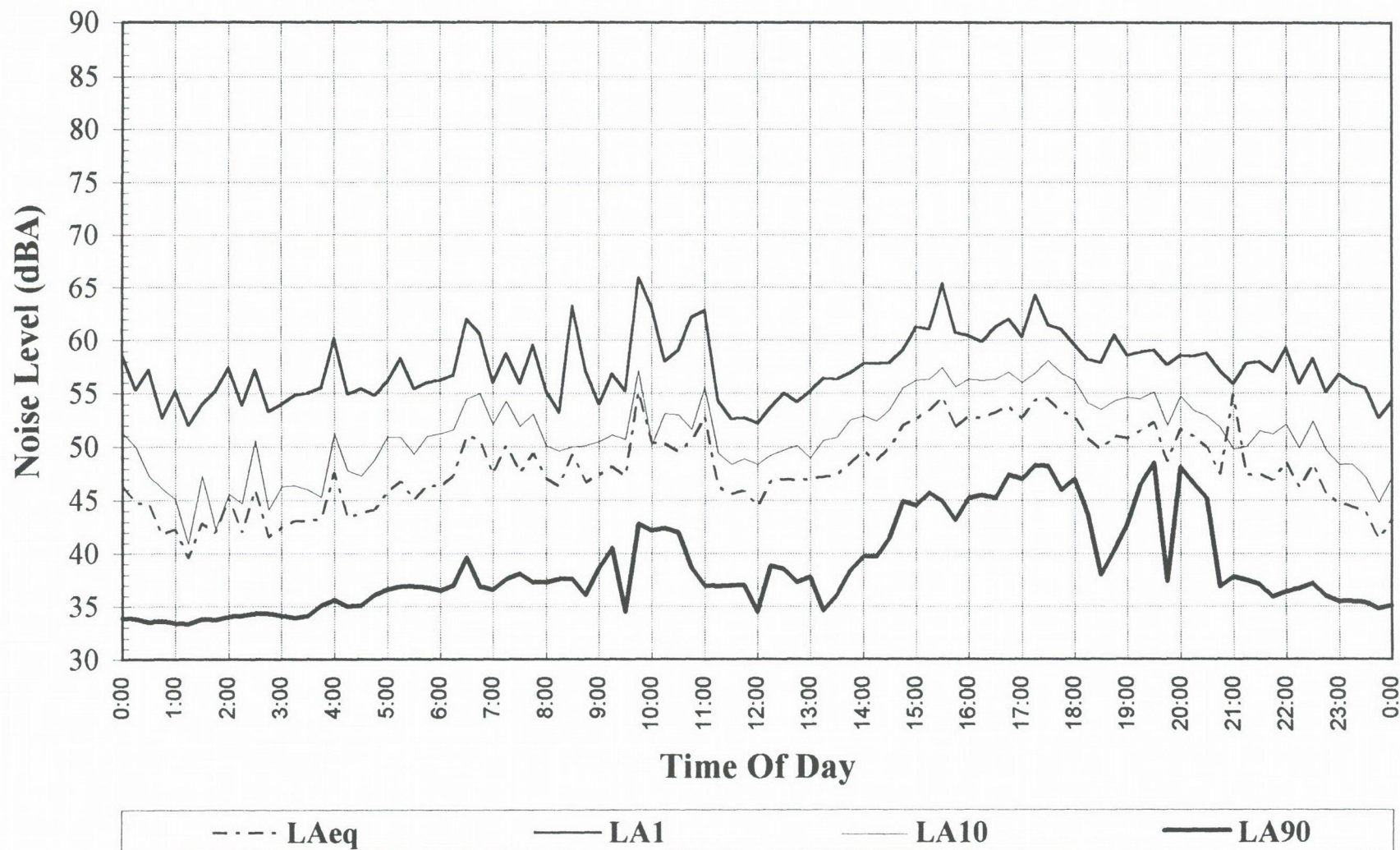
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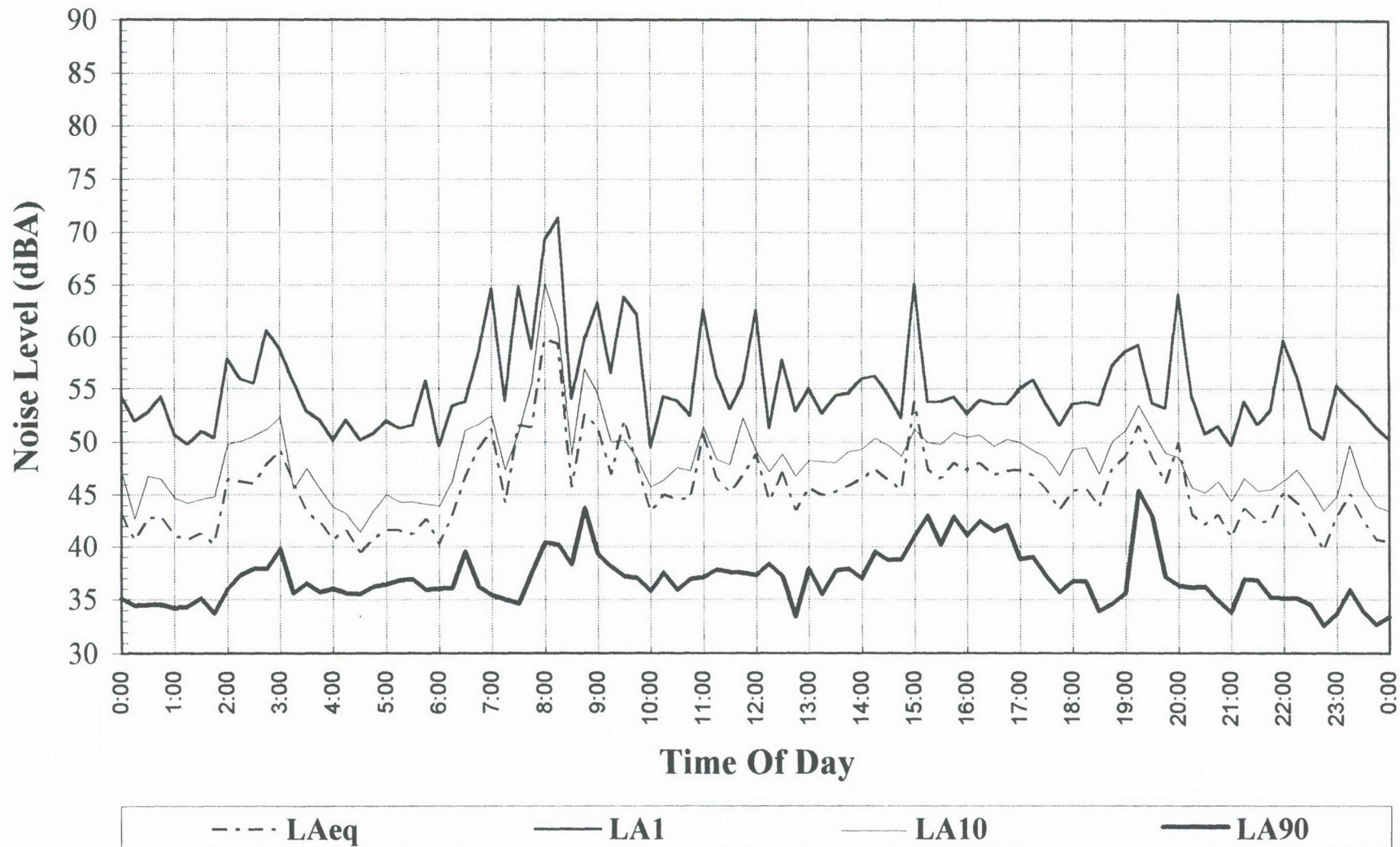
# Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

Friday, 6 March, 1998



## Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

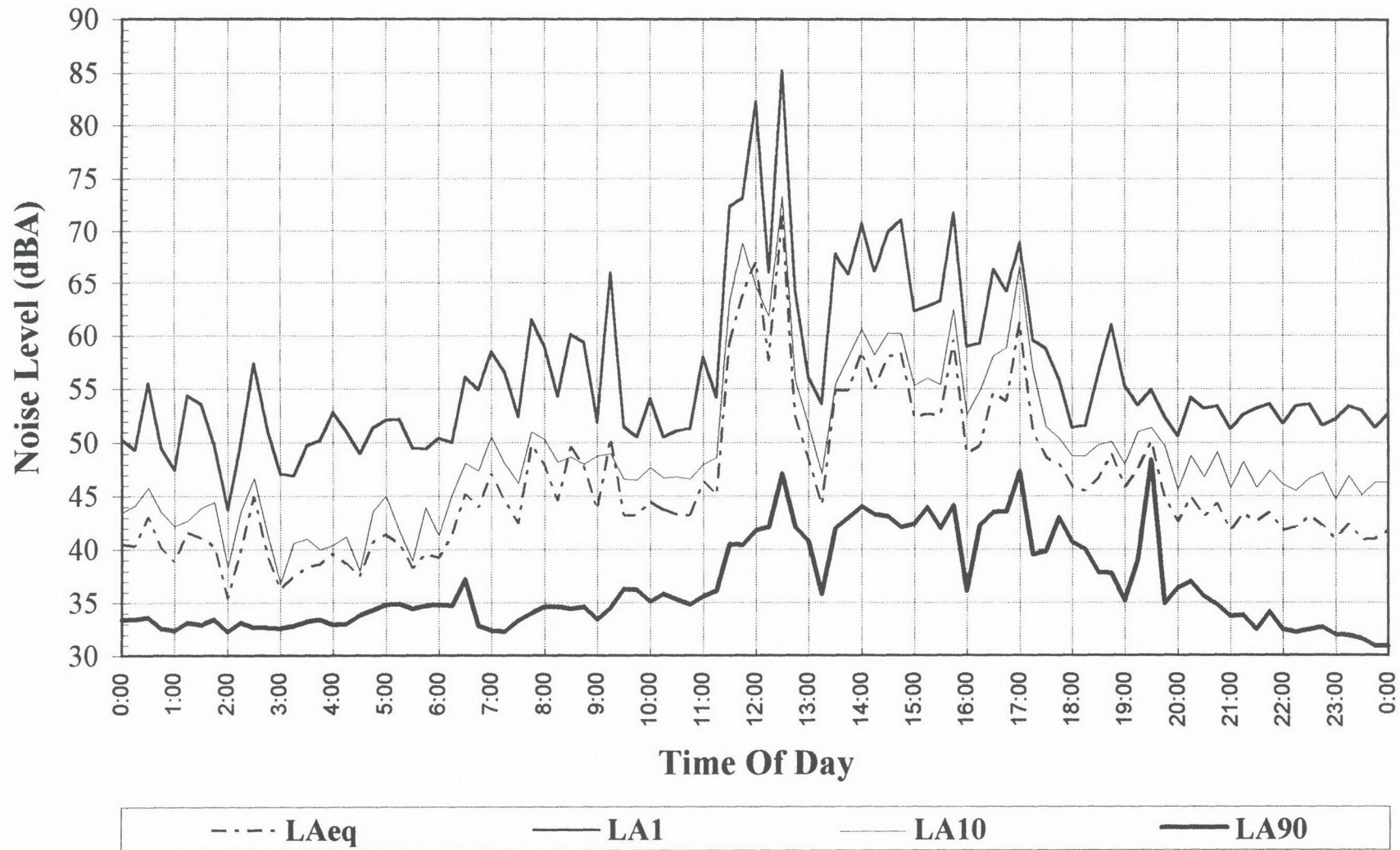
Saturday, 7 March, 1998





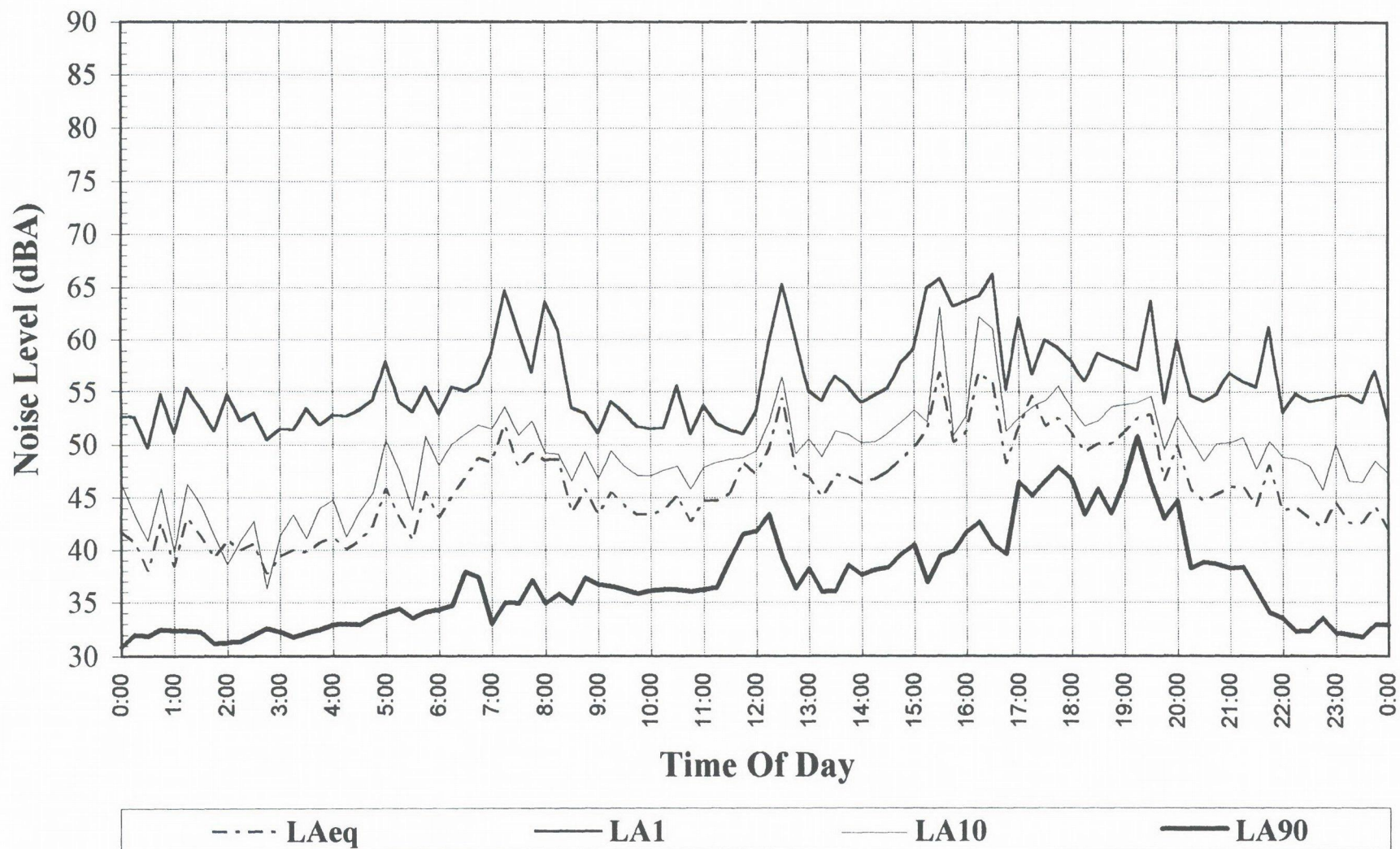
# Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

Sunday, 8 March, 1998



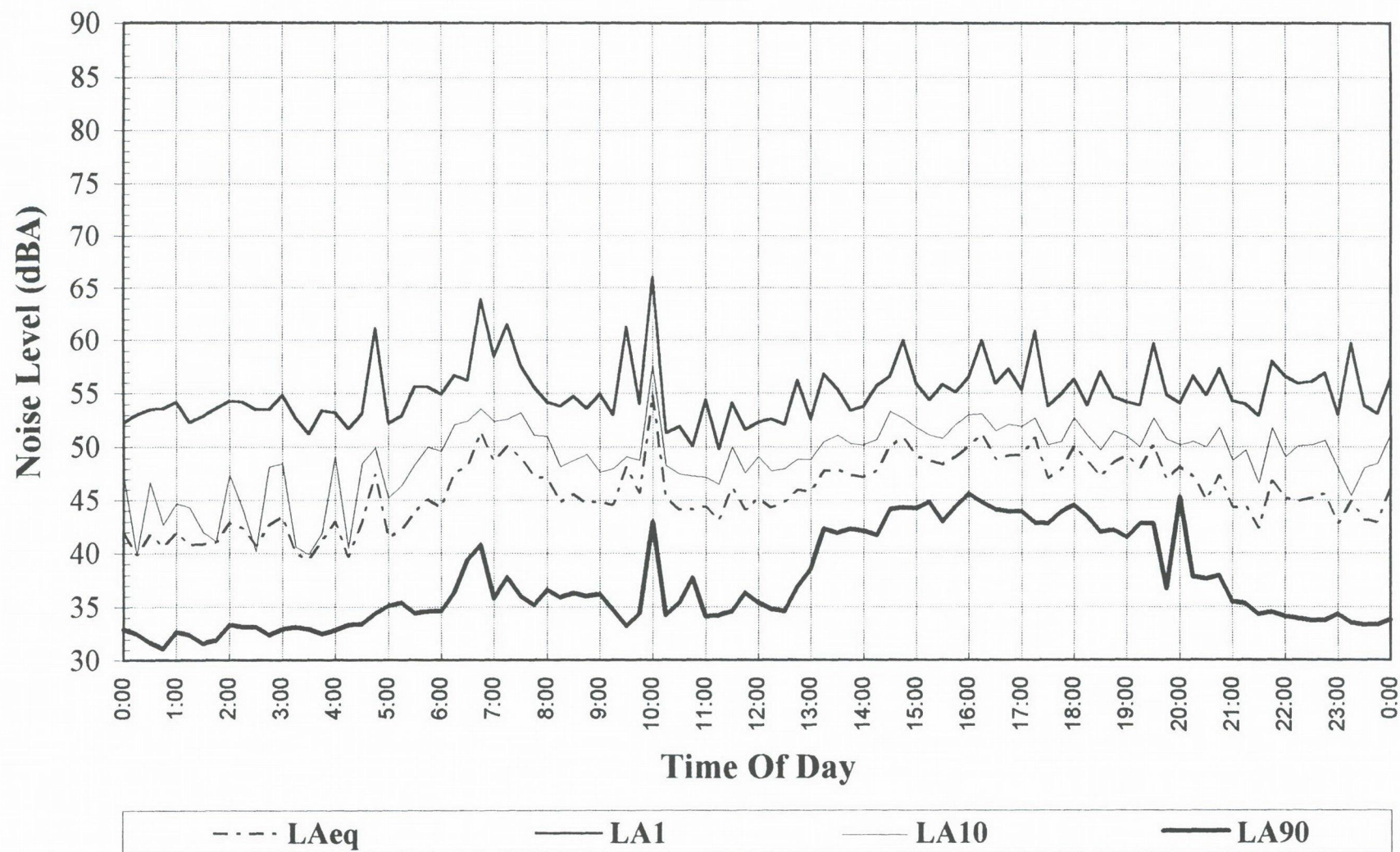
# Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

Monday, 9 March, 1998



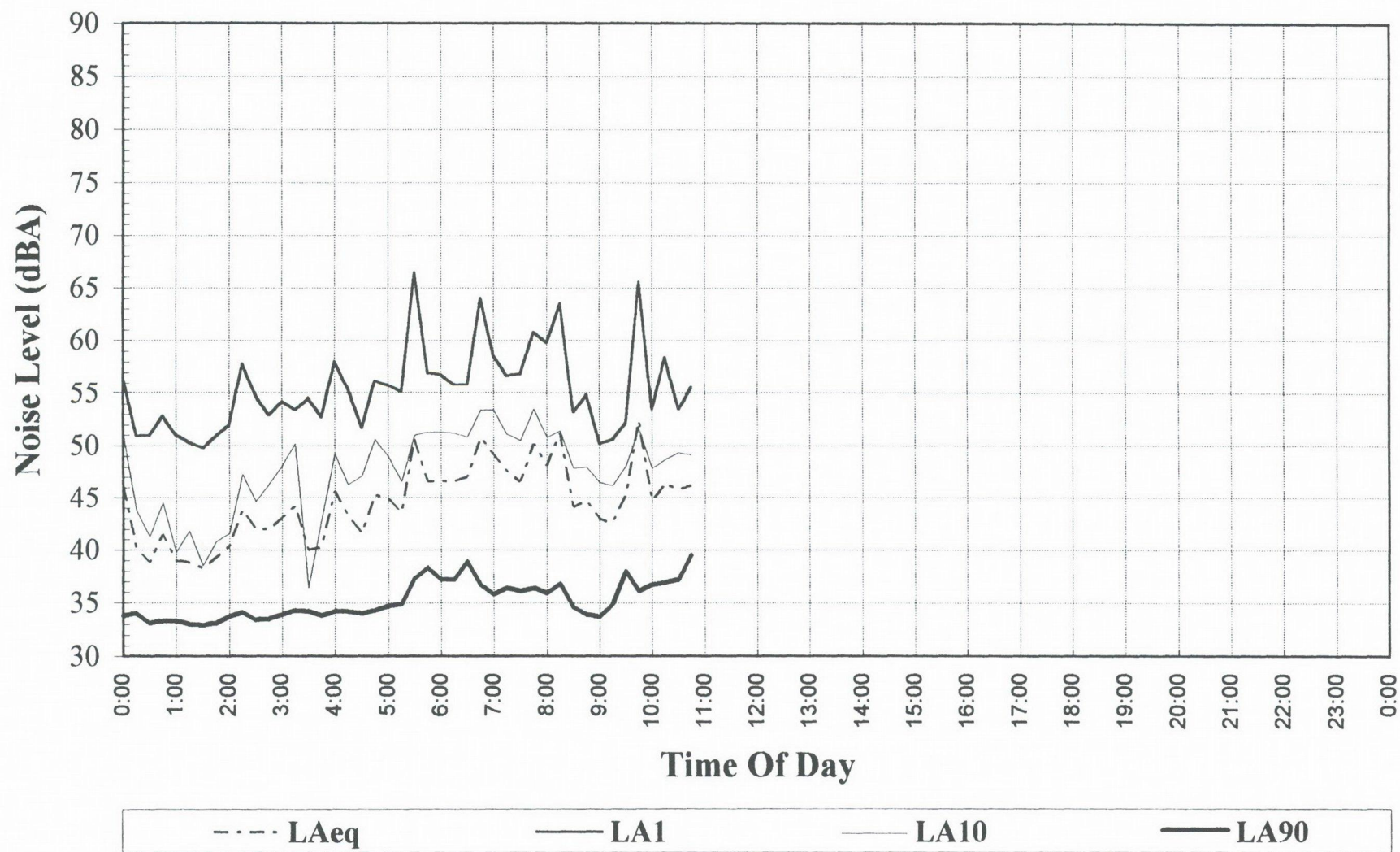


**Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball**  
**Tuesday, 10 March, 1998**



## Noise Levels at Location 8 - Lot 3 (Bale), Pacific Hwy, Mooball

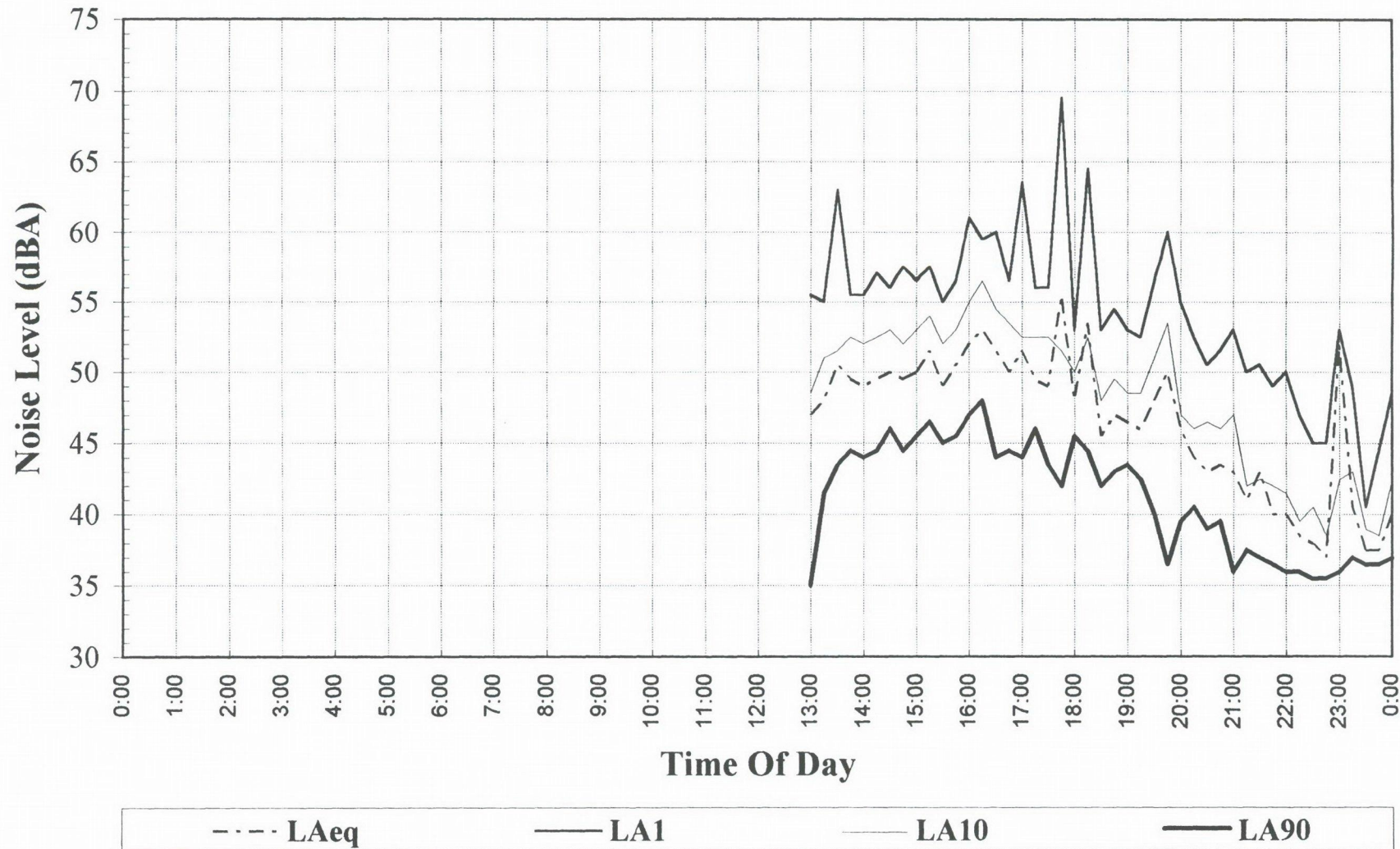
Wednesday, 11 March, 1998





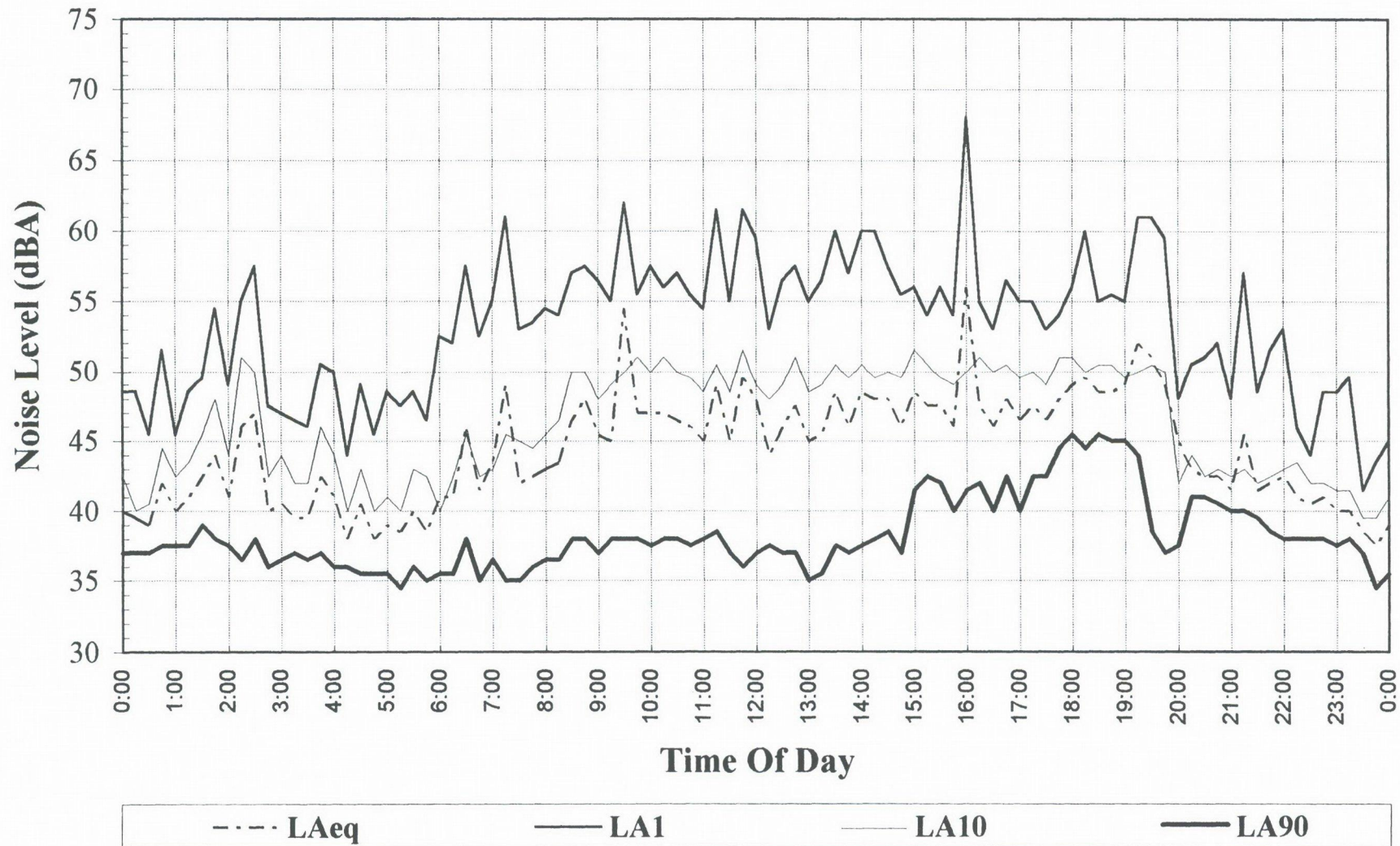
# Noise Levels at Location 9 - "Cowell Park", Mooball Road

Saturday, 7 March, 1998



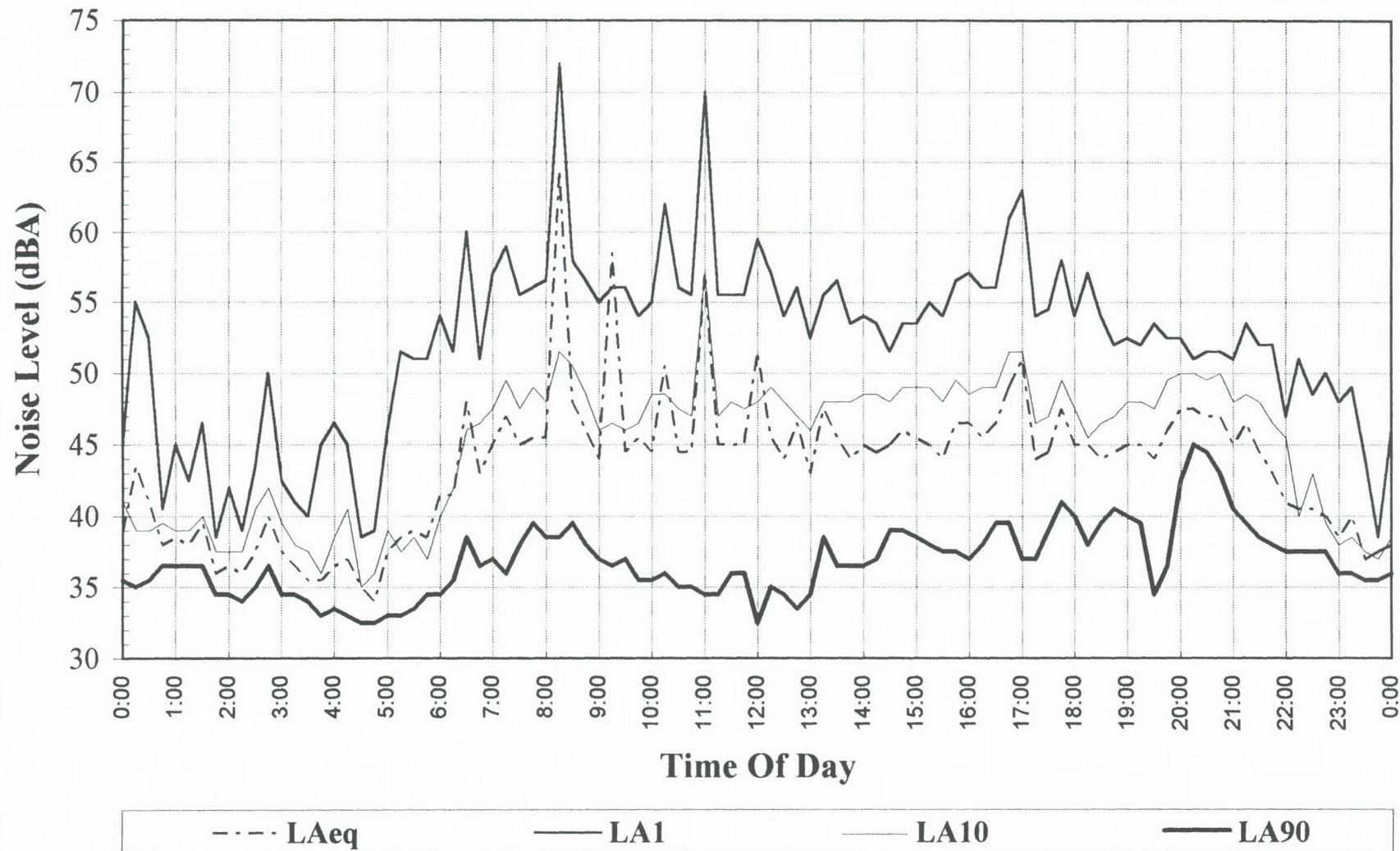
## Noise Levels at Location 9 - "Cowell Park", Mooball Road

Sunday, 8 March, 1998



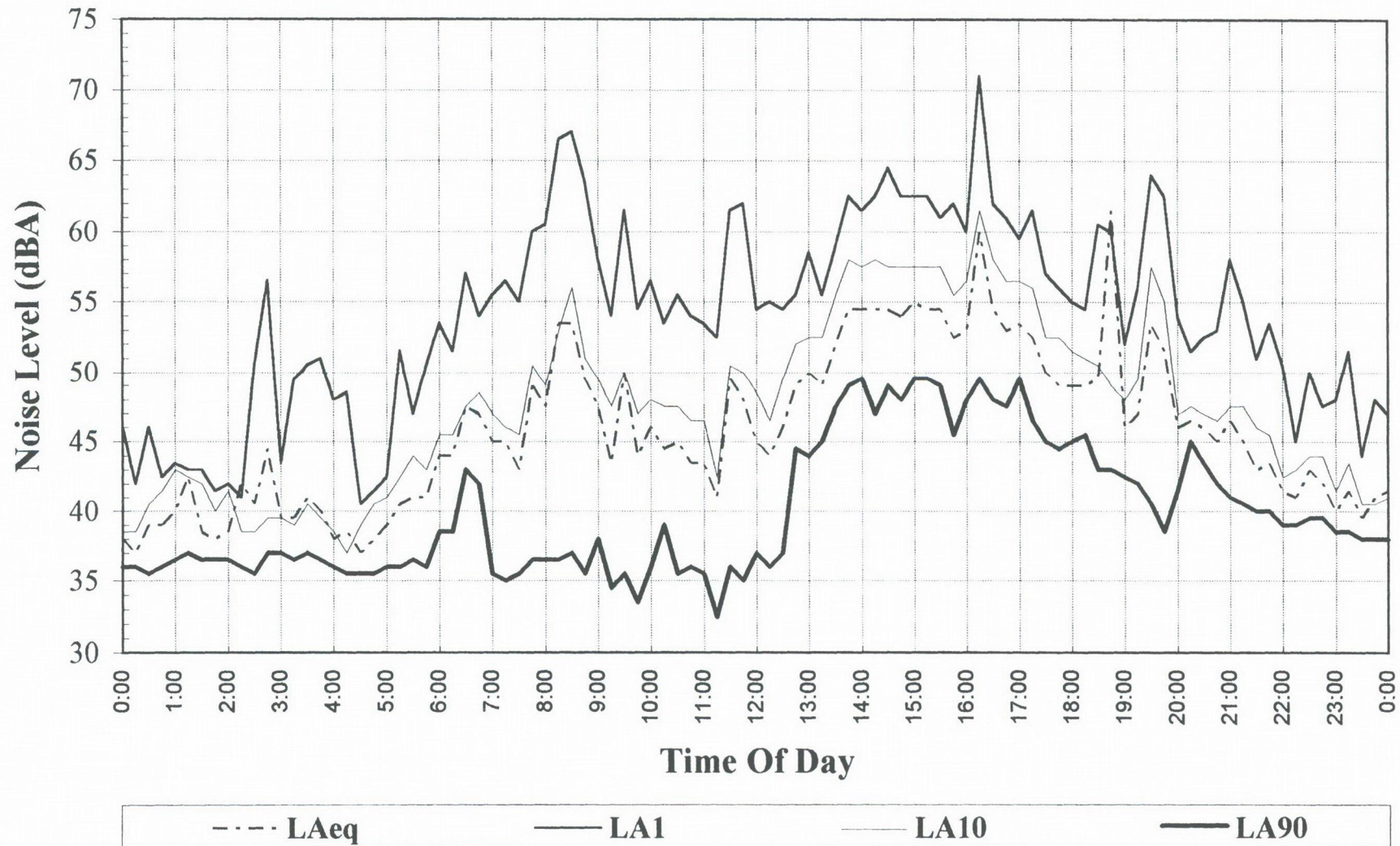


**Noise Levels at Location 9 - "Cowell Park", Mooball Road**  
**Monday, 9 March, 1998**



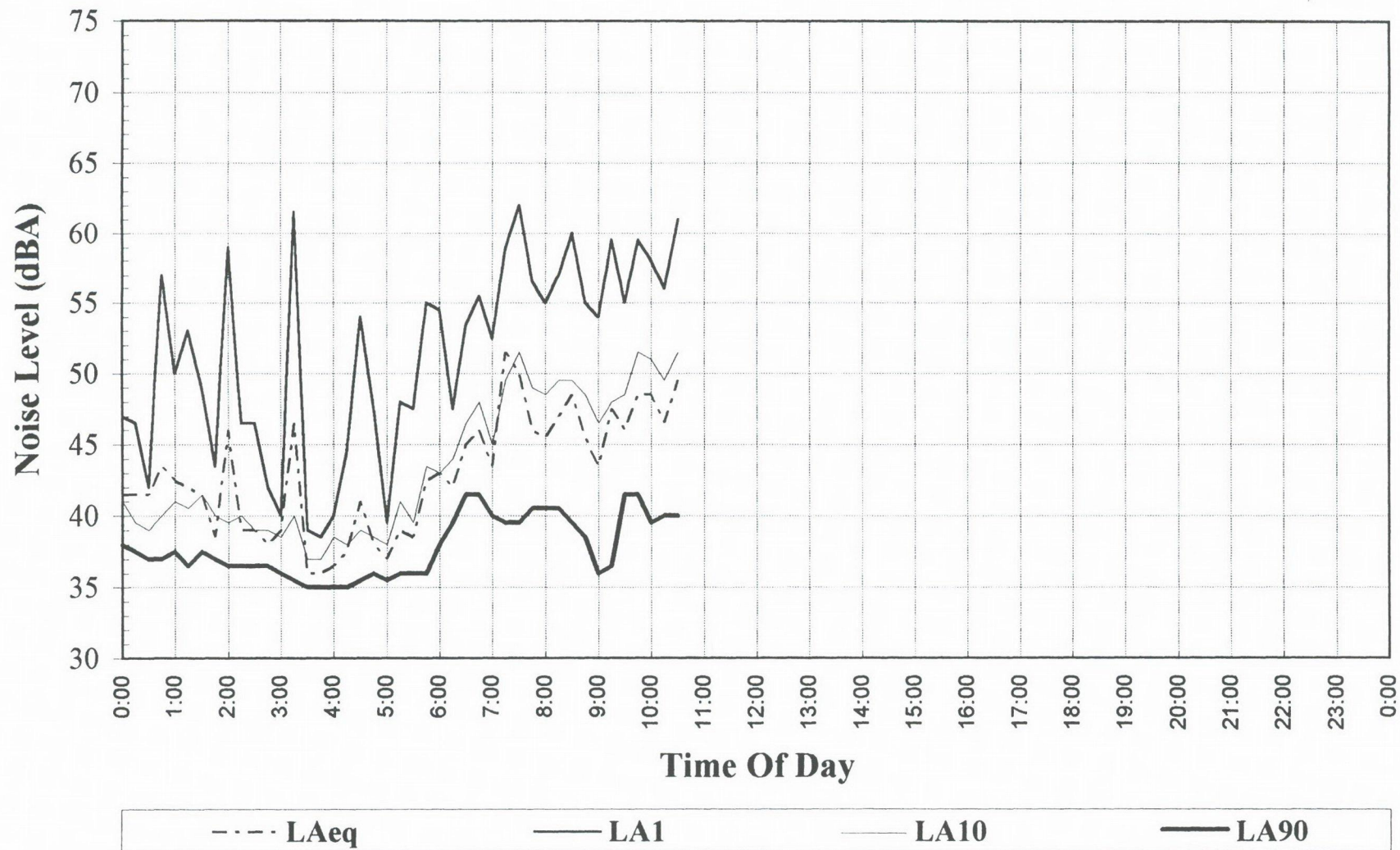
## Noise Levels at Location 9 - "Cowell Park", Mooball Road

Tuesday, 10 March, 1998



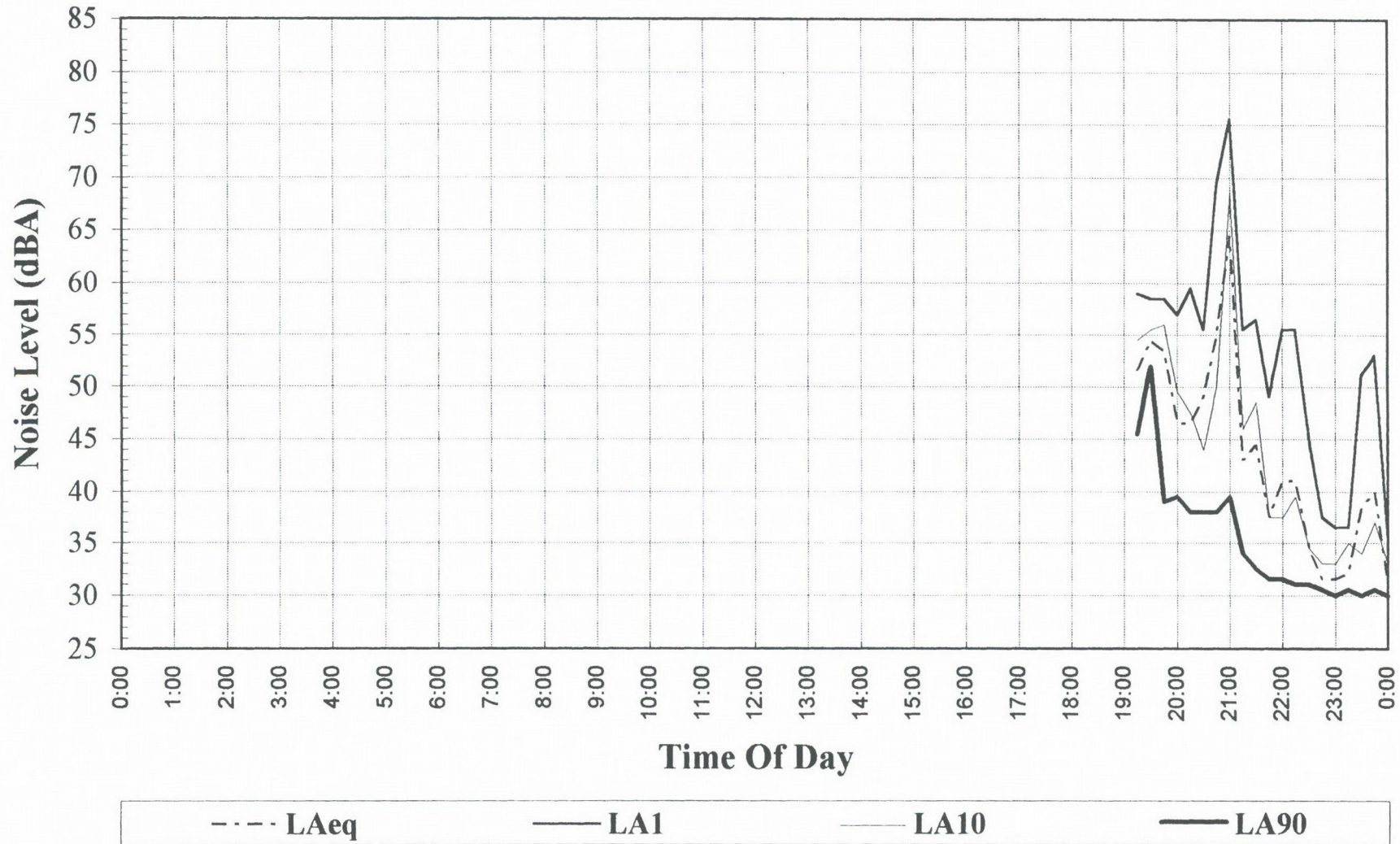


**Noise Levels at Location 9 - "Cowell Park", Mooball Road**  
**Wednesday, 11 March, 1998**



## Noise Levels at Location 10 - Cnr Warwick Pk & Pottsville Roads

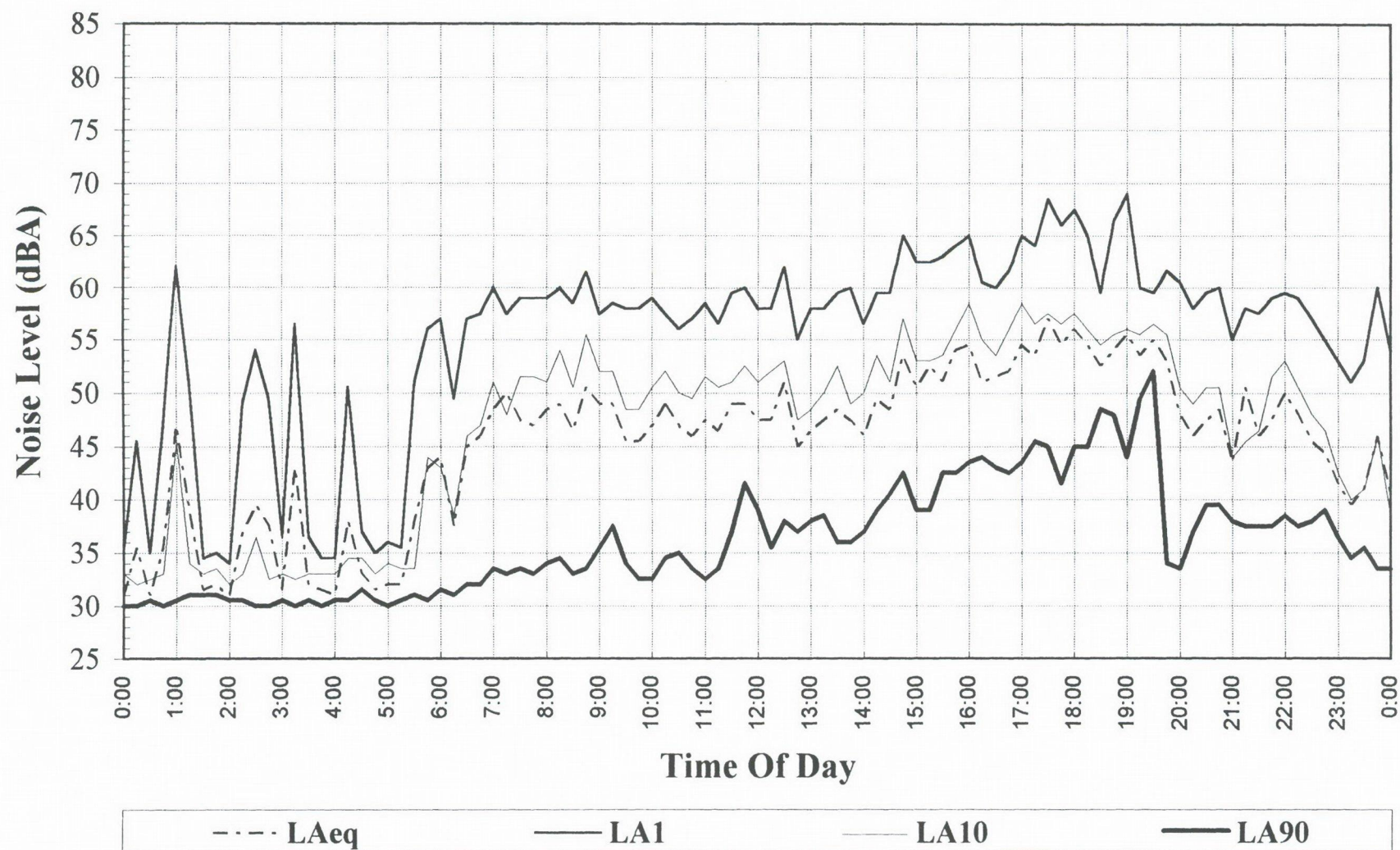
Thursday, 26 February, 1998





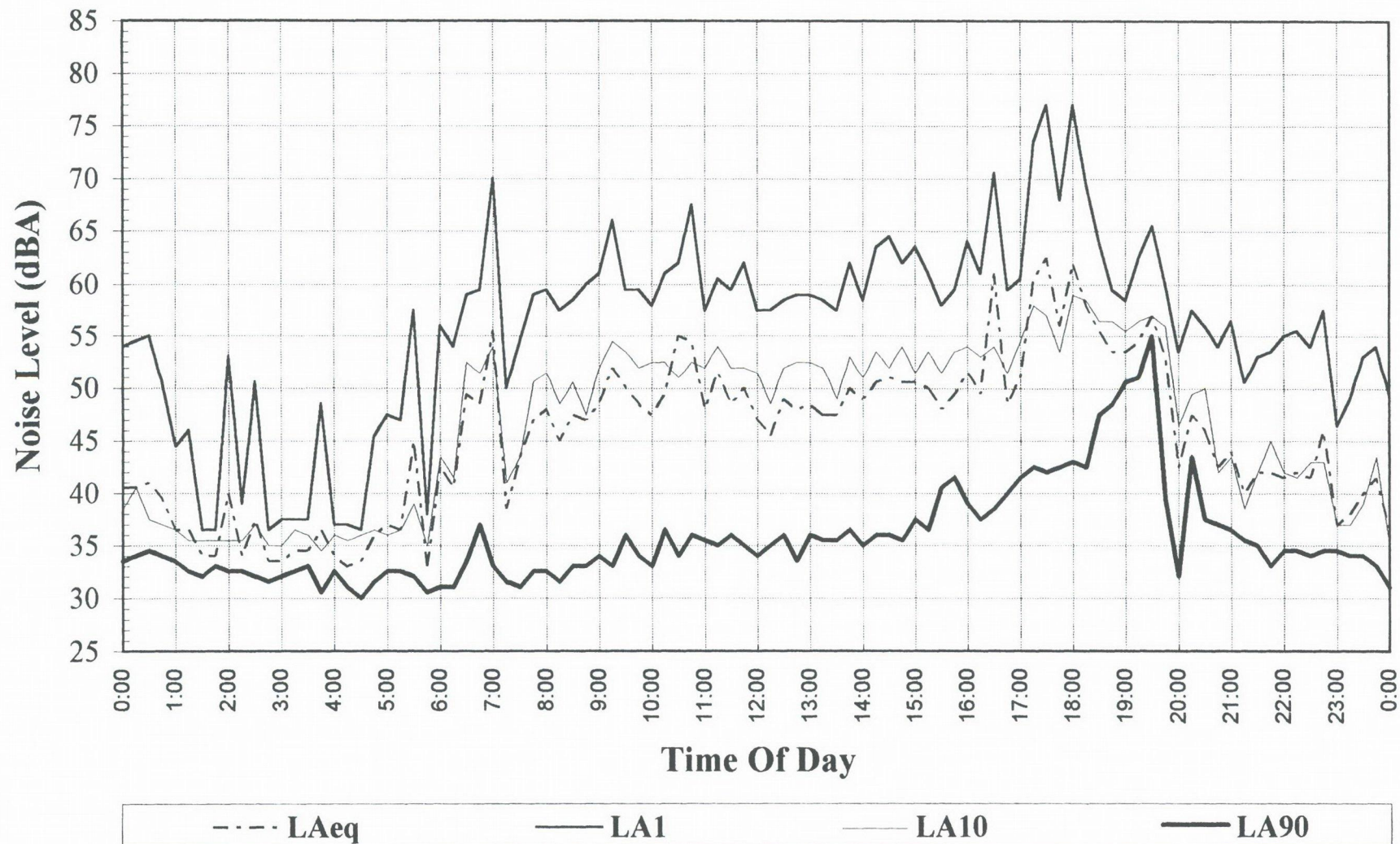
## Noise Levels at Location 10 - Cnr Warwick Pk & Pottsville Roads

Friday, 27 February, 1998



## Noise Levels at Location 10 - Cnr Warwick Pk & Pottsville Roads

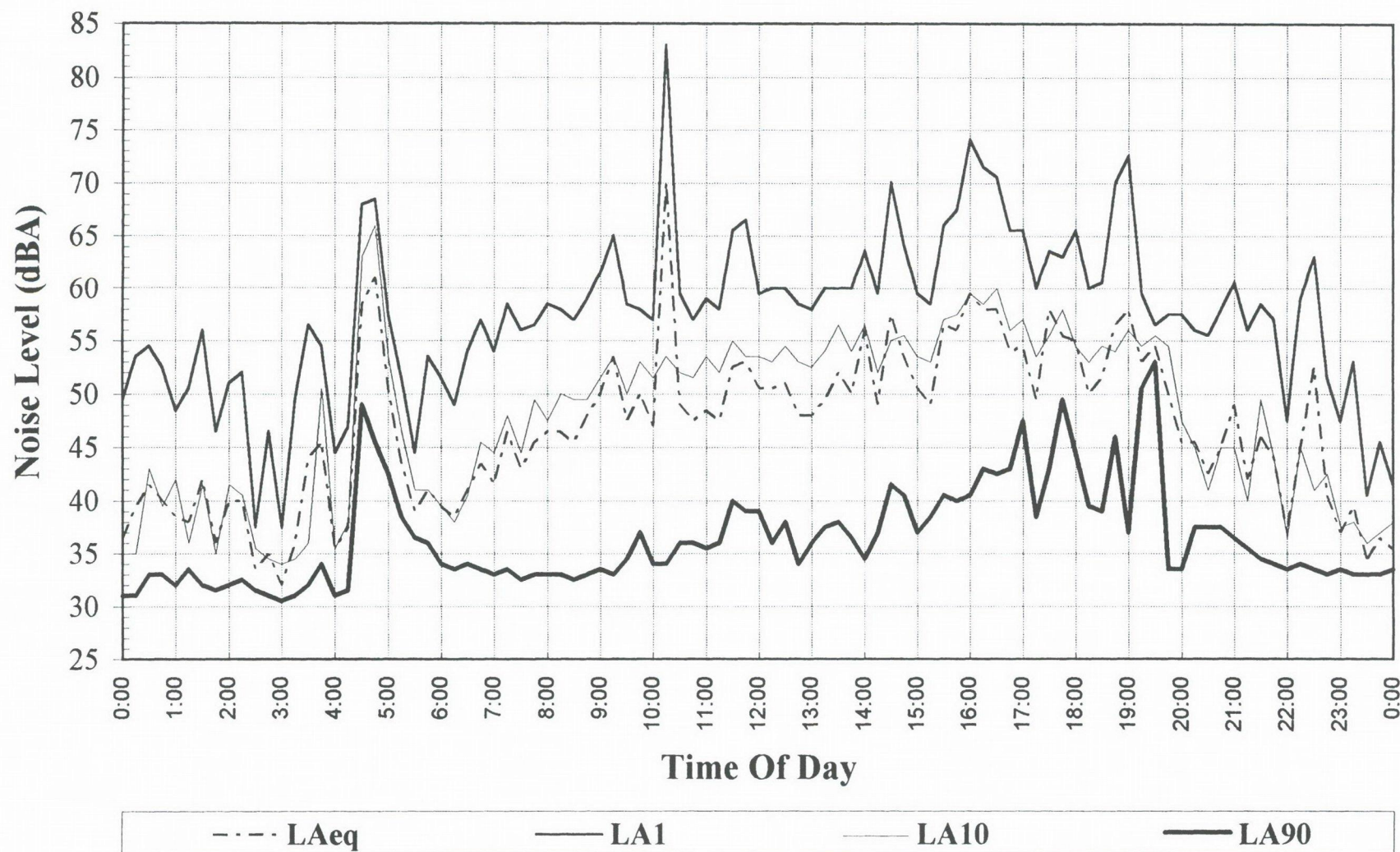
Saturday, 28 February, 1998





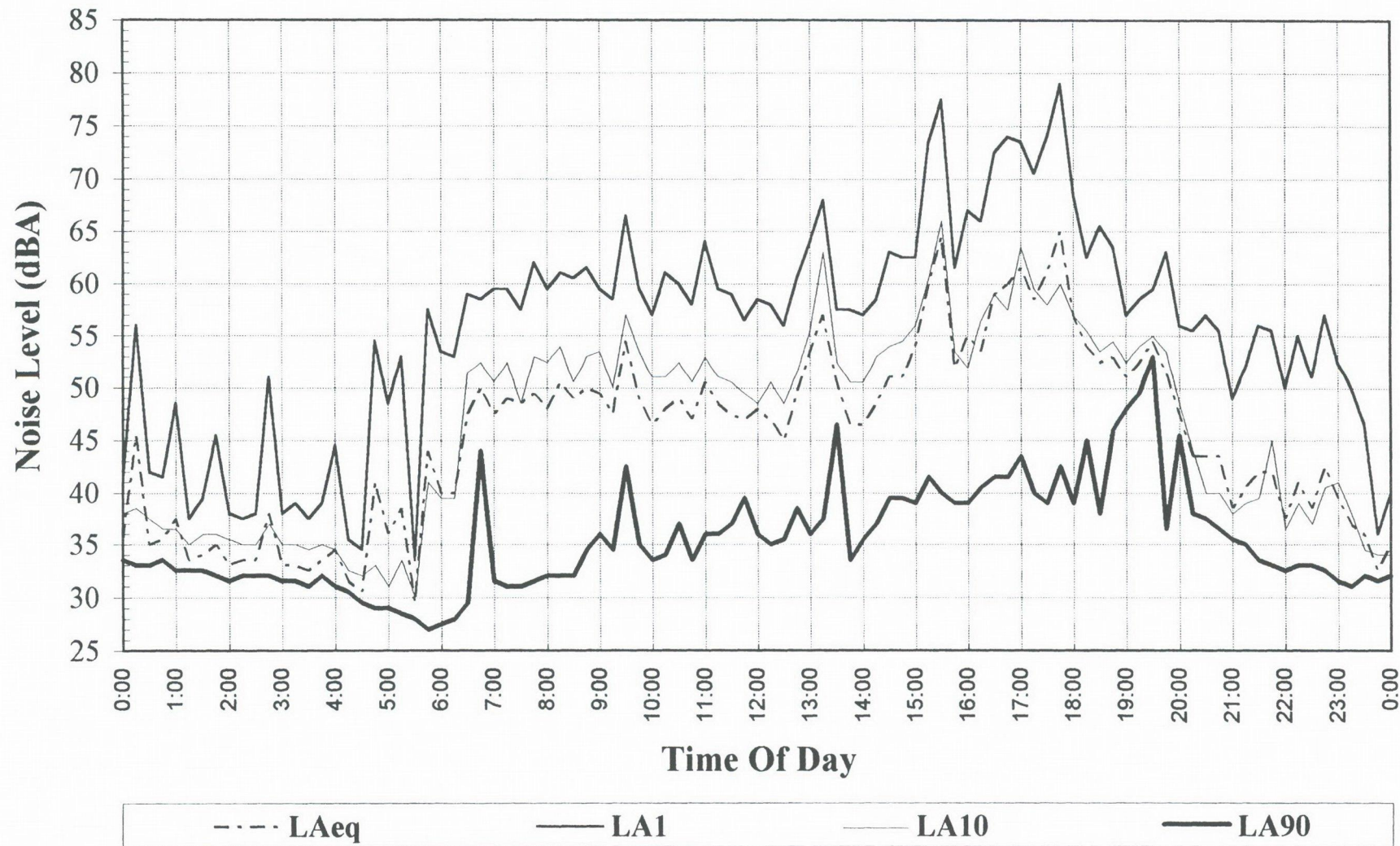
# Noise Levels at Location 10 - Cnr Warwick Pk & Pottsville Roads

Sunday, 1 March, 1998



## Noise Levels at Location 10 - Cnr Warwick Pk & Pottsville Roads

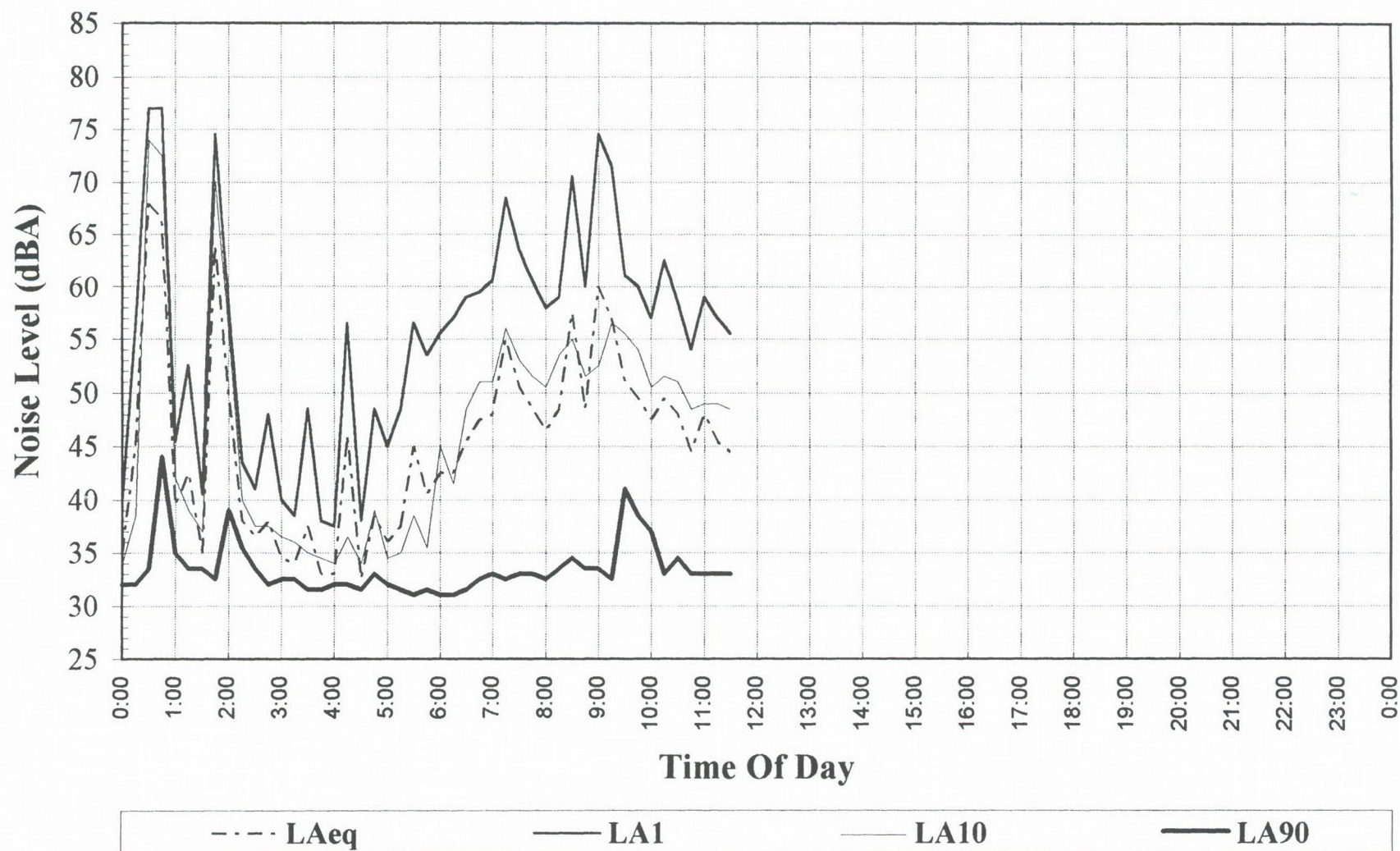
Monday, 2 March, 1998





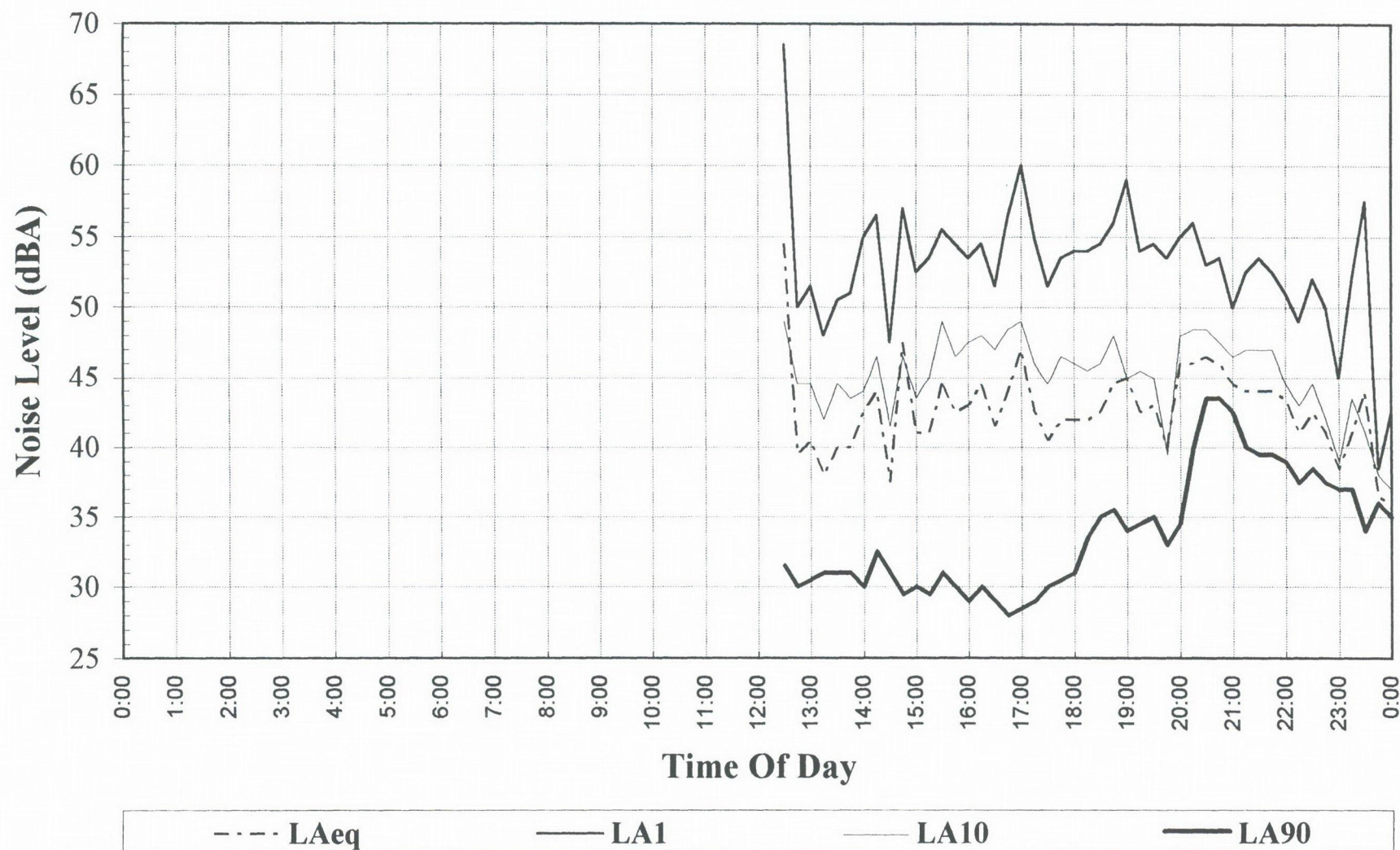
## Noise Levels at Location 10 - Cnr Warwick Pk & Pottsville Roads

Tuesday, 3 March, 1998



## Noise Levels at Location 11 - "Frosty Hollow", Pottsville Road

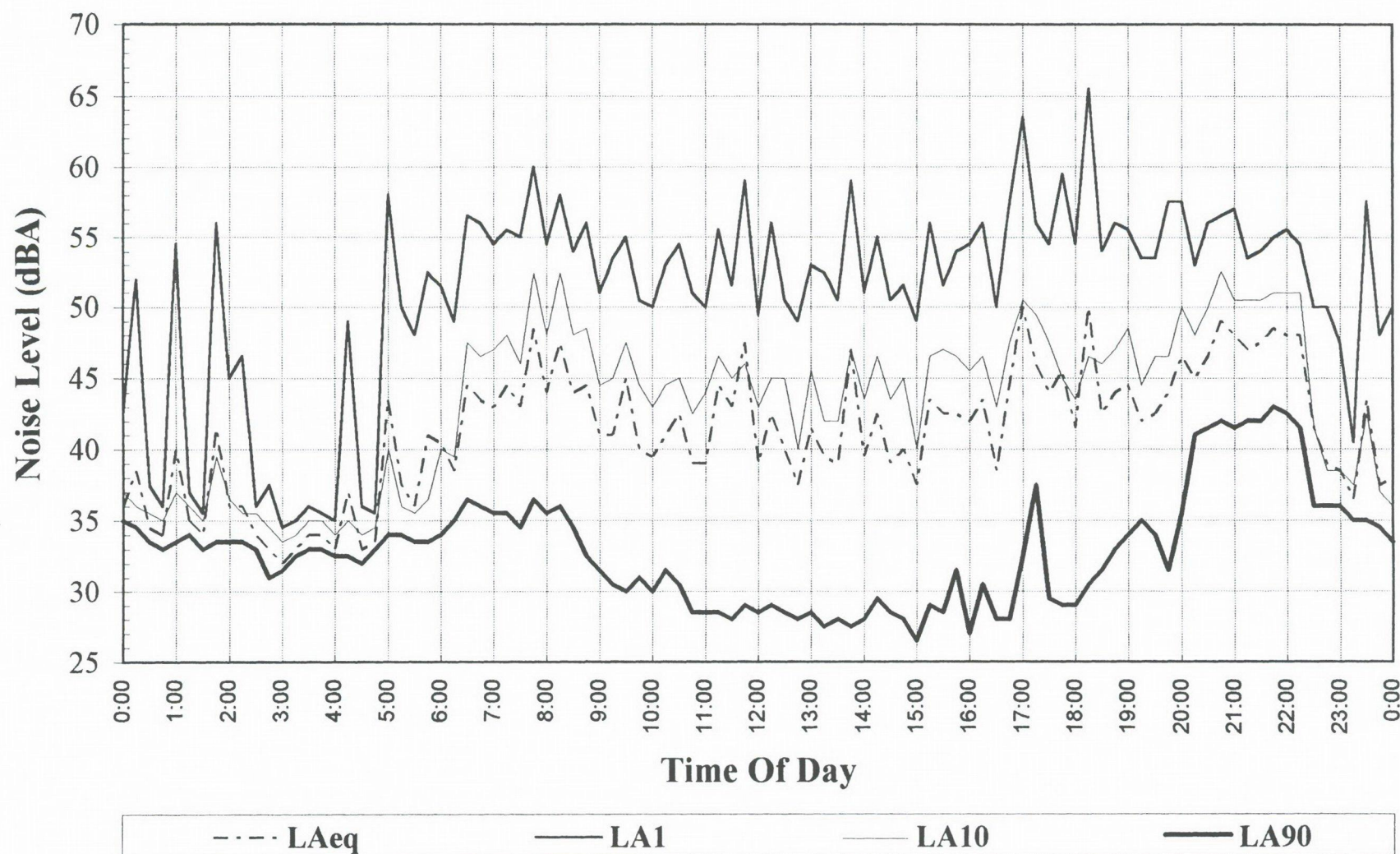
Tuesday, 3 March, 1998



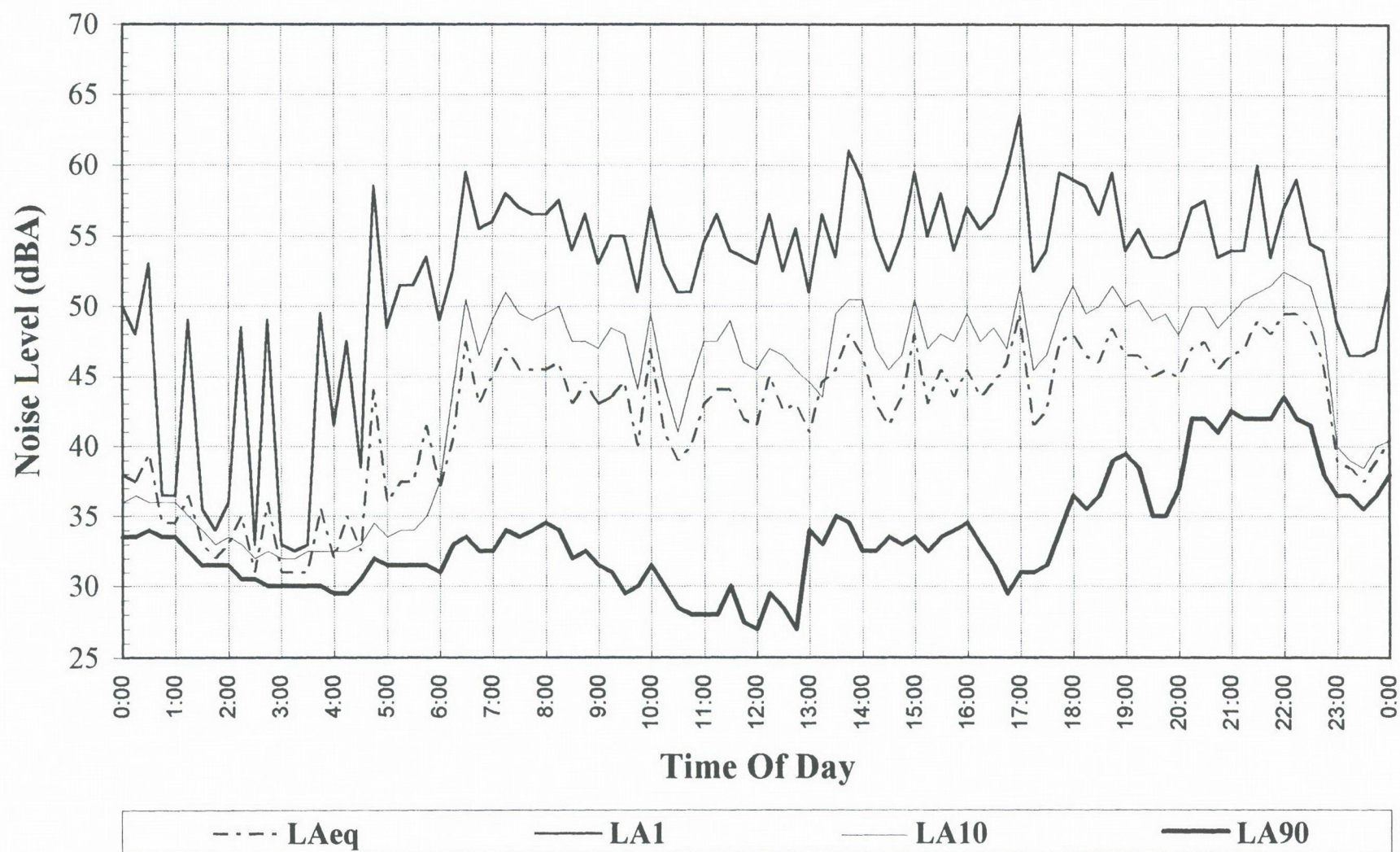


## Noise Levels at Location 11 - "Frosty Hollow", Pottsville Road

Wednesday, 4 March, 1998



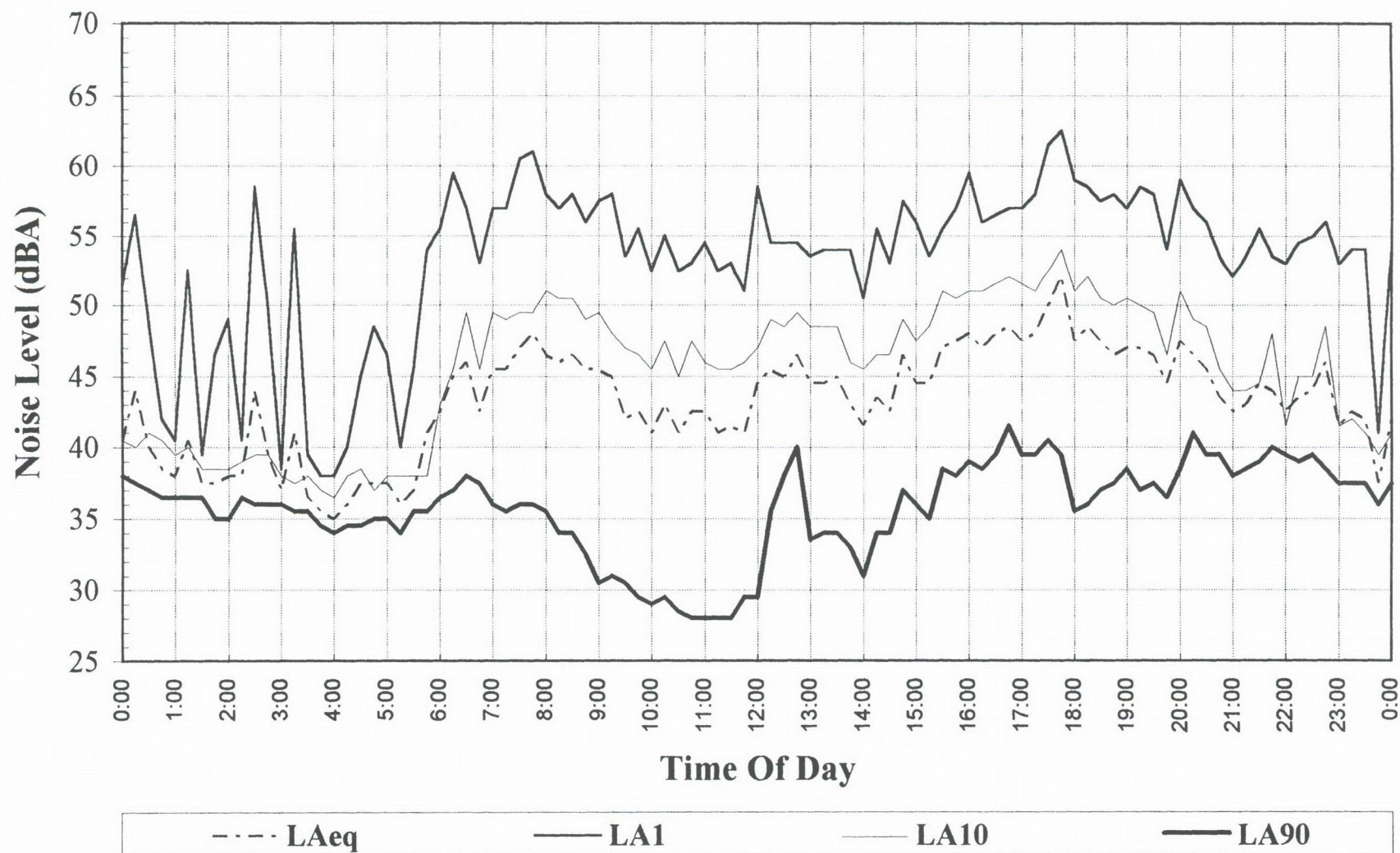
# **Noise Levels at Location 11 - "Frosty Hollow", Pottsville Road** **Thursday, 5 March, 1998**





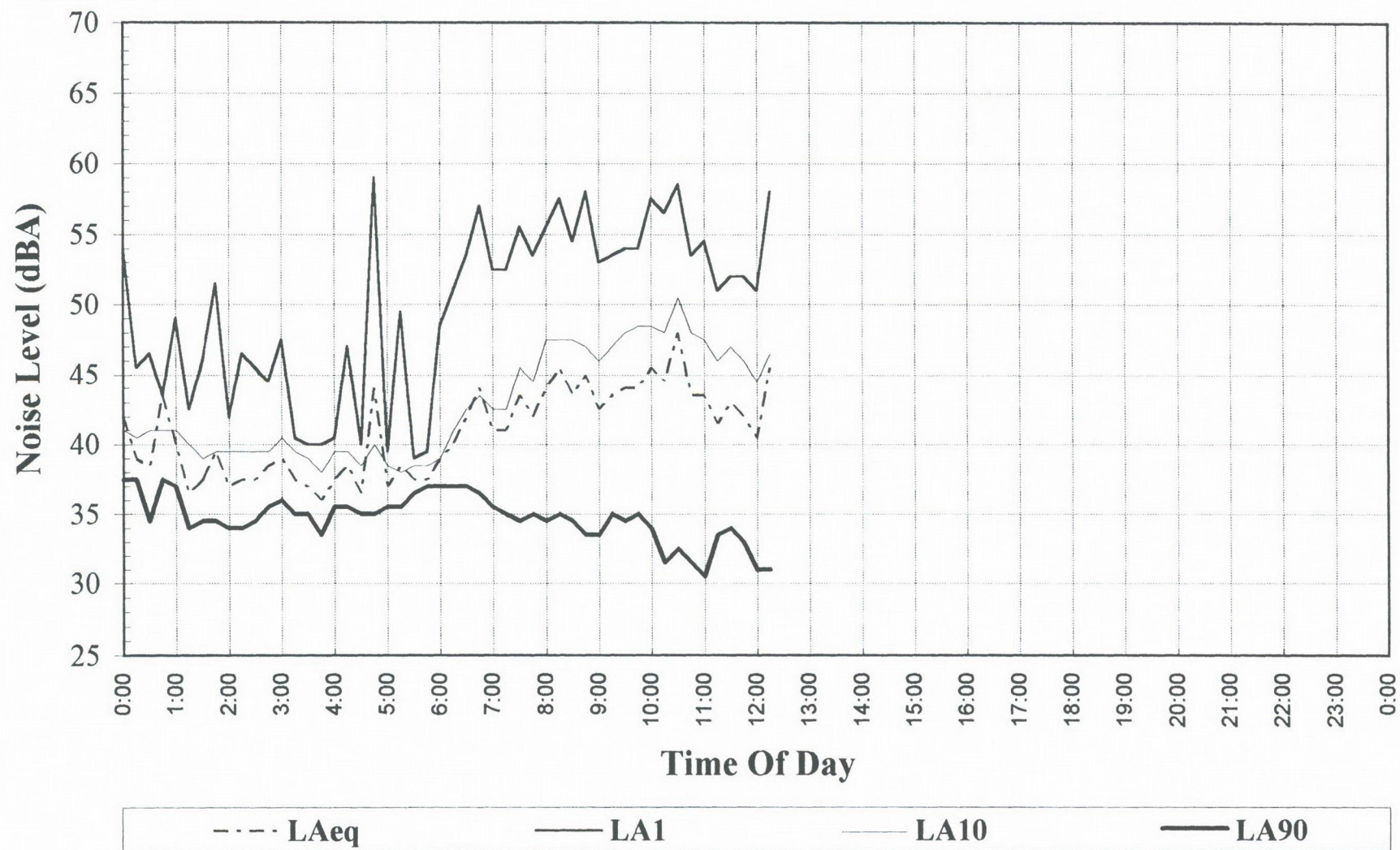
## Noise Levels at Location 11 - "Frosty Hollow", Pottsville Road

Friday, 6 March, 1998



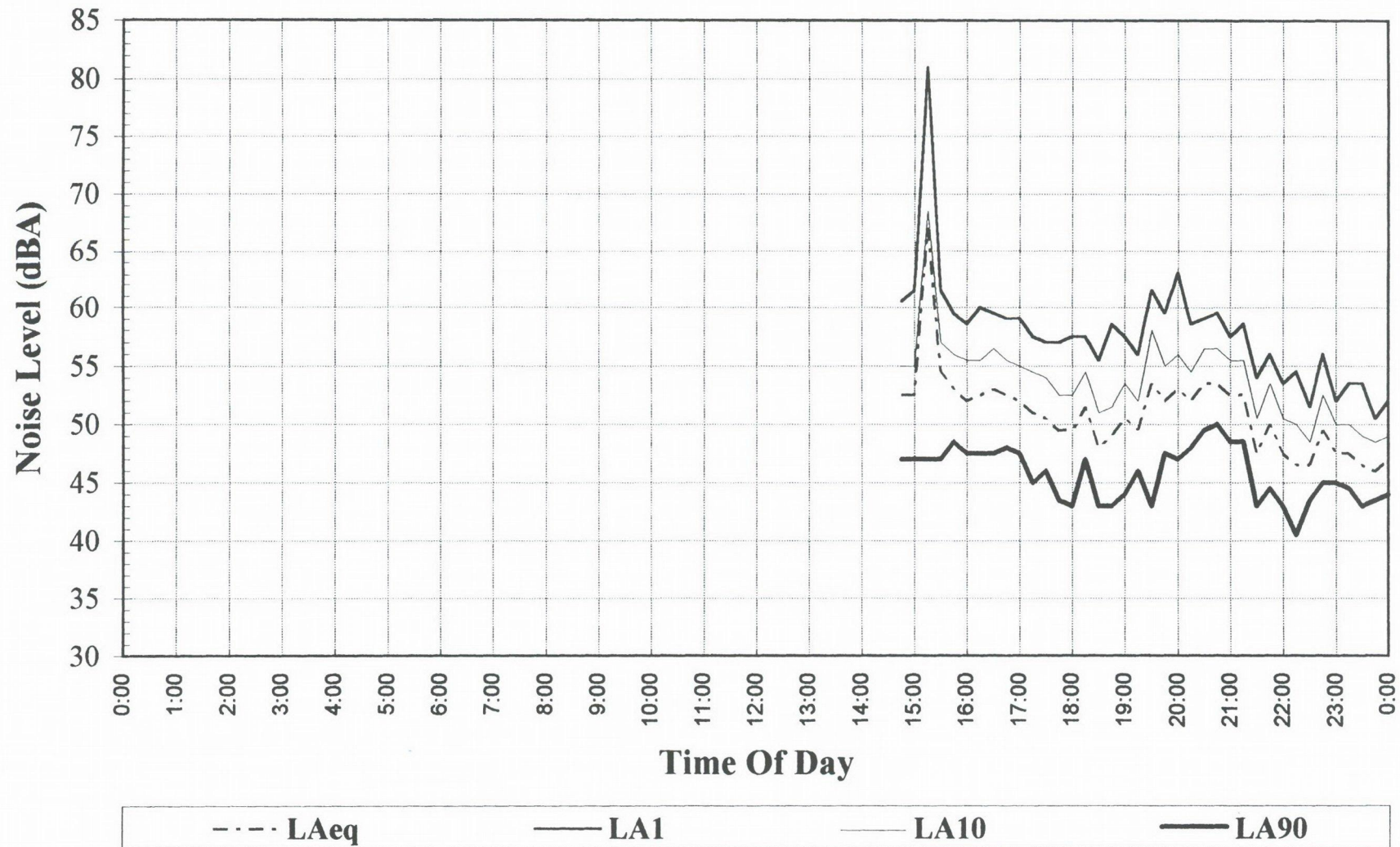
## Noise Levels at Location 11 - "Frosty Hollow", Pottsville Road

Saturday, 7 March, 1998



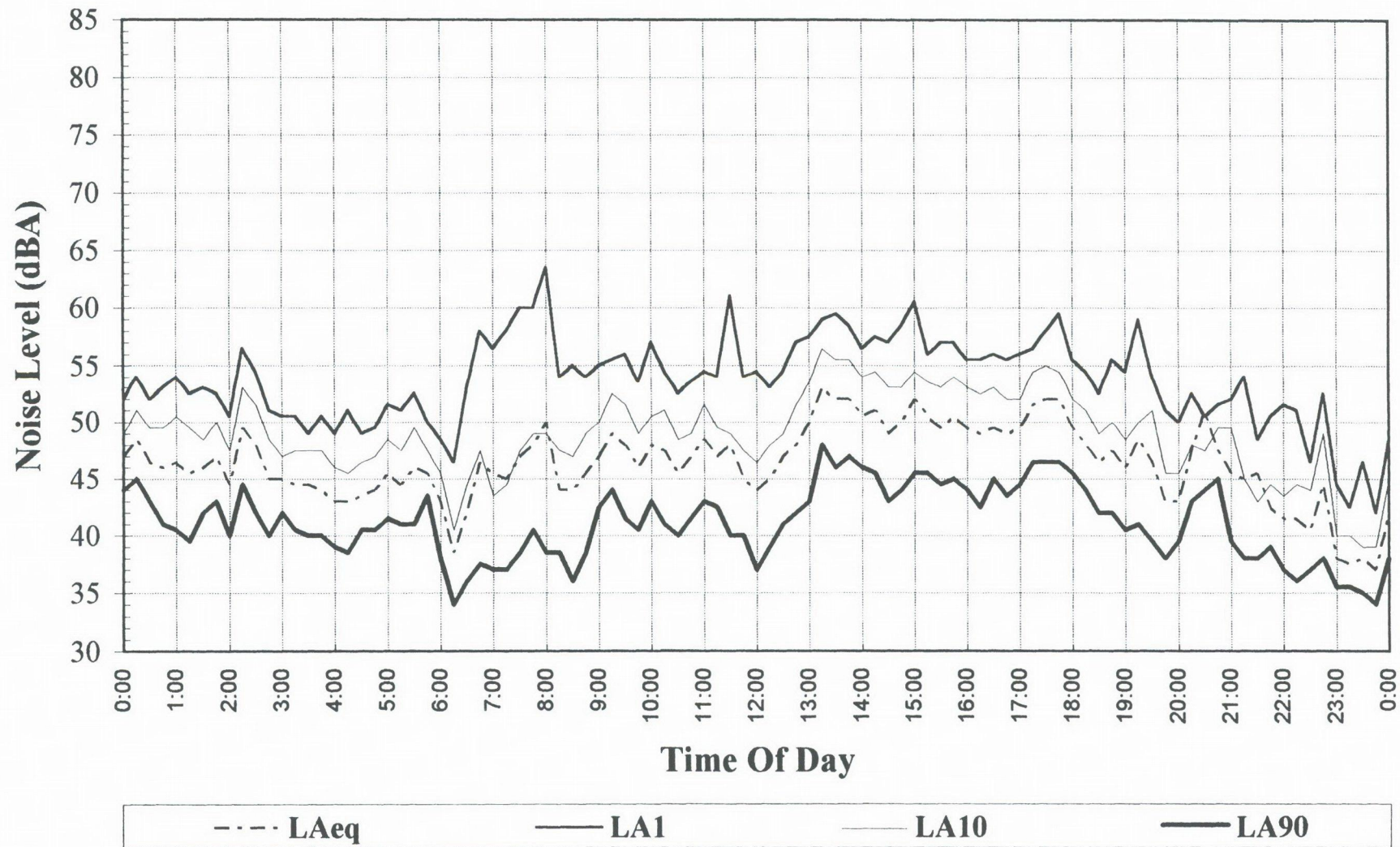


**Noise Levels at Location 12 - Lot 6 (Edwards), 765 Pottsville Rd**  
**Saturday, 7 March, 1998**



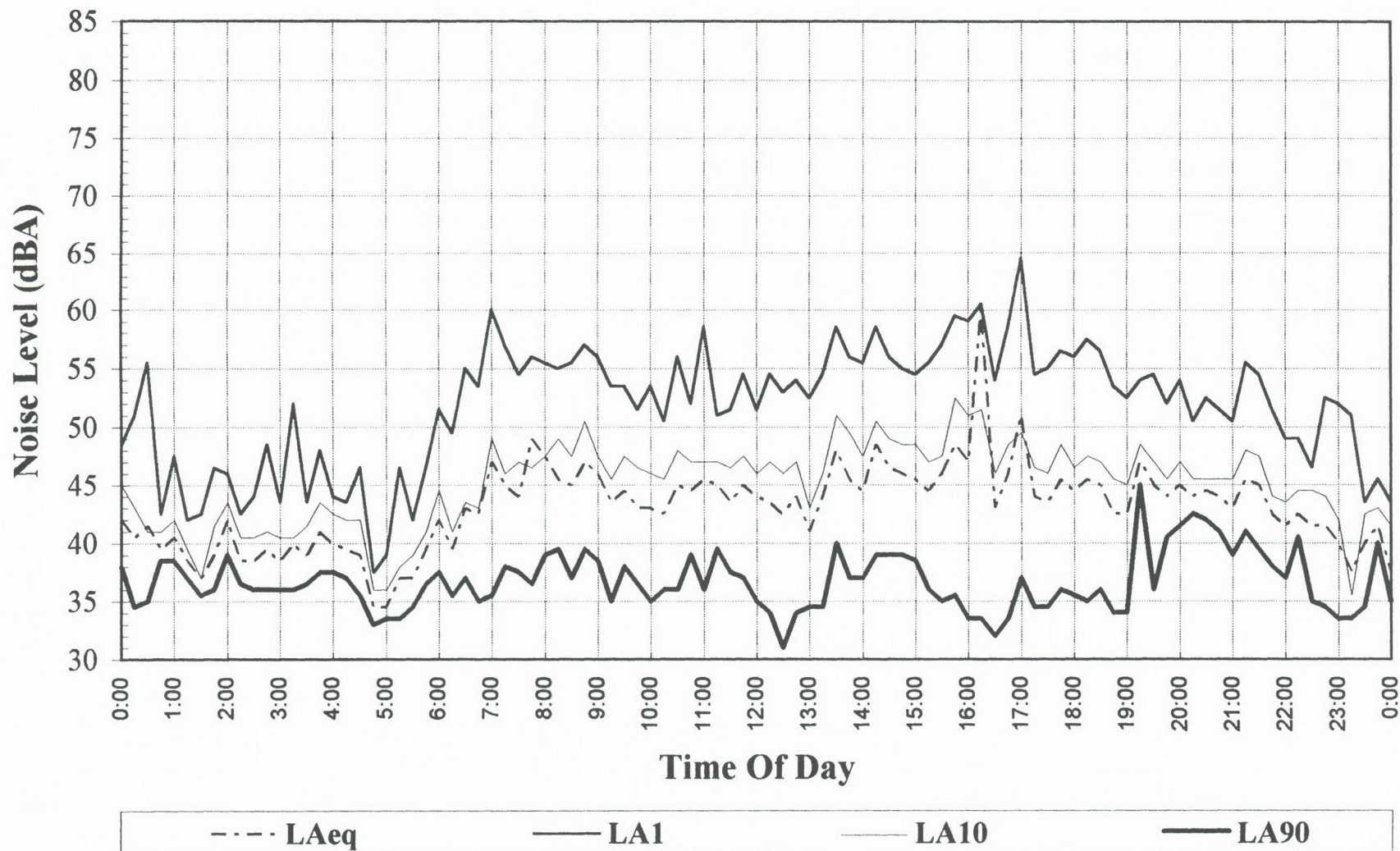
## Noise Levels at Location 12 - Lot 6 (Edwards), 765 Pottsville Rd

Sunday, 8 March, 1998



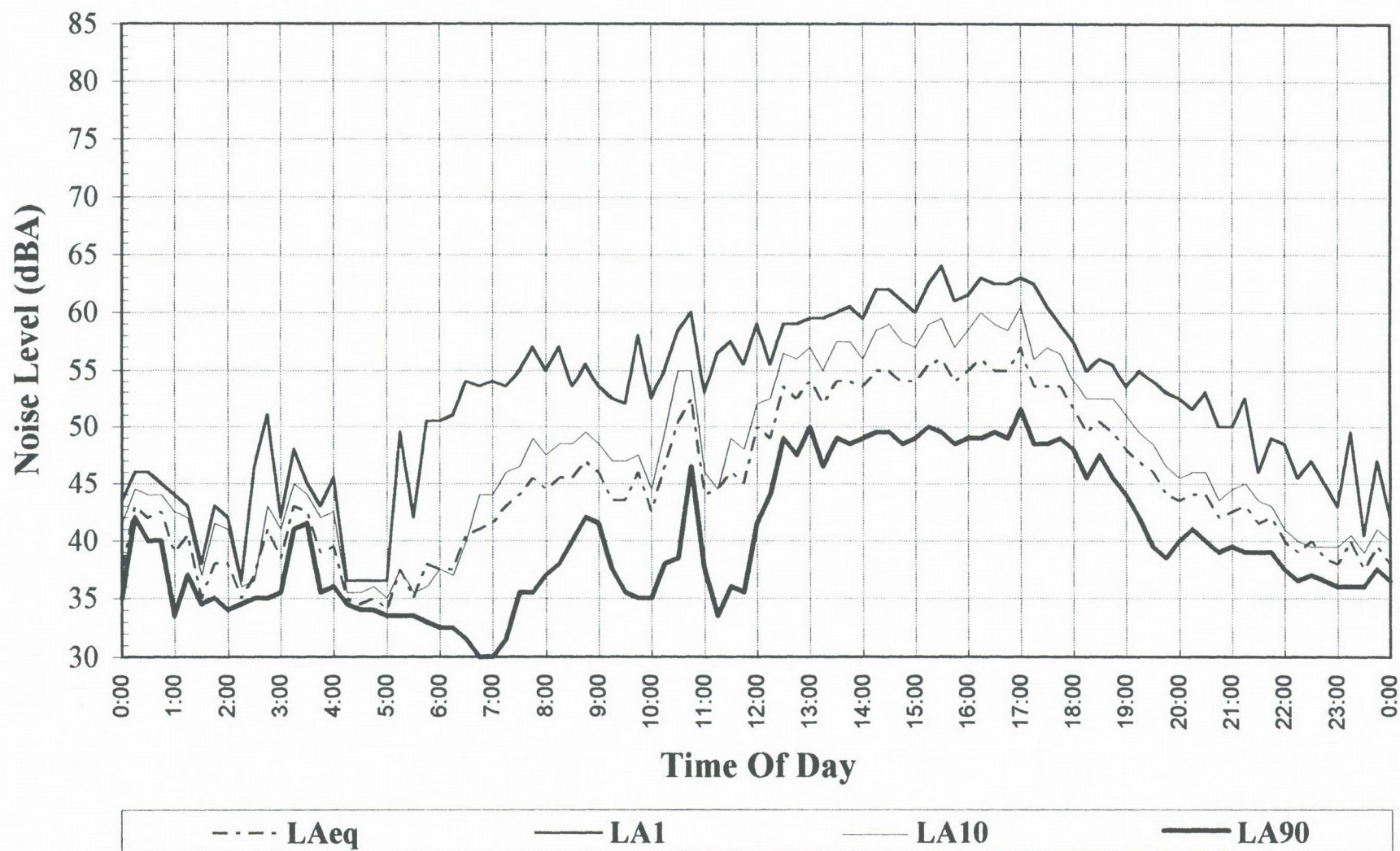


**Noise Levels at Location 12 - Lot 6 (Edwards), 765 Pottsville Rd**  
**Monday, 9 March, 1998**



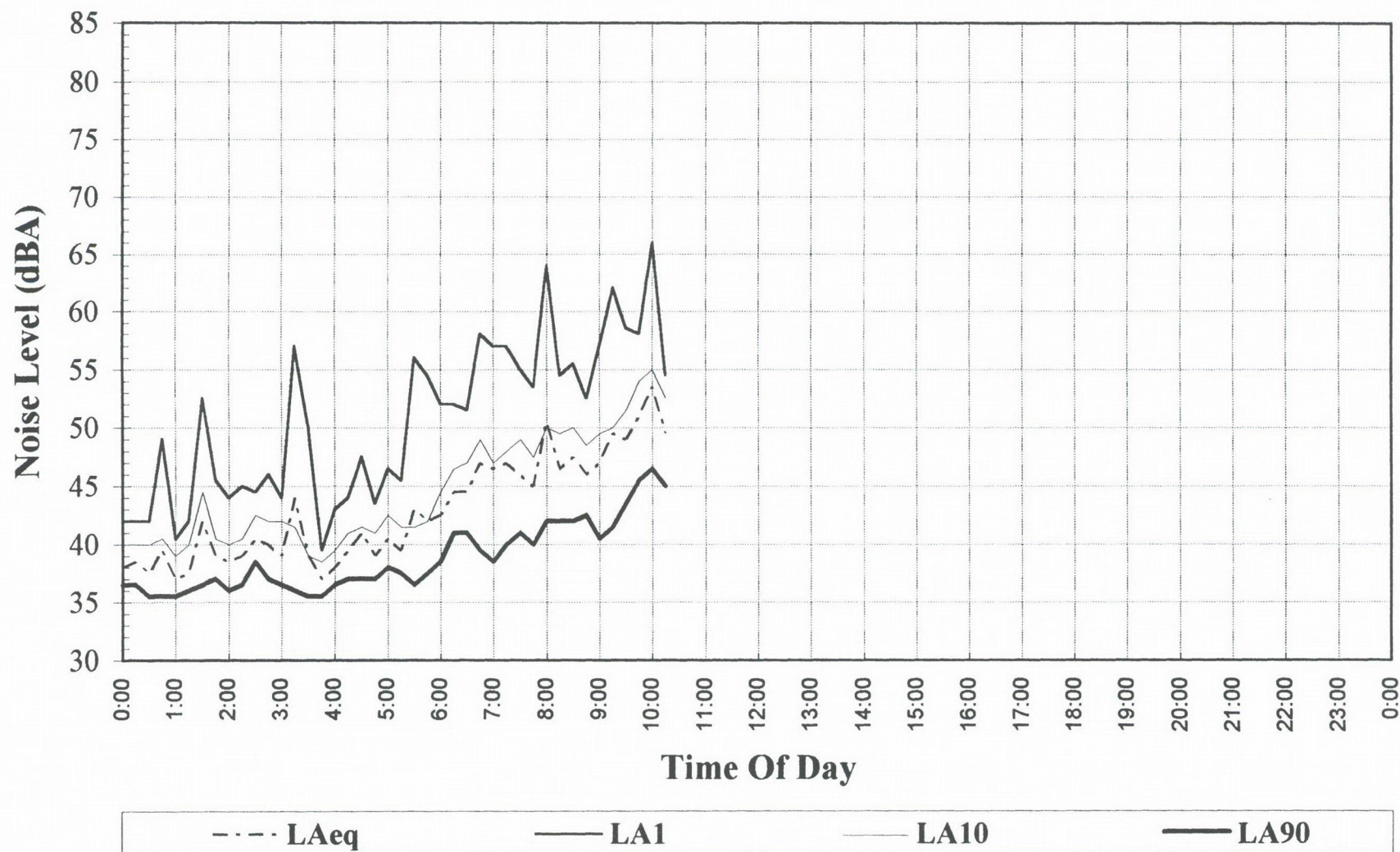
## Noise Levels at Location 12 - Lot 6 (Edwards), 765 Pottsville Rd

Tuesday, 10 March, 1998



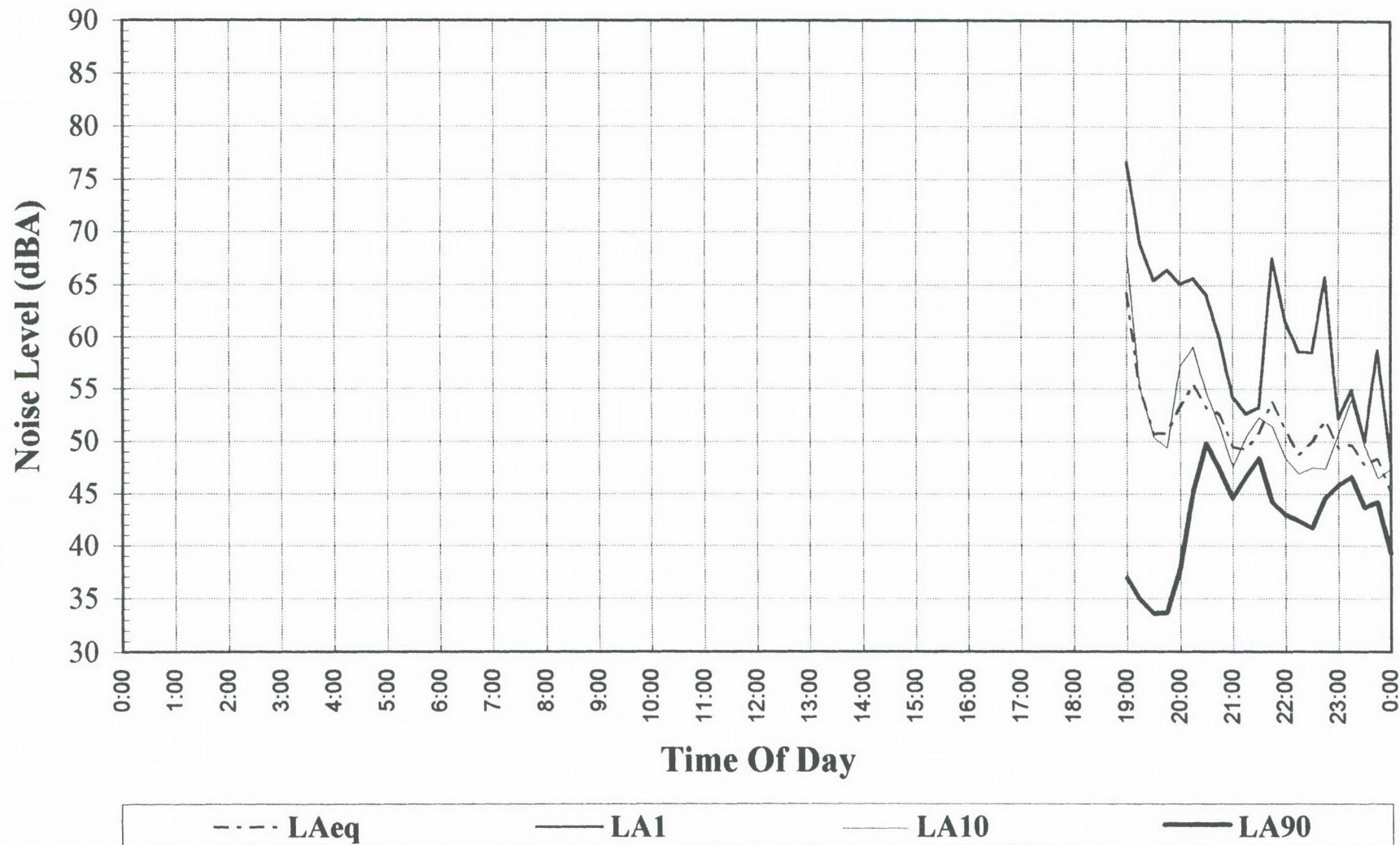


**Noise Levels at Location 12 - Lot 6 (Edwards), 765 Pottsville Rd**  
**Wednesday, 11 March, 1998**



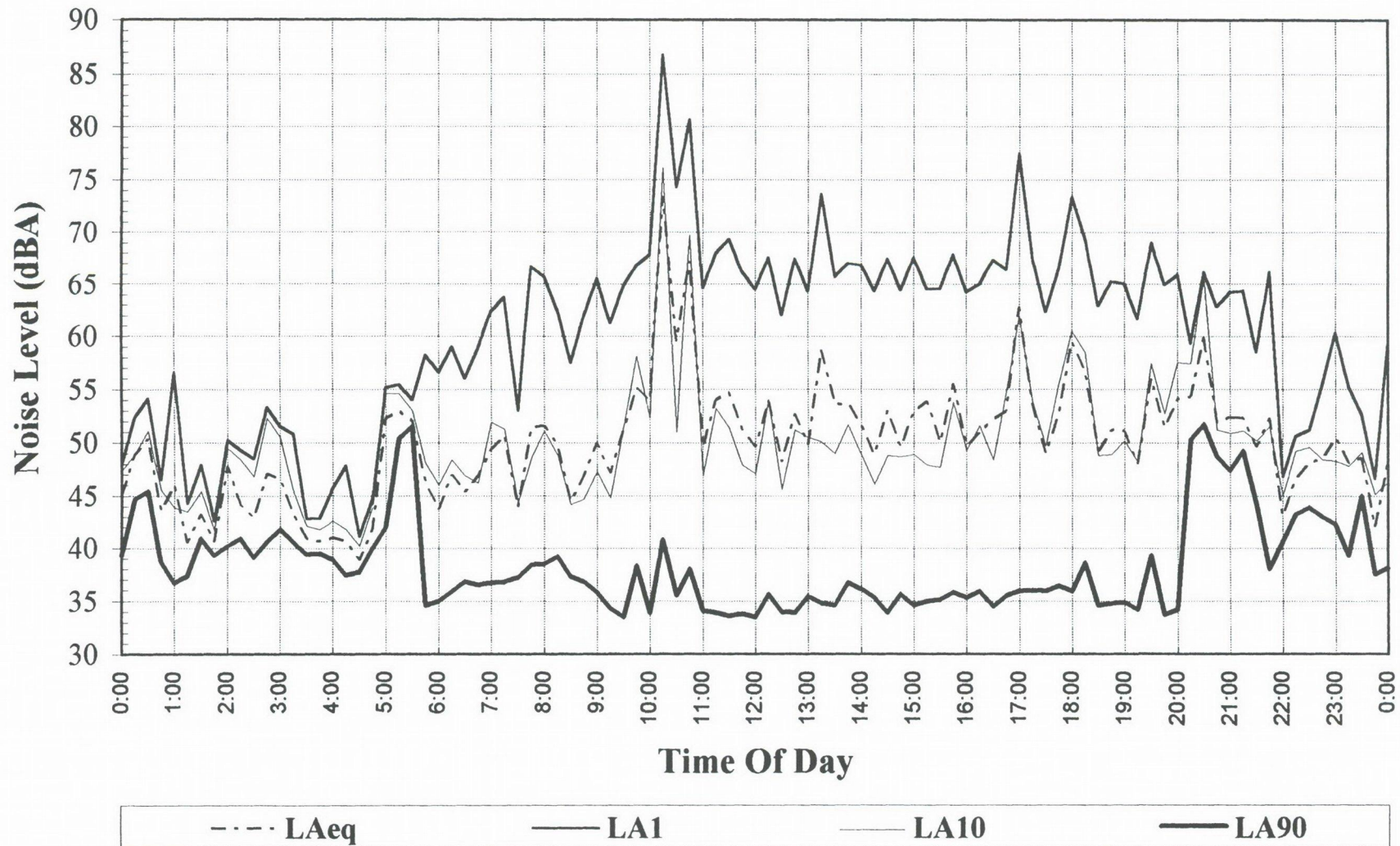
# Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

Friday, 27 February, 1998



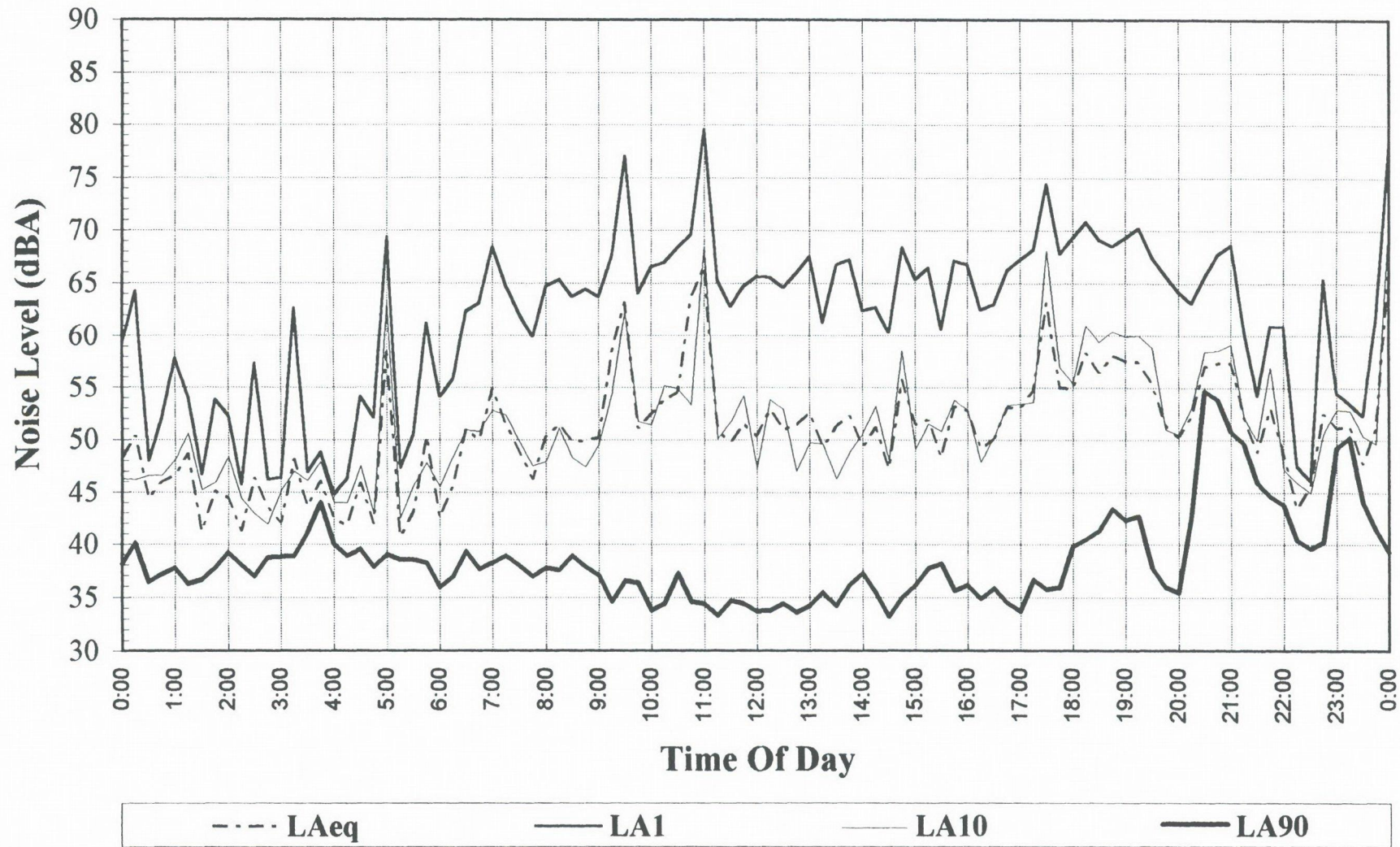


**Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd**  
**Saturday, 28 February, 1998**



# Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

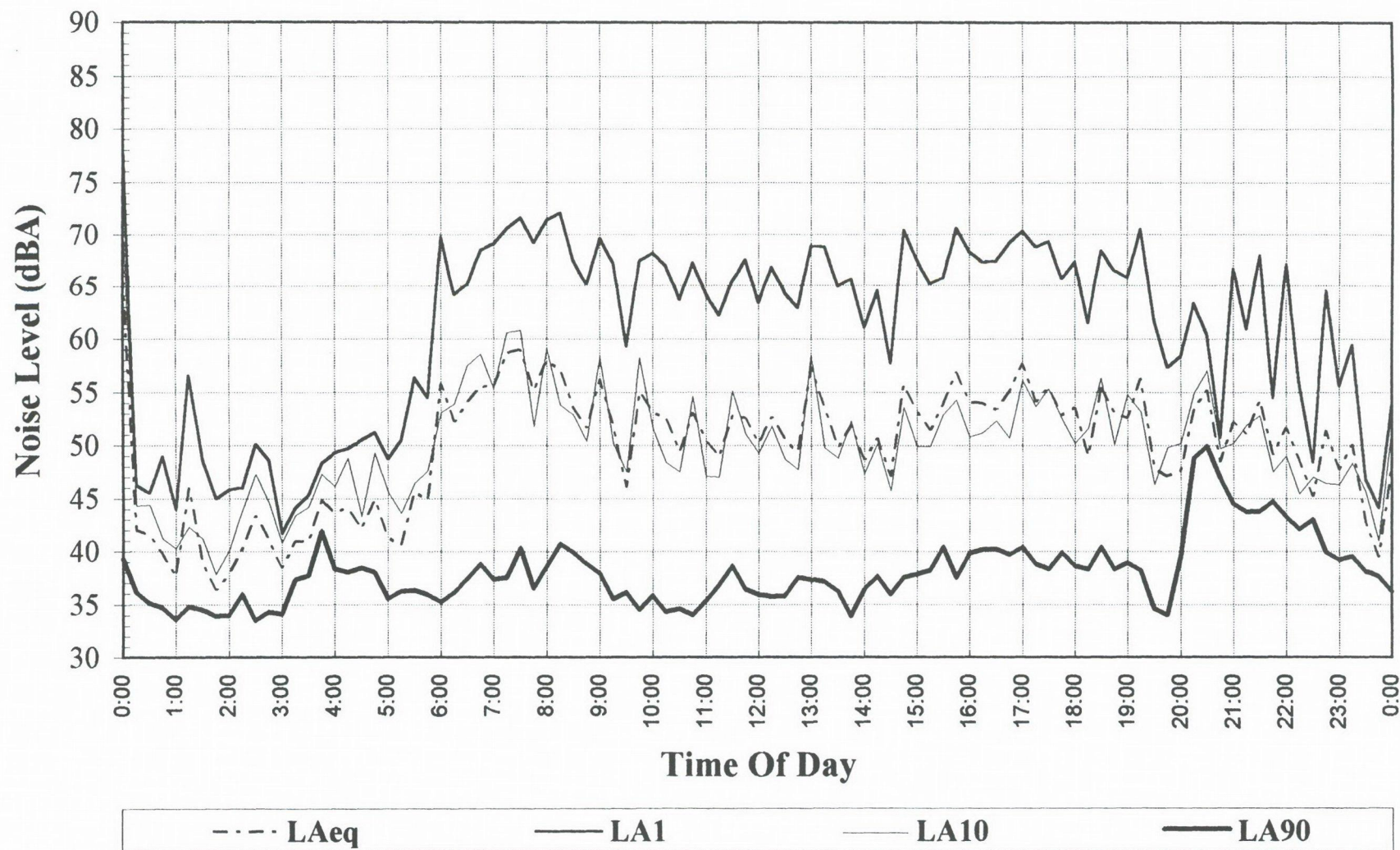
Sunday, 1 March, 1998





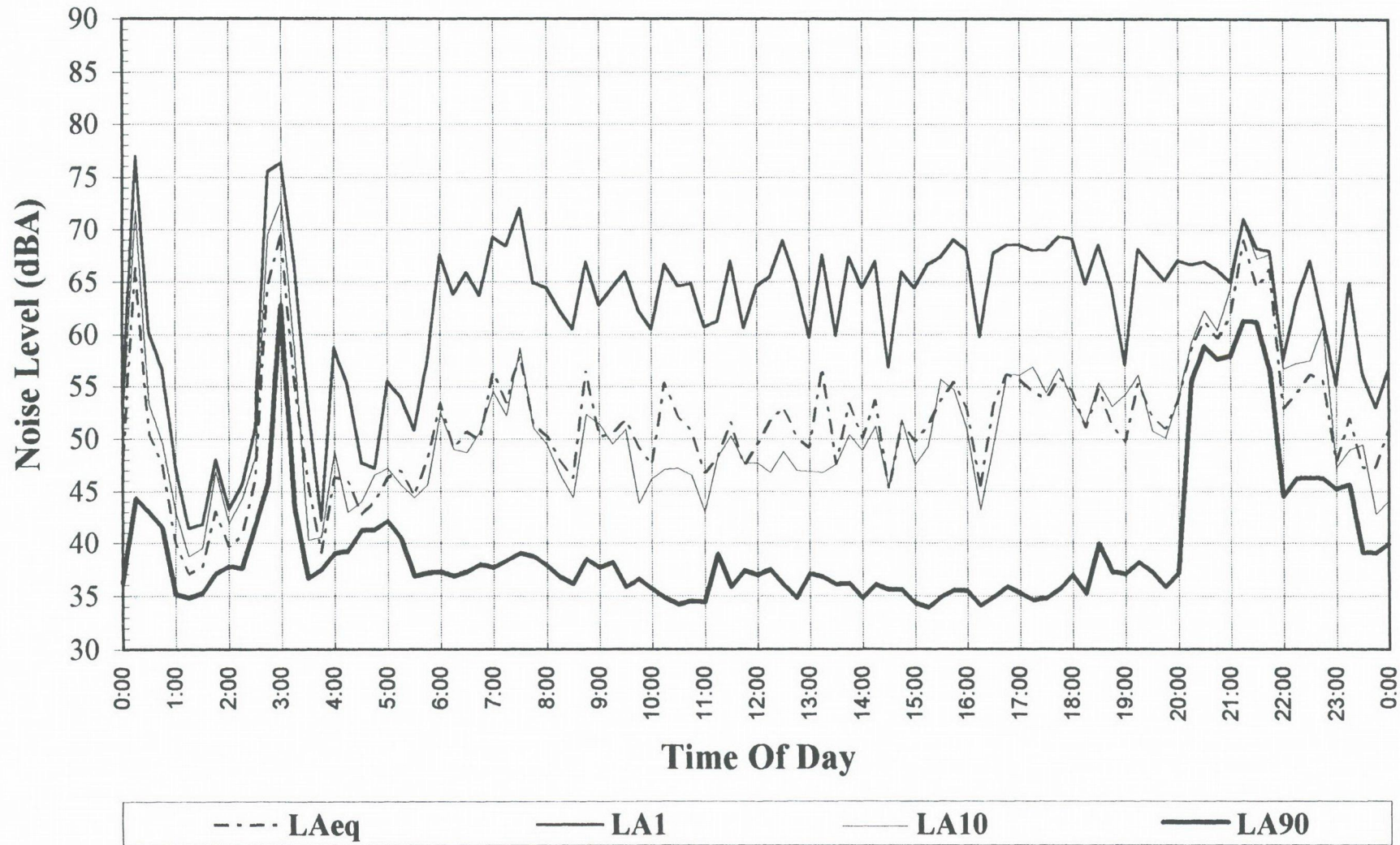
## Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

Monday, 2 March, 1998



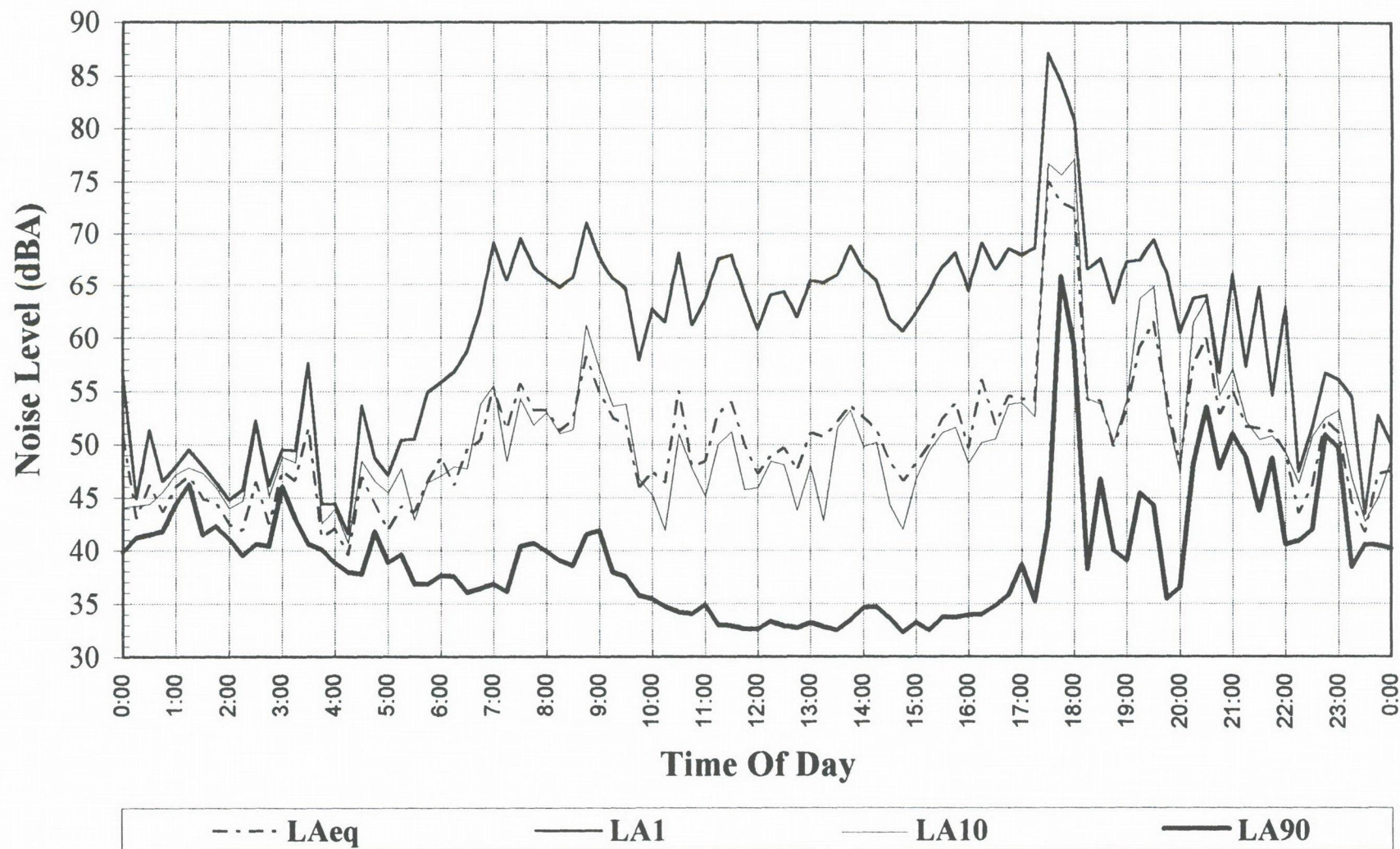
## Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

Tuesday, 3 March, 1998



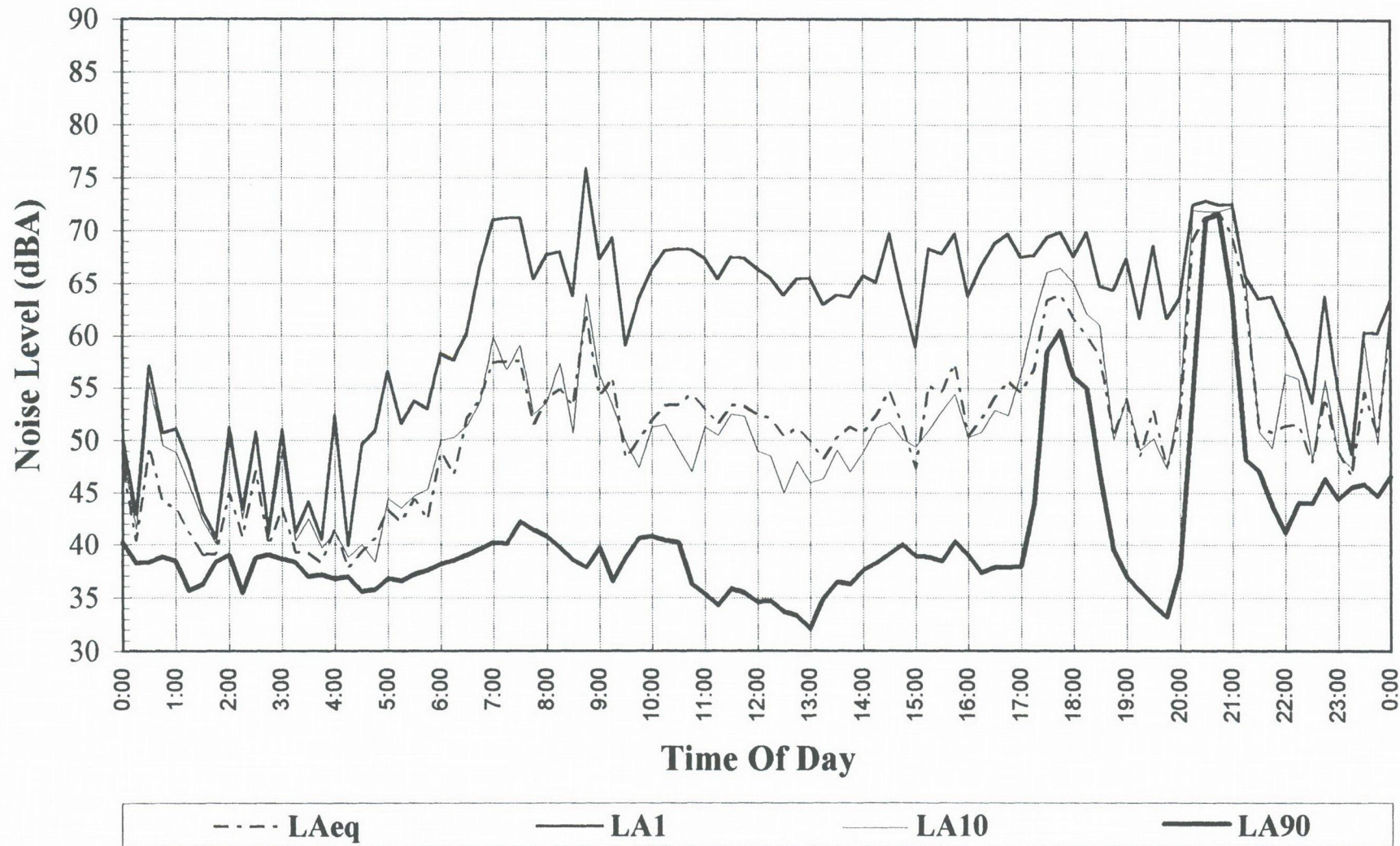


**Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd**  
**Wednesday, 4 March, 1998**



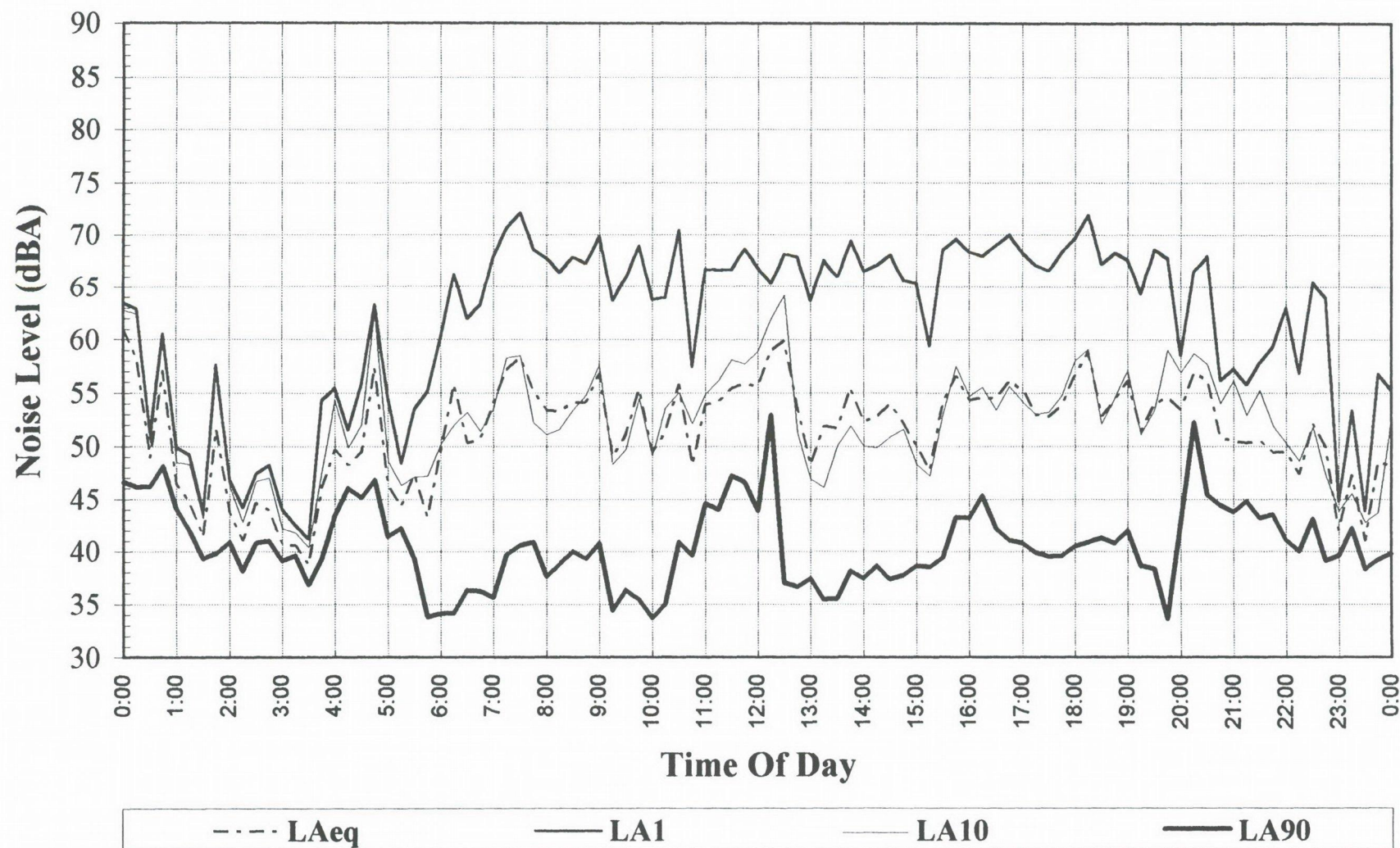
## Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

Thursday, 5 March, 1998



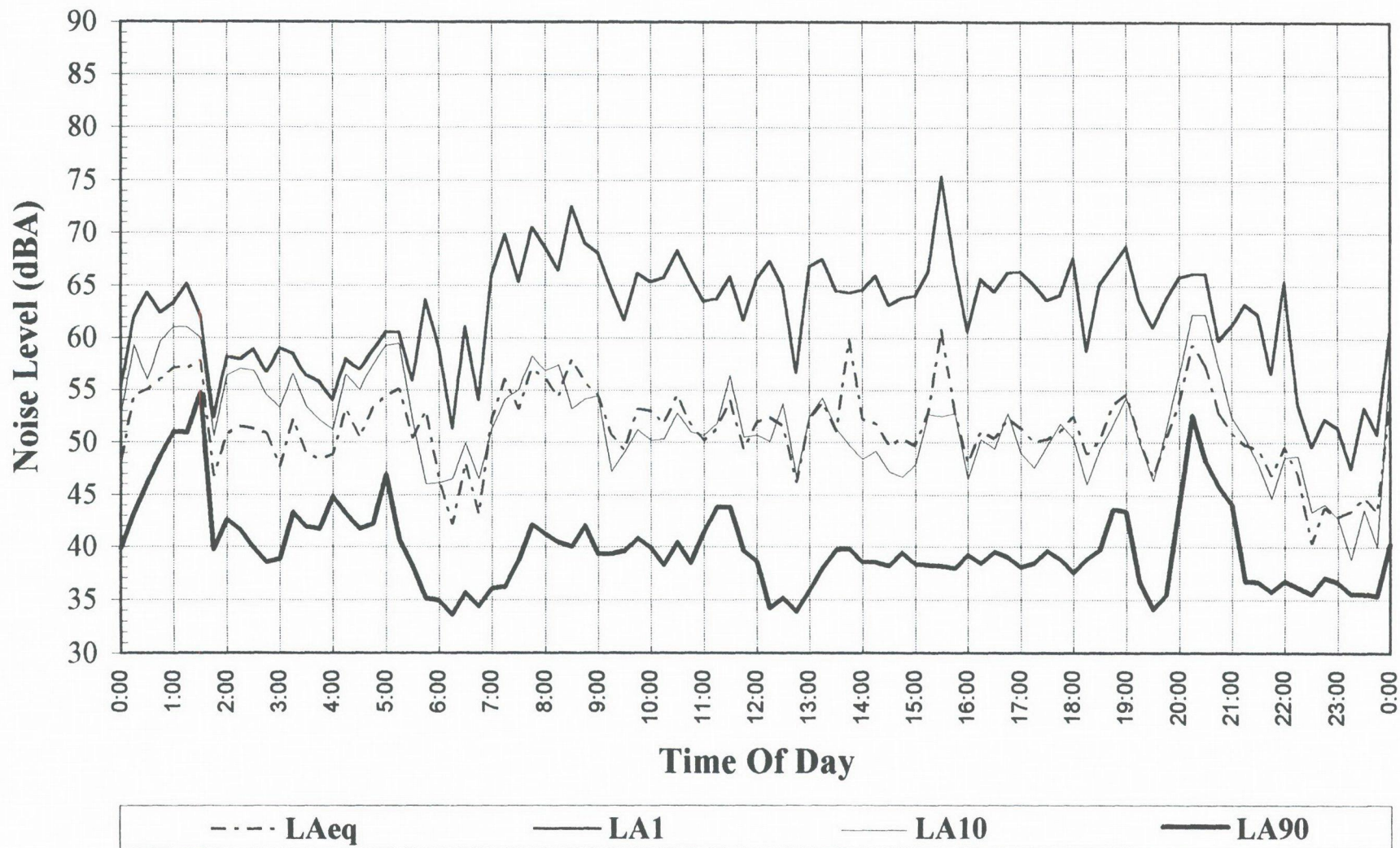


# Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd Friday, 6 March, 1998



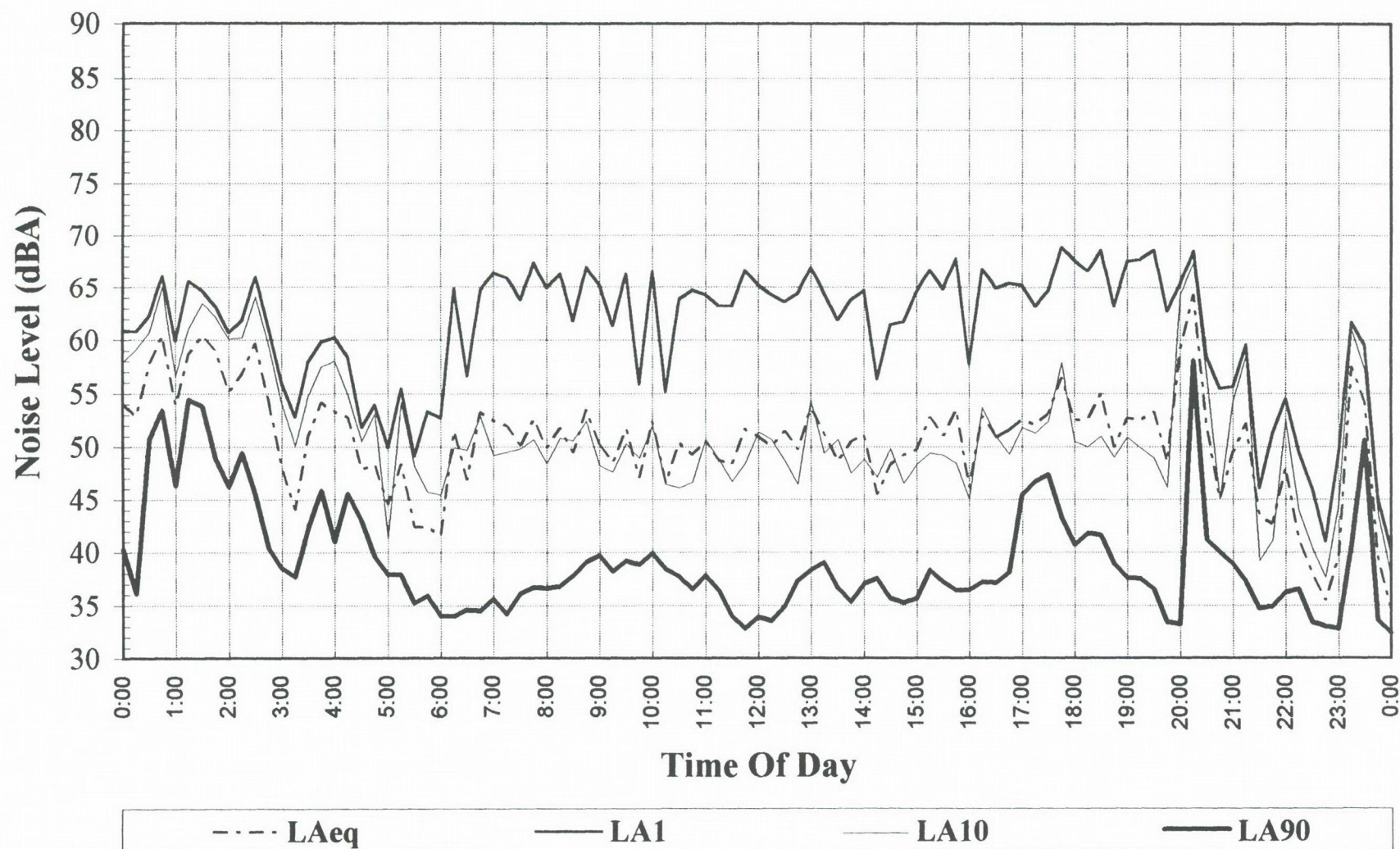
## Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

Saturday, 7 March, 1998



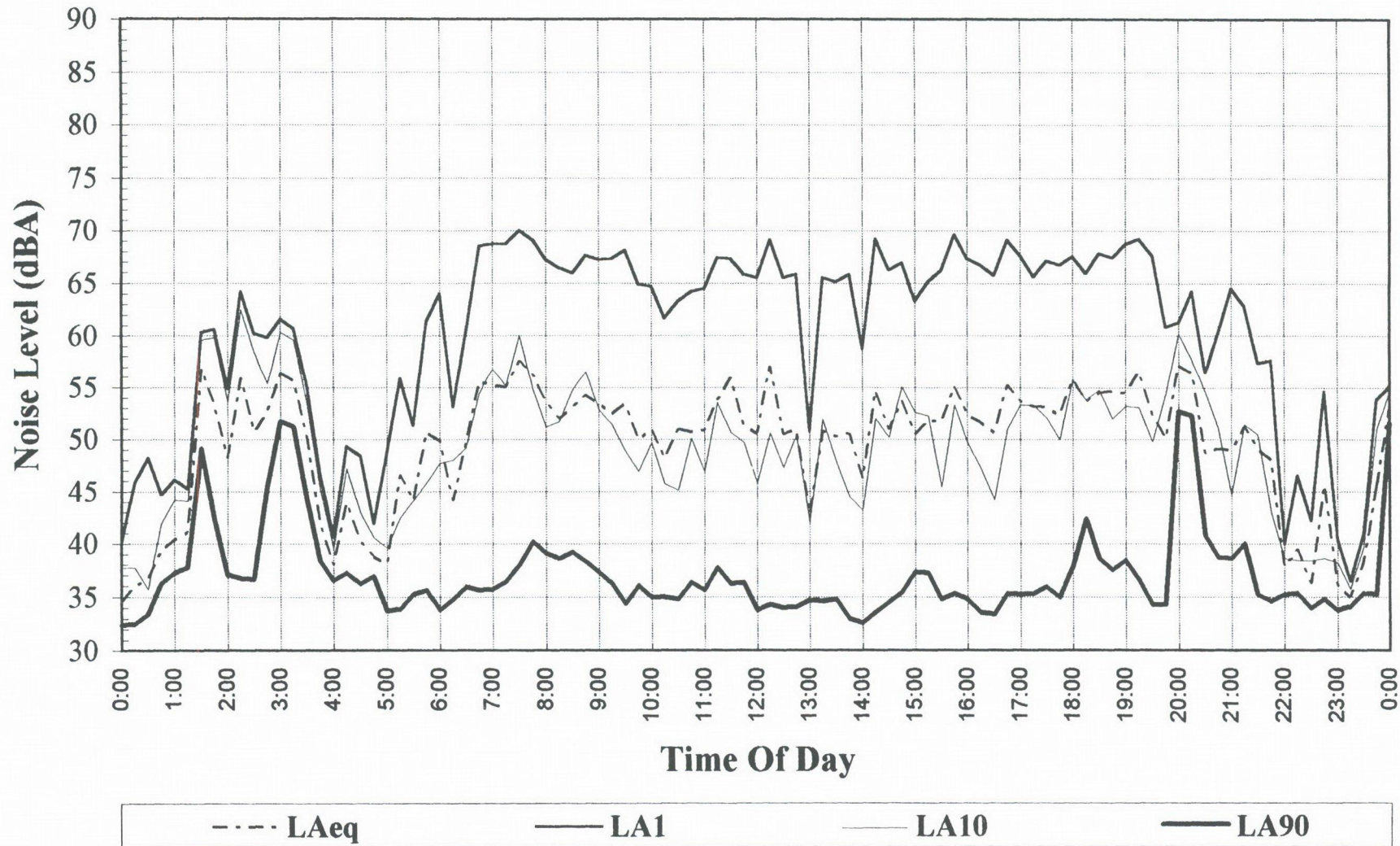


**Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd**  
**Sunday, 8 March, 1998**



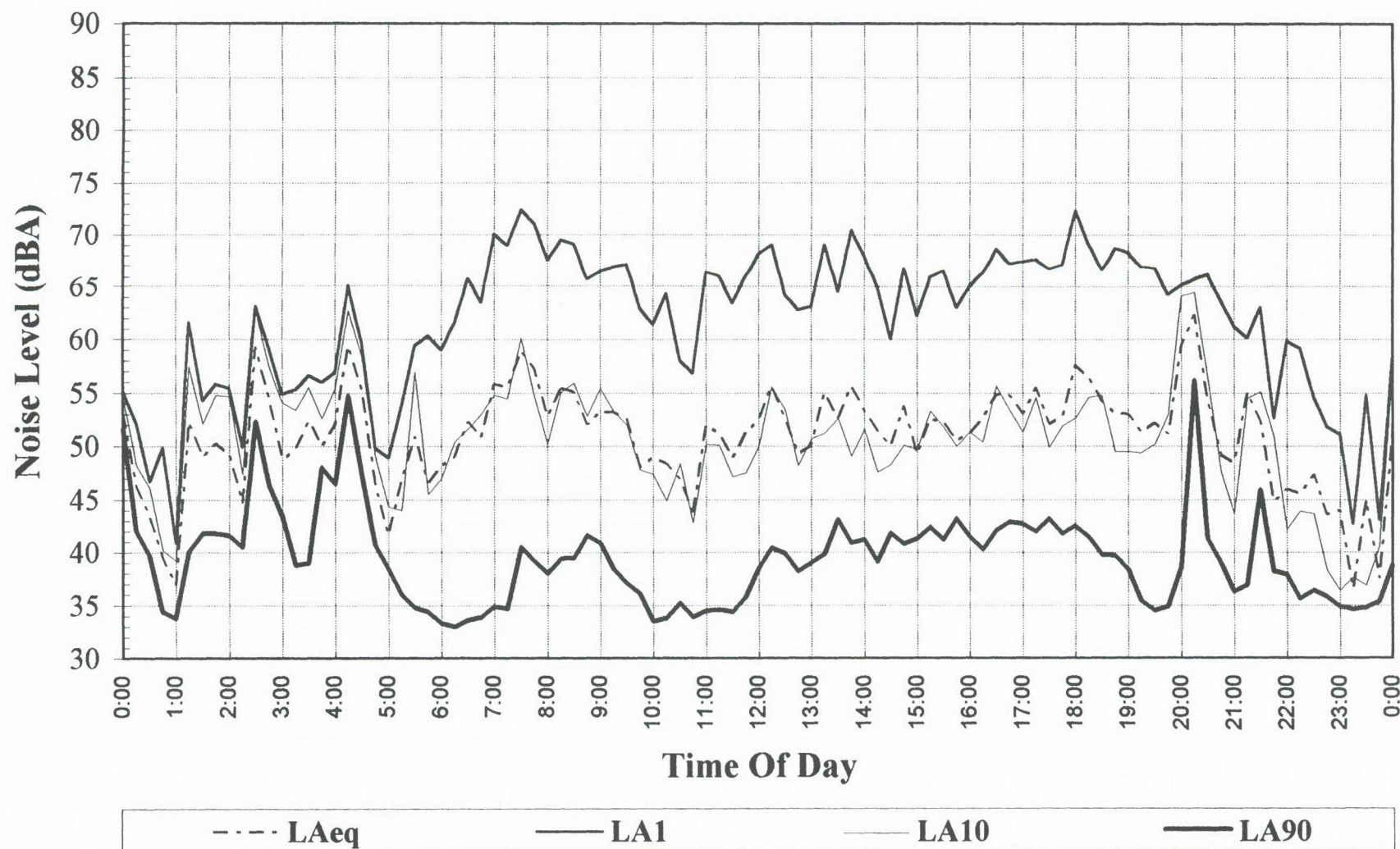
## Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd

Monday, 9 March, 1998

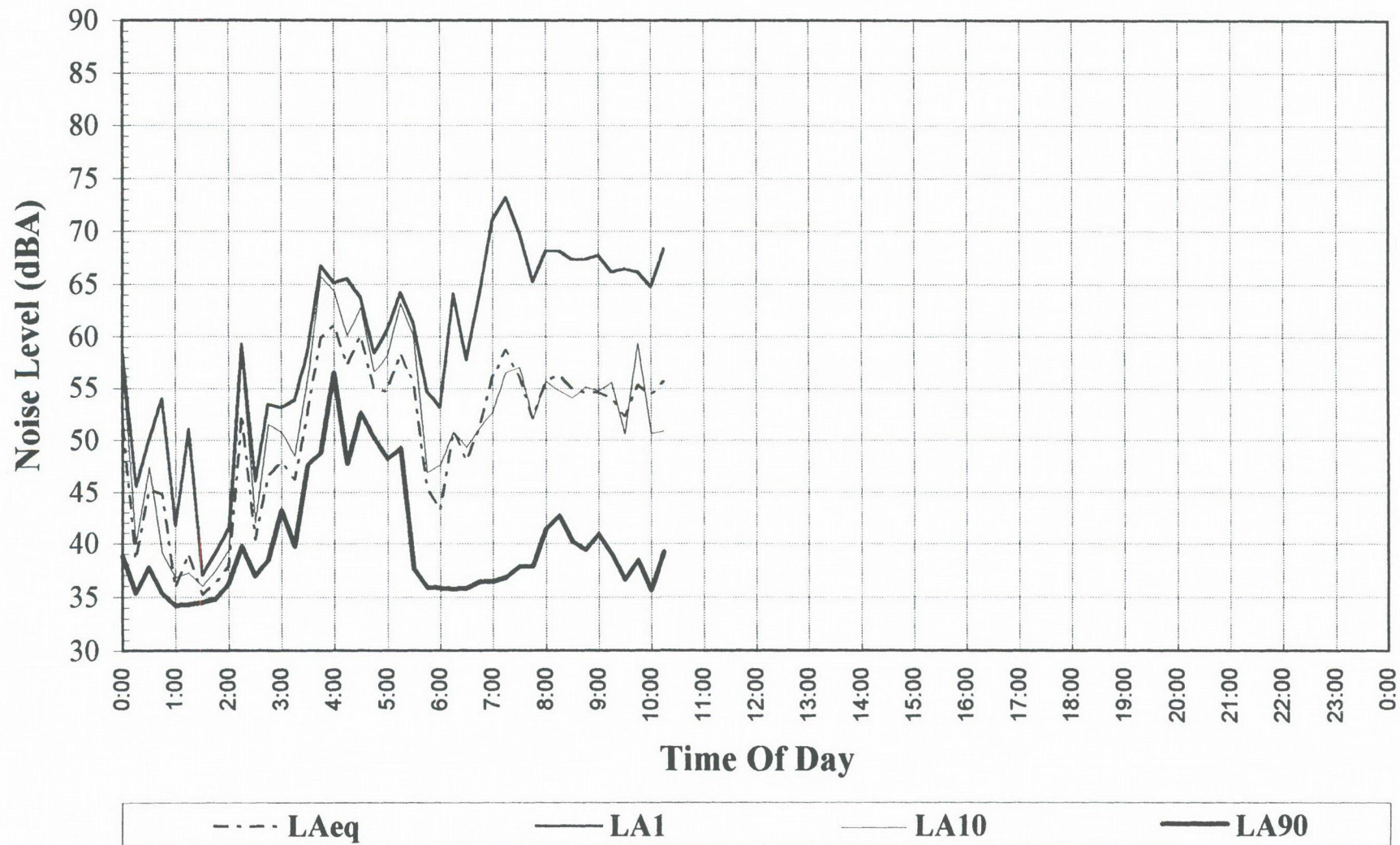




**Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd**  
**Tuesday, 10 March, 1998**



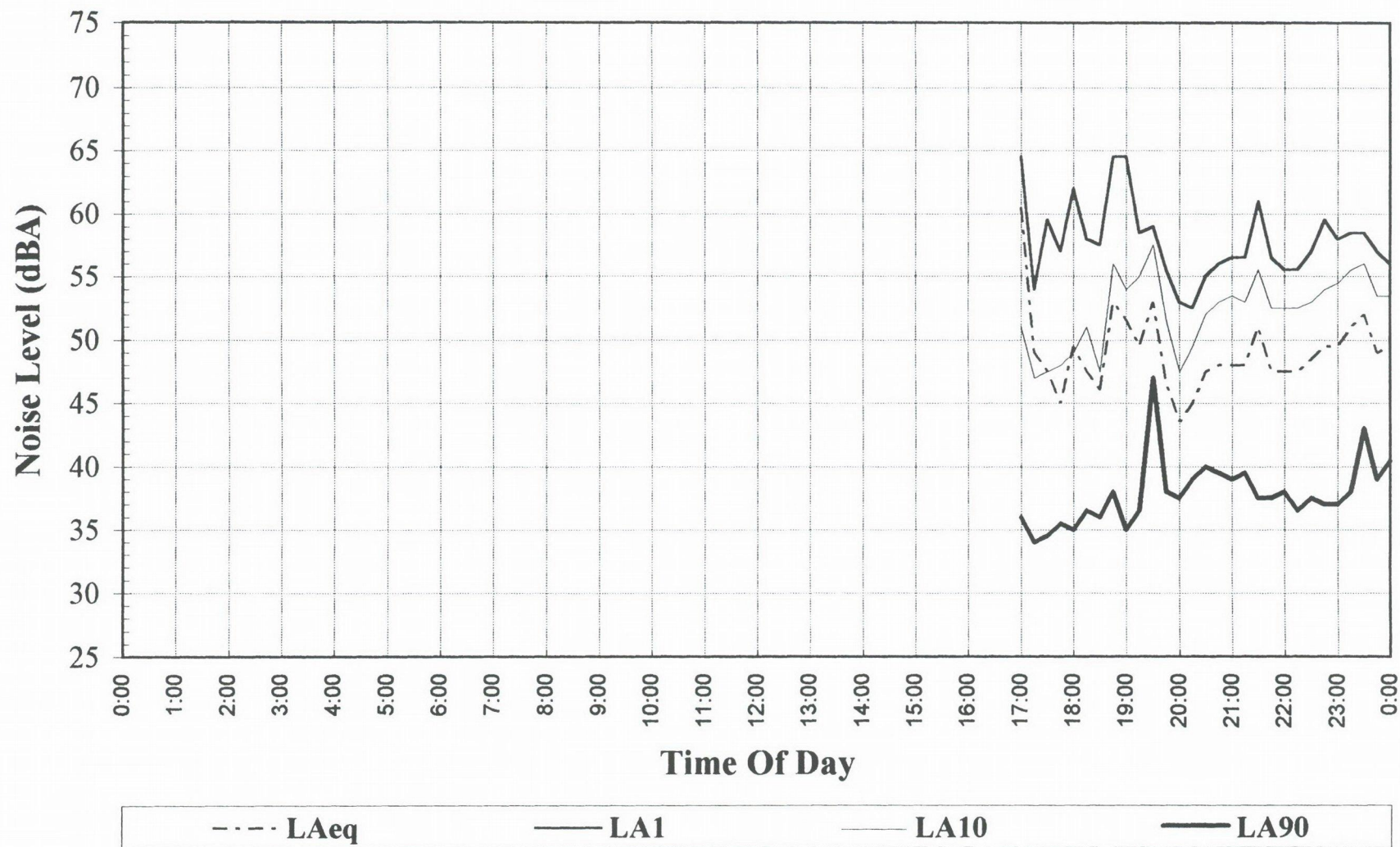
**Noise Levels at Location 13 - Lot 2(Everingham), Cudgera Ck Rd**  
**Wednesday, 11 March, 1998**





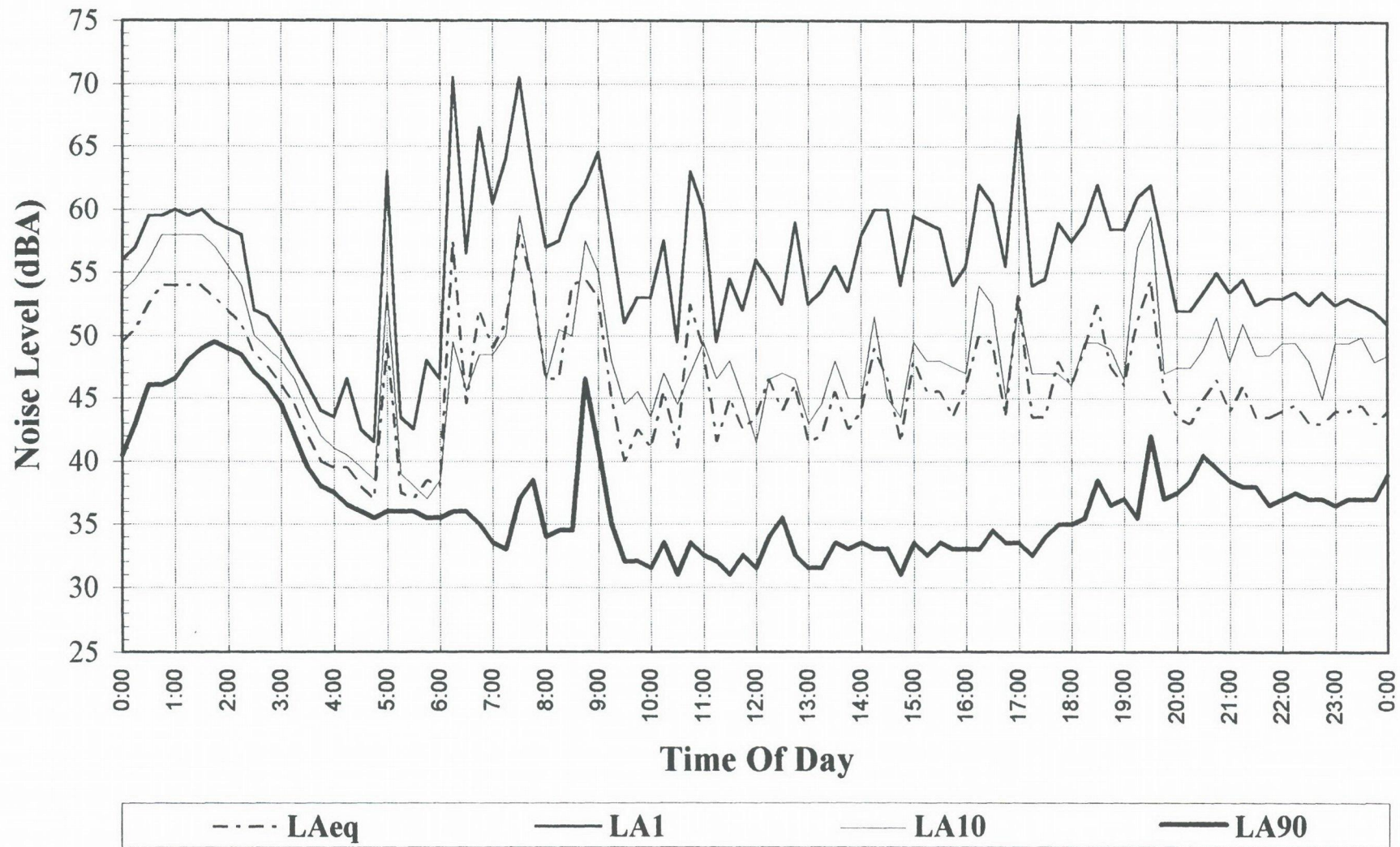
## Noise Levels at Location 14 - 44 Kanes Rd, Round Mountain

Tuesday, 3 March, 1998



## Noise Levels at Location 14 - 44 Kanes Rd, Round Mountain

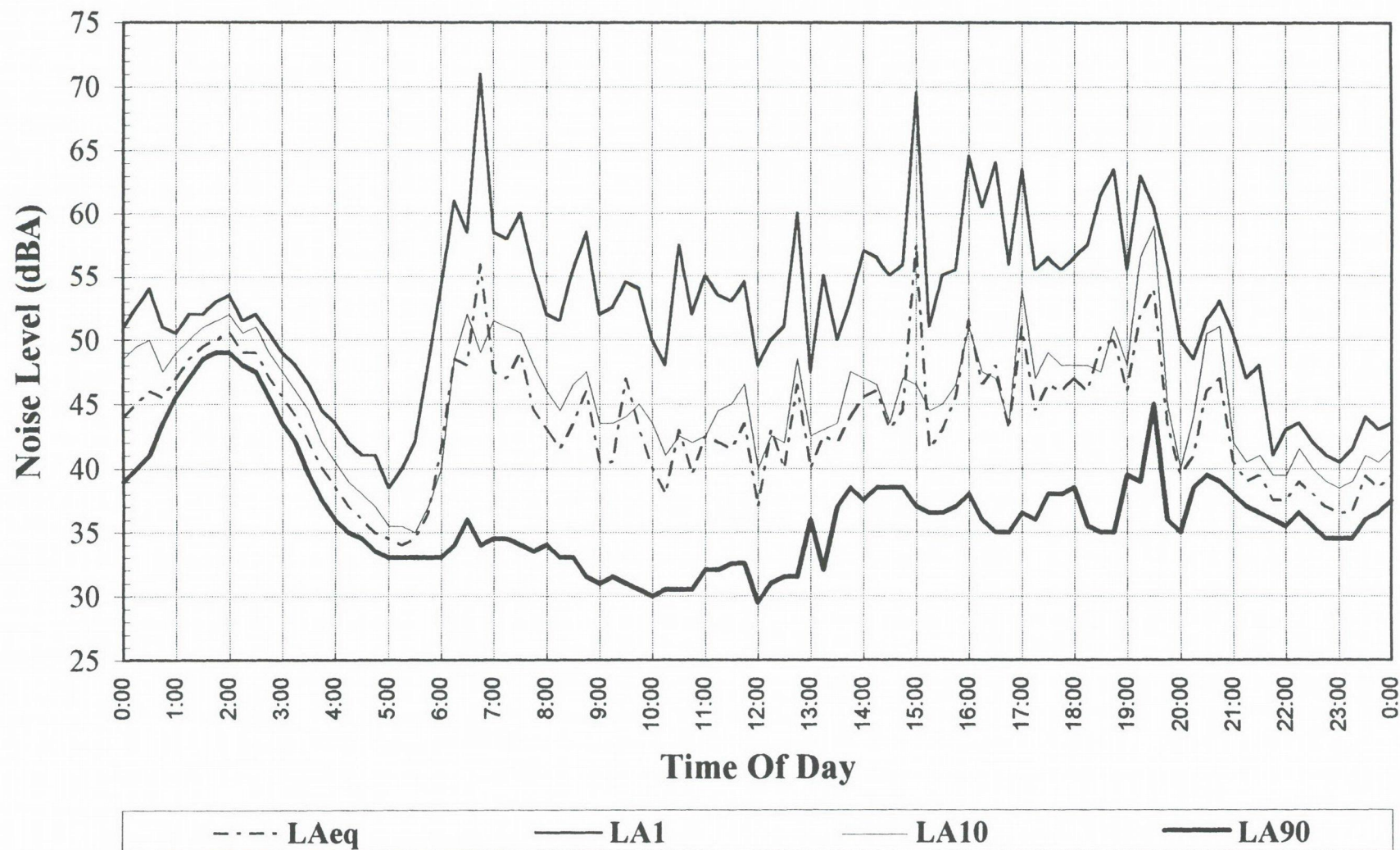
Wednesday, 4 March, 1998





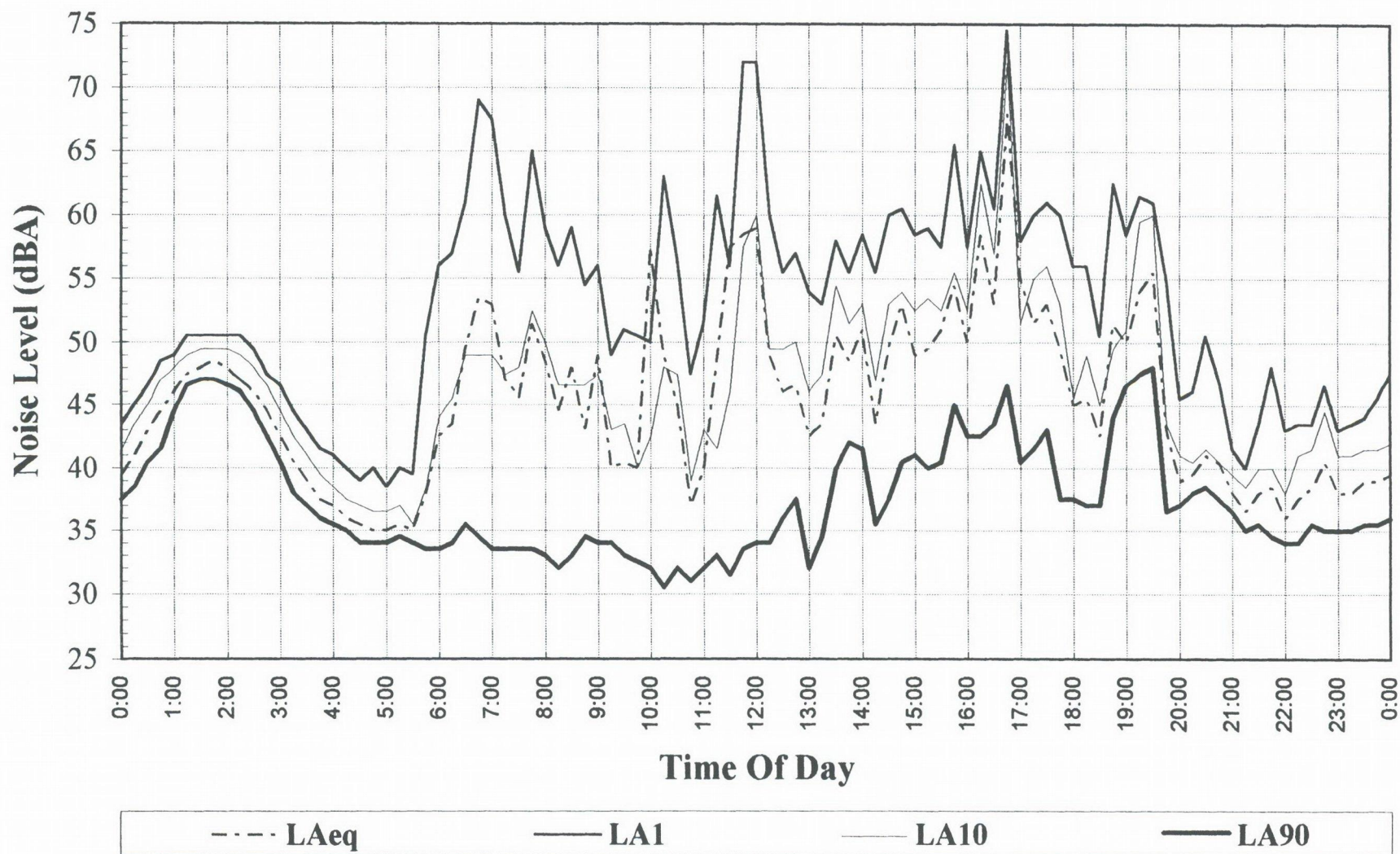
# Noise Levels at Location 14 - 44 Kanes Rd, Round Mountain

Thursday, 5 March, 1998



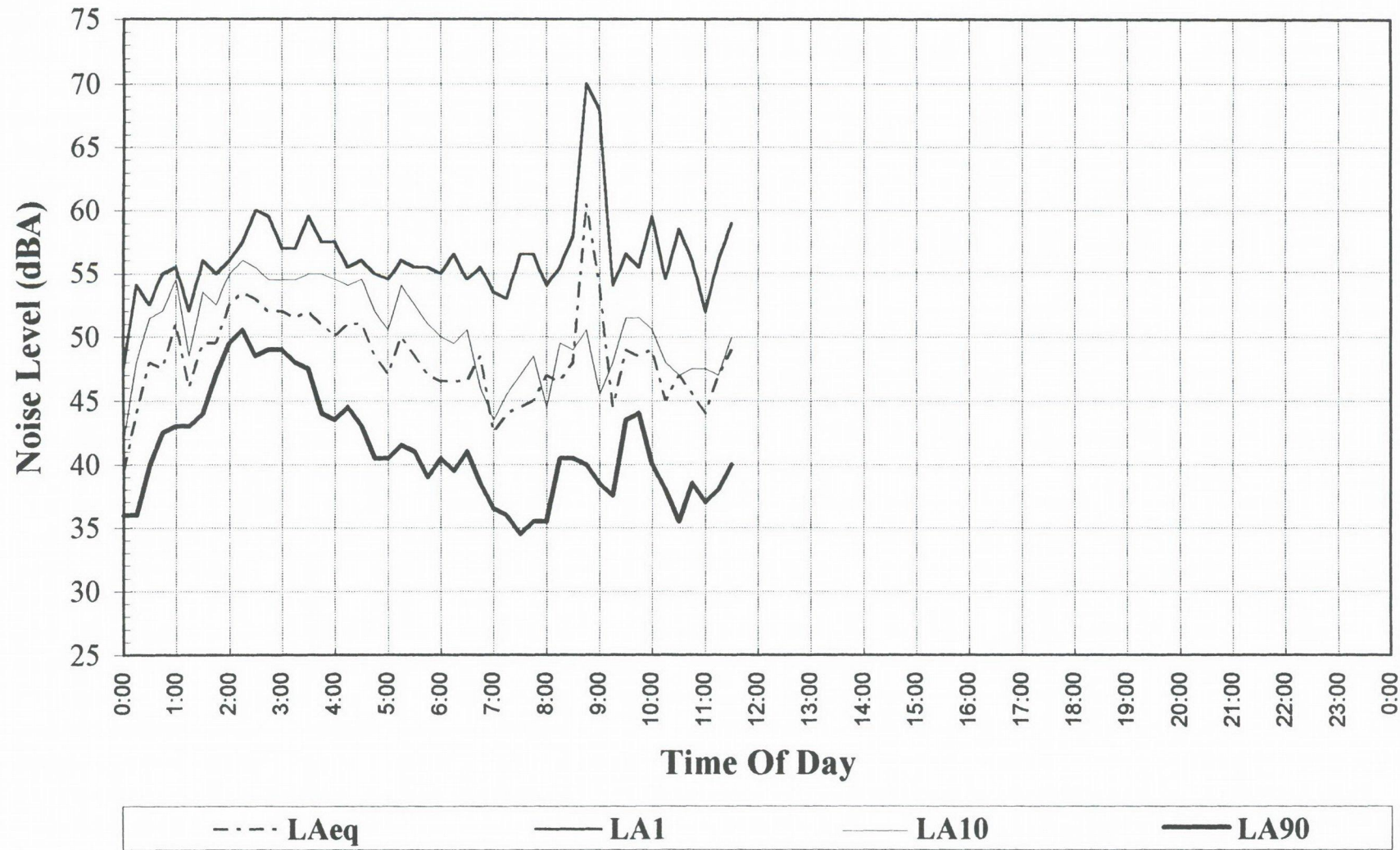
## Noise Levels at Location 14 - 44 Kanes Rd, Round Mountain

Friday, 6 March, 1998



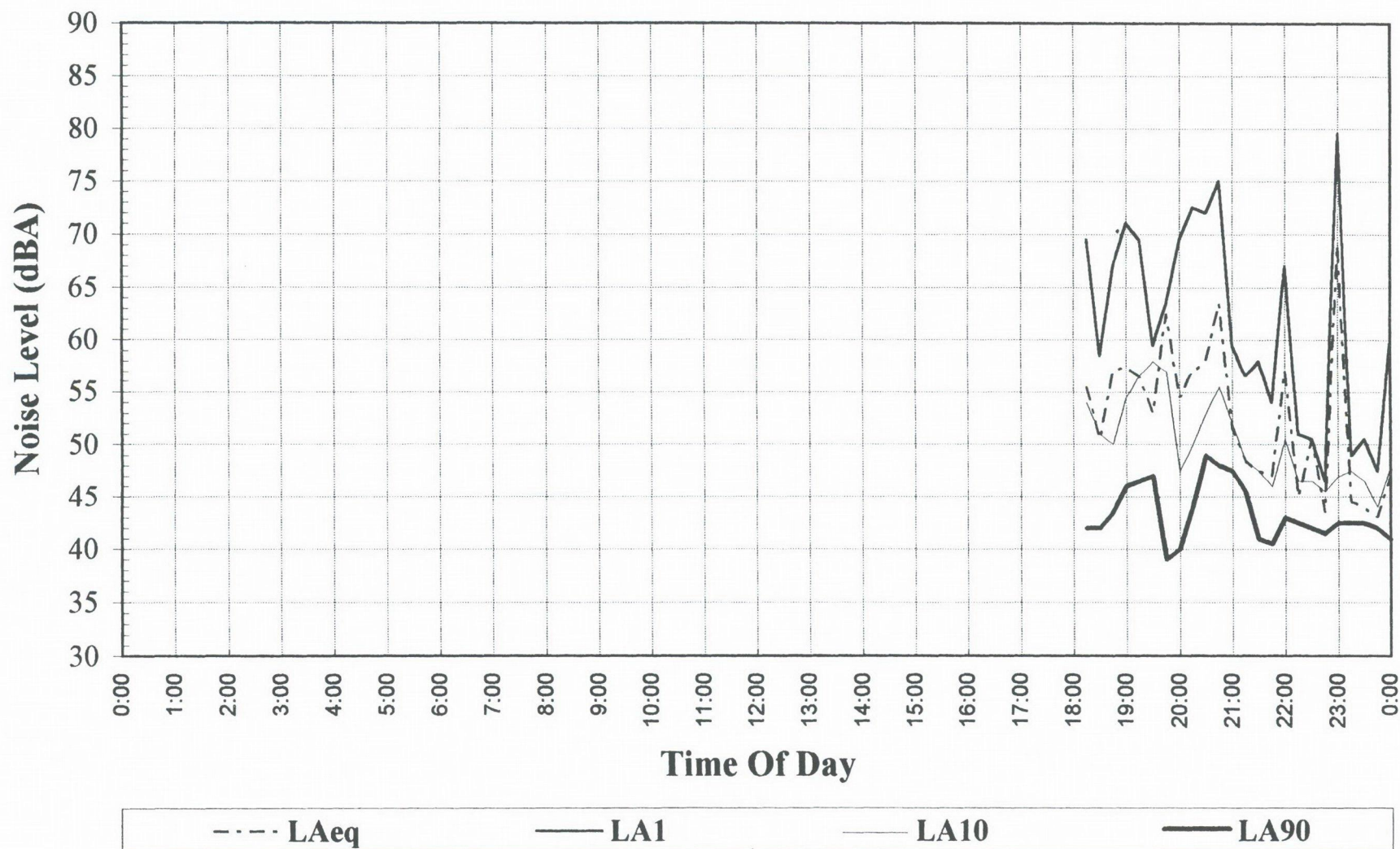


**Noise Levels at Location 14 - 44 Kanes Rd, Round Mountain**  
**Saturday, 7 March, 1998**



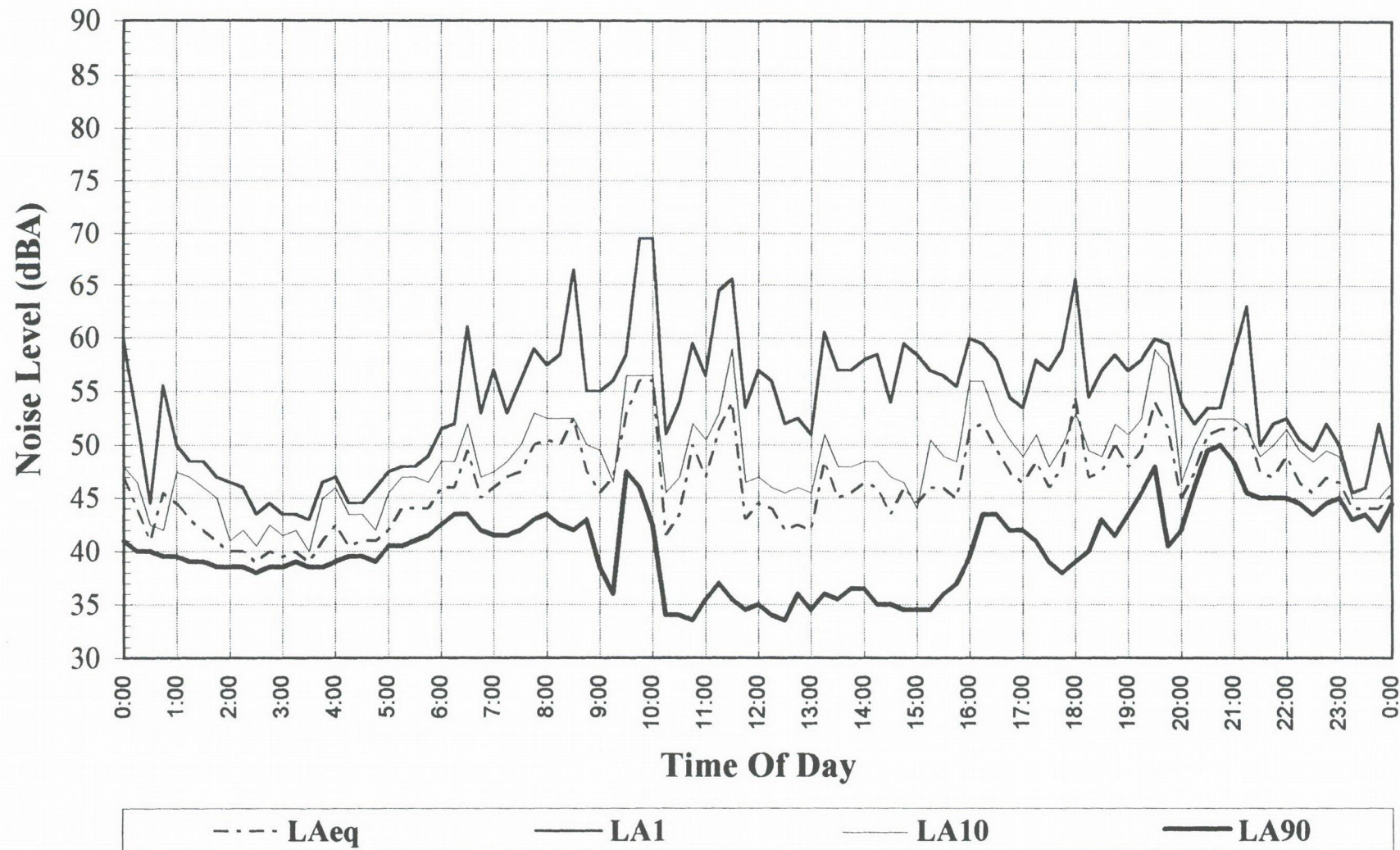
## Noise Levels at Location 15 - Lot 14 (McGrath), Kanes Road

Thursday, 26 February, 1998



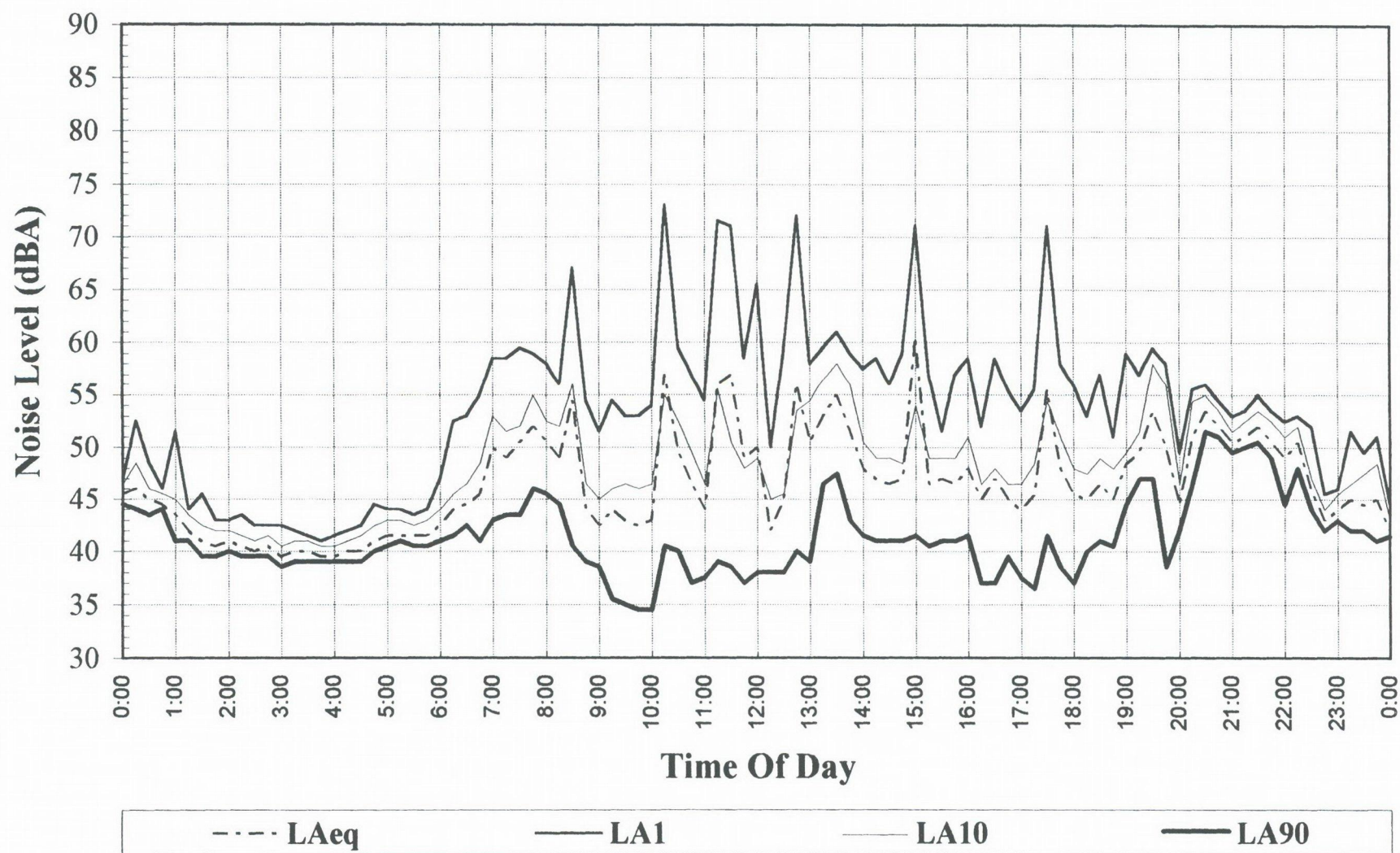


**Noise Levels at Location 15 - Lot 14 (McGrath), Kanes Road**  
**Friday, 27 February, 1998**



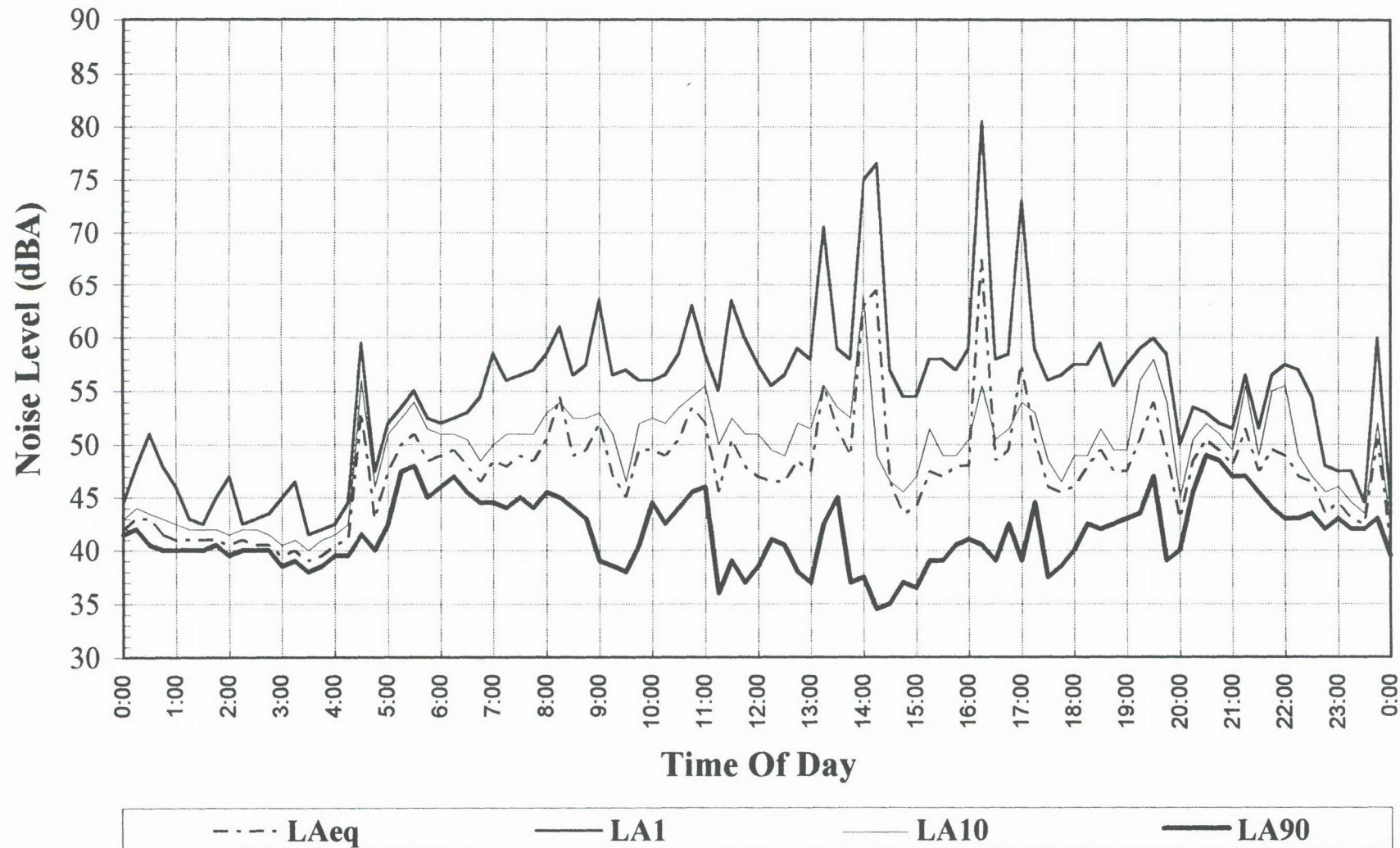
## Noise Levels at Location 15 - Lot 14 (McGrath), Kanes Road

Saturday, 28 February, 1998



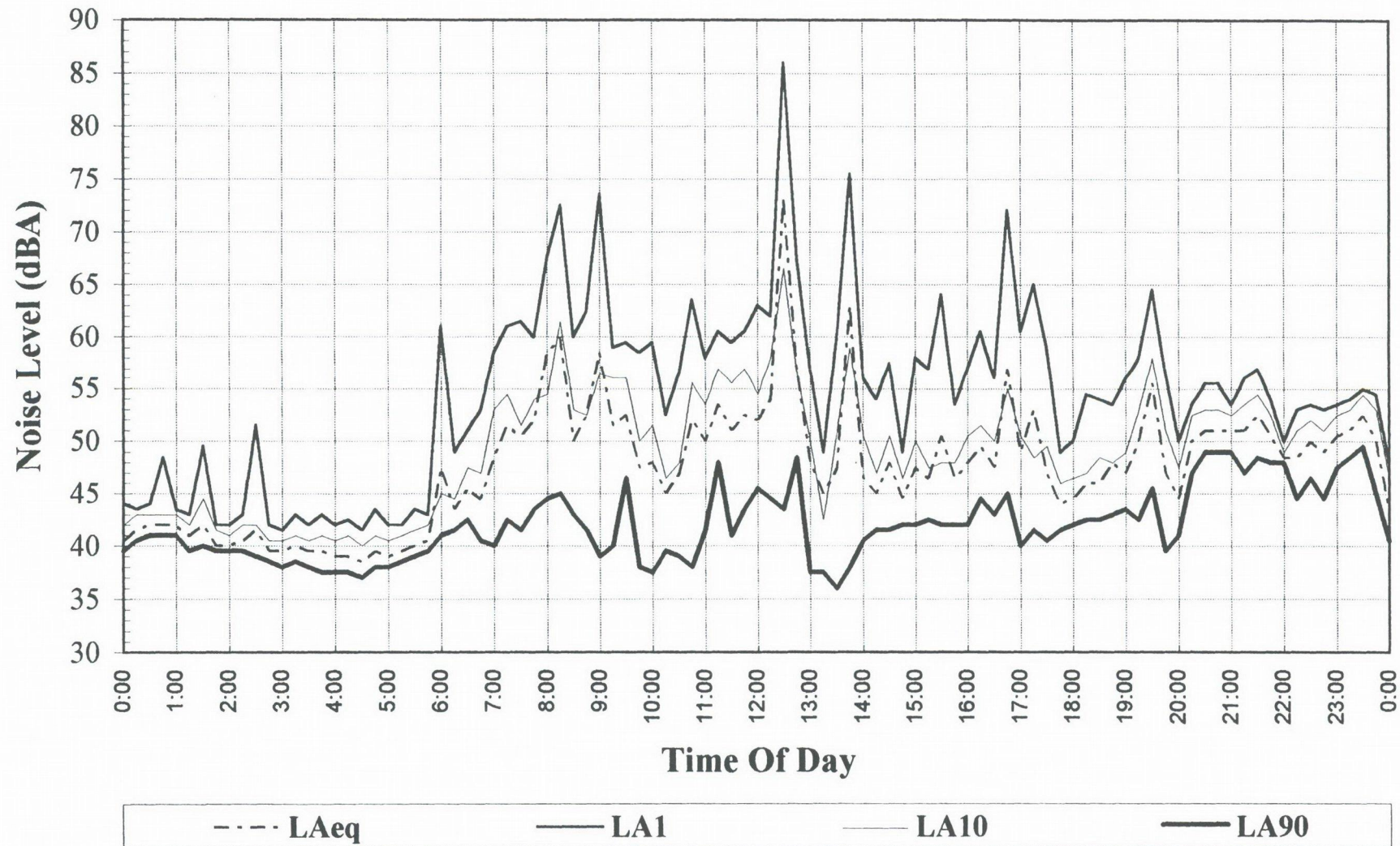


**Noise Levels at Location 15 - Lot 14 (McGrath), Kanes Road**  
**Sunday, 1 March, 1998**



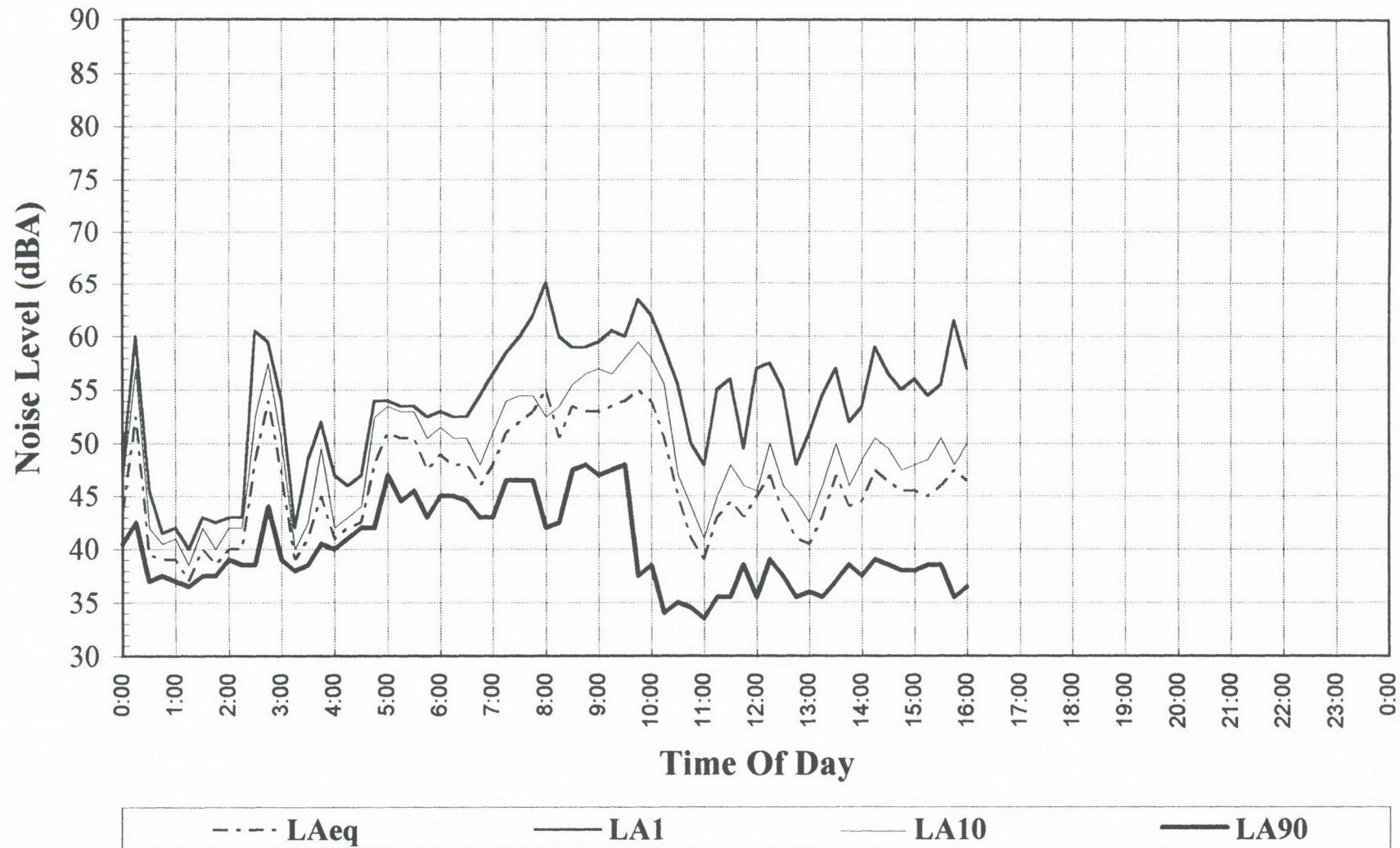
## Noise Levels at Location 15 - Lot 14 (McGrath), Kanes Road

Monday, 2 March, 1998



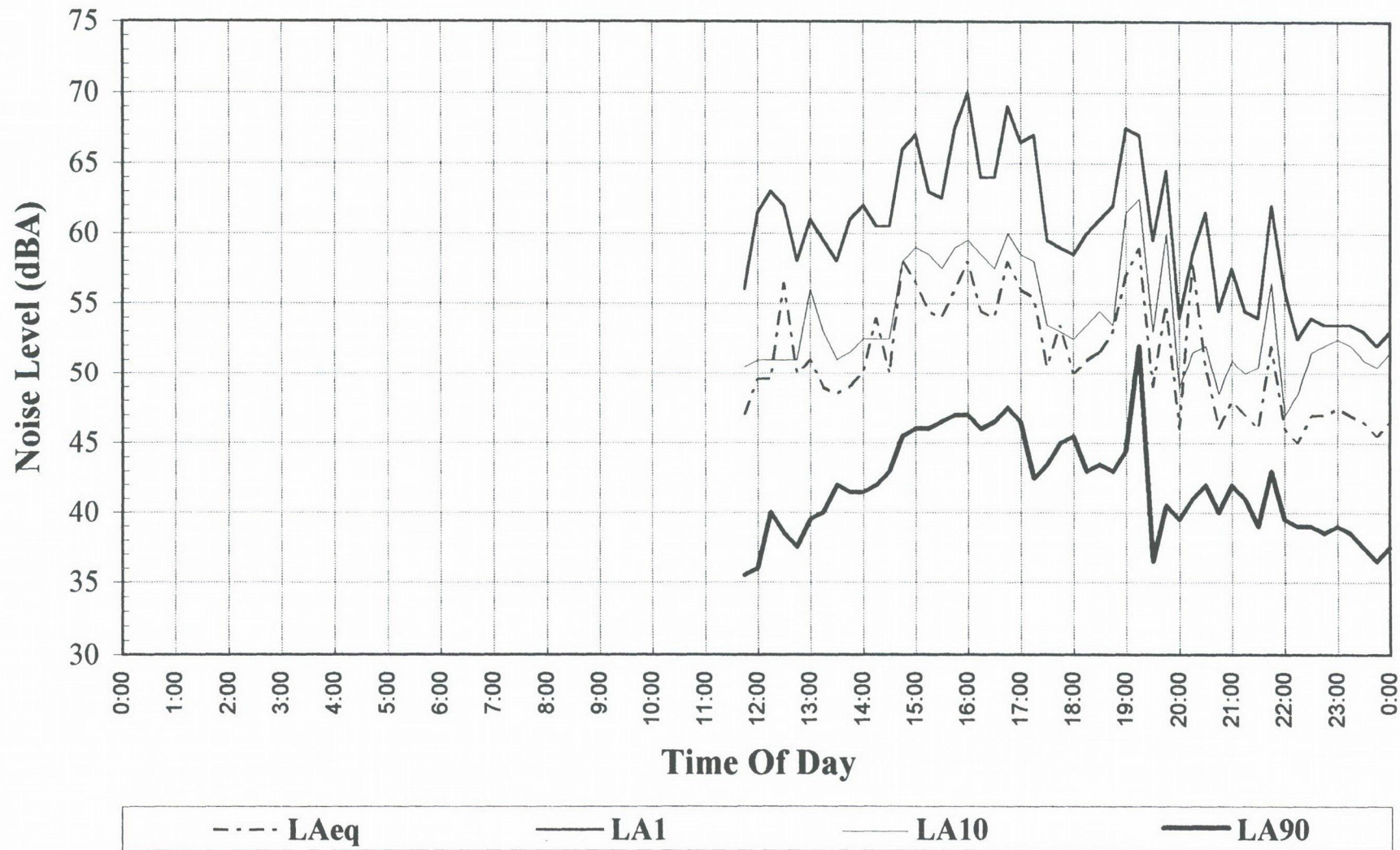


**Noise Levels at Location 15 - Lot 14 (McGrath), Kanes Road**  
**Tuesday, 3 March, 1998**



## Noise Levels at Location 16 - Lot 5, Wilman Rd, Round Mtn

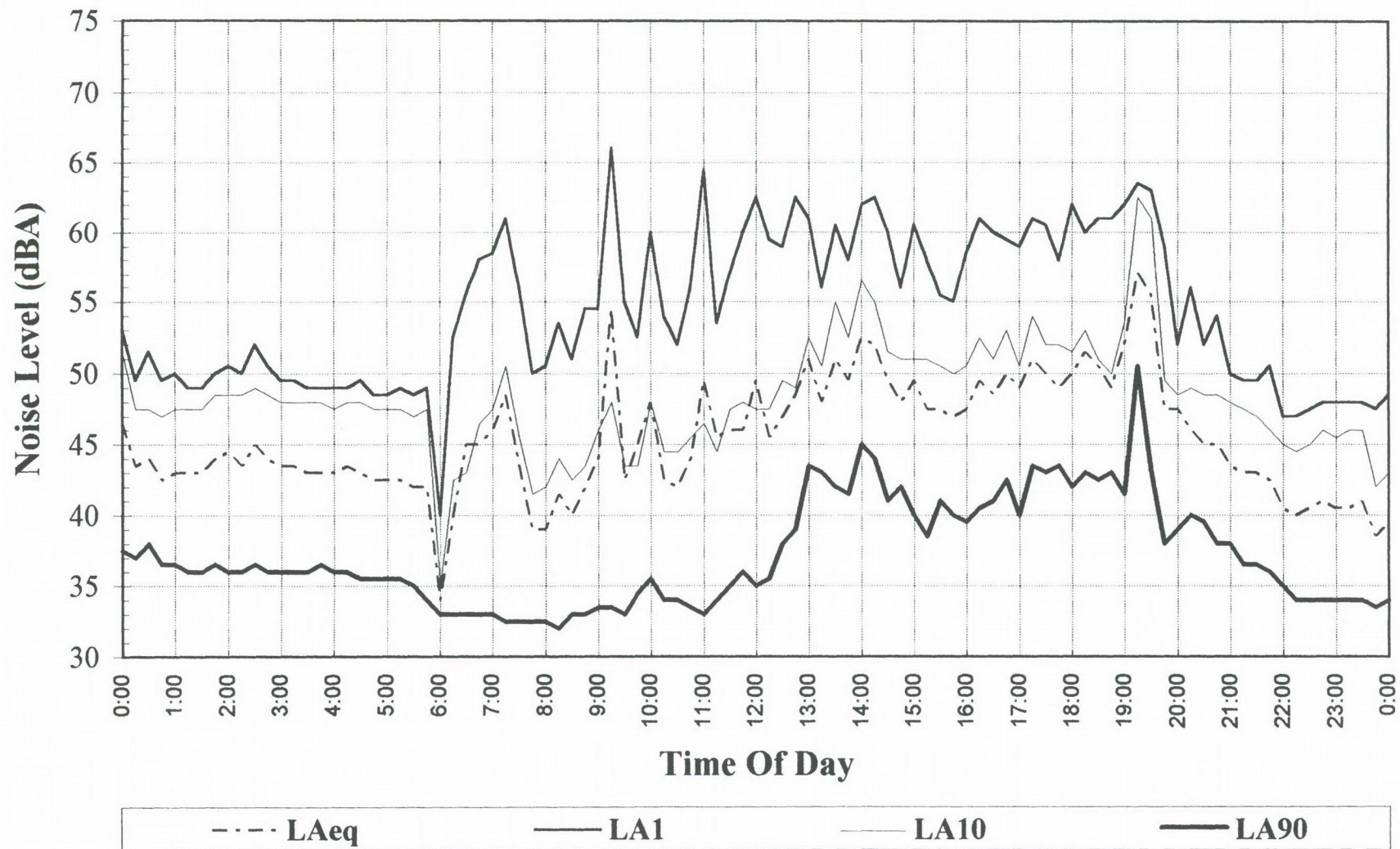
Saturday, 7 March, 1998





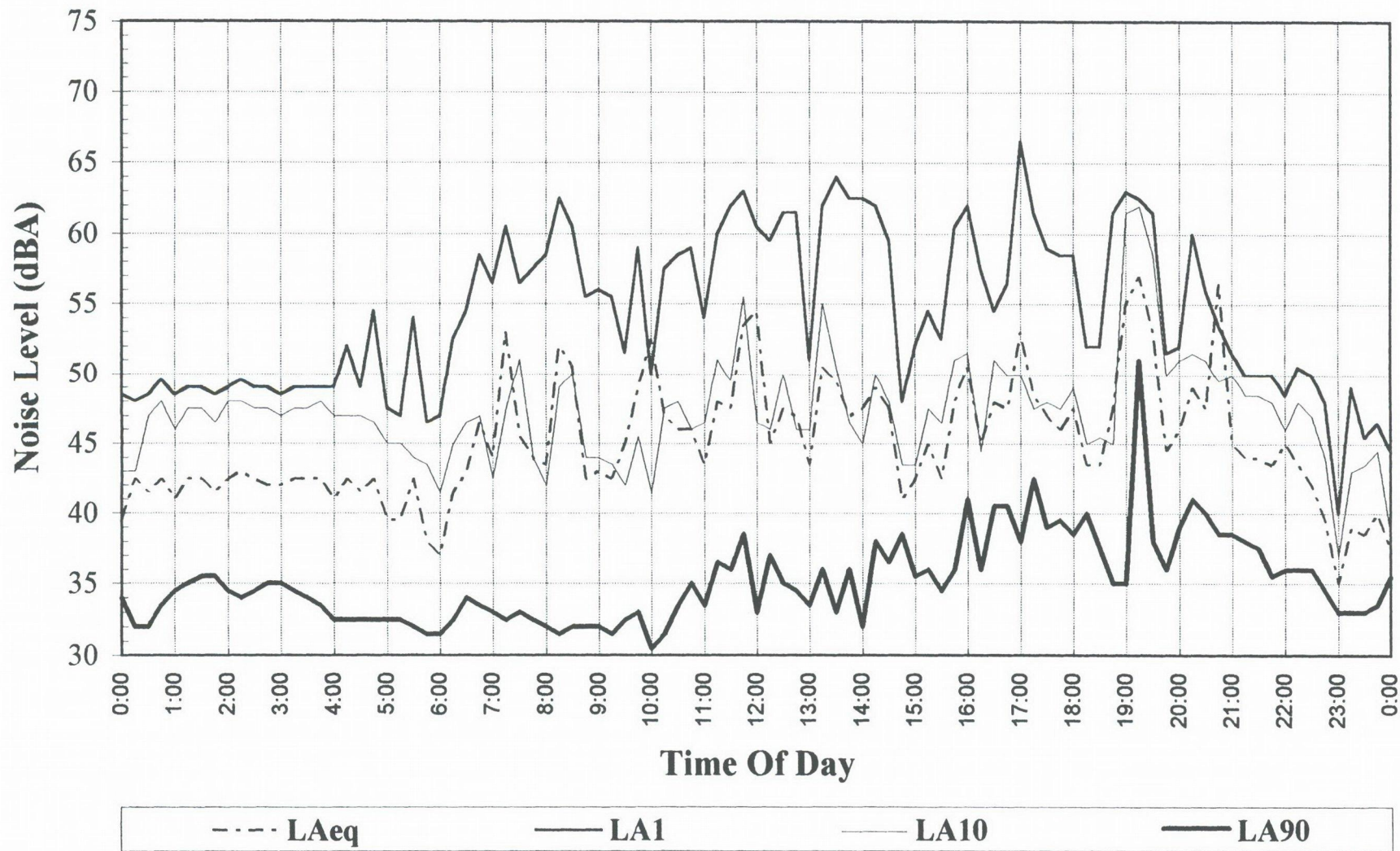
# Noise Levels at Location 16 - Lot 5, Wilman Rd, Round Mtn

Sunday, 8 March, 1998



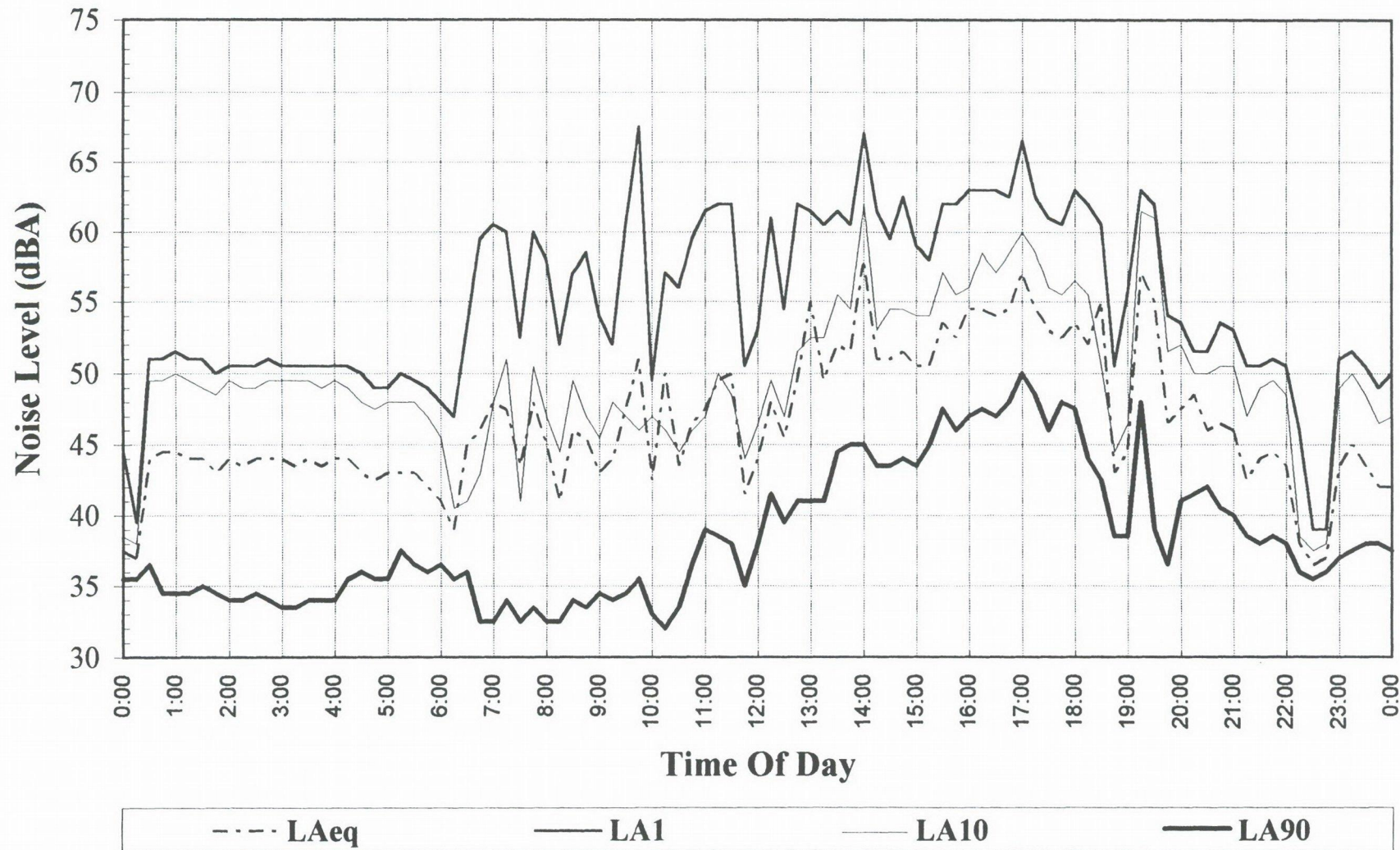
## Noise Levels at Location 16 - Lot 5, Wilman Rd, Round Mtn

Monday, 9 March, 1998



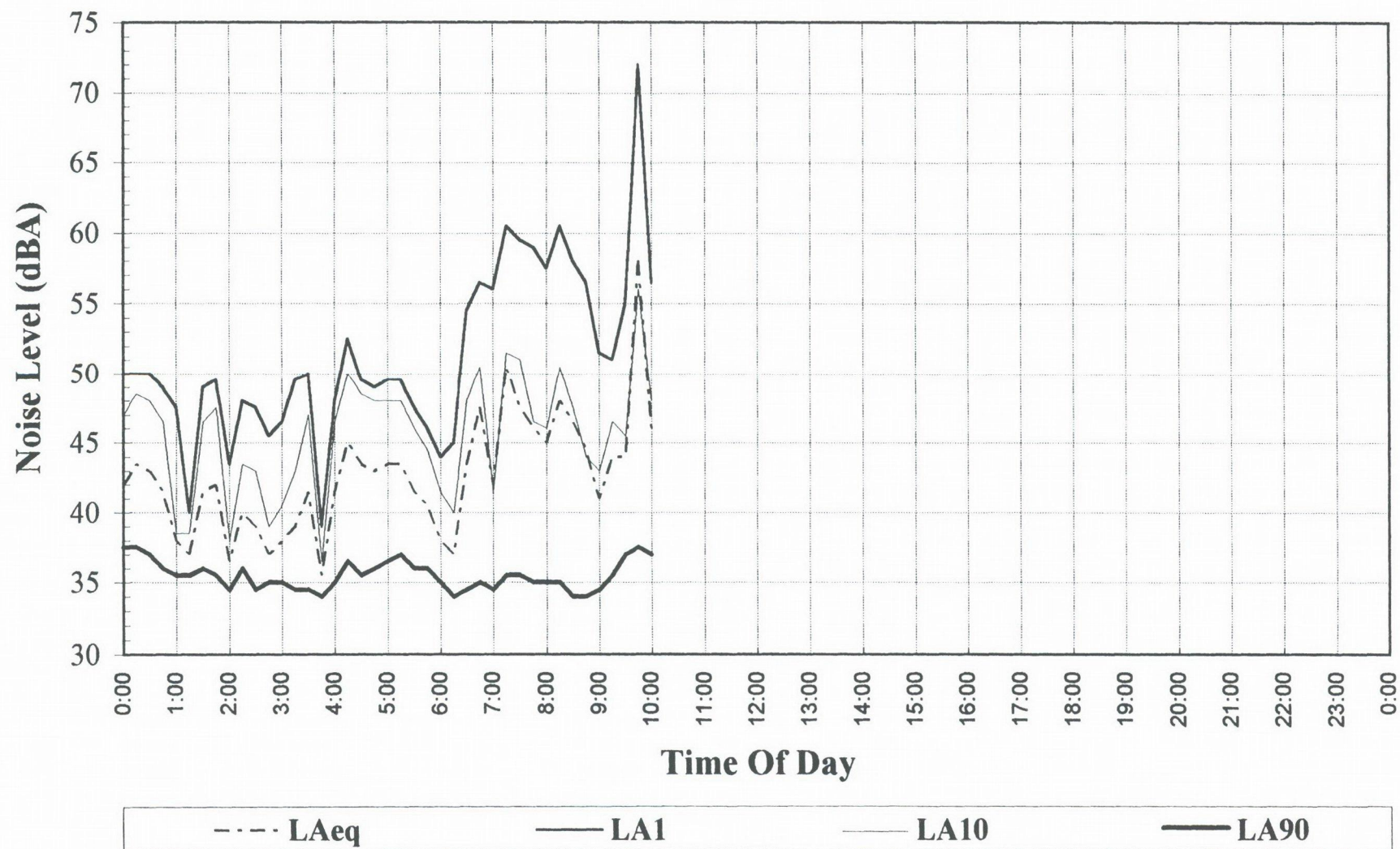


**Noise Levels at Location 16 - Lot 5, Wilman Rd, Round Mtn**  
**Tuesday, 10 March, 1998**



## Noise Levels at Location 16 - Lot 5, Wilman Rd, Round Mtn

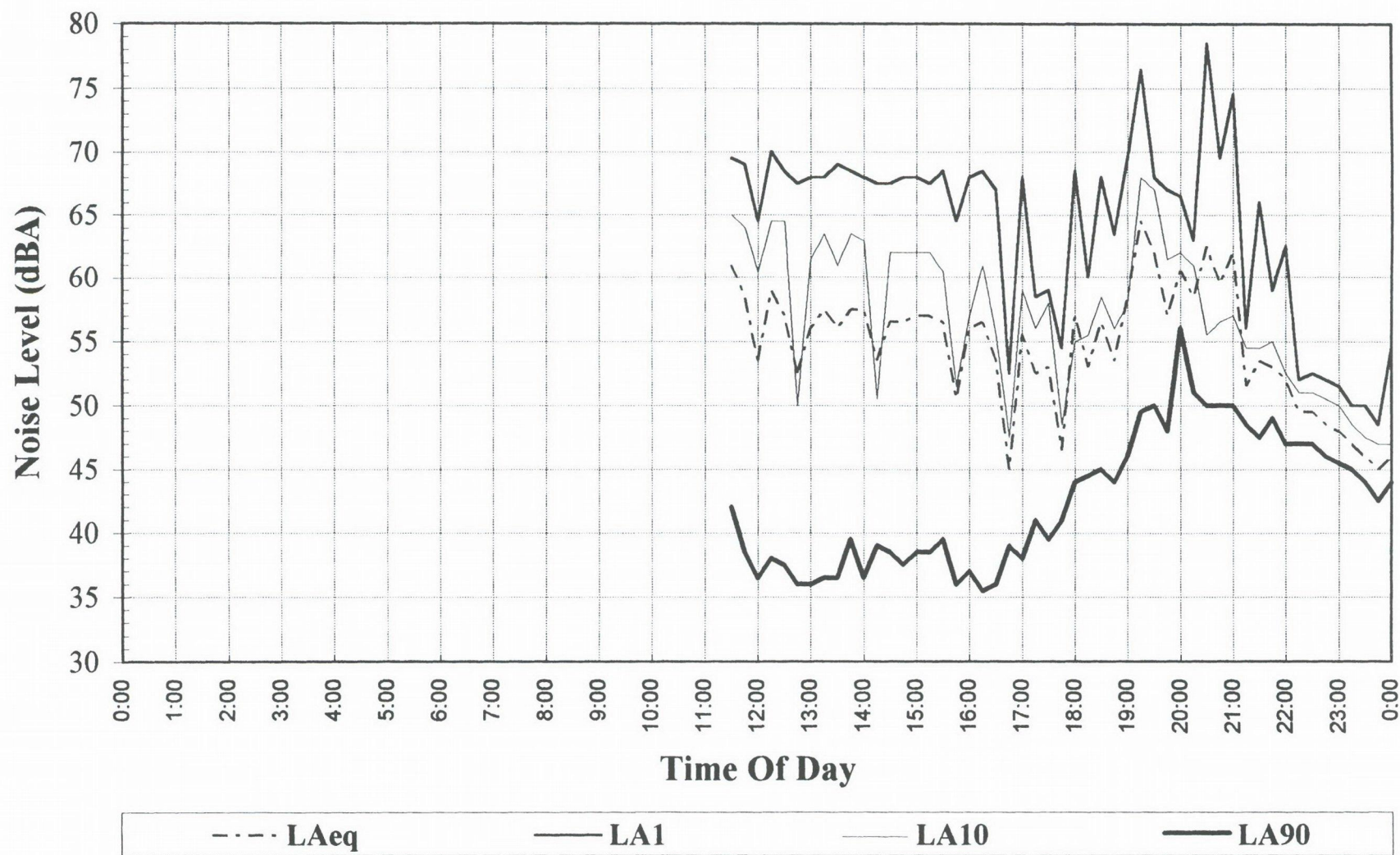
Wednesday, 11 March, 1998





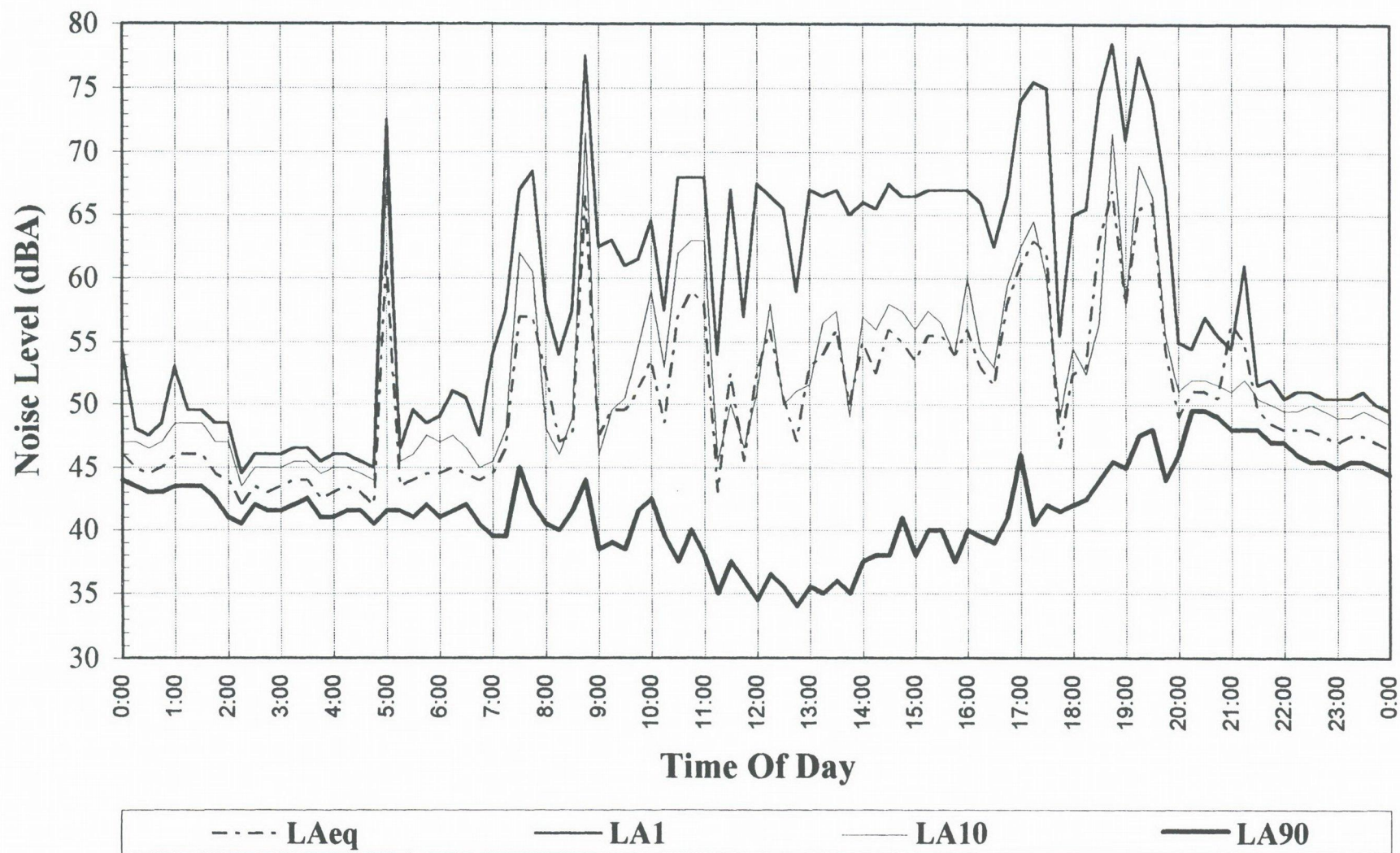
# Noise Levels at Location 17 - Lot 3 (Mary), Round Mountain Rd

Tuesday, 3 March, 1998



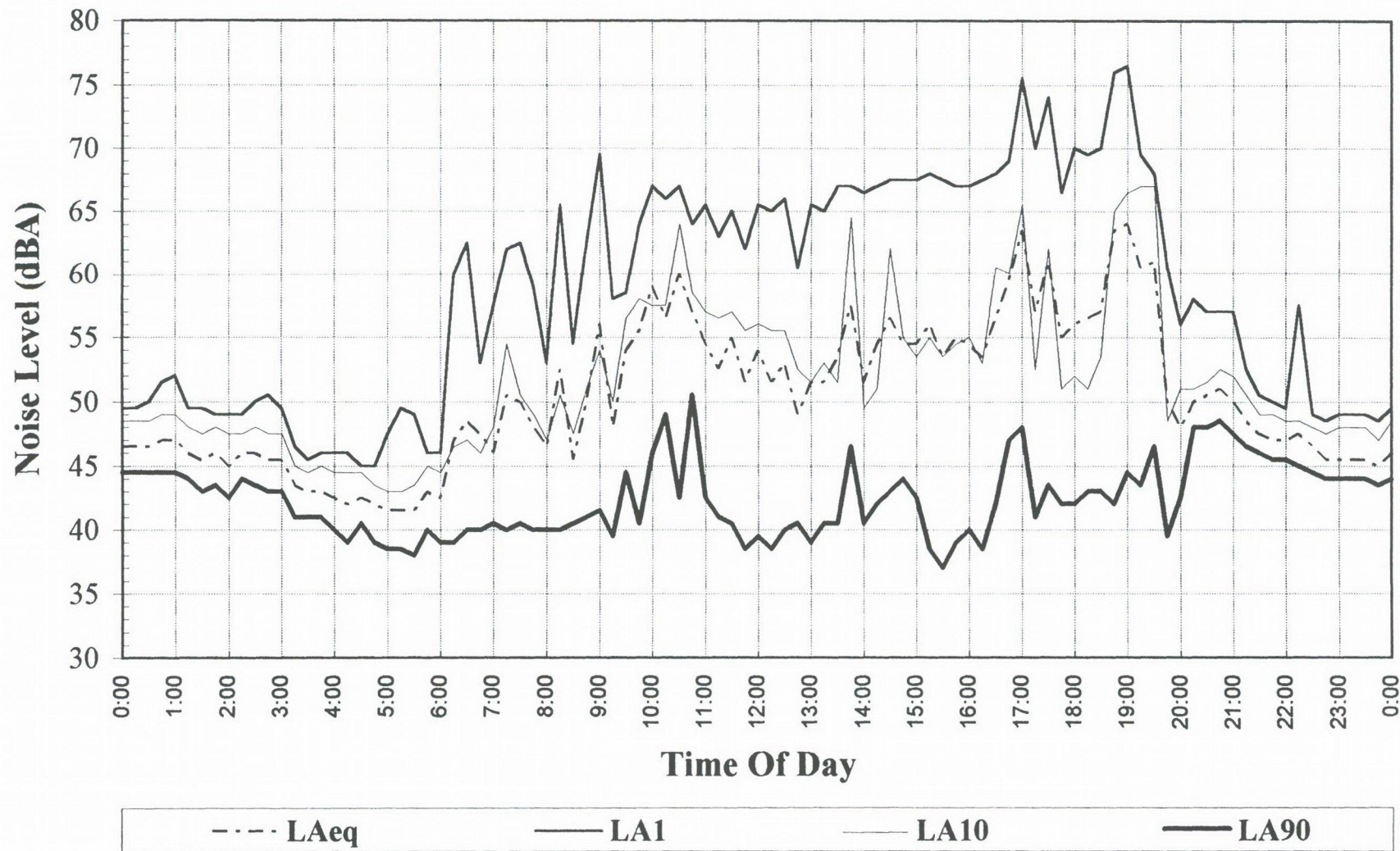
## Noise Levels at Location 17 - Lot 3 (Mary), Round Mountain Rd

Wednesday, 4 March, 1998



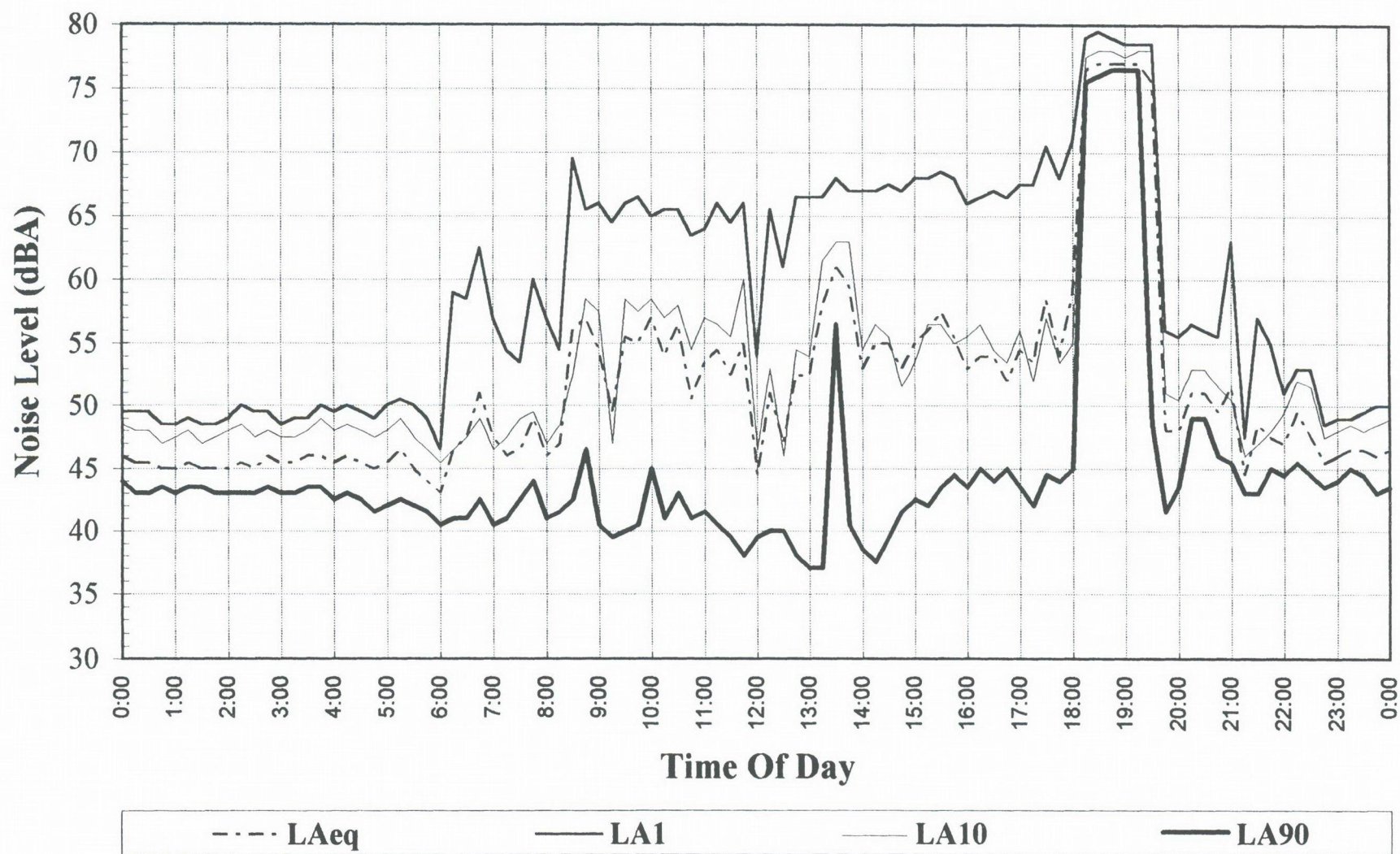


**Noise Levels at Location 17 - Lot 3 (Mary), Round Mountain Rd**  
**Thursday, 5 March, 1998**



## Noise Levels at Location 17 - Lot 3 (Mary), Round Mountain Rd

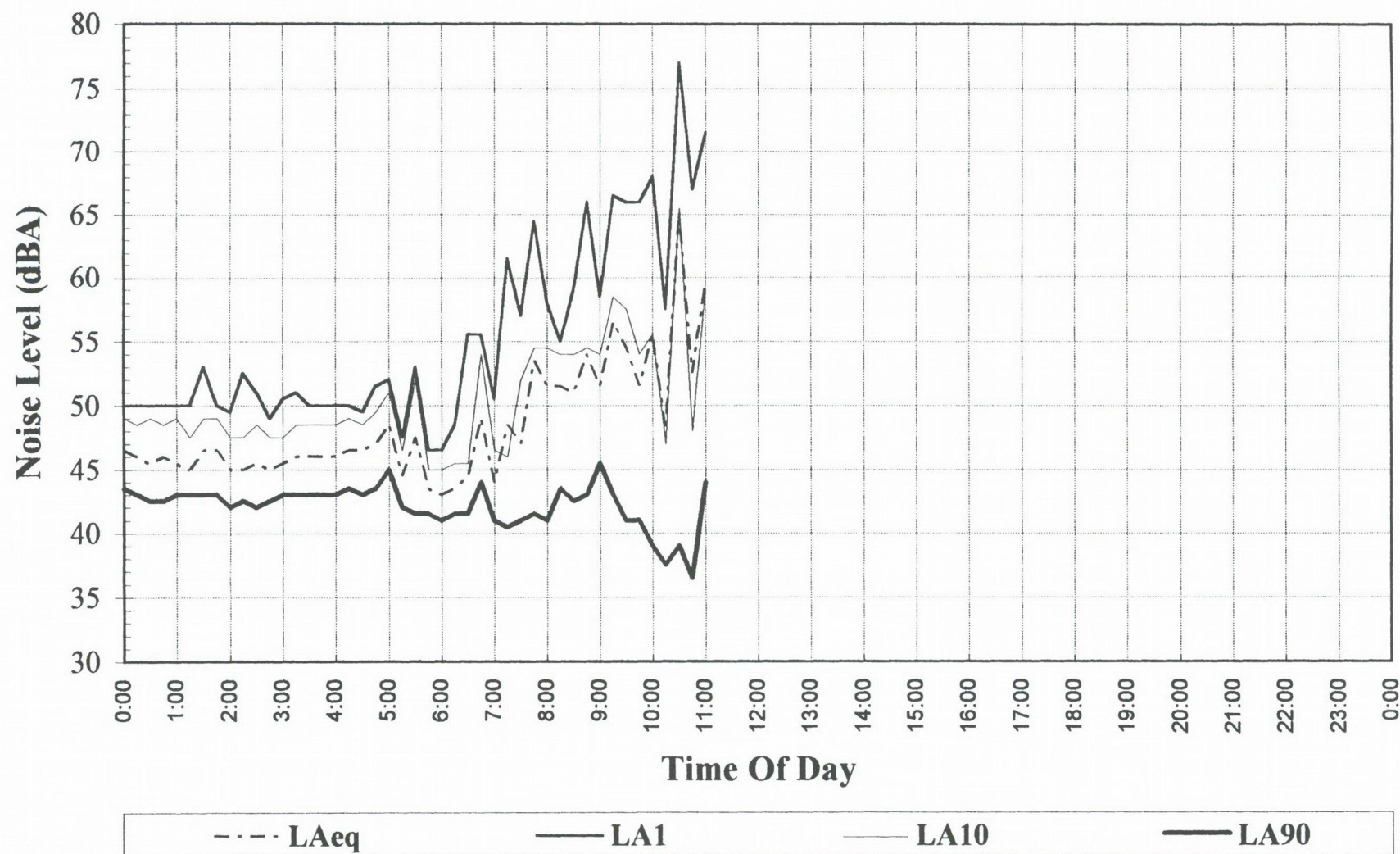
Friday, 6 March, 1998





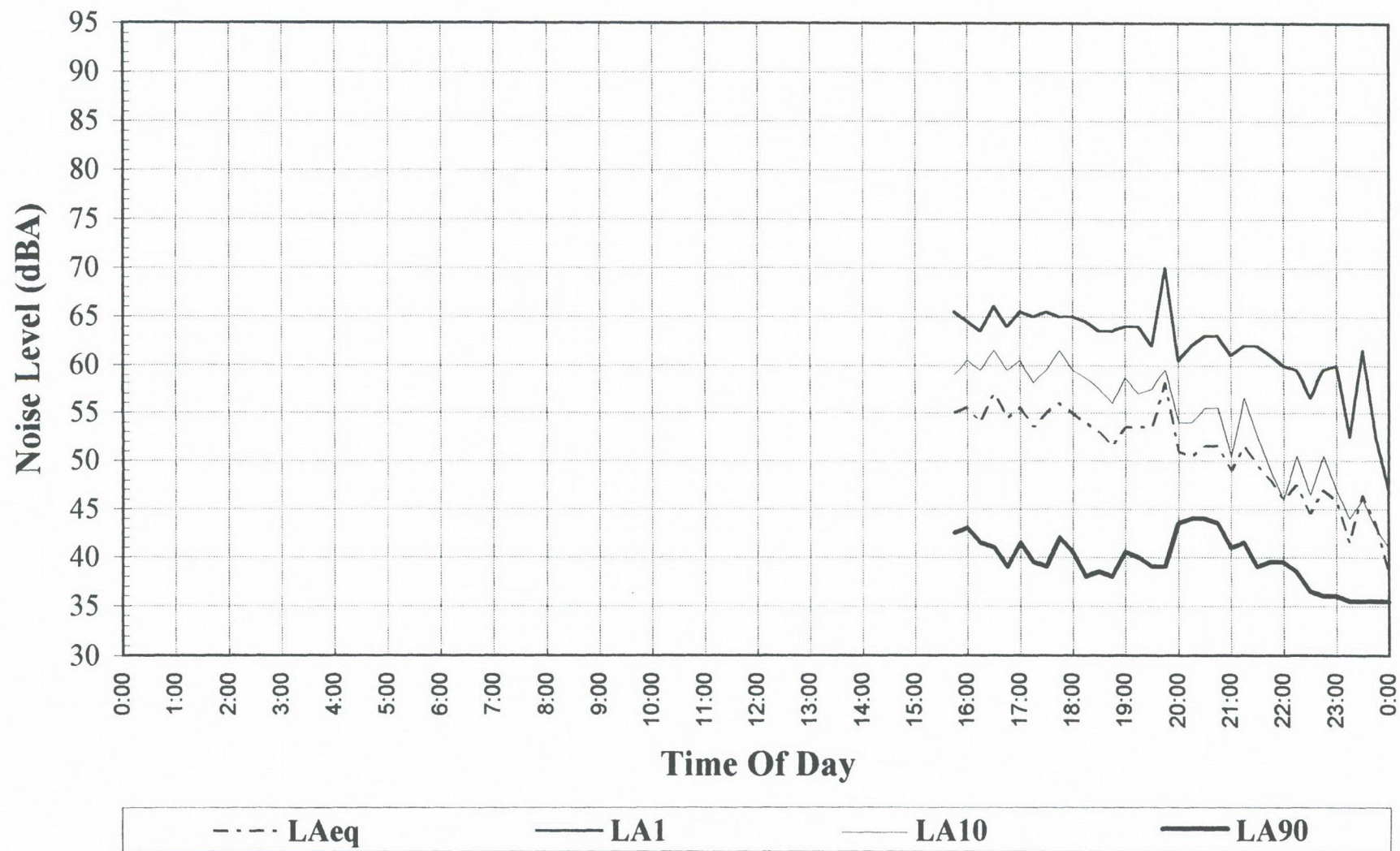
# Noise Levels at Location 17 - Lot 3 (Mary), Round Mountain Rd

Saturday, 7 March, 1998



## Noise Levels at Location 18 - Lot 72 (Jackson), Clothiers Ck Rd

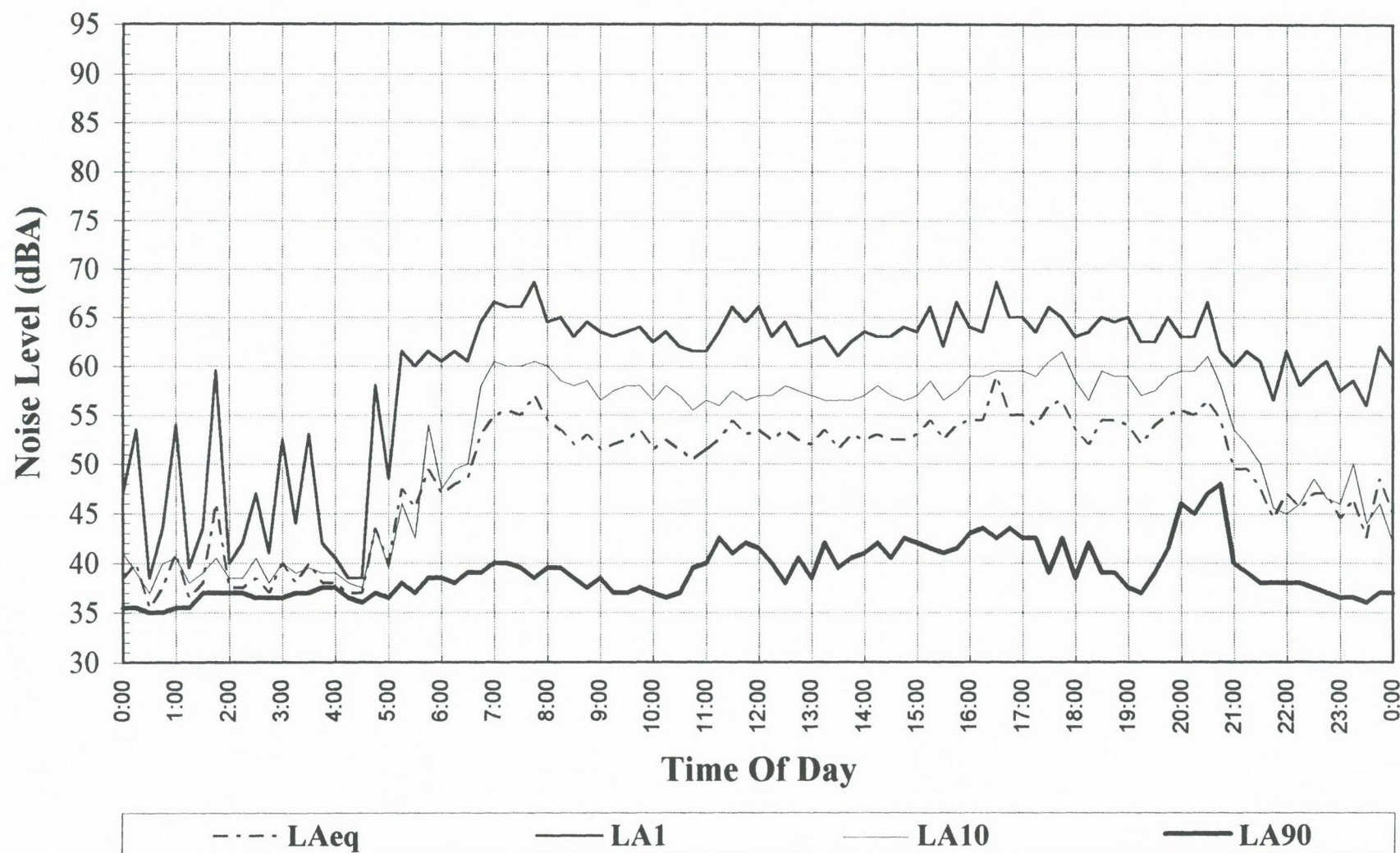
Thursday, 26 February, 1998





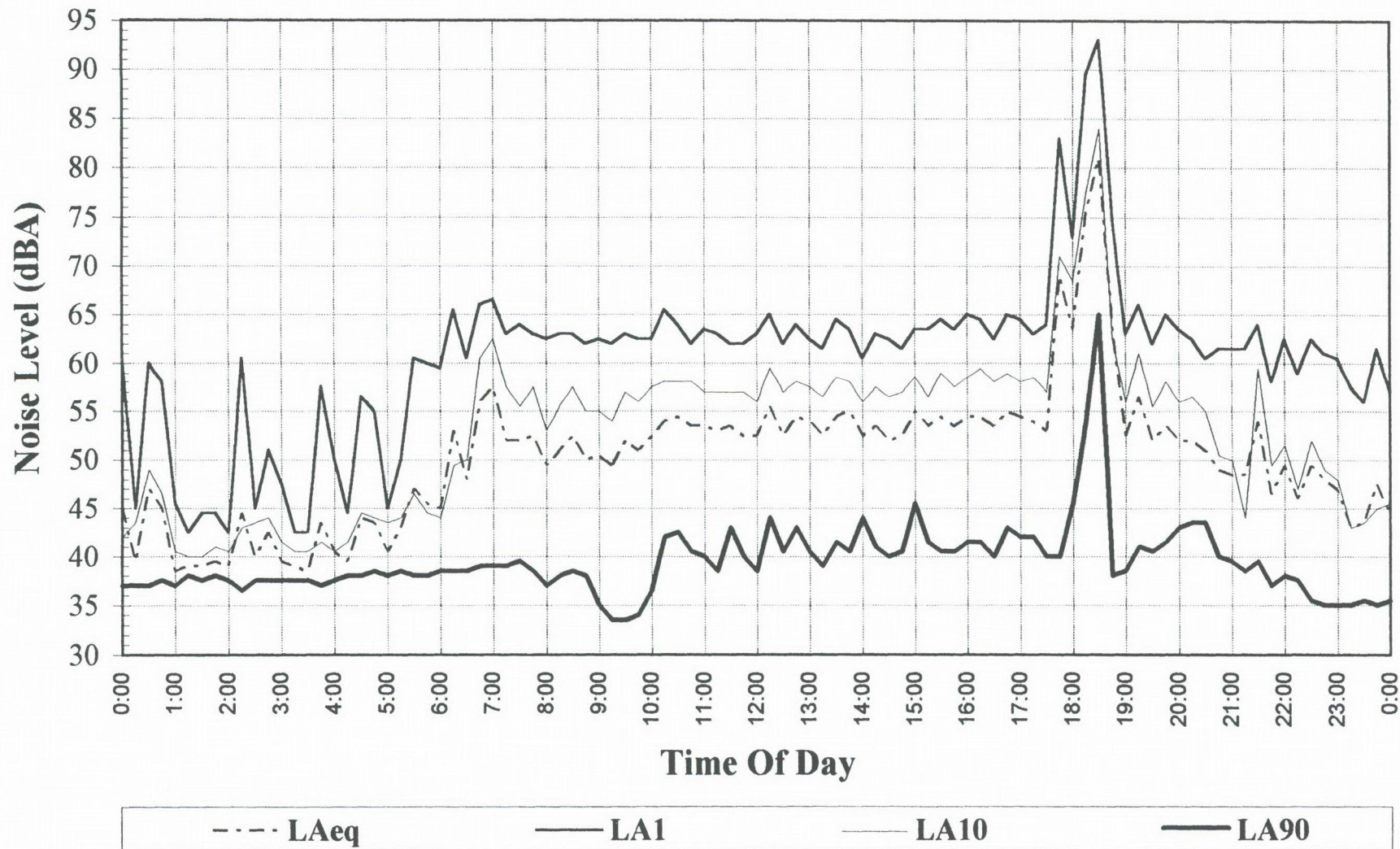
## Noise Levels at Location 18 - Lot 72 (Jackson), Clothiers Ck Rd

Friday, 27 February, 1998



## Noise Levels at Location 18 - Lot 72 (Jackson), Clothiers Ck Rd

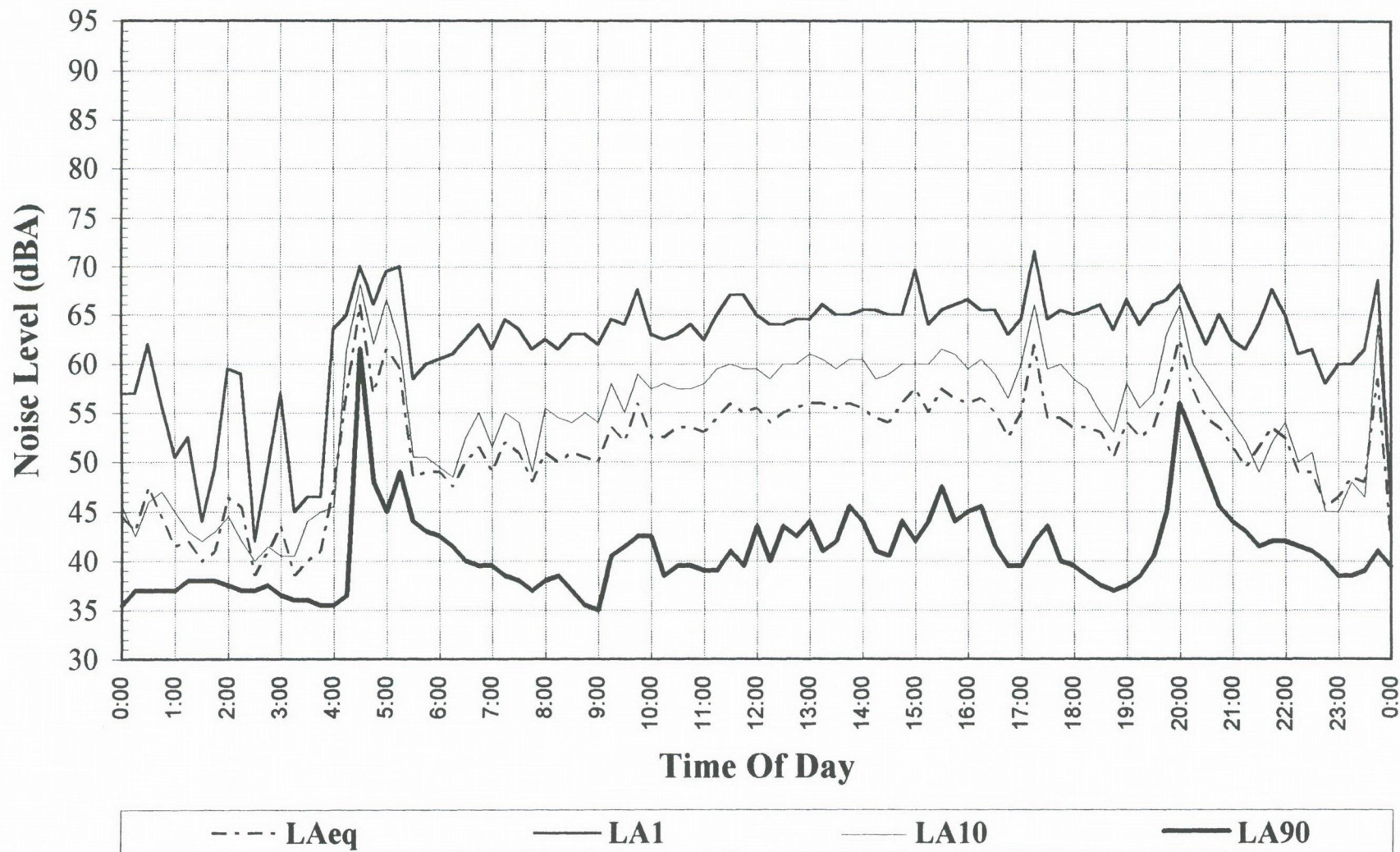
Saturday, 28 February, 1998





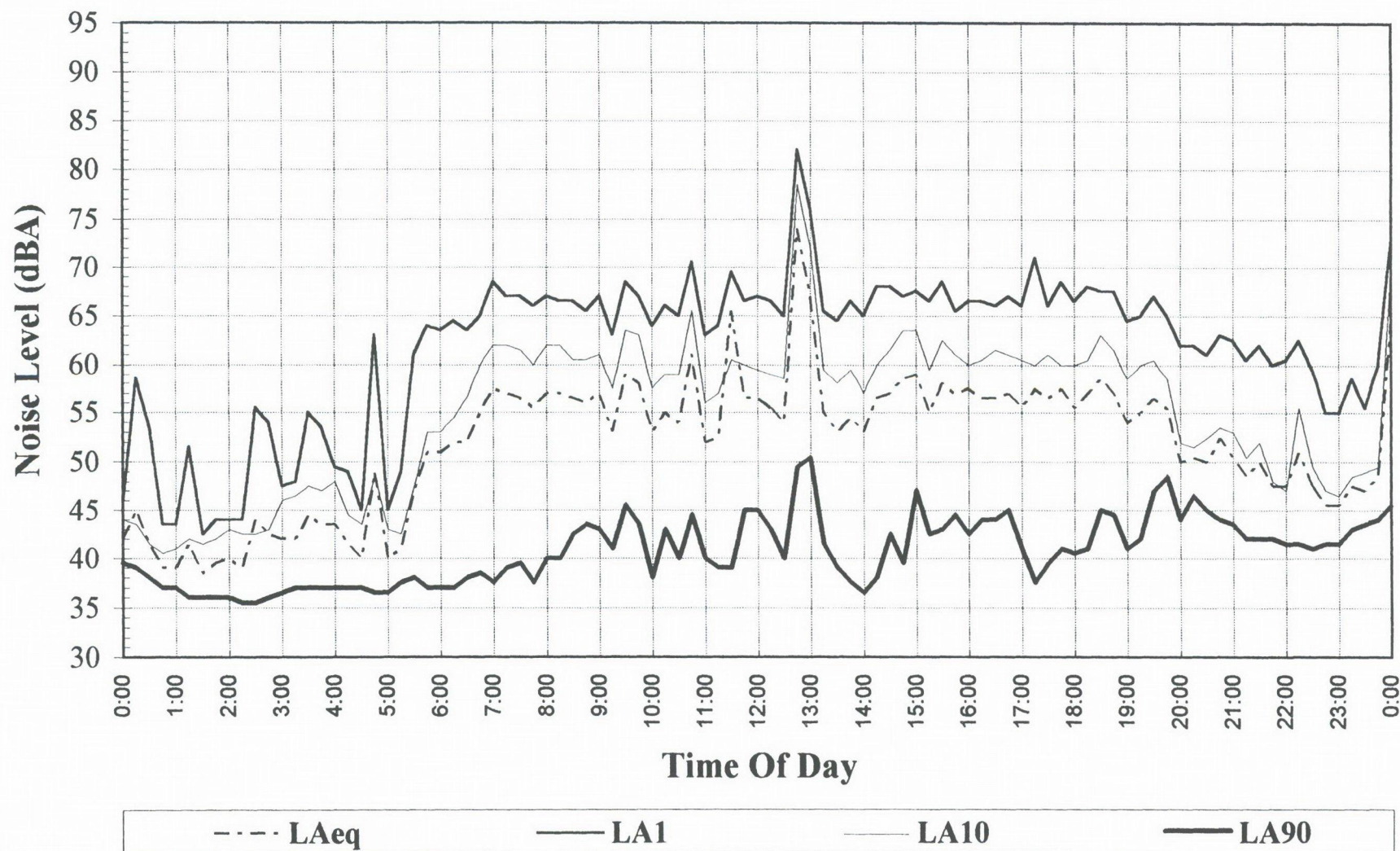
## Noise Levels at Location 18 - Lot 72 (Jackson), Clothiers Ck Rd

Sunday, 1 March, 1998



# Noise Levels at Location 18 - Lot 72 (Jackson), Clothiers Ck Rd

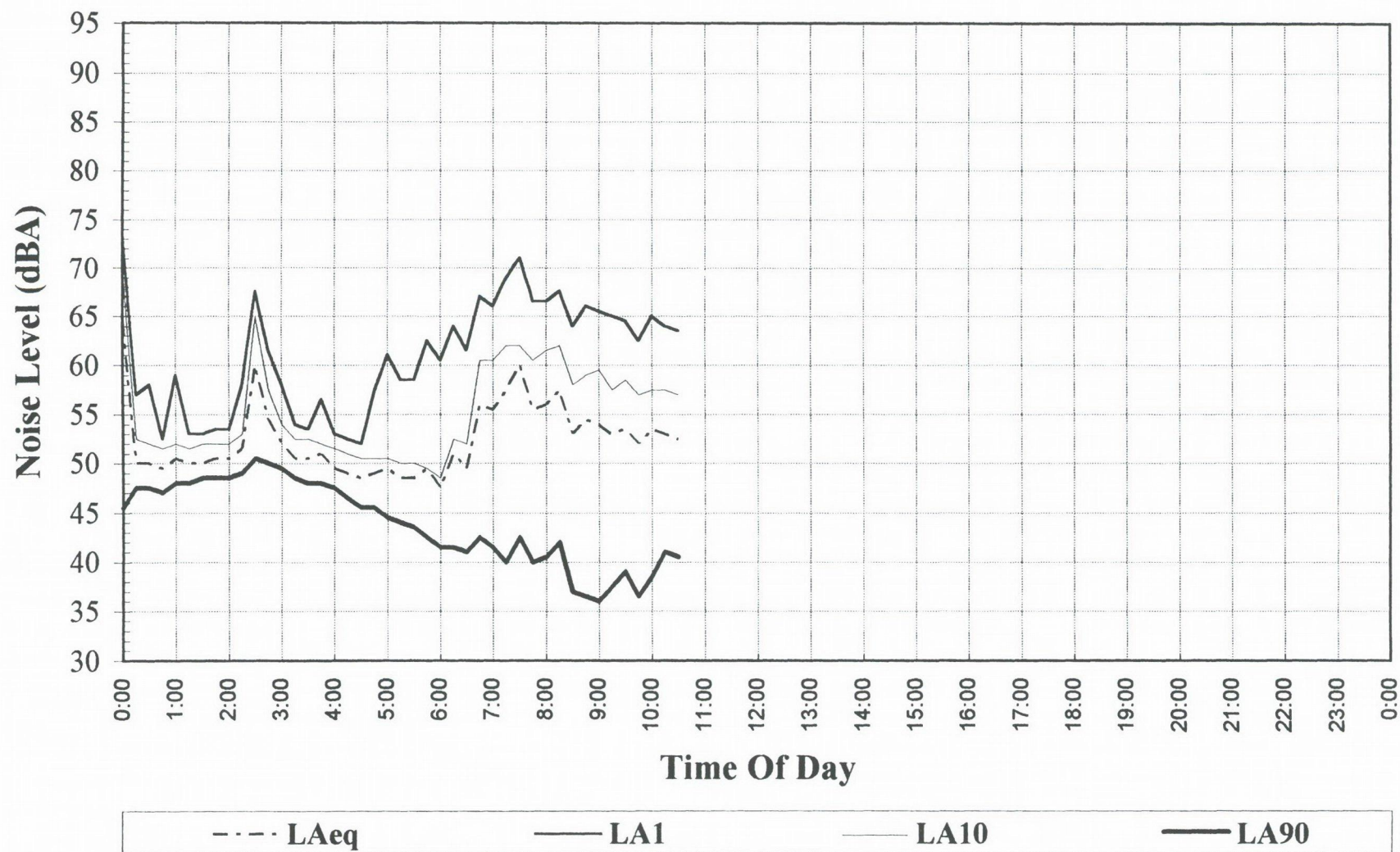
Monday, 2 March, 1998





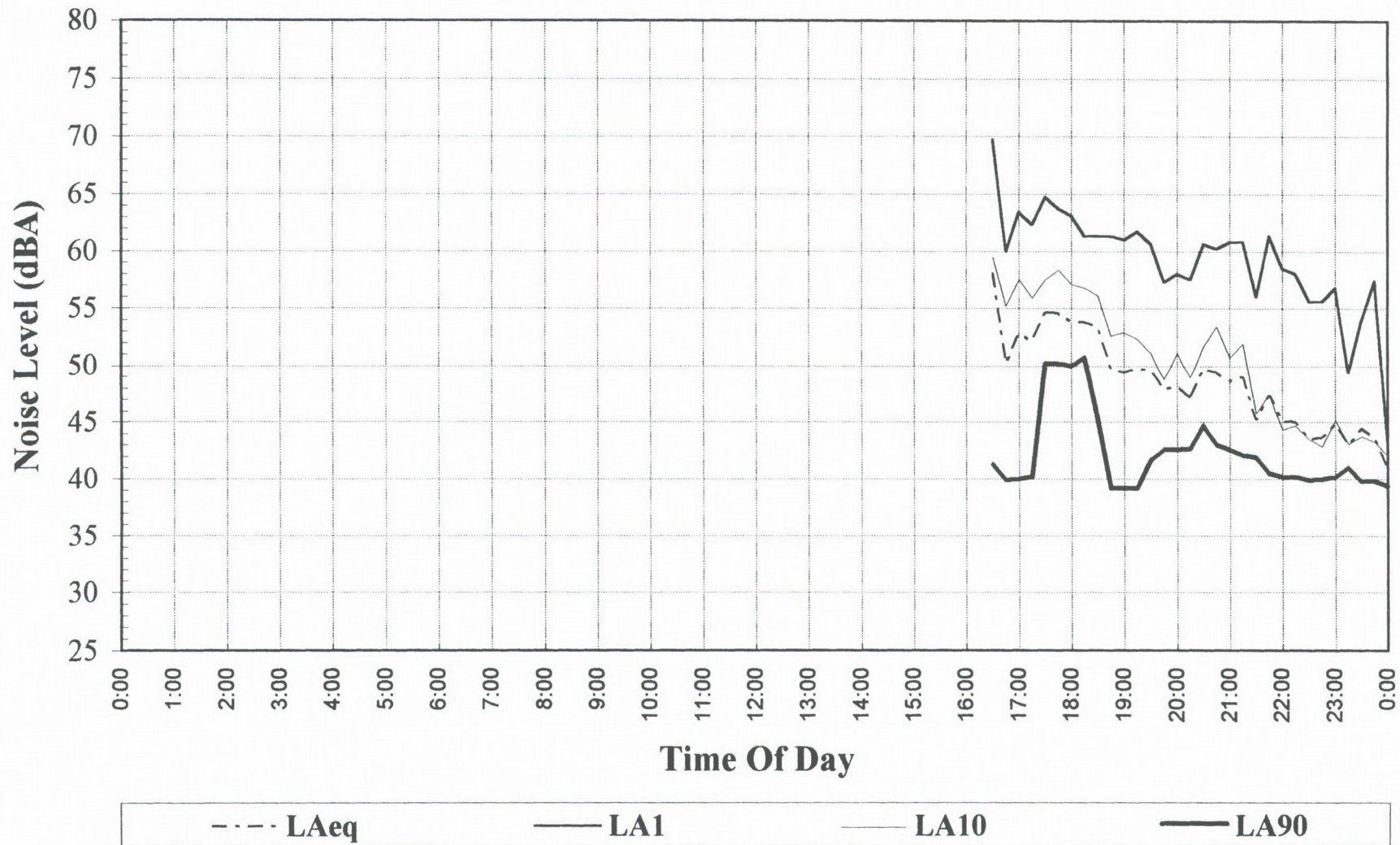
## Noise Levels at Location 18 - Lot 72 (Jackson), Clothiers Ck Rd

Tuesday, 3 March, 1998



## Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

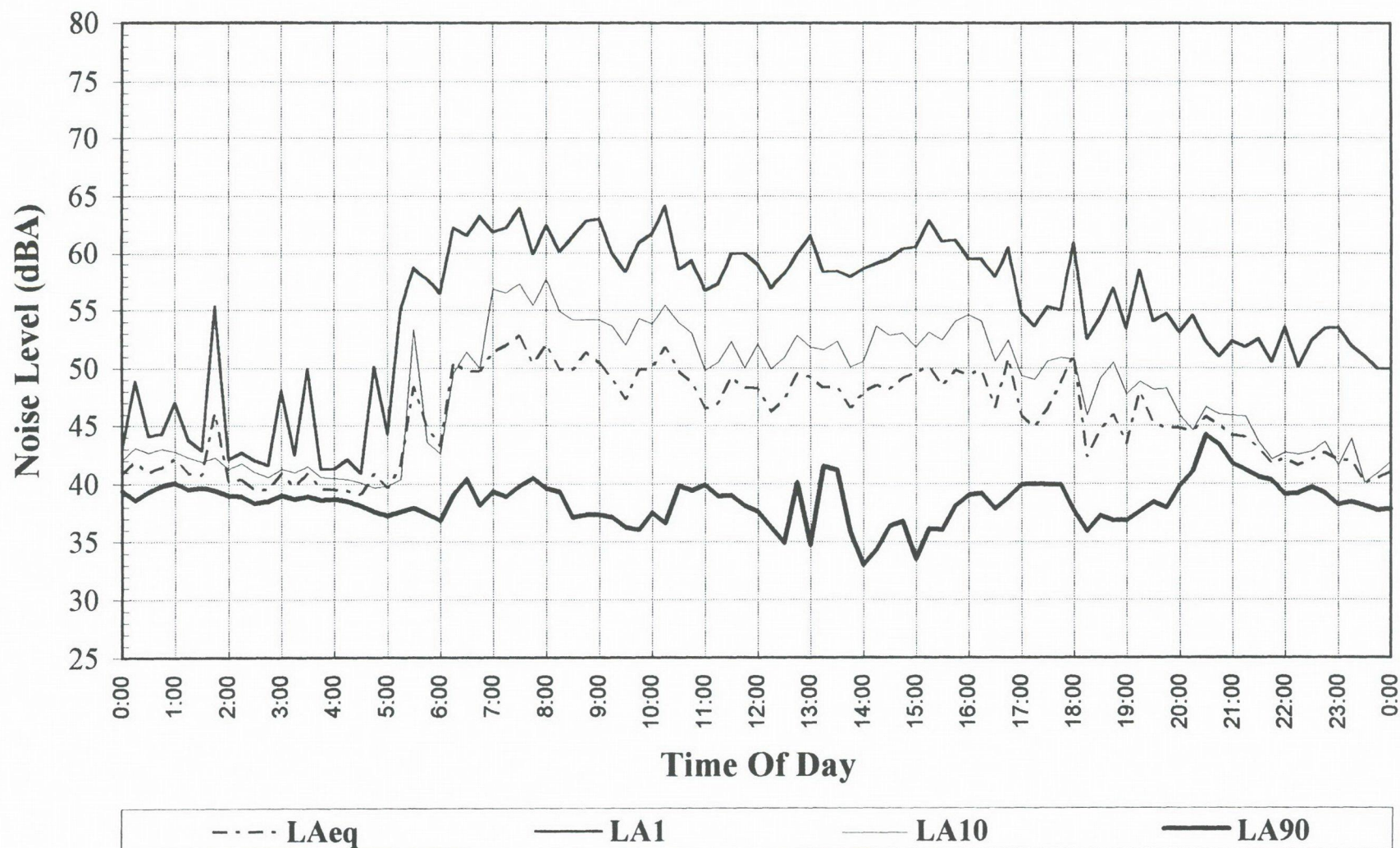
Thursday, 26 February, 1998





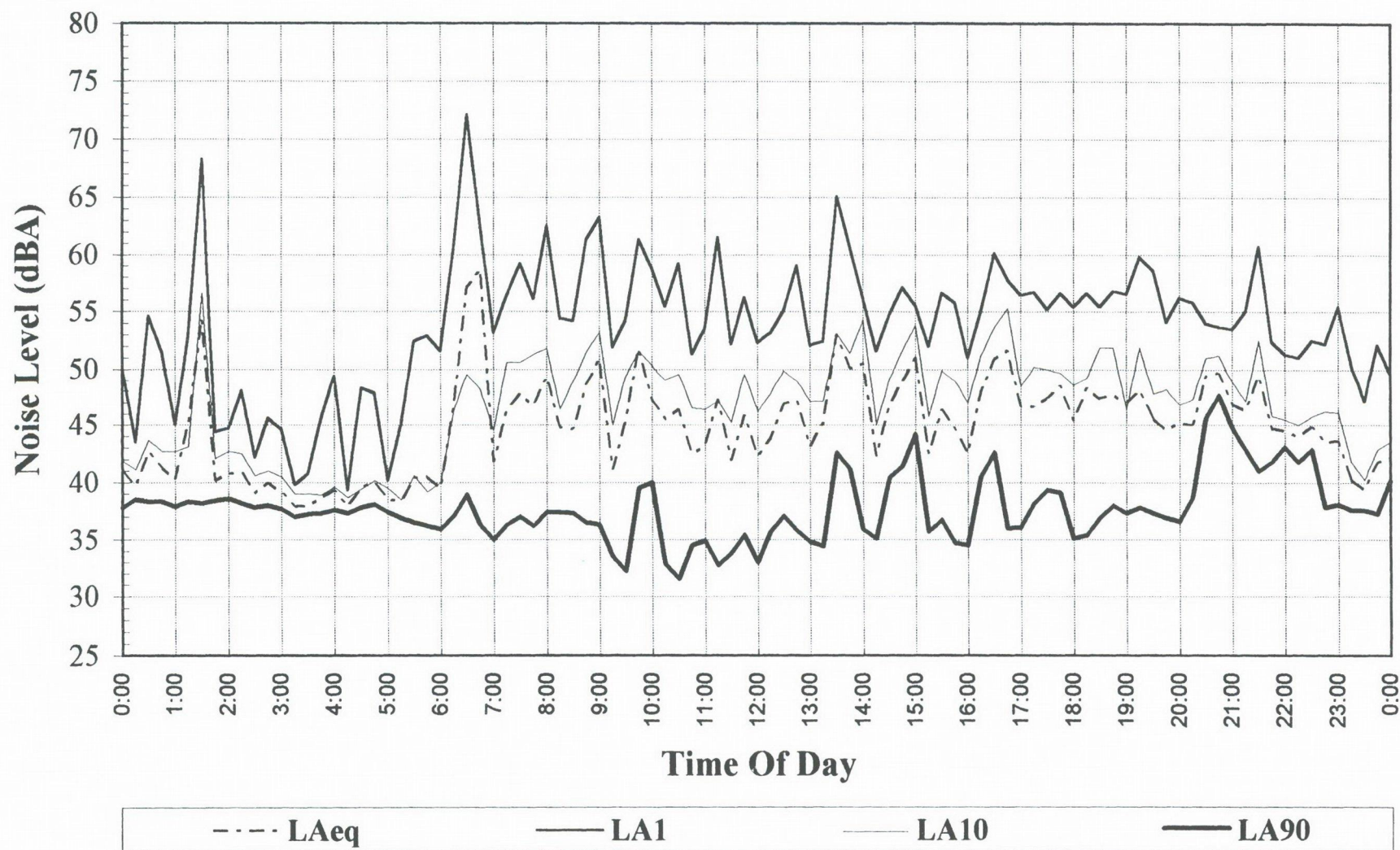
# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Friday, 27 February, 1998



## Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

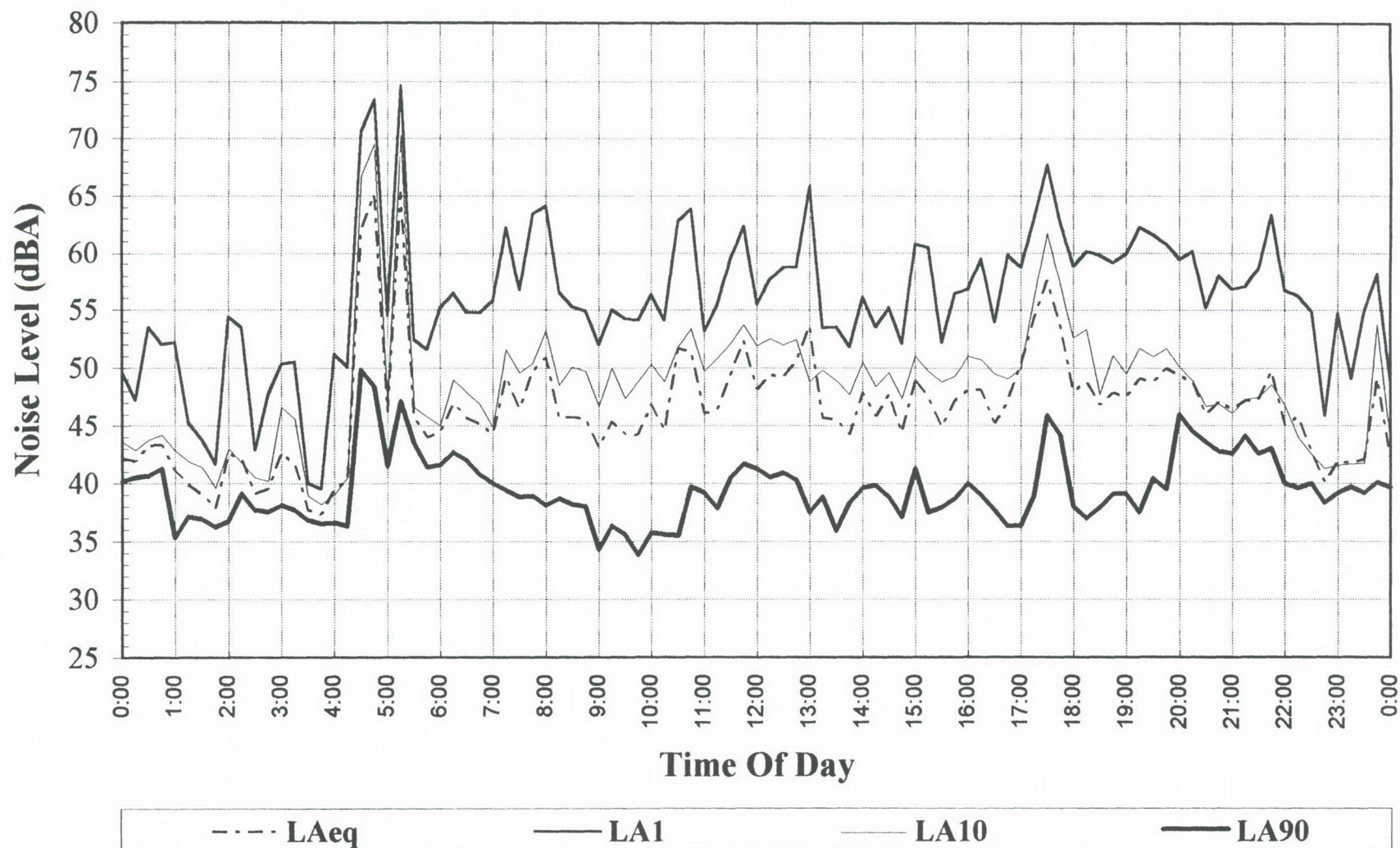
Saturday, 28 February, 1998





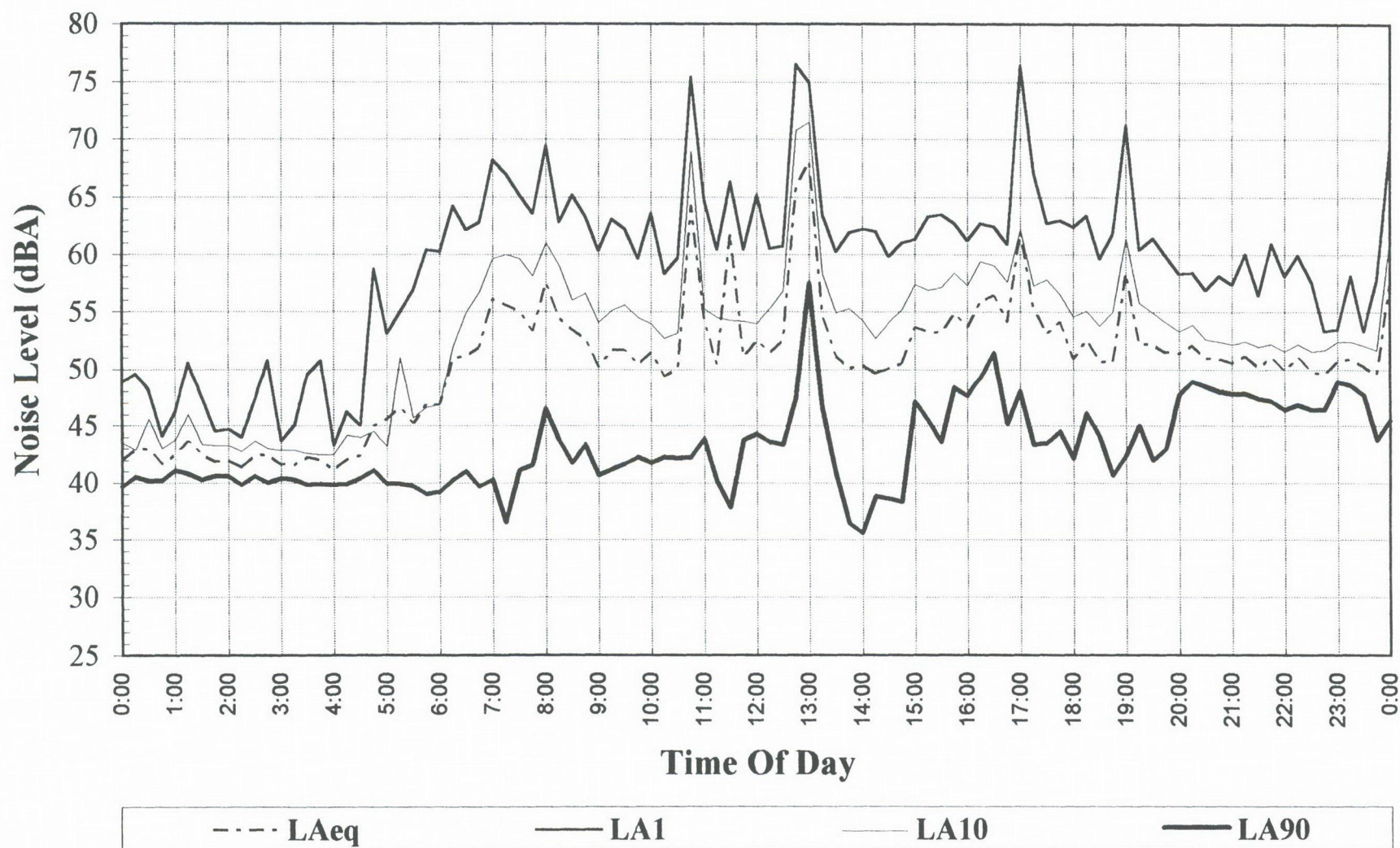
# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Sunday, 1 March, 1998



## Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

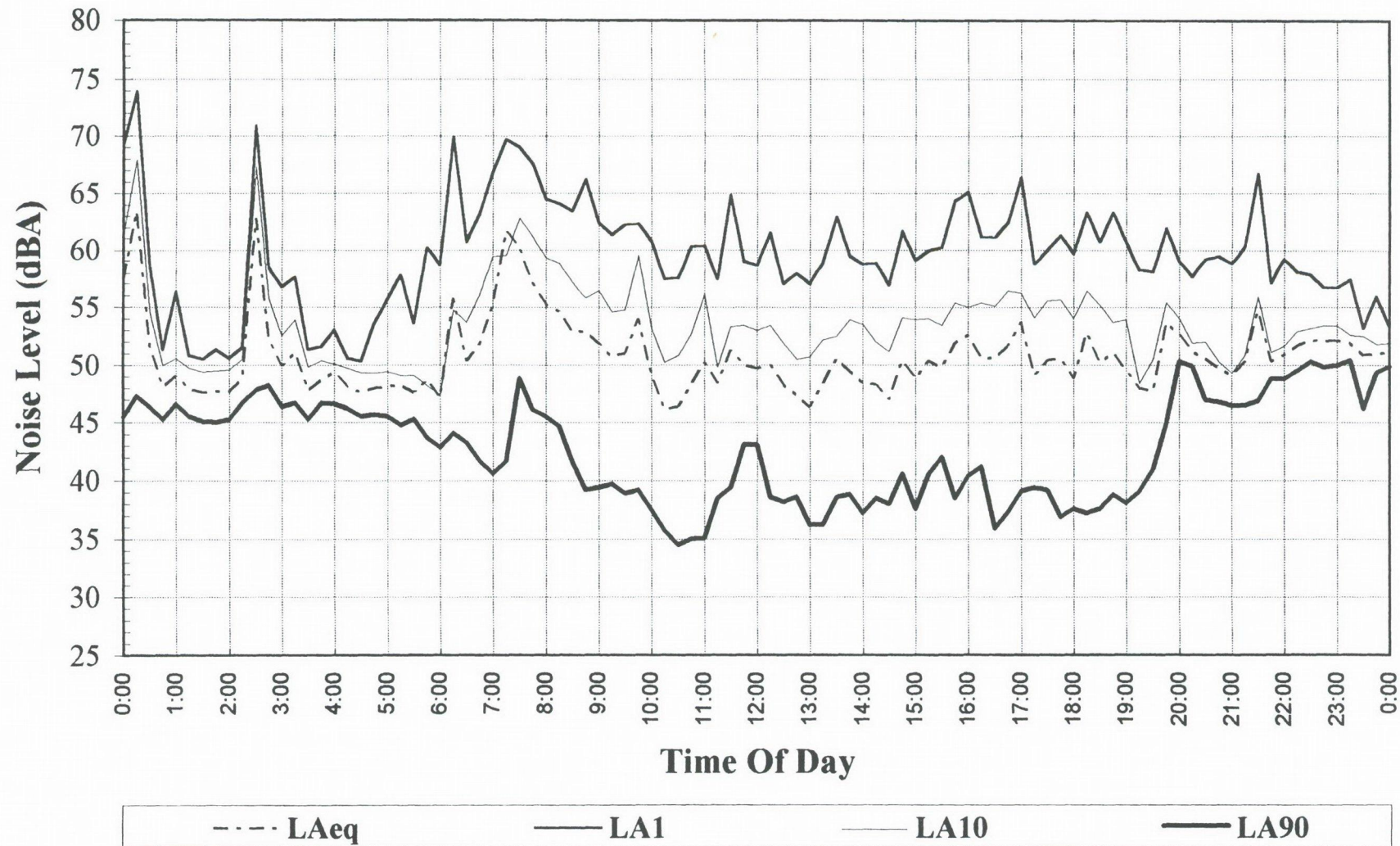
Monday, 2 March, 1998





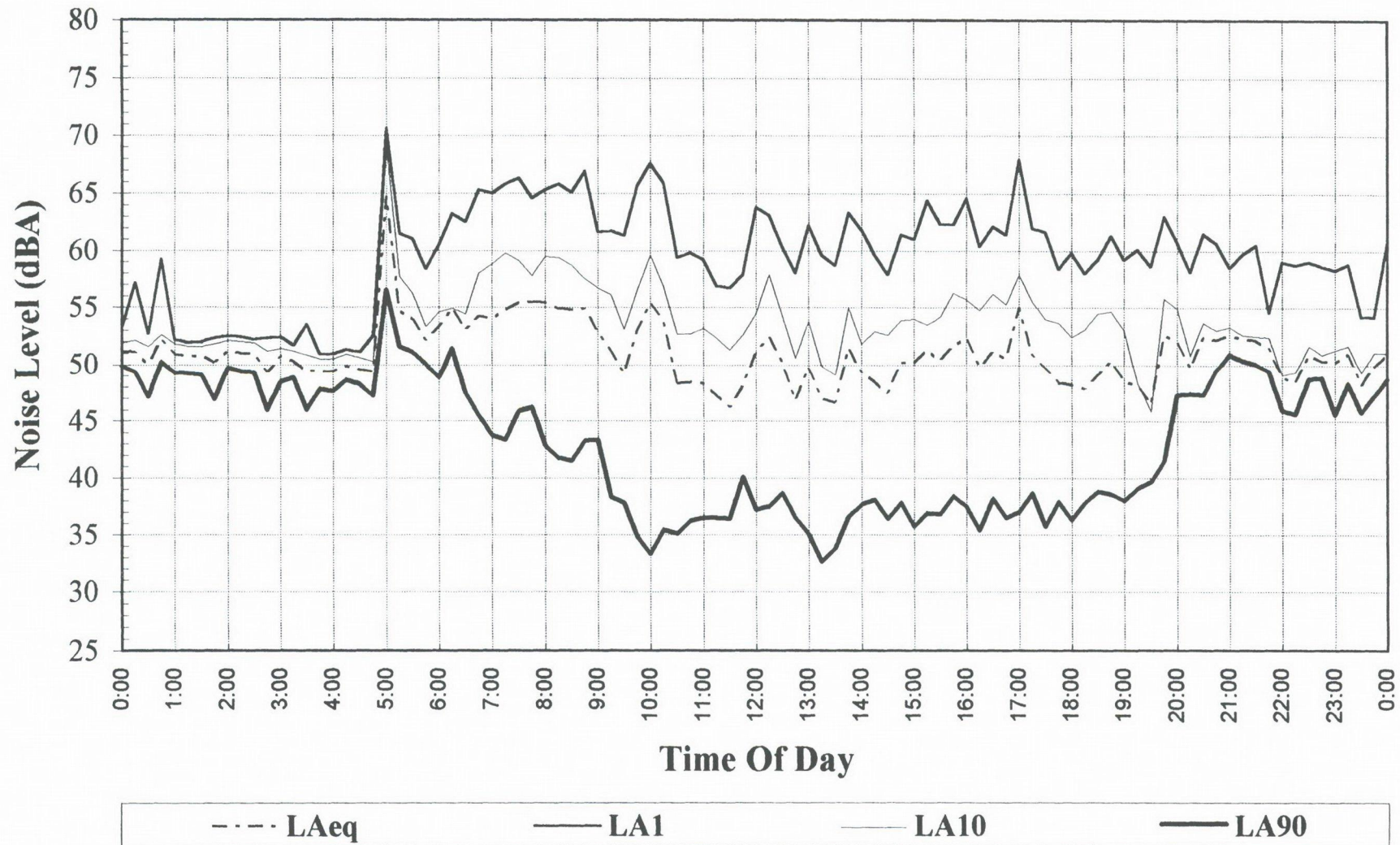
# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Tuesday, 3 March, 1998



## Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

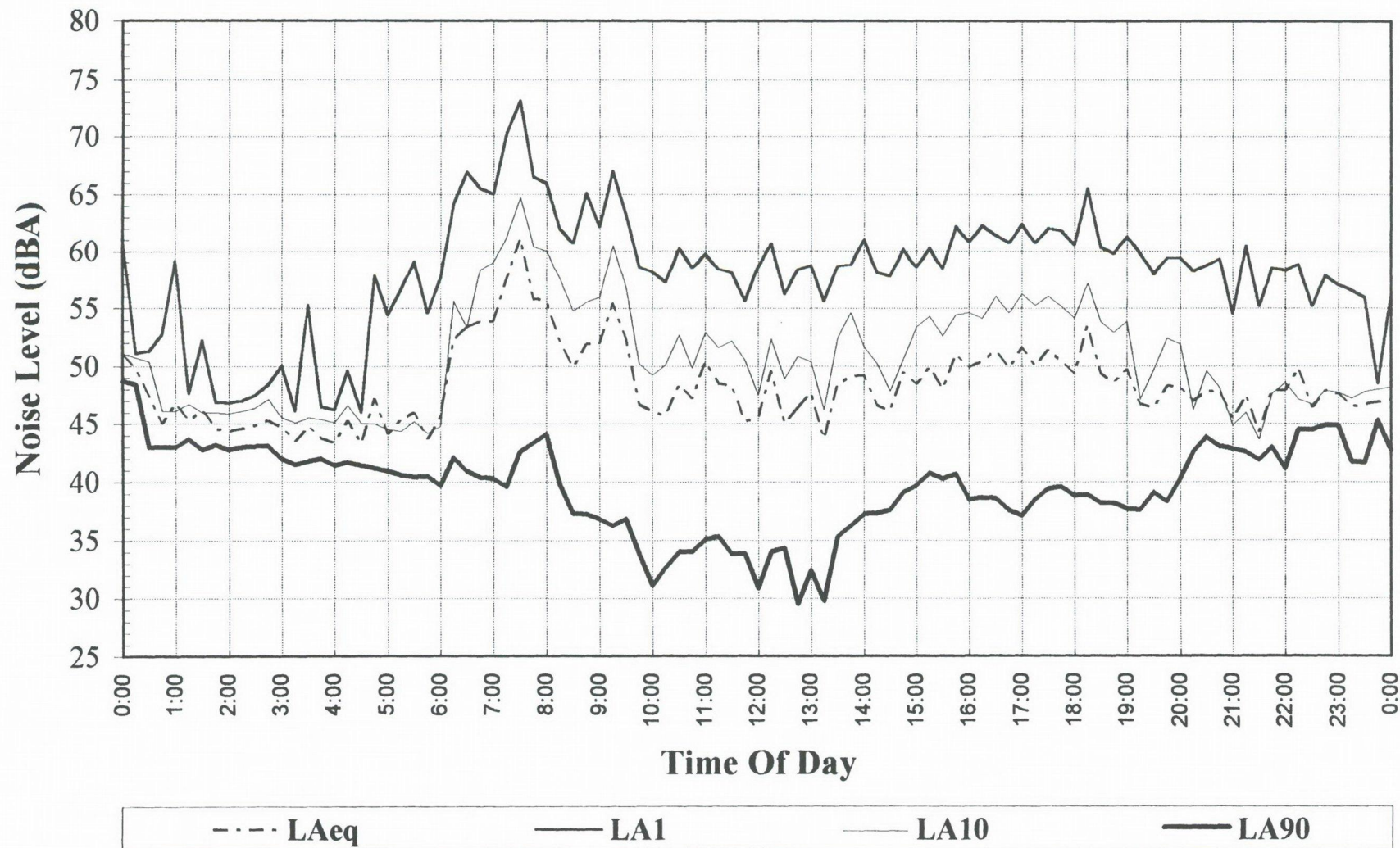
Wednesday, 4 March, 1998





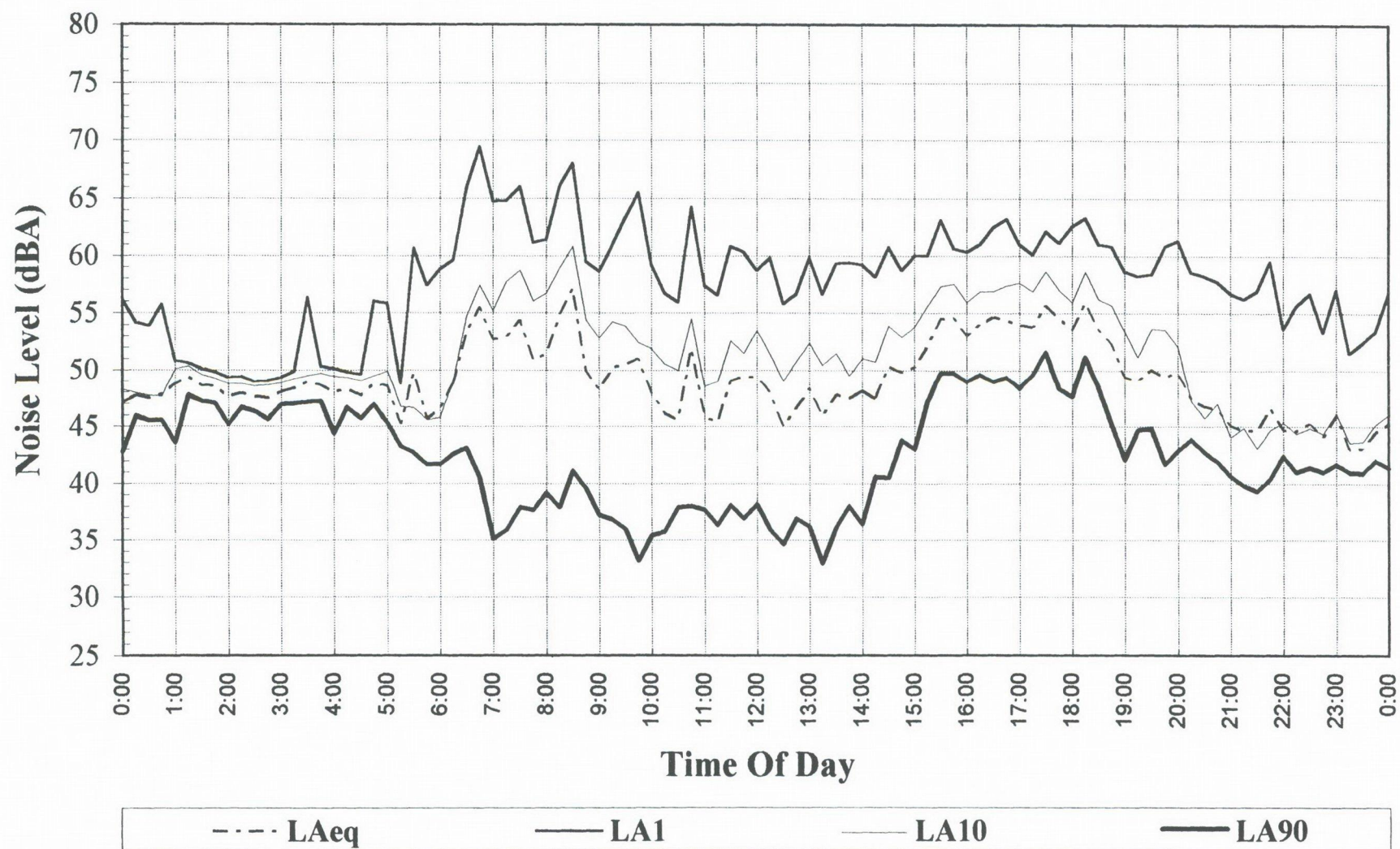
# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Thursday, 5 March, 1998



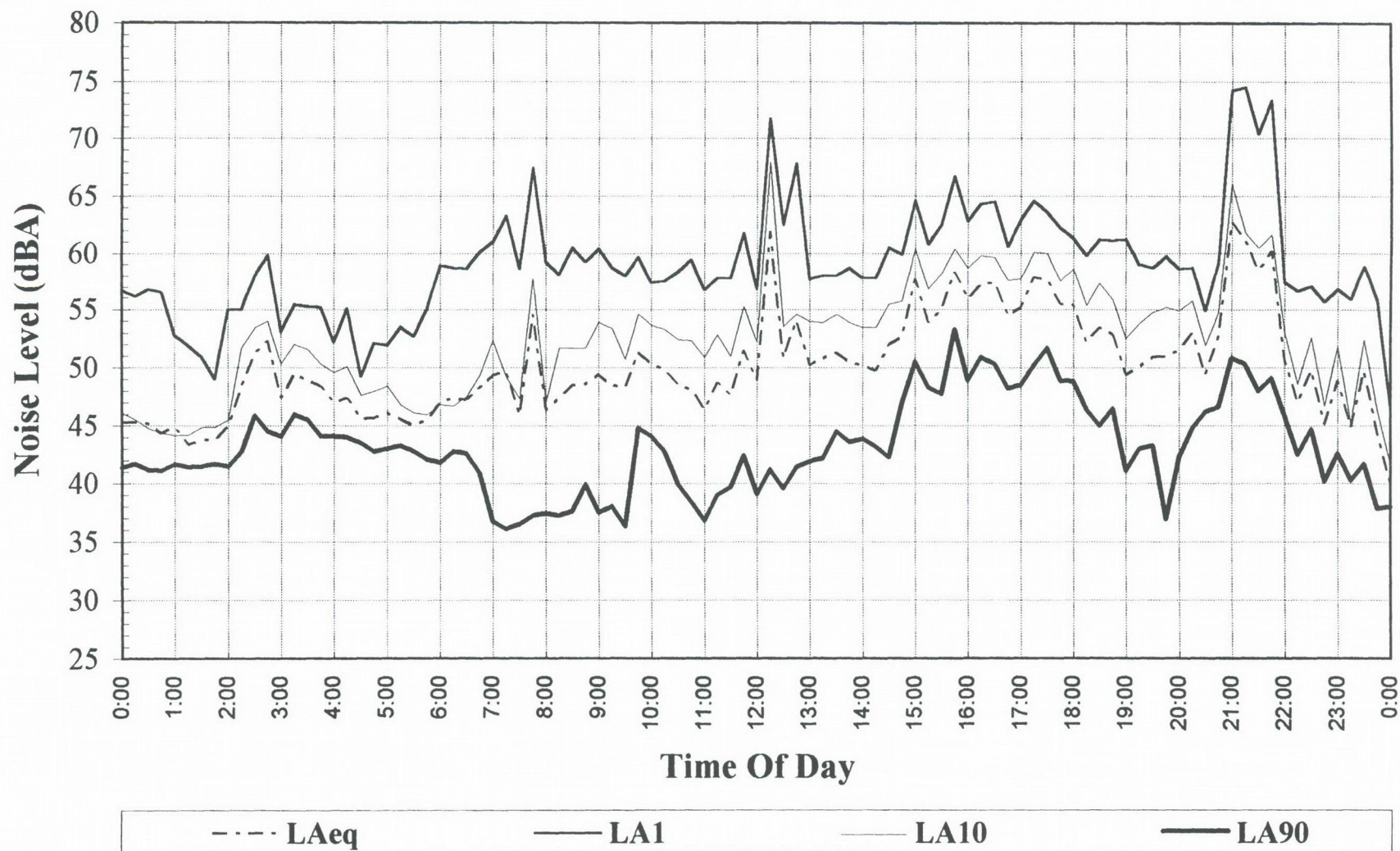
## Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Friday, 6 March, 1998



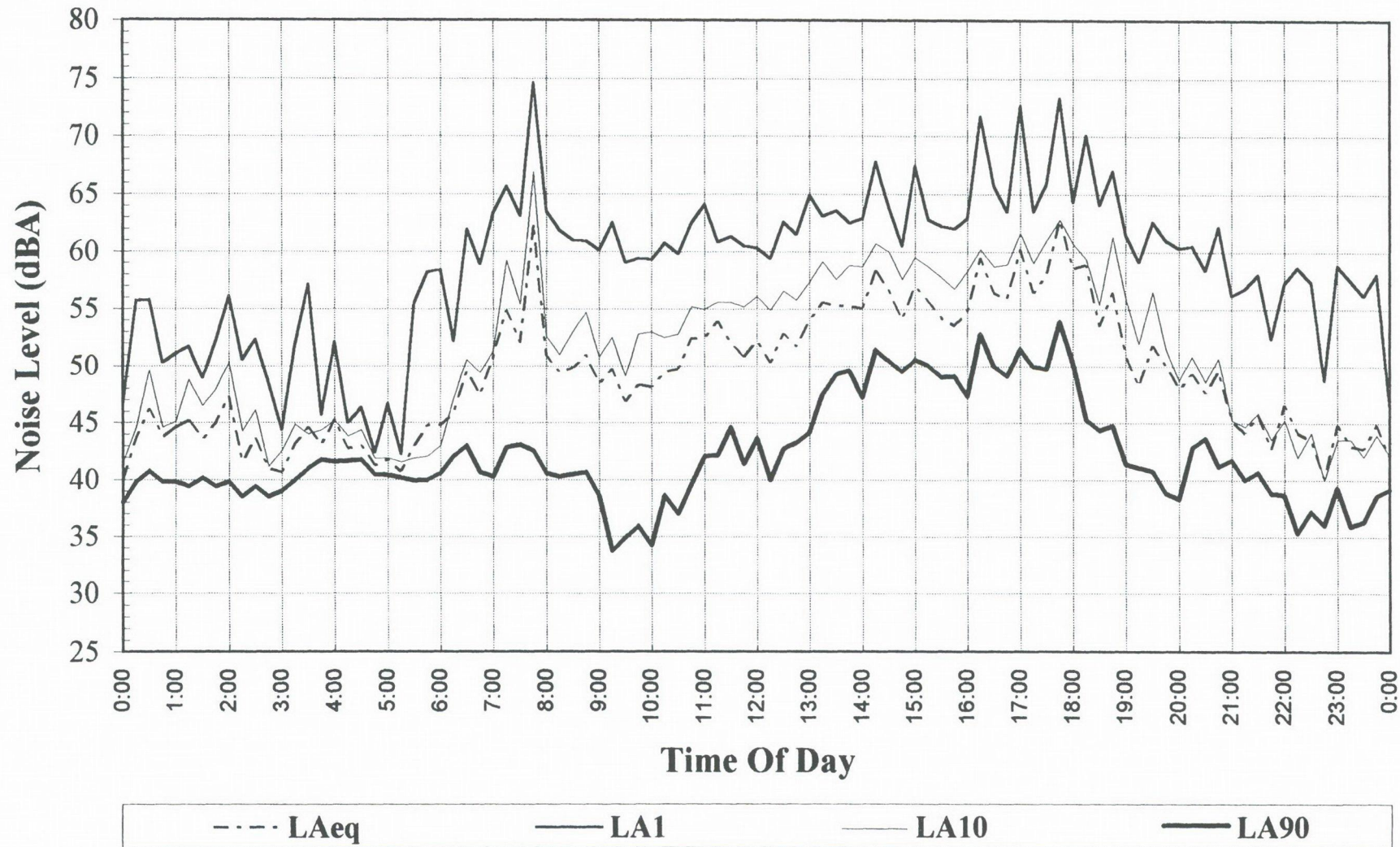


**Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd**  
**Saturday, 7 March, 1998**



# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

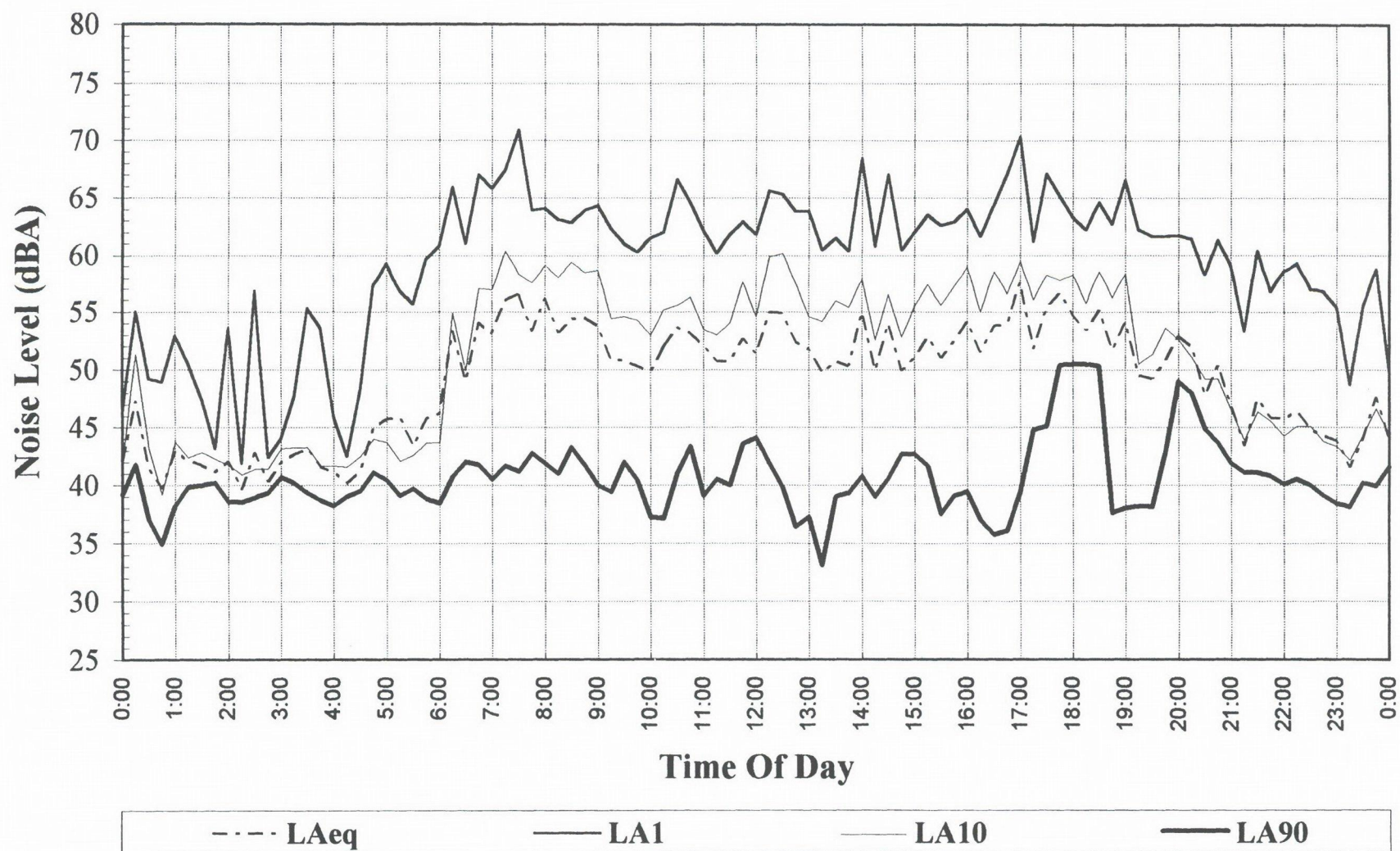
Sunday, 8 March, 1998





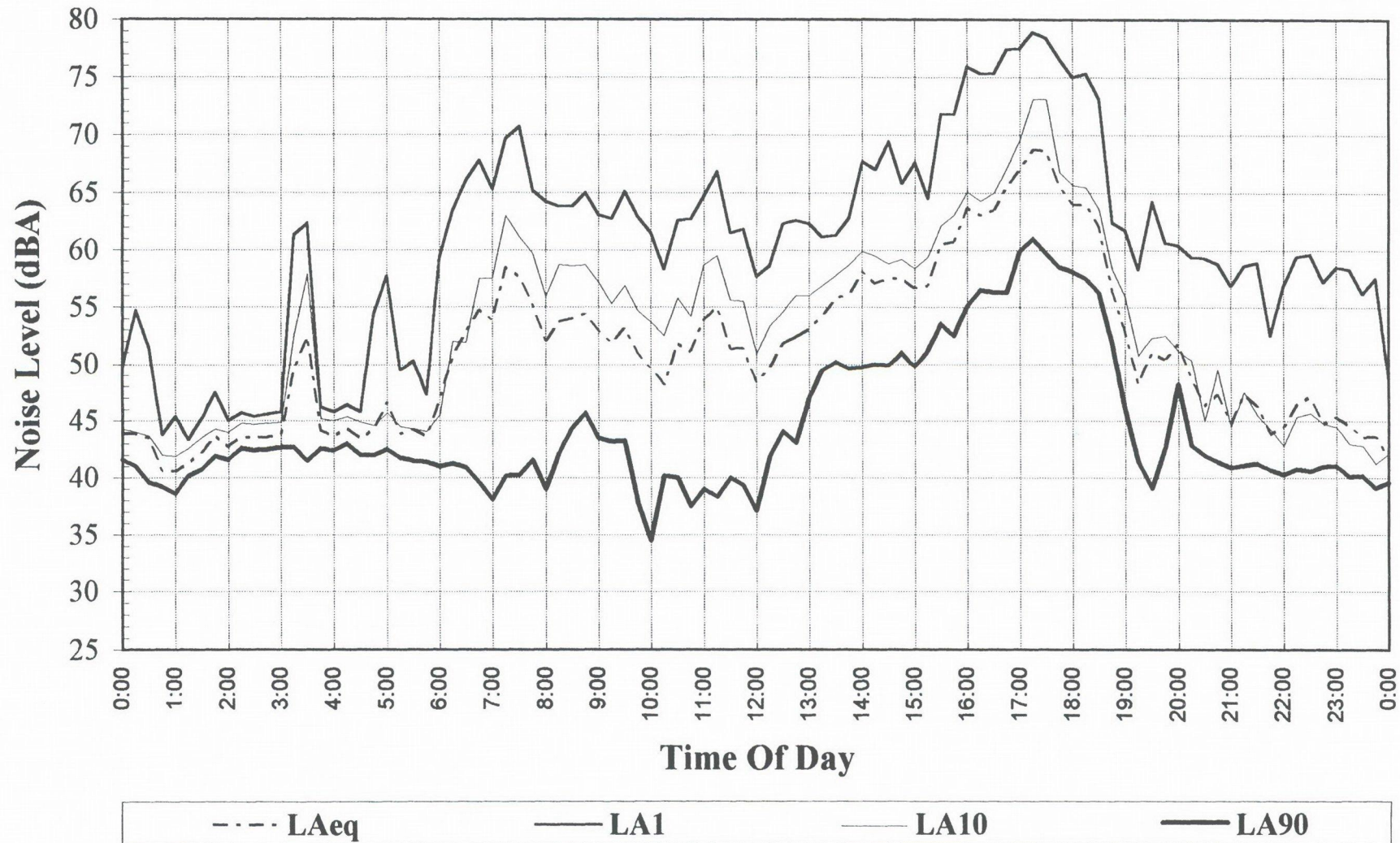
# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Monday, 9 March, 1998



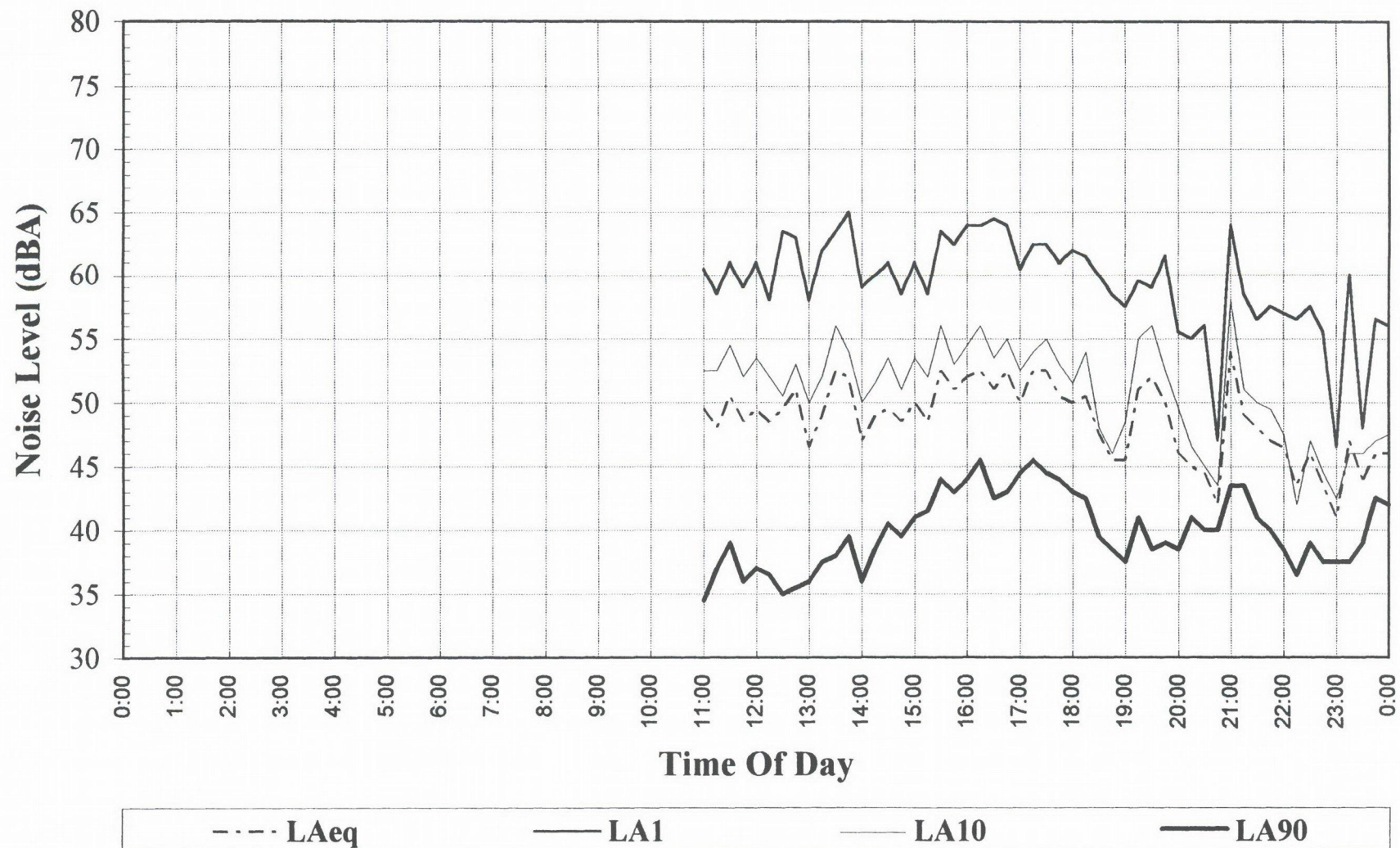
# Noise Levels at Location 19 - Lot3 (Howarth), Clothiers Creek Rd

Tuesday, 10 March, 1998



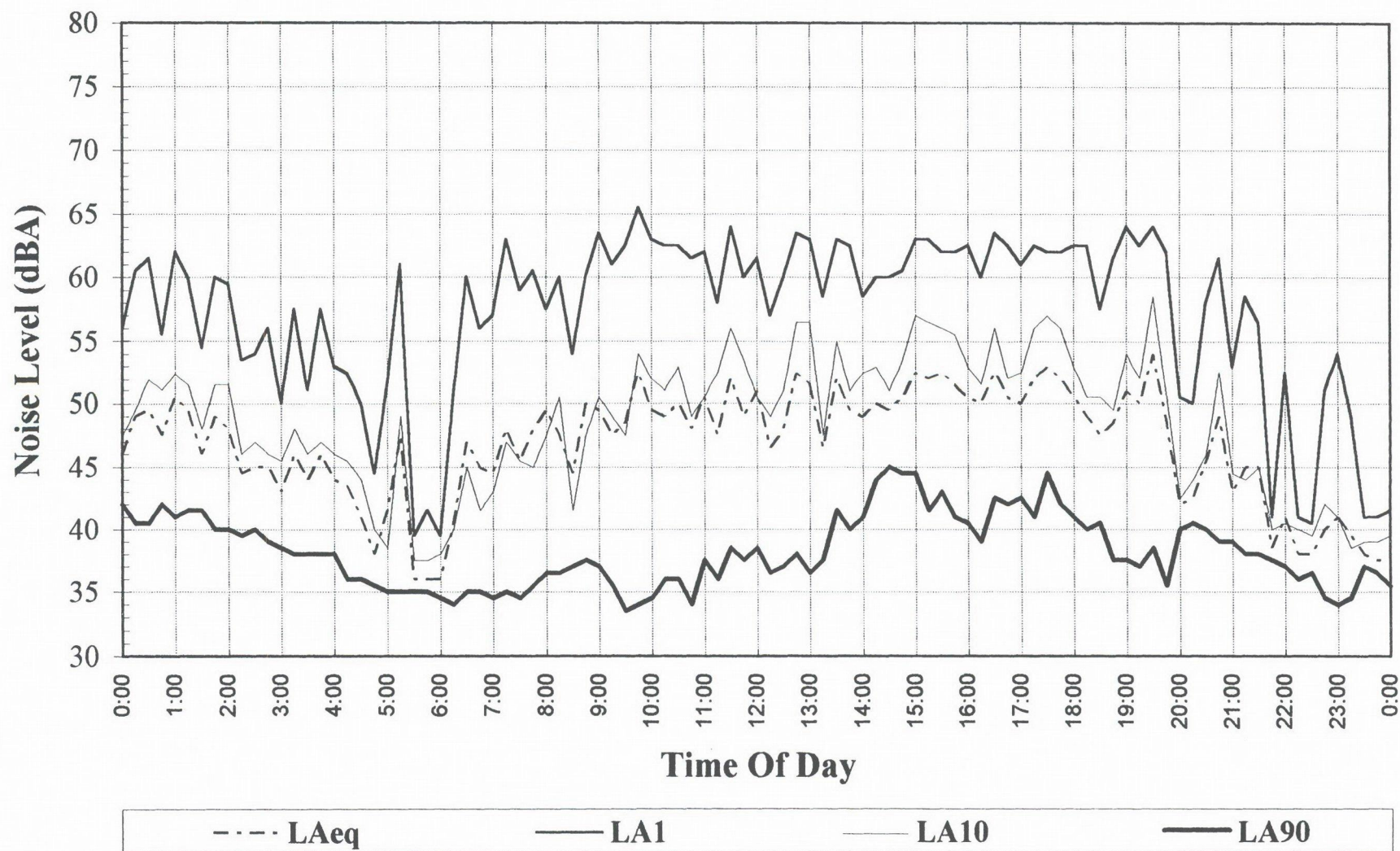


**Noise Levels at Location 20 - C.J.Kane, Eviron Rd, Duranbah**  
**Saturday, 7 March, 1998**



## Noise Levels at Location 20 - C.J.Kane, Eviron Rd, Duranbah

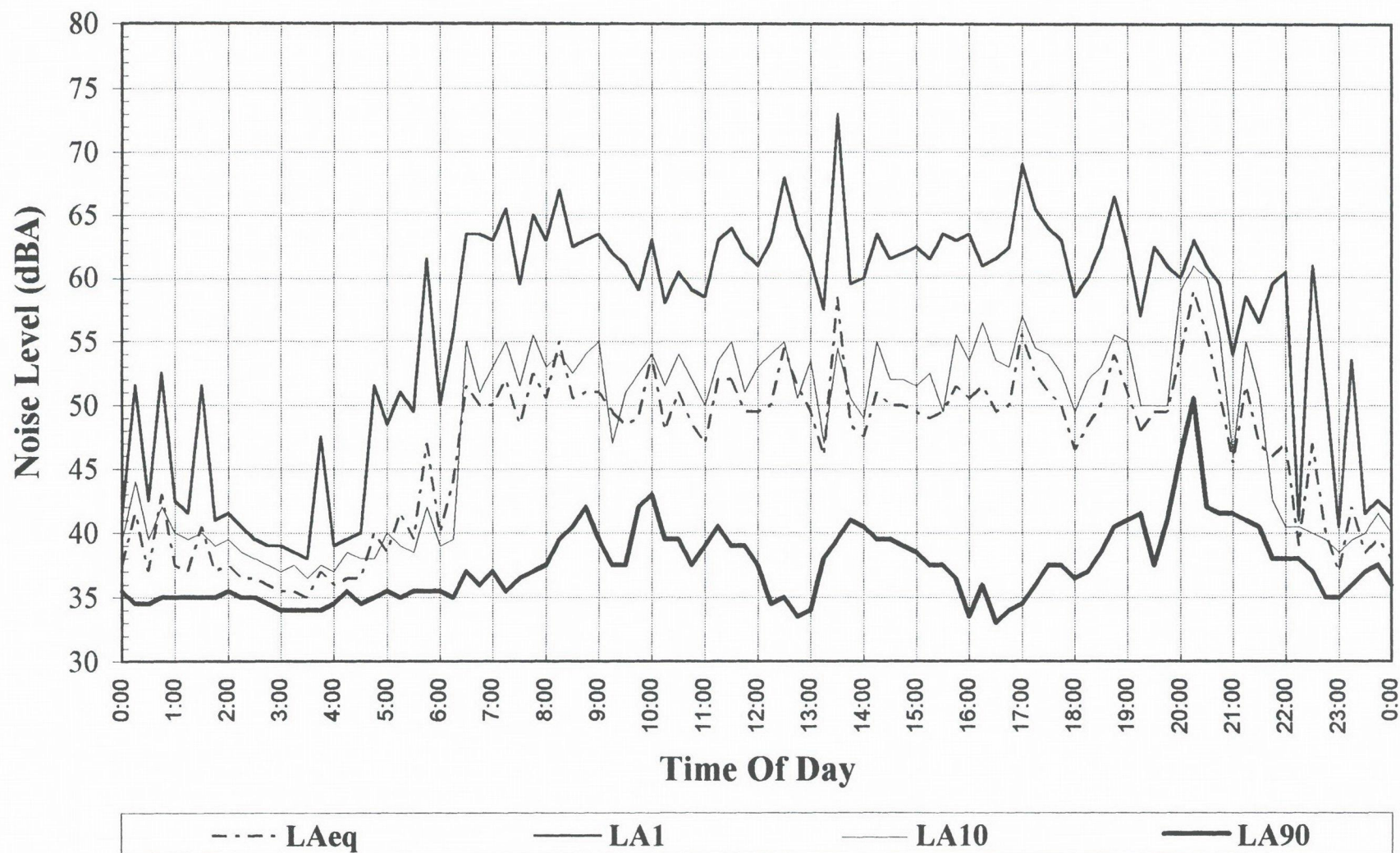
Sunday, 8 March, 1998





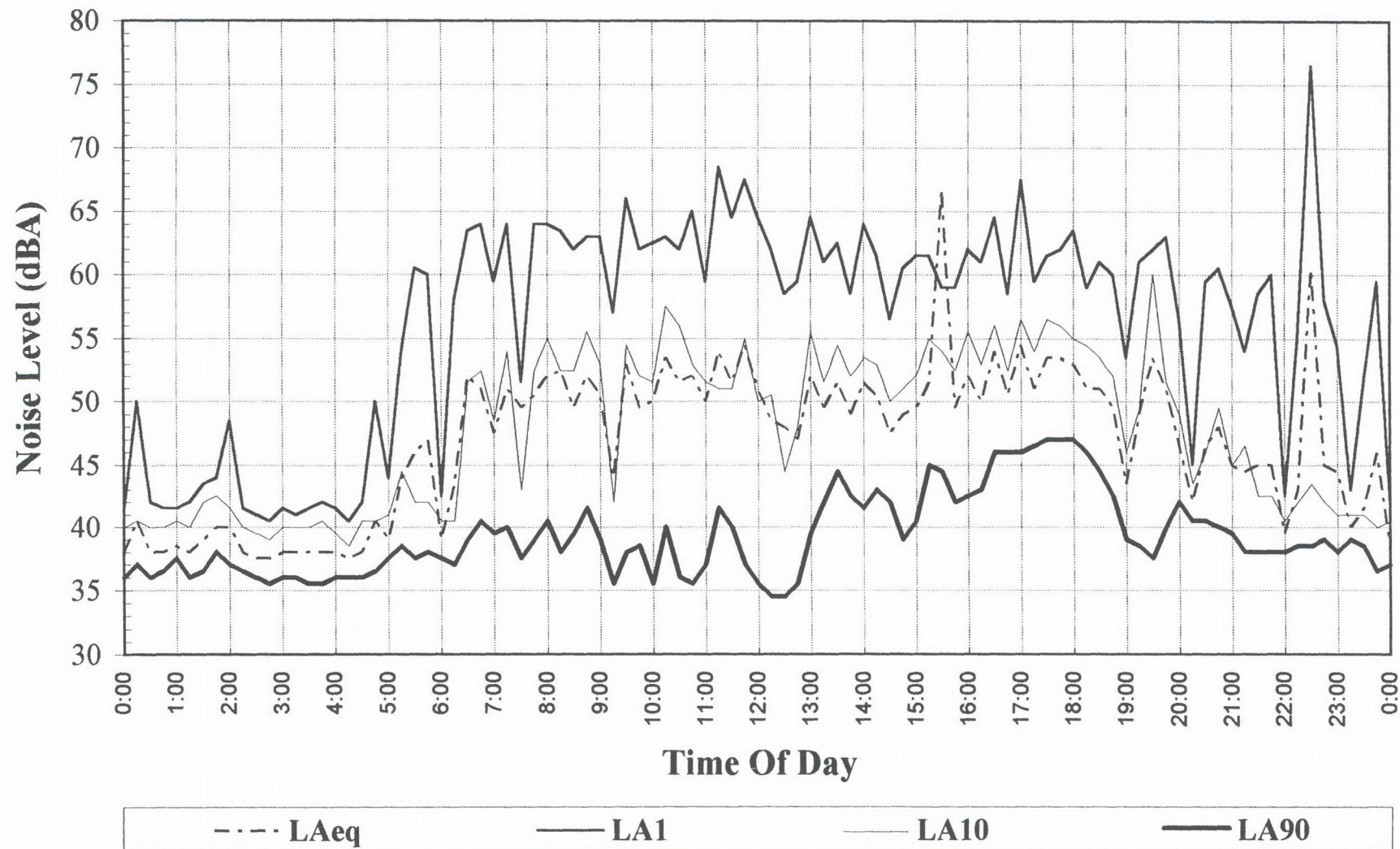
## Noise Levels at Location 20 - C.J.Kane, Eviron Rd, Duranbah

Monday, 9 March, 1998



## Noise Levels at Location 20 - C.J.Kane, Eviron Rd, Duranbah

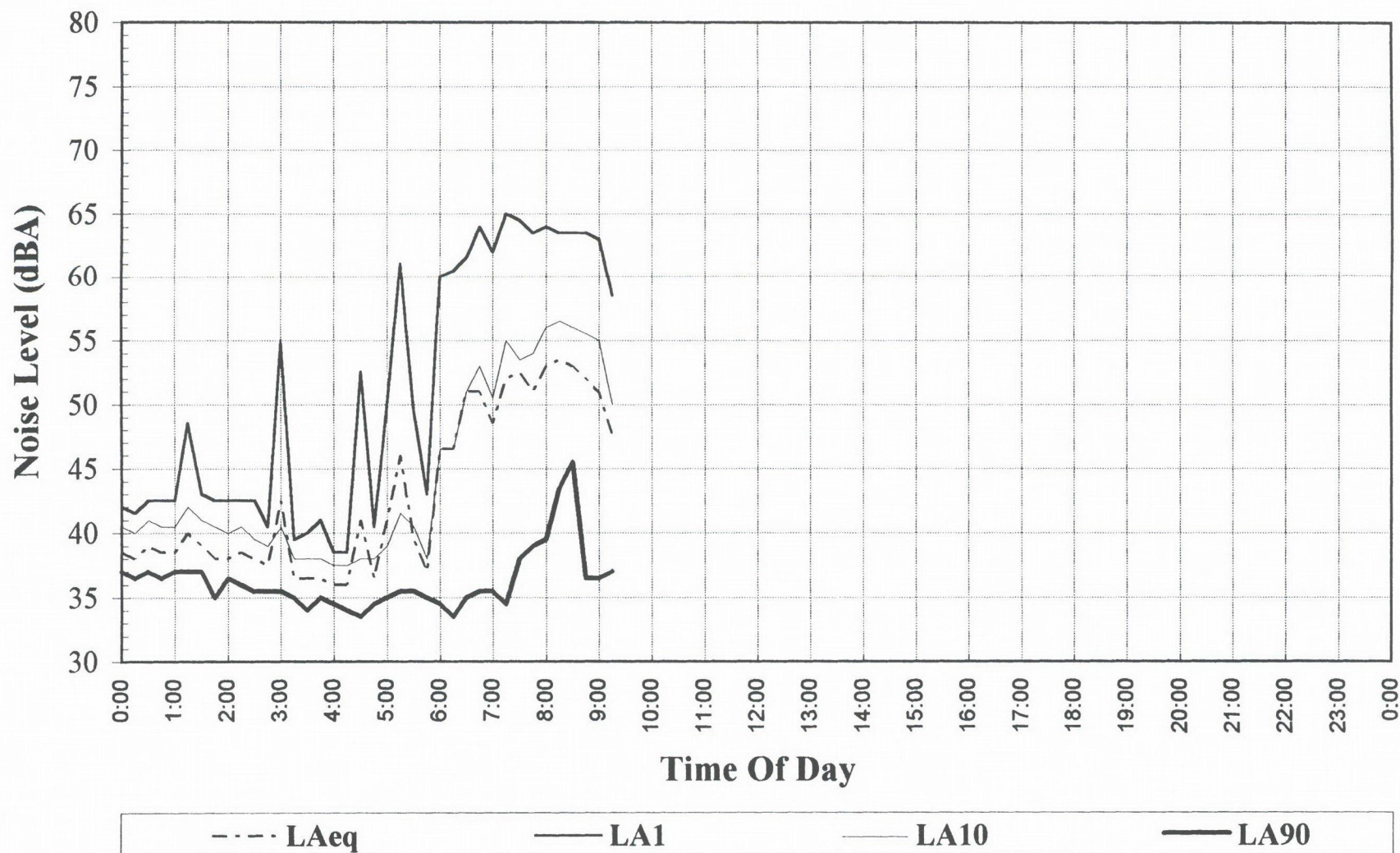
Tuesday, 10 March, 1998





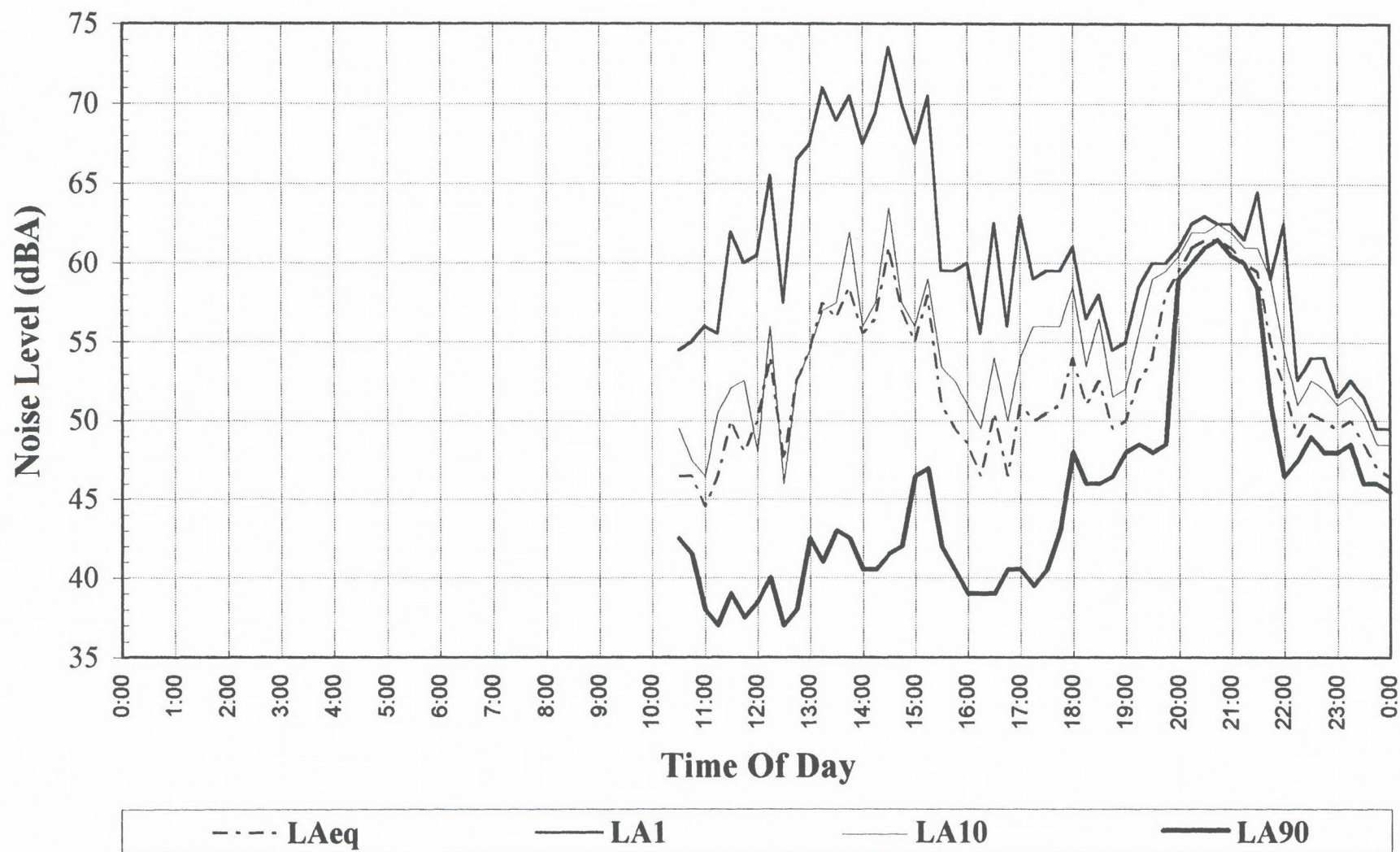
## Noise Levels at Location 20 - C.J.Kane, Eviron Rd, Duranbah

Wednesday, 11 March, 1998



## Noise Levels at Location 21 - Tweed Valley Cemetery, Eviron Rd

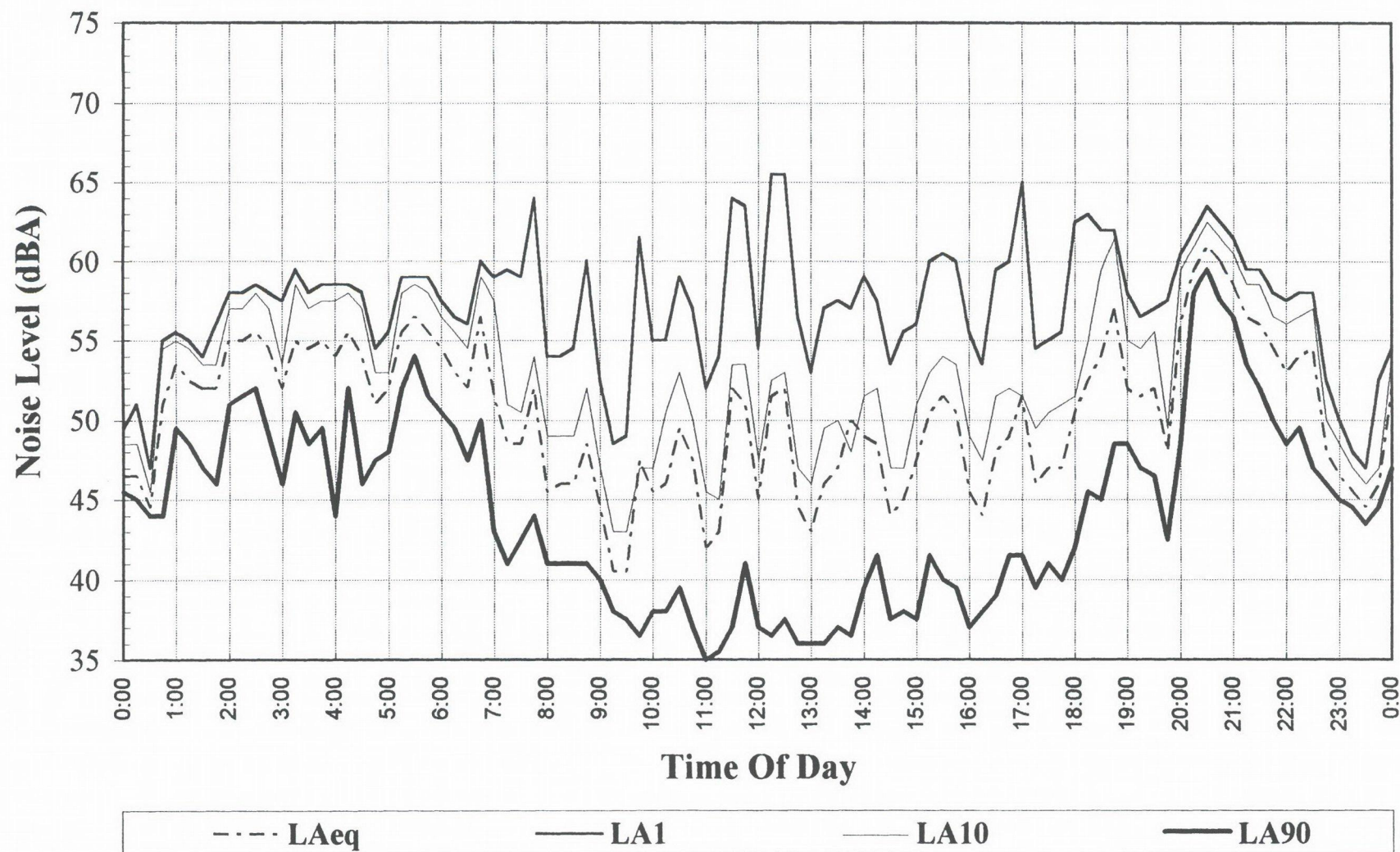
Tuesday, 3 March, 1998





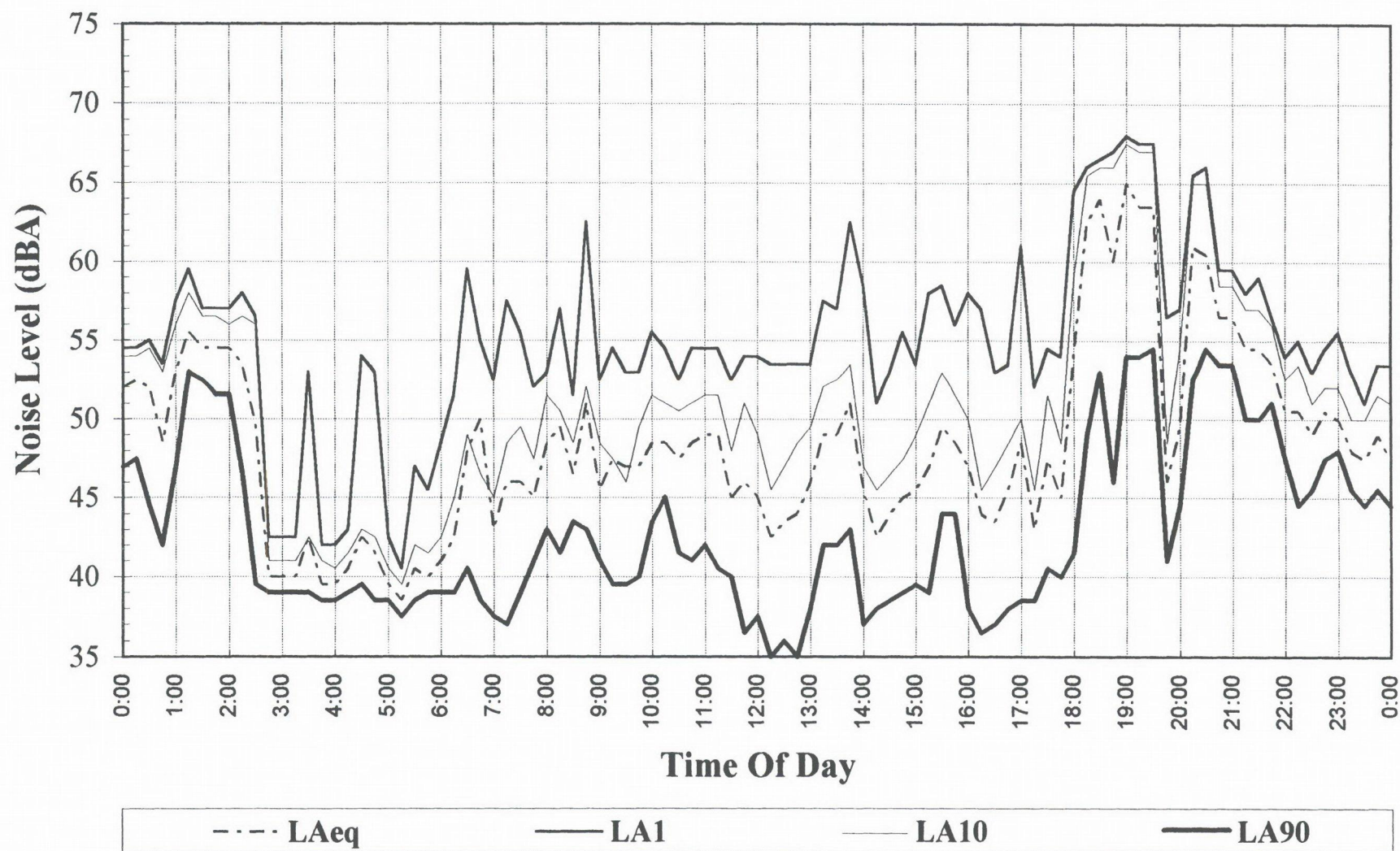
## Noise Levels at Location 21 - Tweed Valley Cemetery, Eviron Rd

Wednesday, 4 March, 1998



## Noise Levels at Location 21 - Tweed Valley Cemetery, Eviron Rd

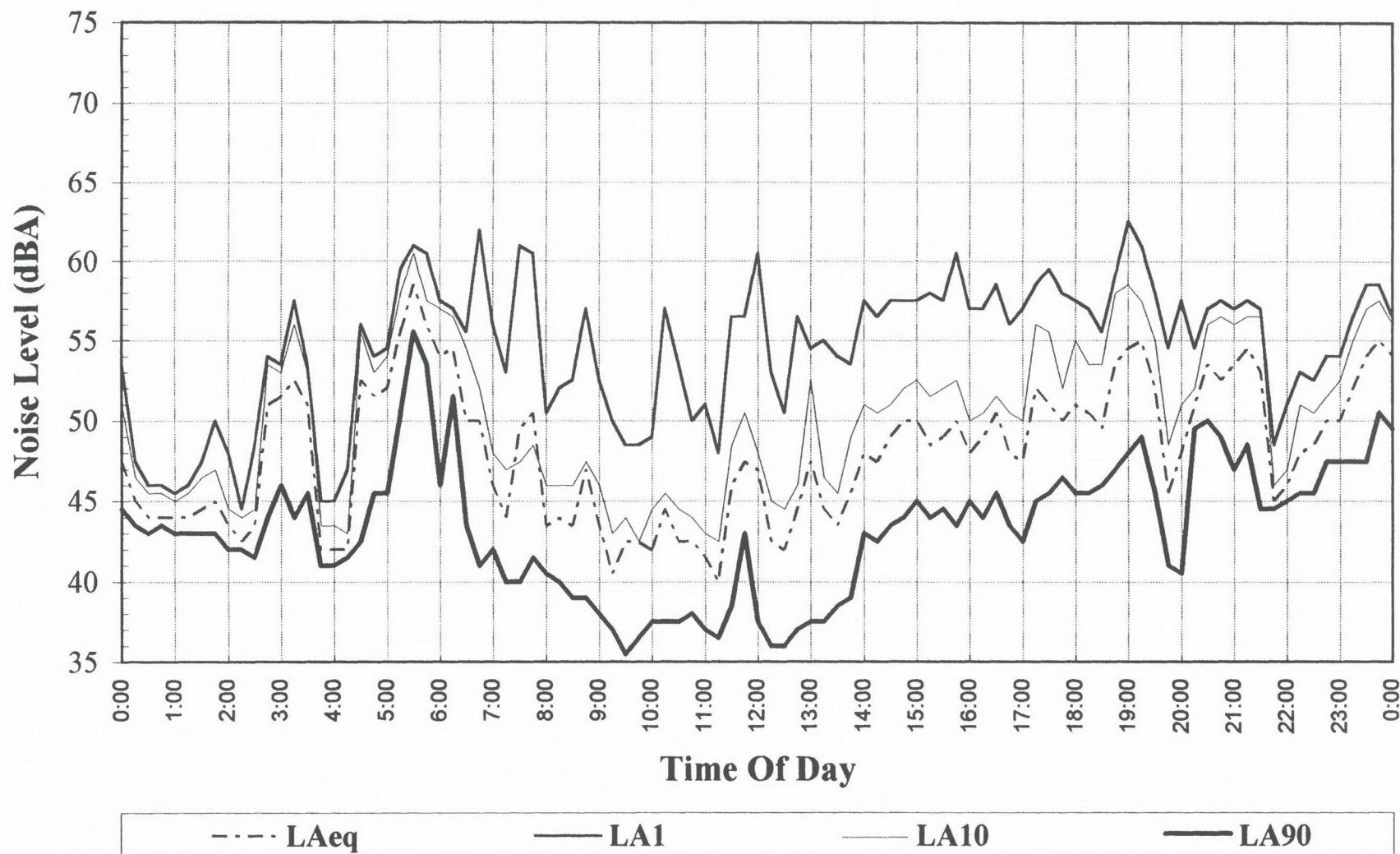
Thursday, 5 March, 1998





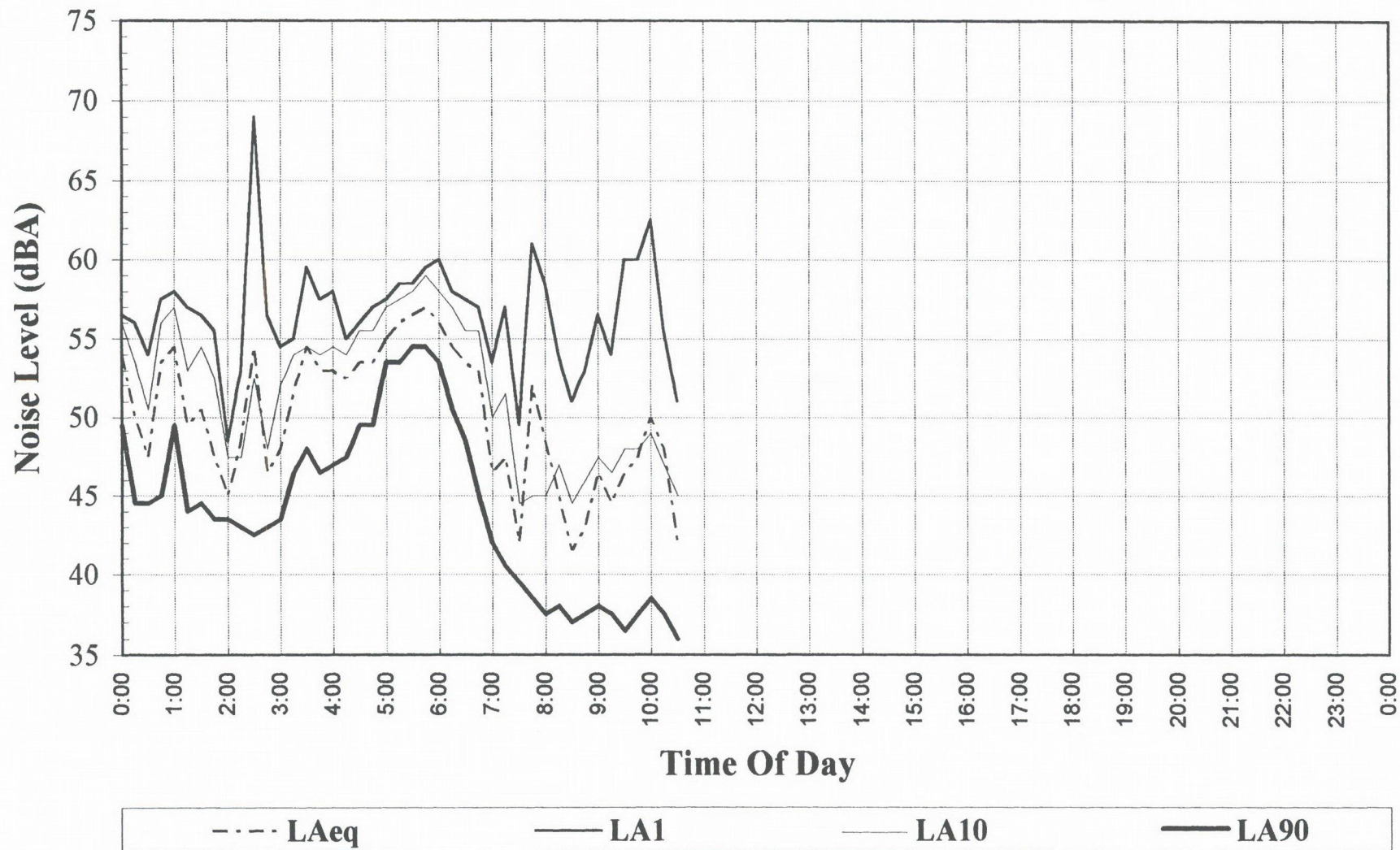
## Noise Levels at Location 21 - Tweed Valley Cemetery, Eviron Rd

Friday, 6 March, 1998



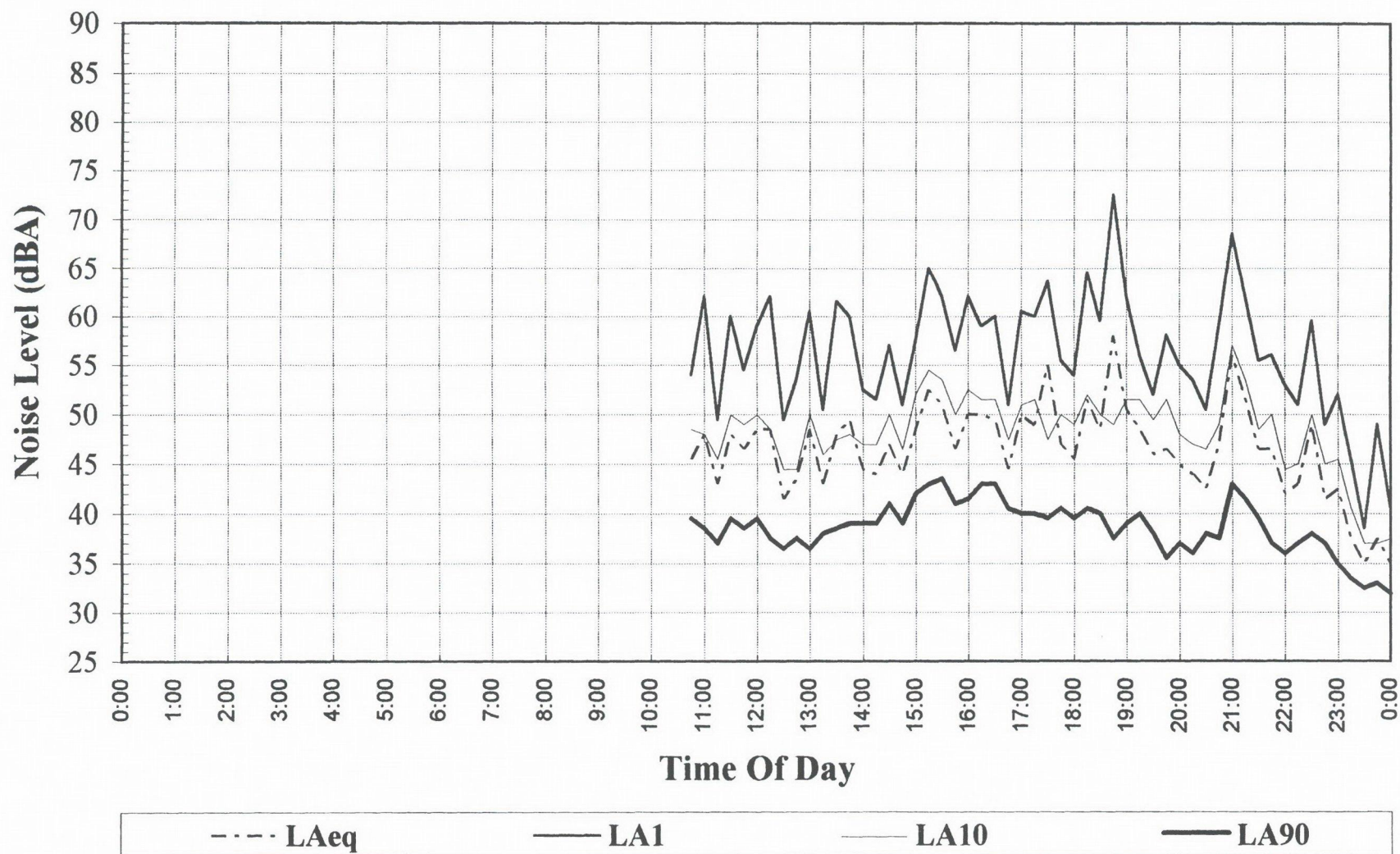
## Noise Levels at Location 21 - Tweed Valley Cemetery, Eviron Rd

Saturday, 7 March, 1998



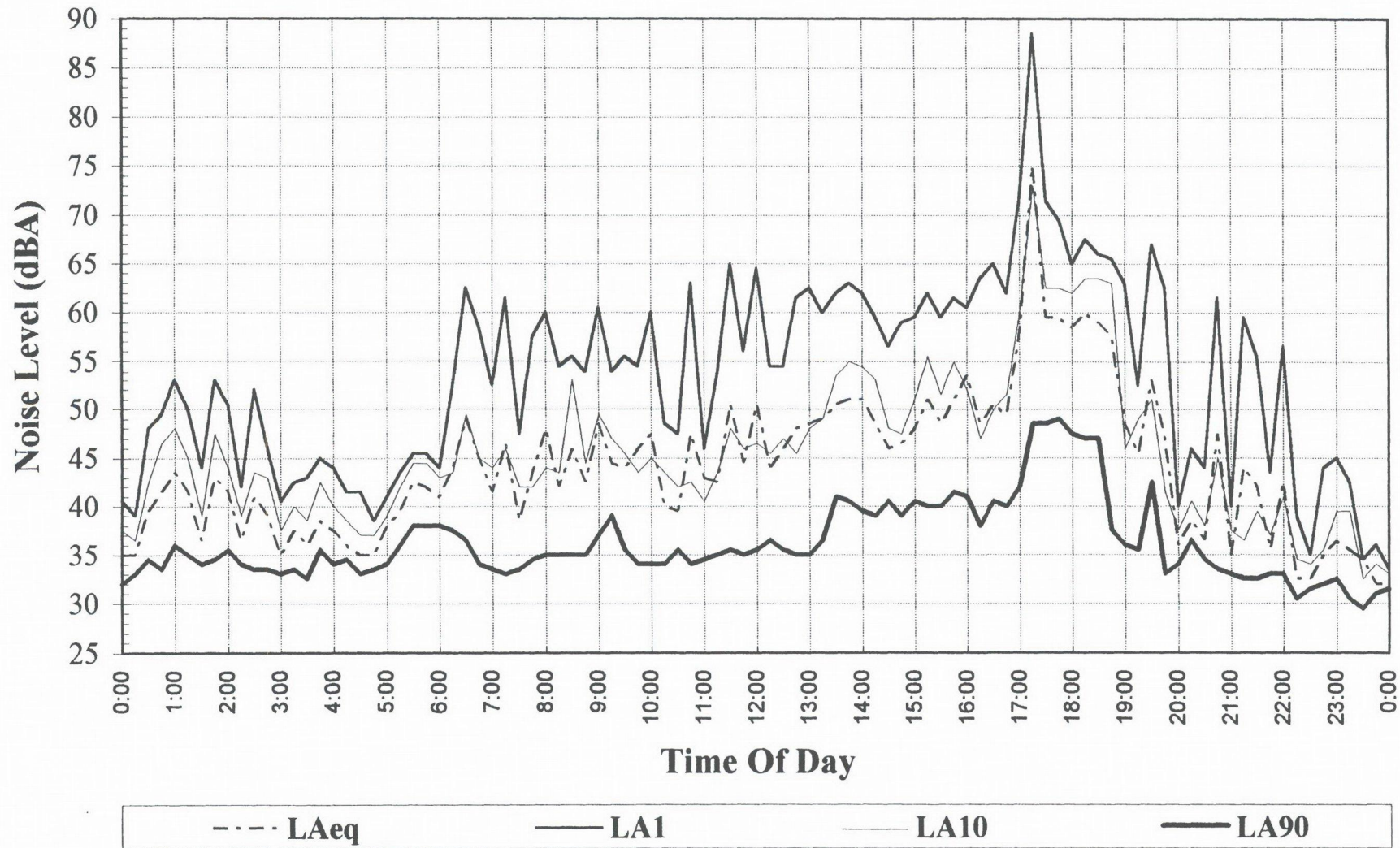


**Noise Levels at Location 22 - "Dunarra", 240 Duranbah Road**  
**Saturday, 7 March, 1998**



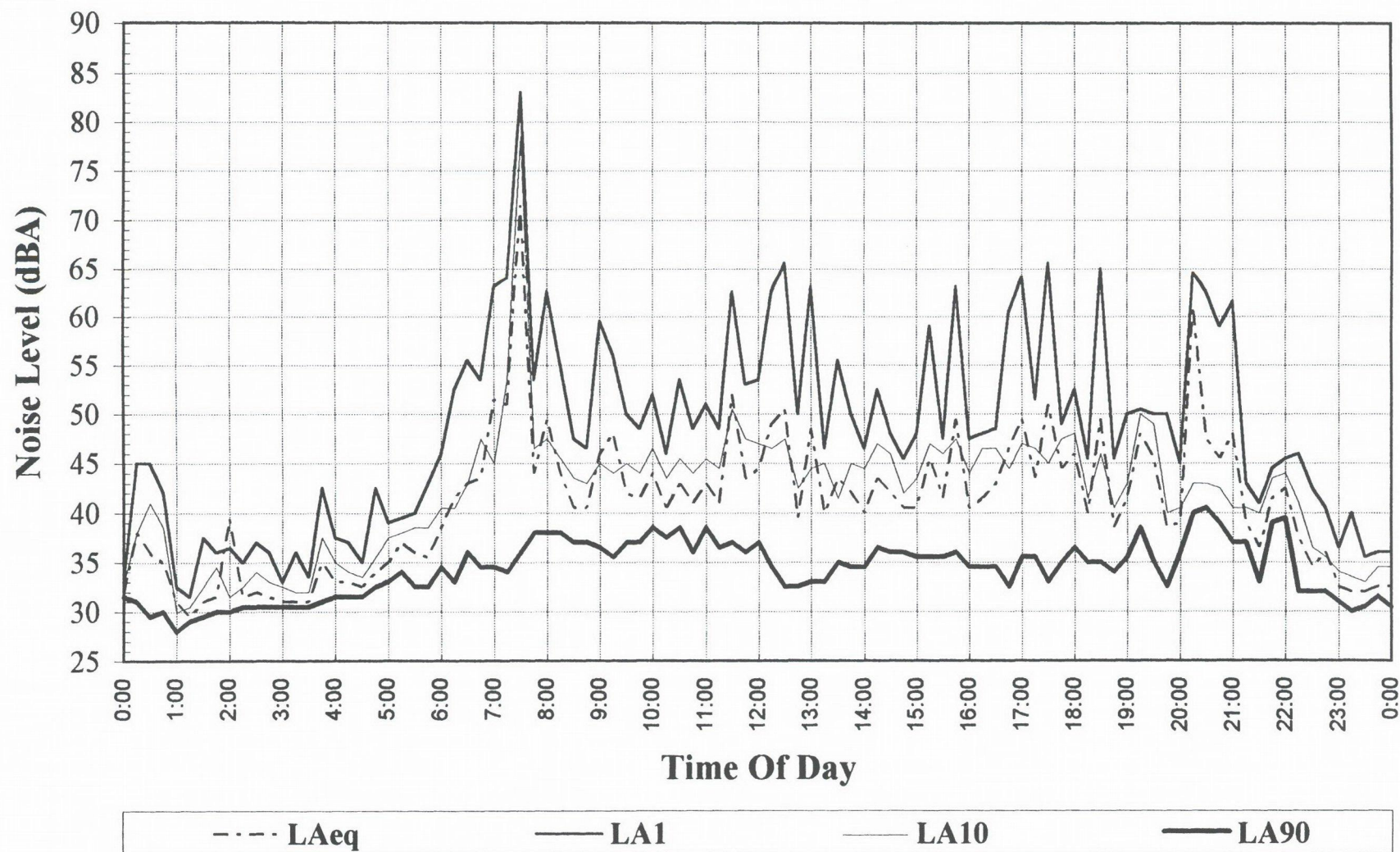
## Noise Levels at Location 22 - "Dunarra", 240 Duranbah Road

Sunday, 8 March, 1998



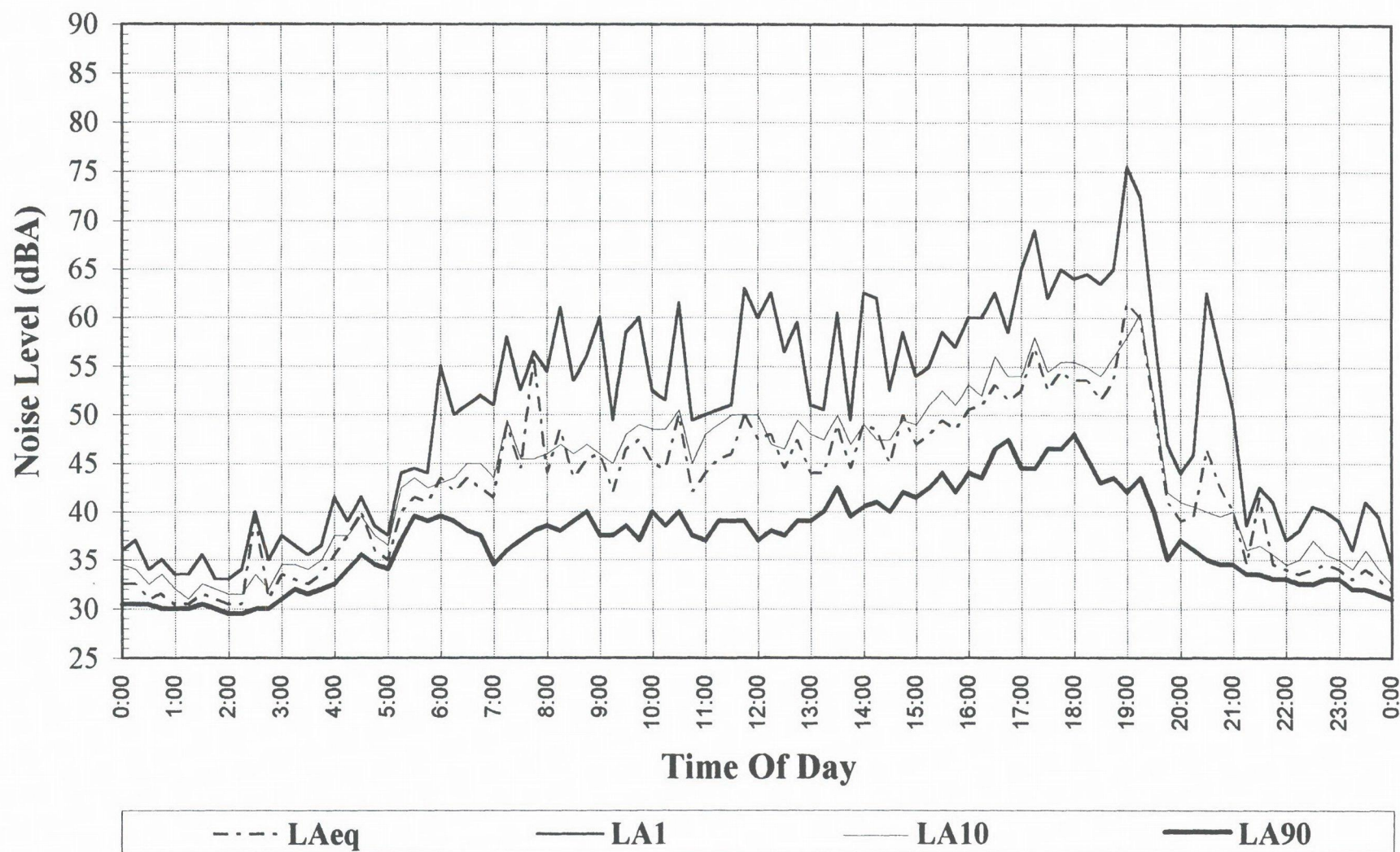


**Noise Levels at Location 22 - "Dunarra", 240 Duranbah Road**  
**Monday, 9 March, 1998**



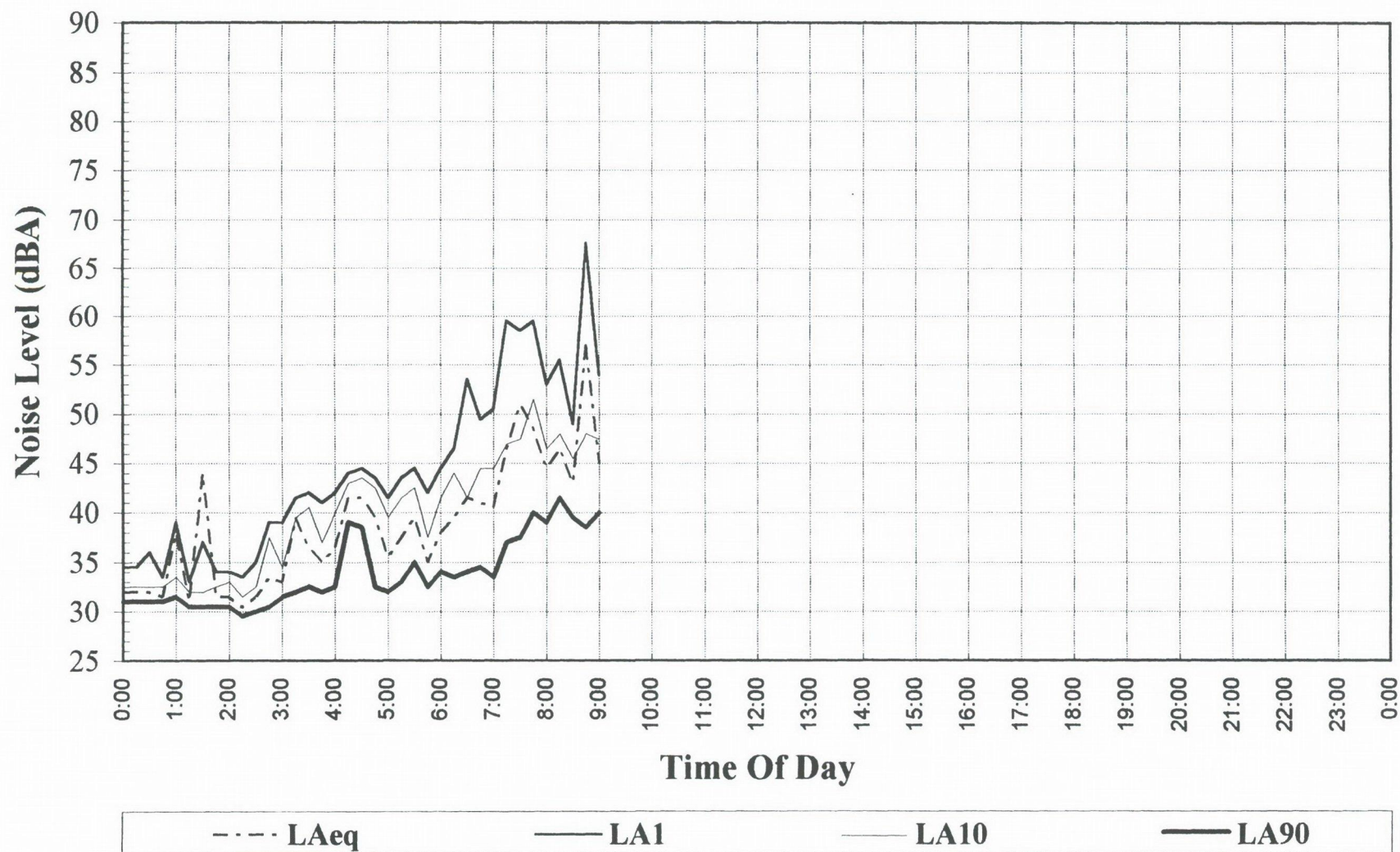
## Noise Levels at Location 22 - "Dunarra", 240 Duranbah Road

Tuesday, 10 March, 1998



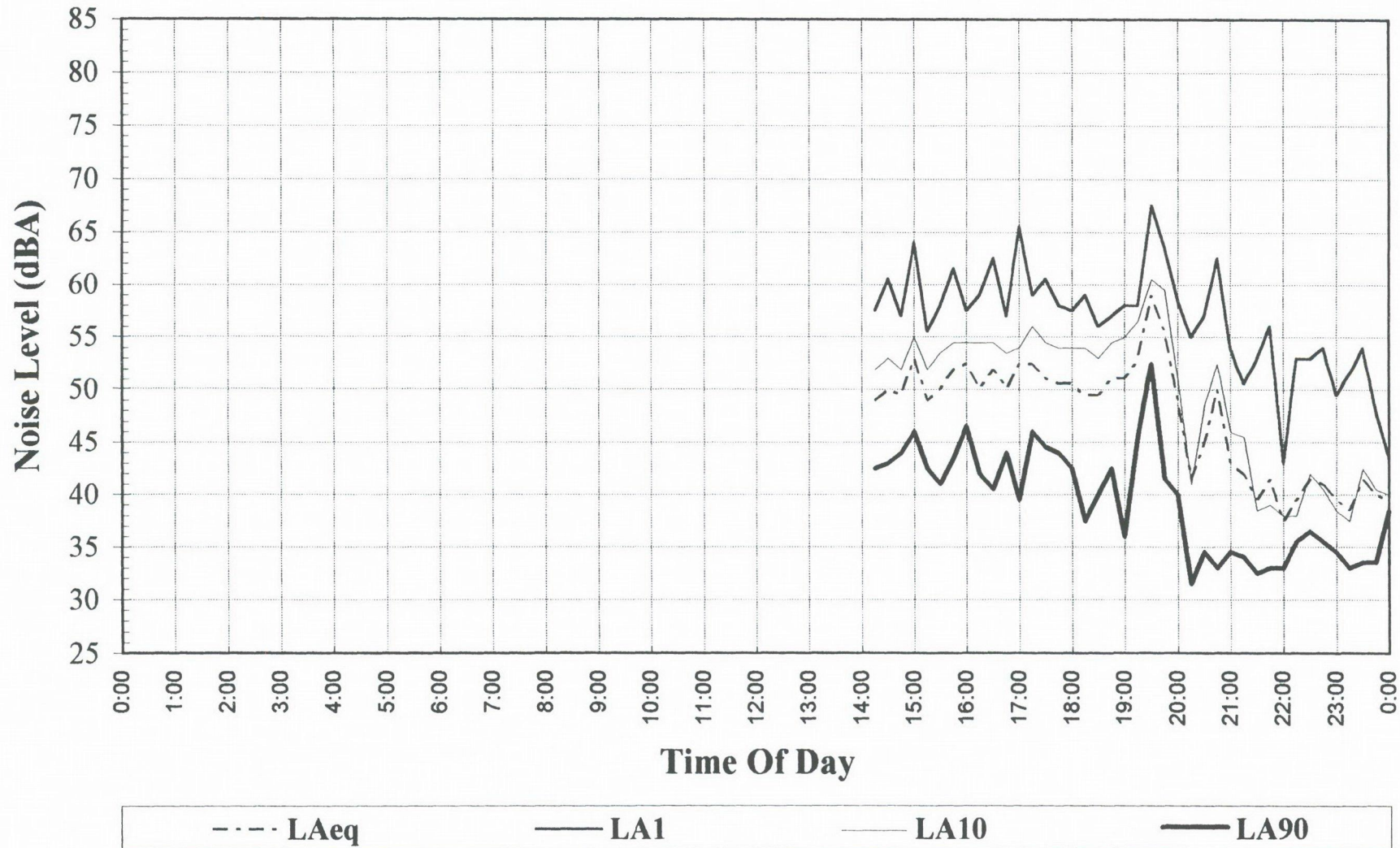


**Noise Levels at Location 22 - "Dunarra", 240 Duranbah Road**  
**Wednesday, 11 March, 1998**



## Noise Levels at Location 23 - Duranbah Public School

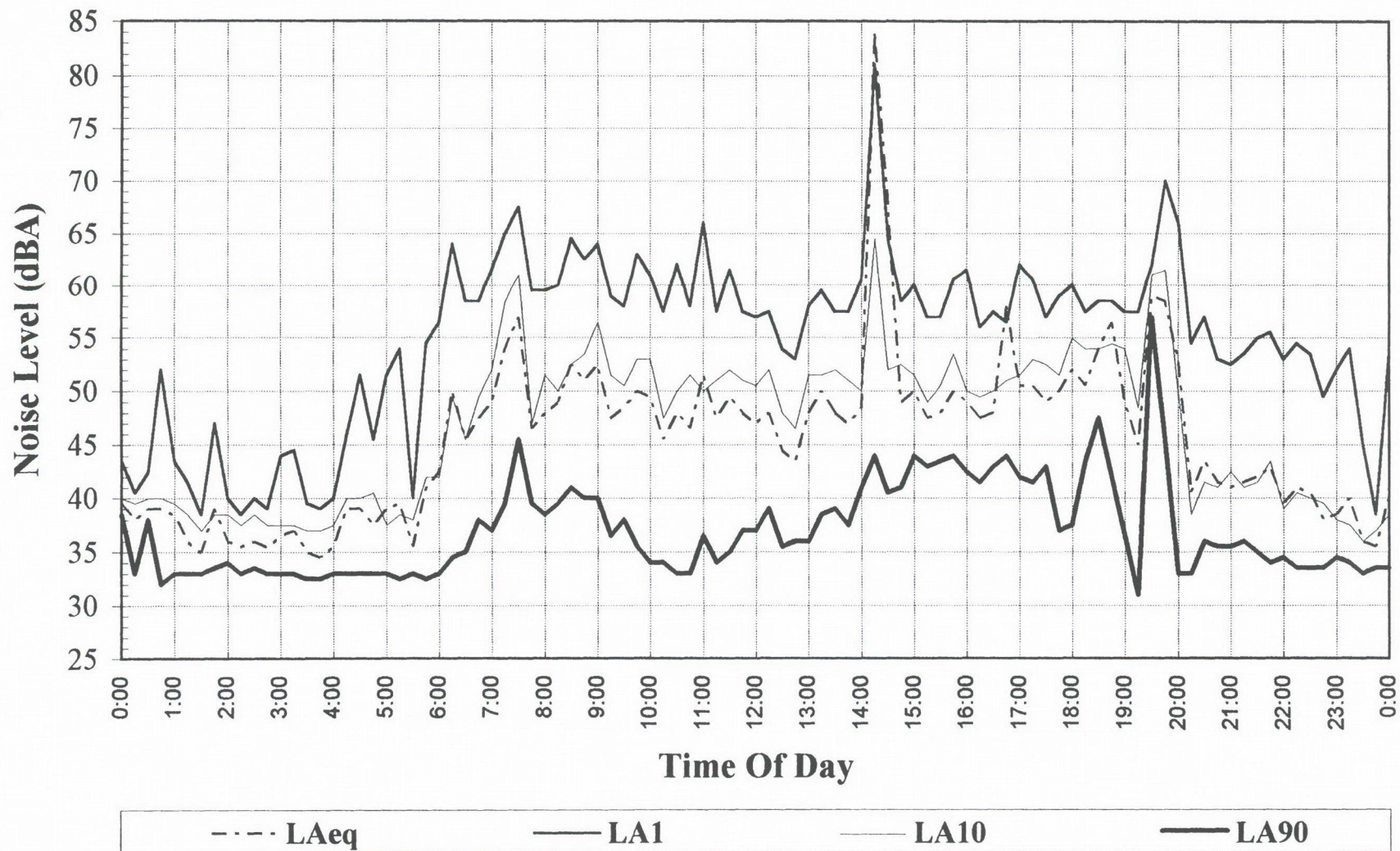
Thursday, 26 February, 1998





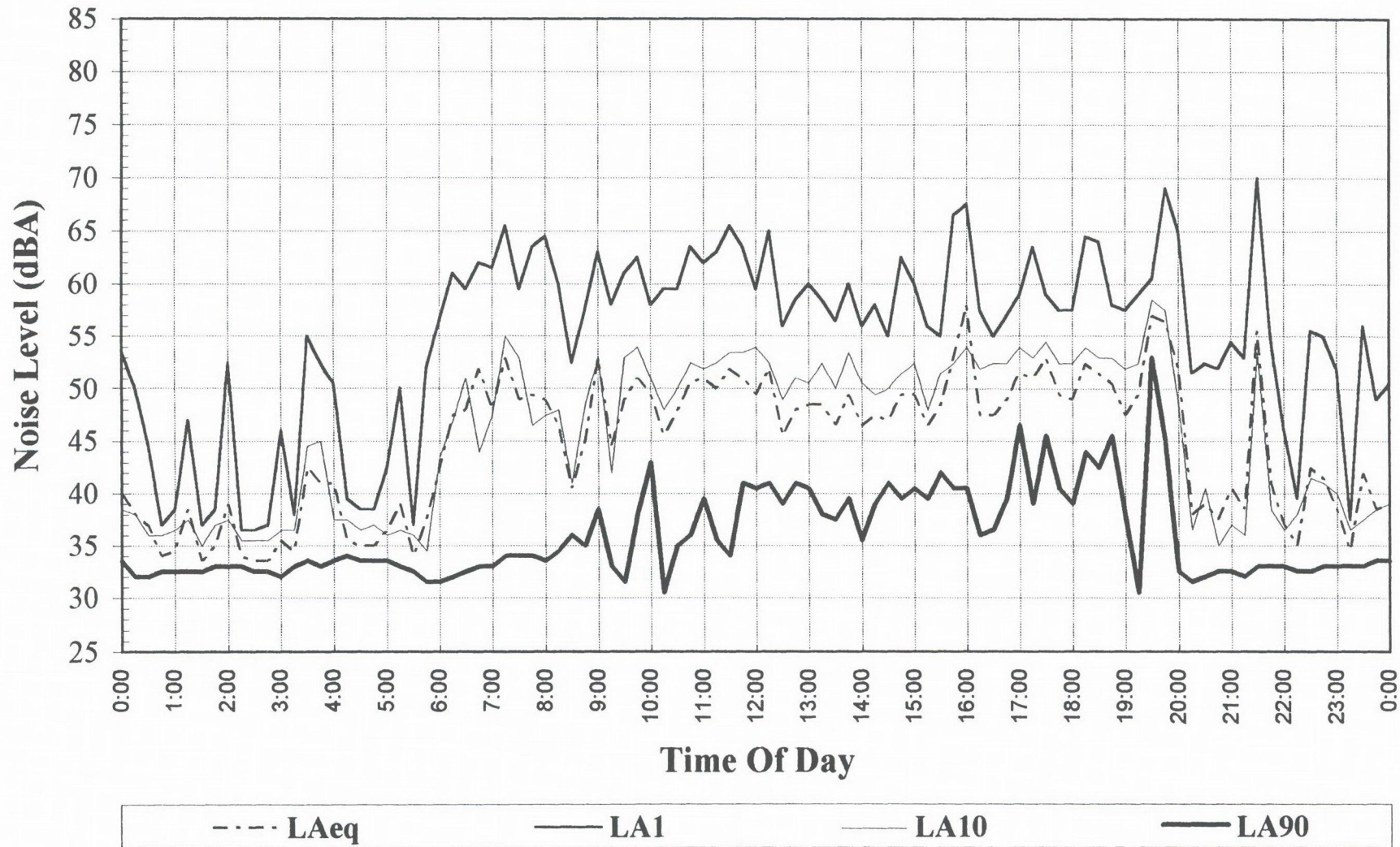
## Noise Levels at Location 23 - Duranbah Public School

Friday, 27 February, 1998



## Noise Levels at Location 23 - Duranbah Public School

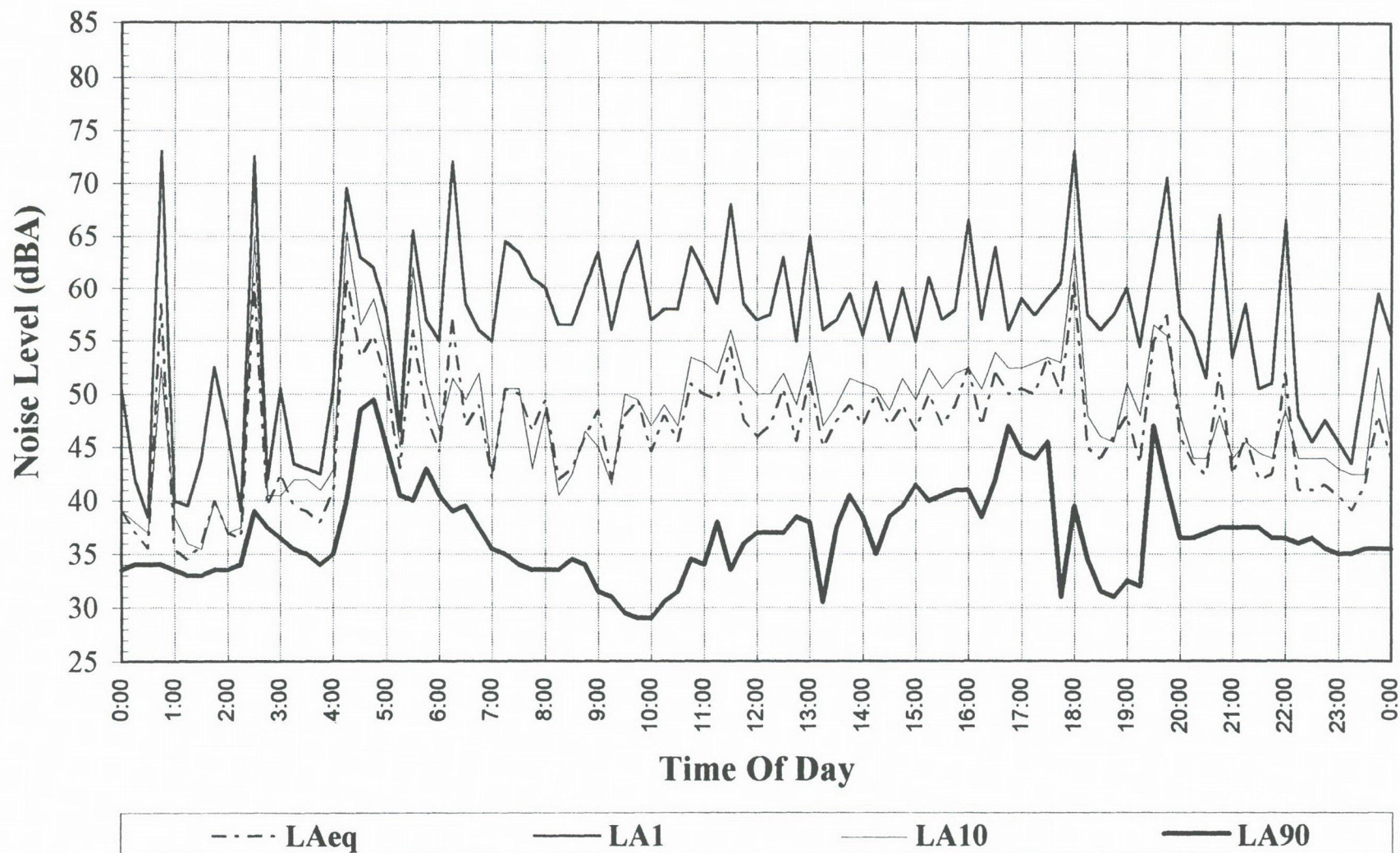
Saturday, 28 February, 1998





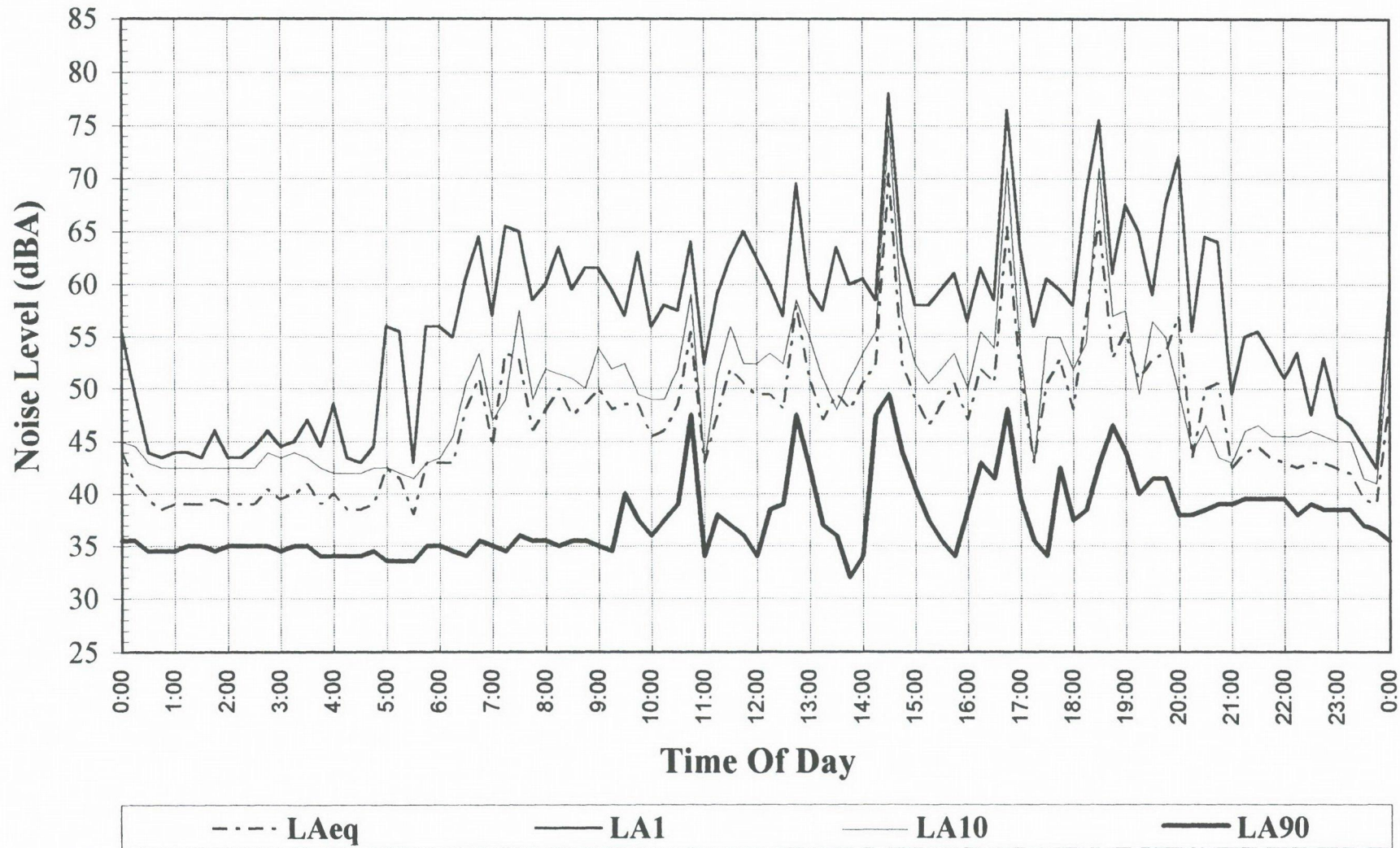
## Noise Levels at Location 23 - Duranbah Public School

Sunday, 1 March, 1998



## Noise Levels at Location 23 - Duranbah Public School

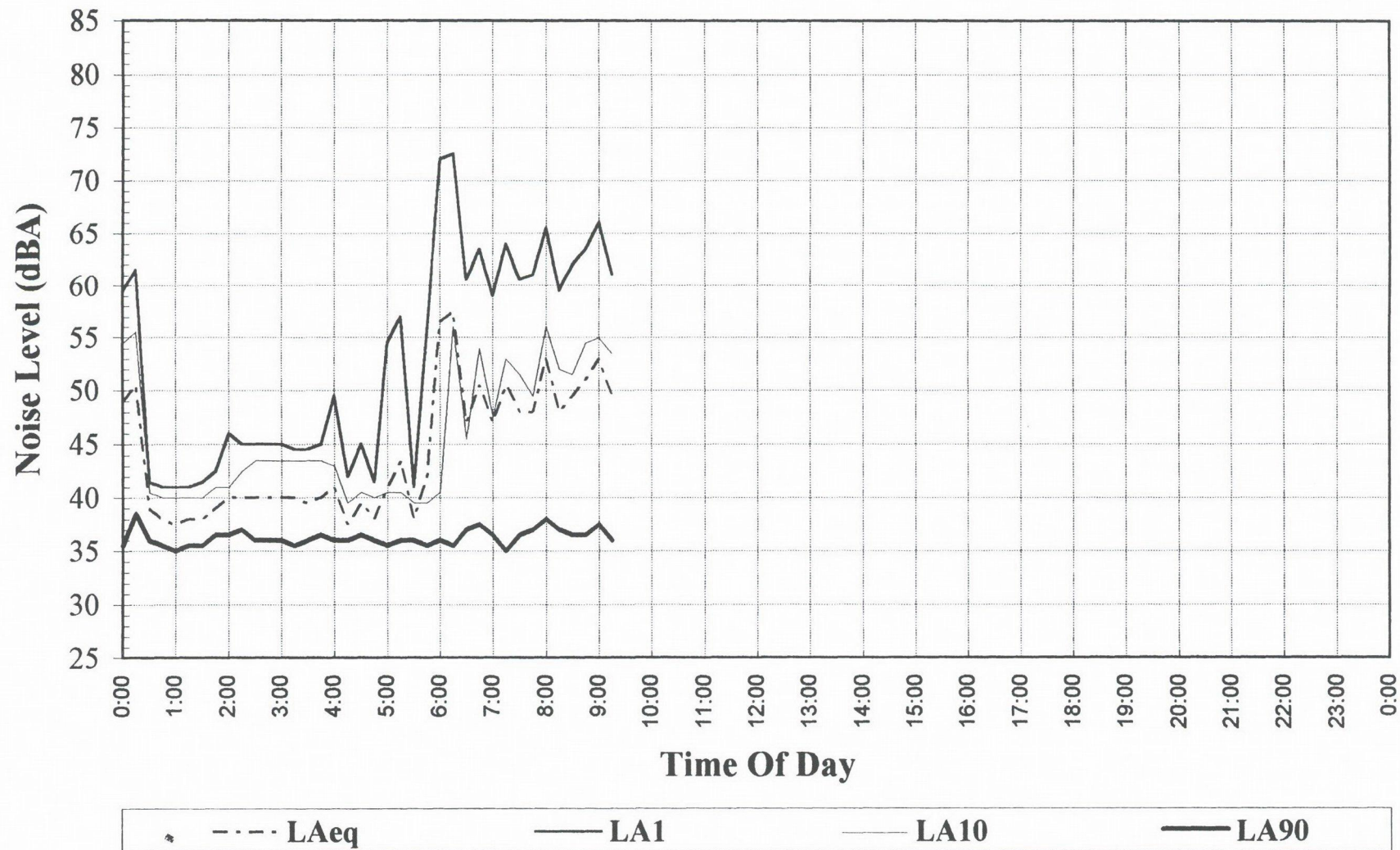
Monday, 2 March, 1998



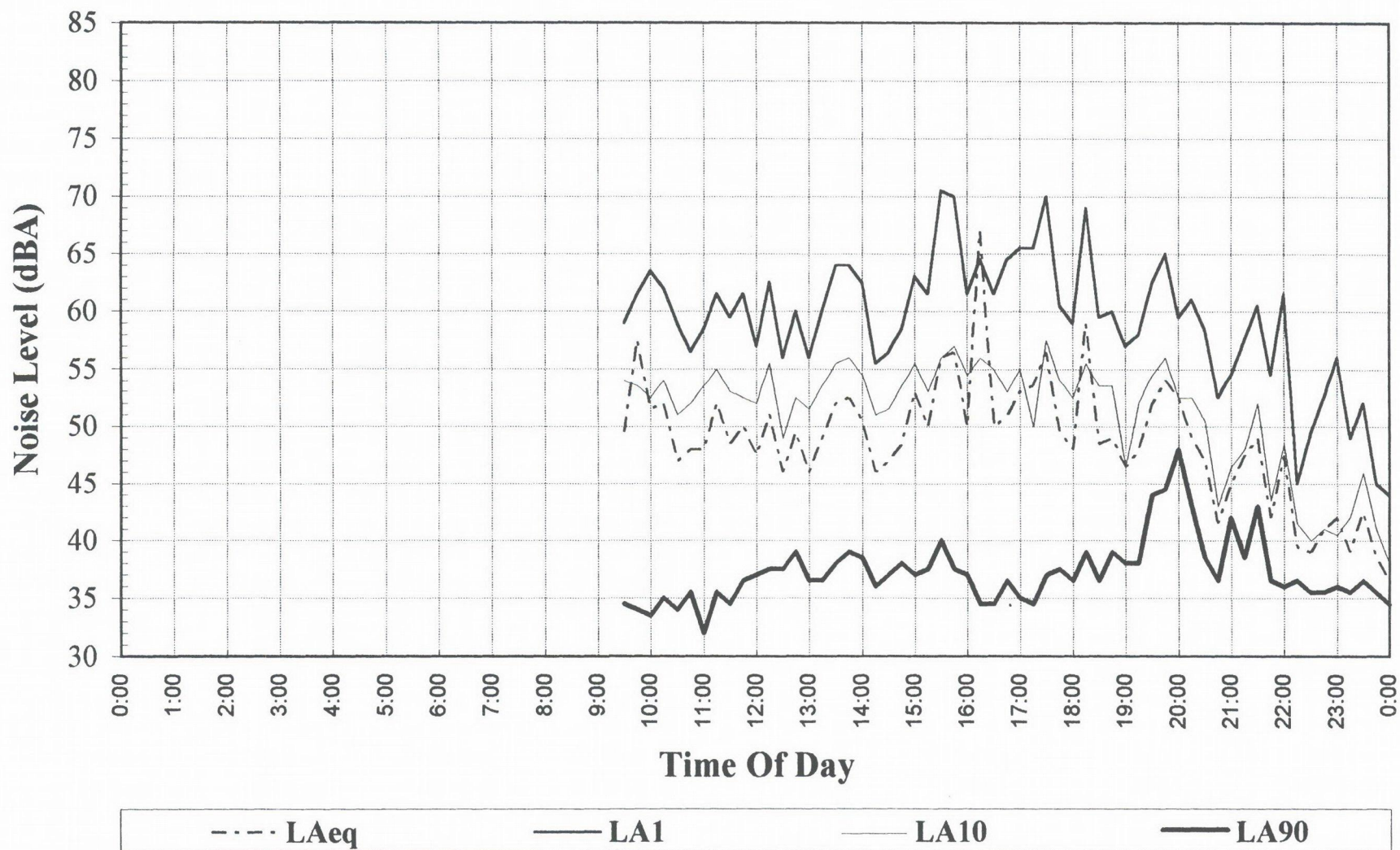


## Noise Levels at Location 23 - Duranbah Public School

Tuesday, 3 March, 1998



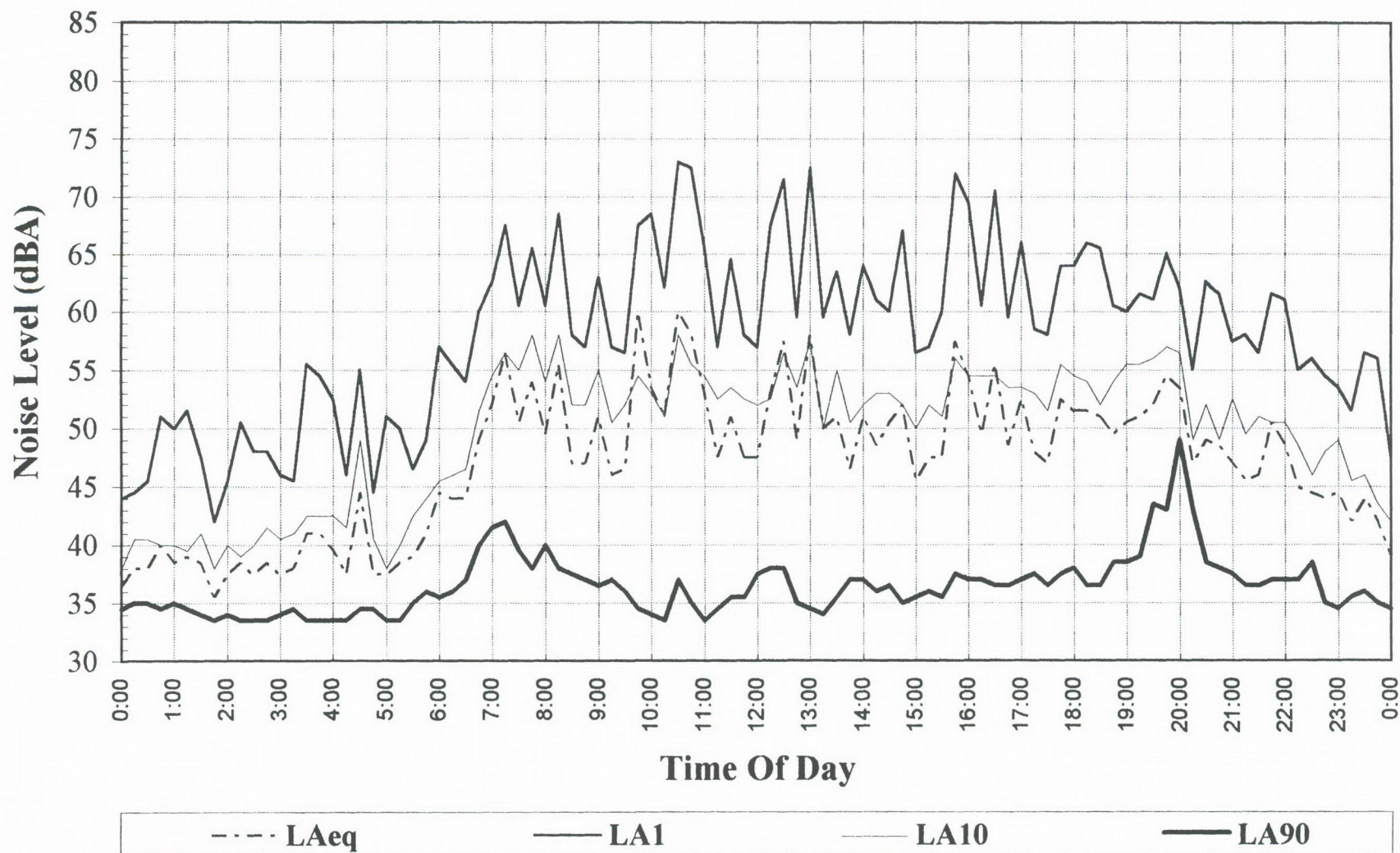
**Noise Levels at Location 24 - "Nyari", Cudgen Rd, Duranbah**  
**Tuesday, 3 March, 1998**





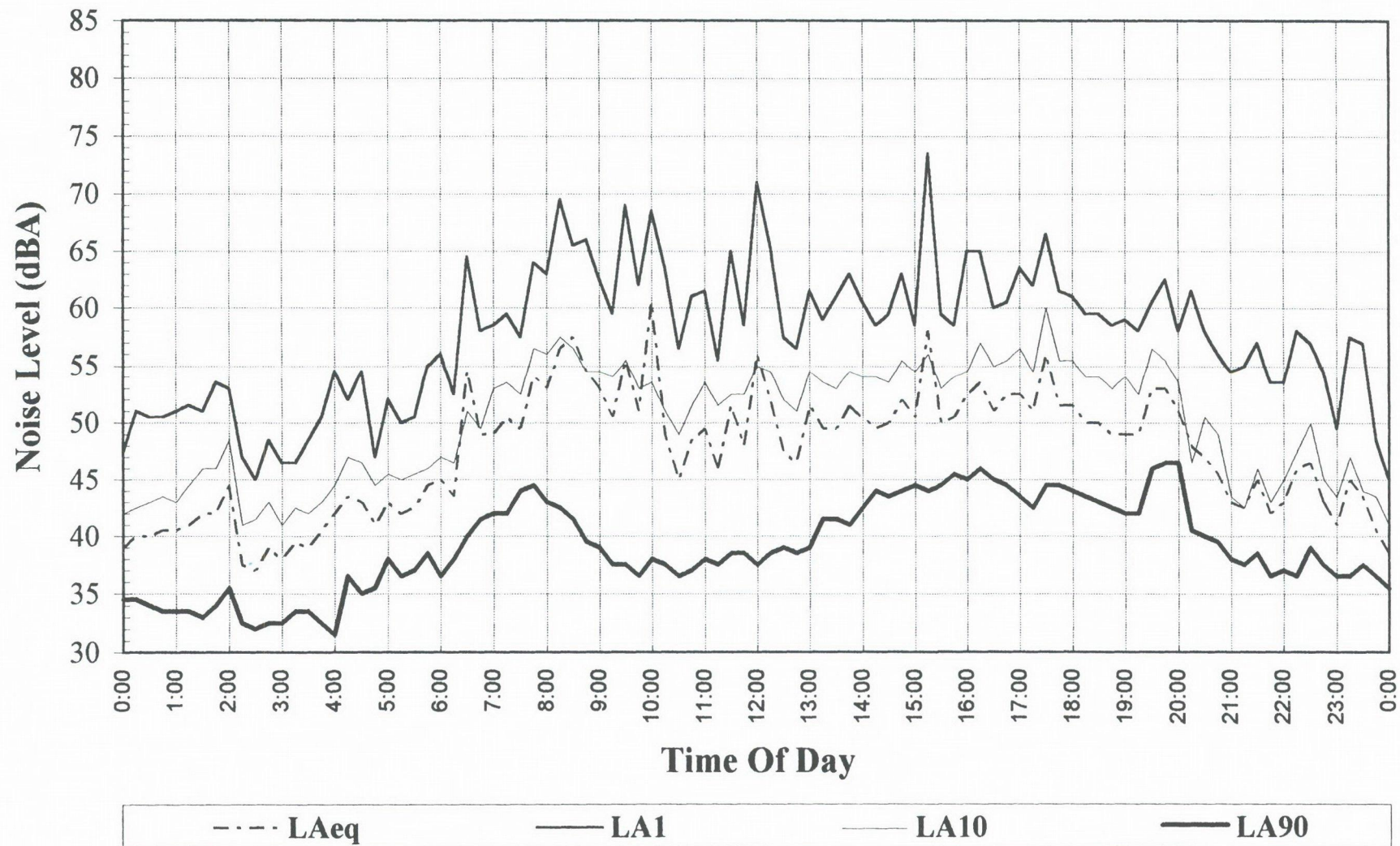
## Noise Levels at Location 24 - "Nyari", Cudgen Rd, Duranbah

Wednesday, 4 March, 1998



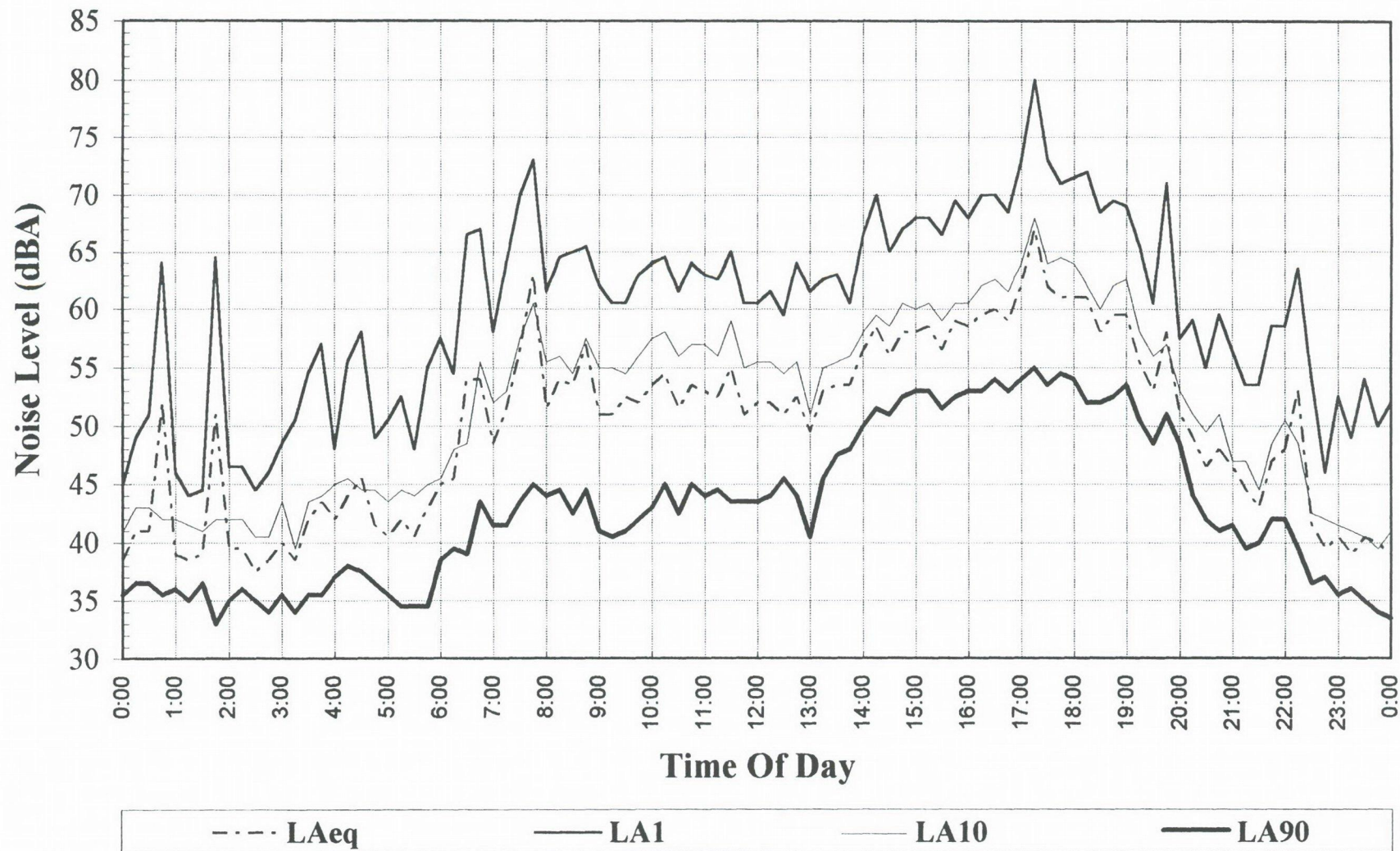
# Noise Levels at Location 24 - "Nyari", Cudgen Rd, Duranbah

Thursday, 5 March, 1998



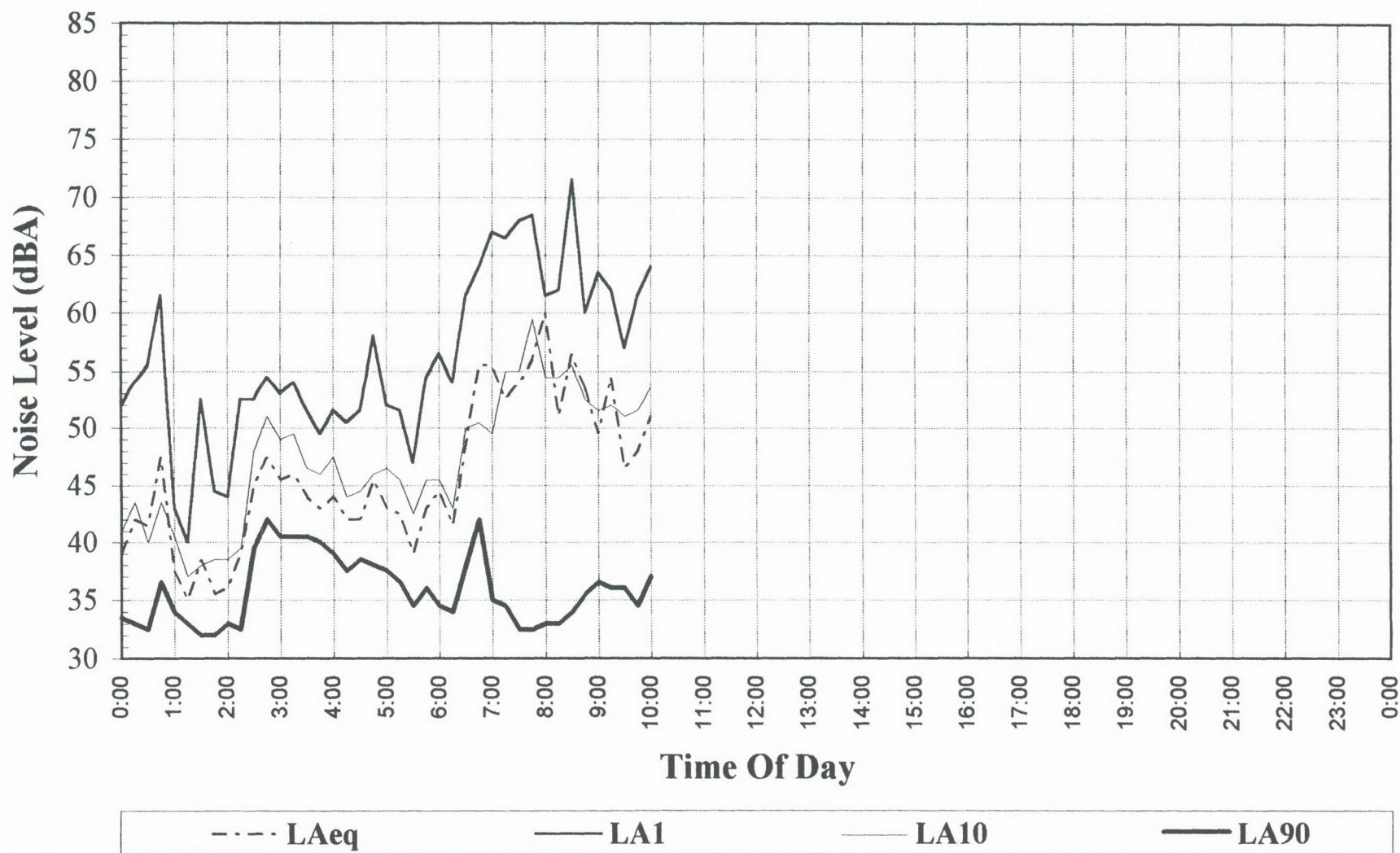


**Noise Levels at Location 24 - "Nyari", Cudgen Rd, Duranbah**  
**Friday, 6 March, 1998**



## Noise Levels at Location 24 - "Nyari", Cudgen Rd, Duranbah

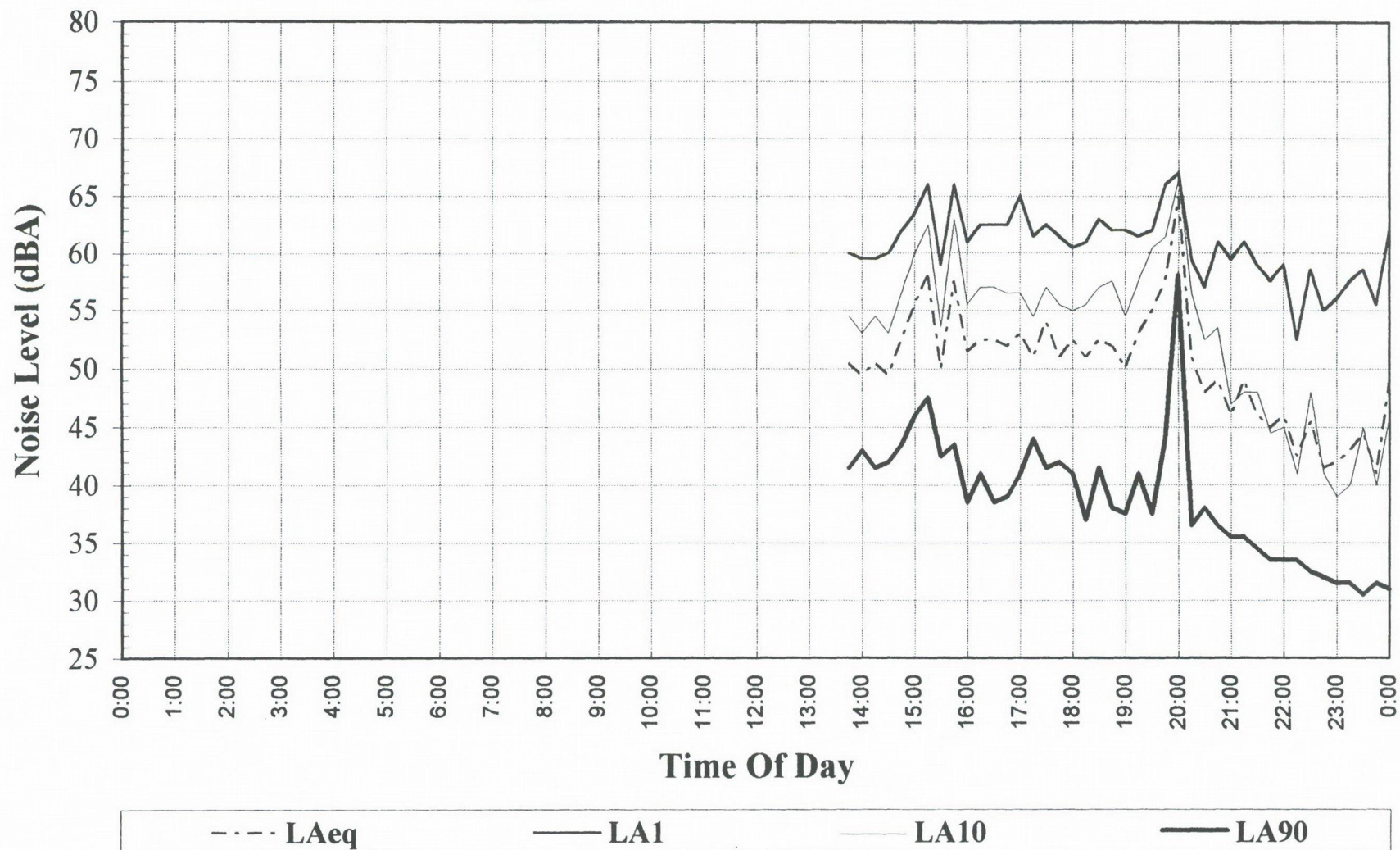
Saturday, 7 March, 1998





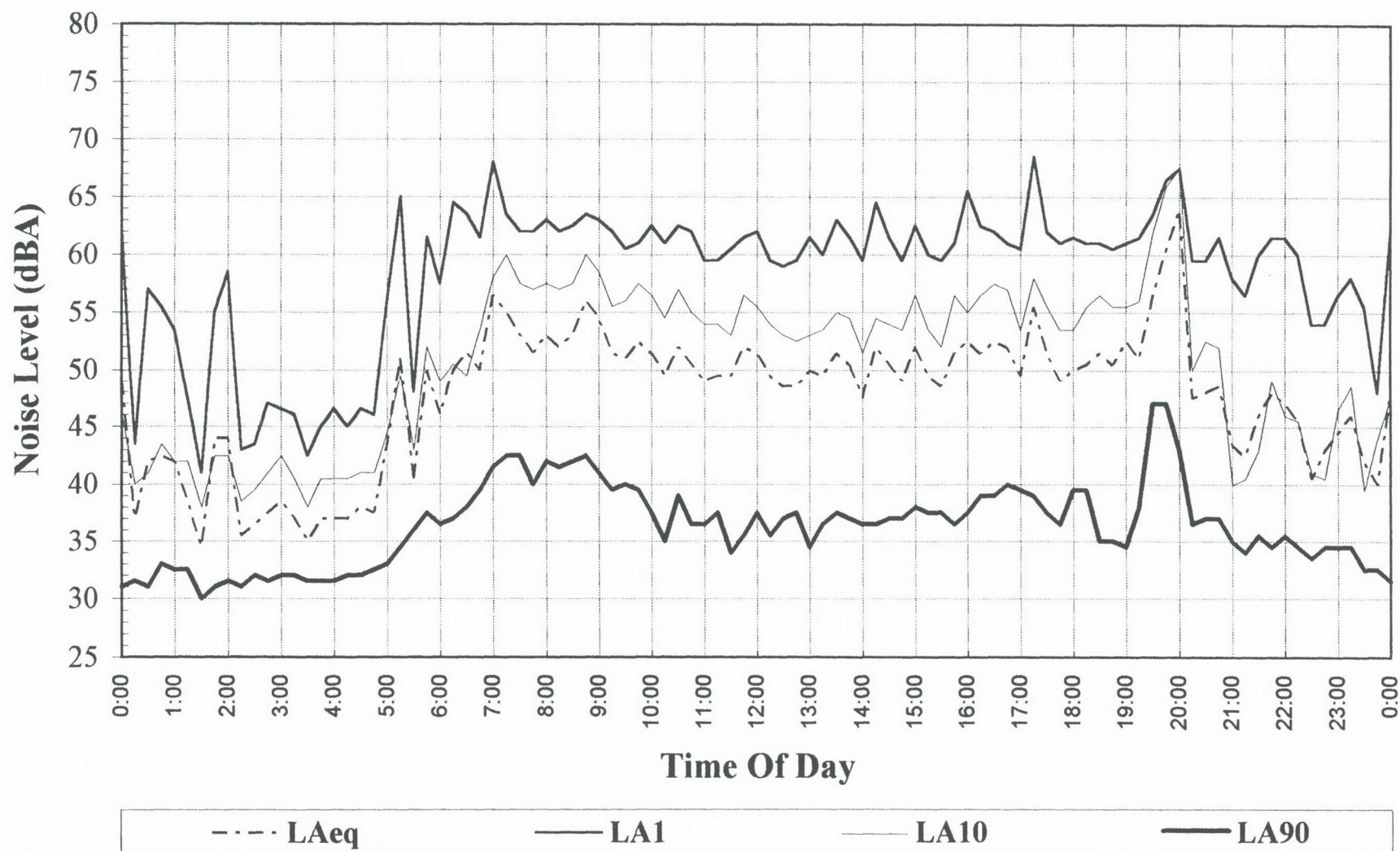
## Noise Levels at Location 25 - "Poiciana Place", Cudgen Road

Thursday, 26 February, 1998



## Noise Levels at Location 25 - "Poiciana Place", Cudgen Road

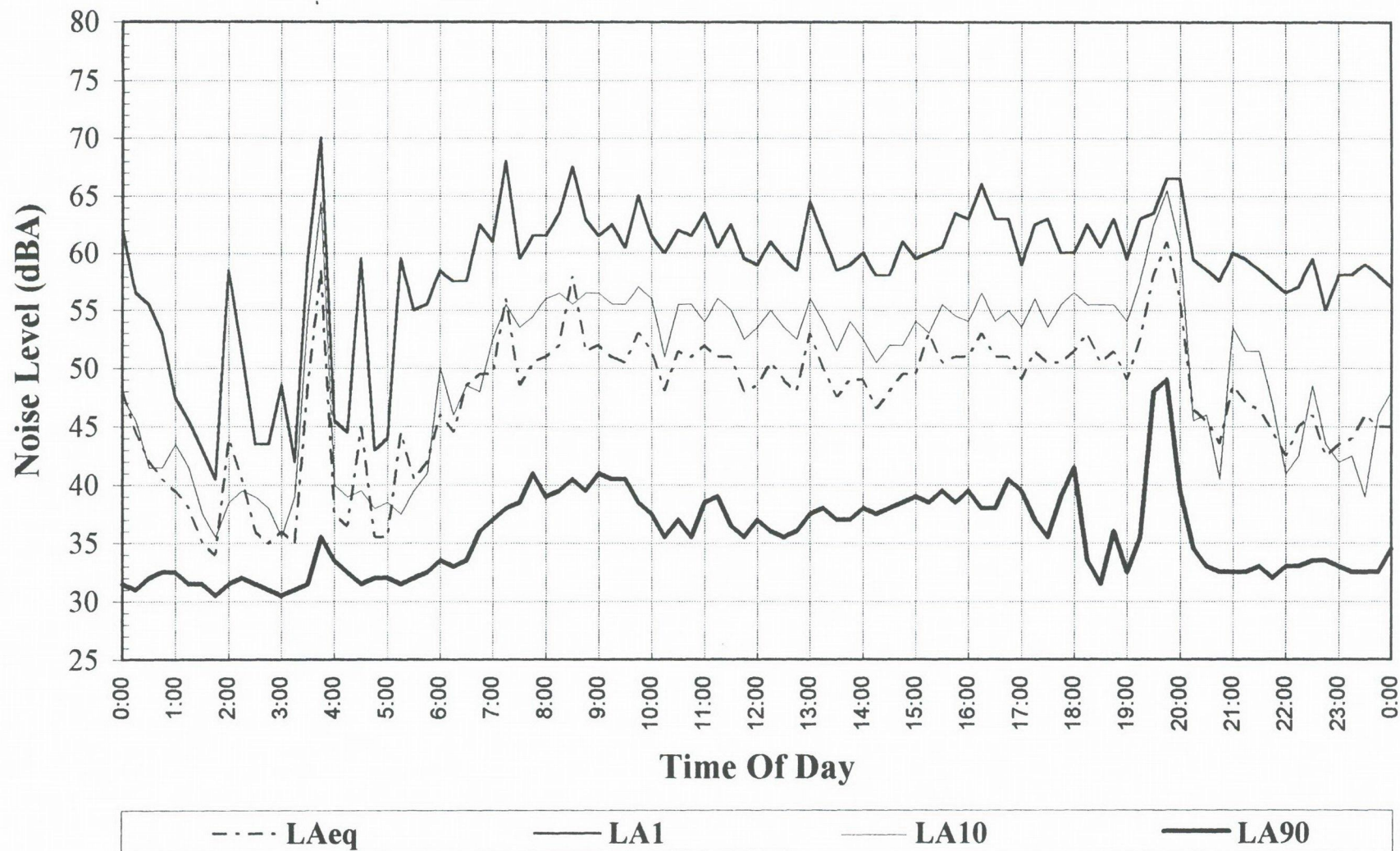
Friday, 27 February, 1998





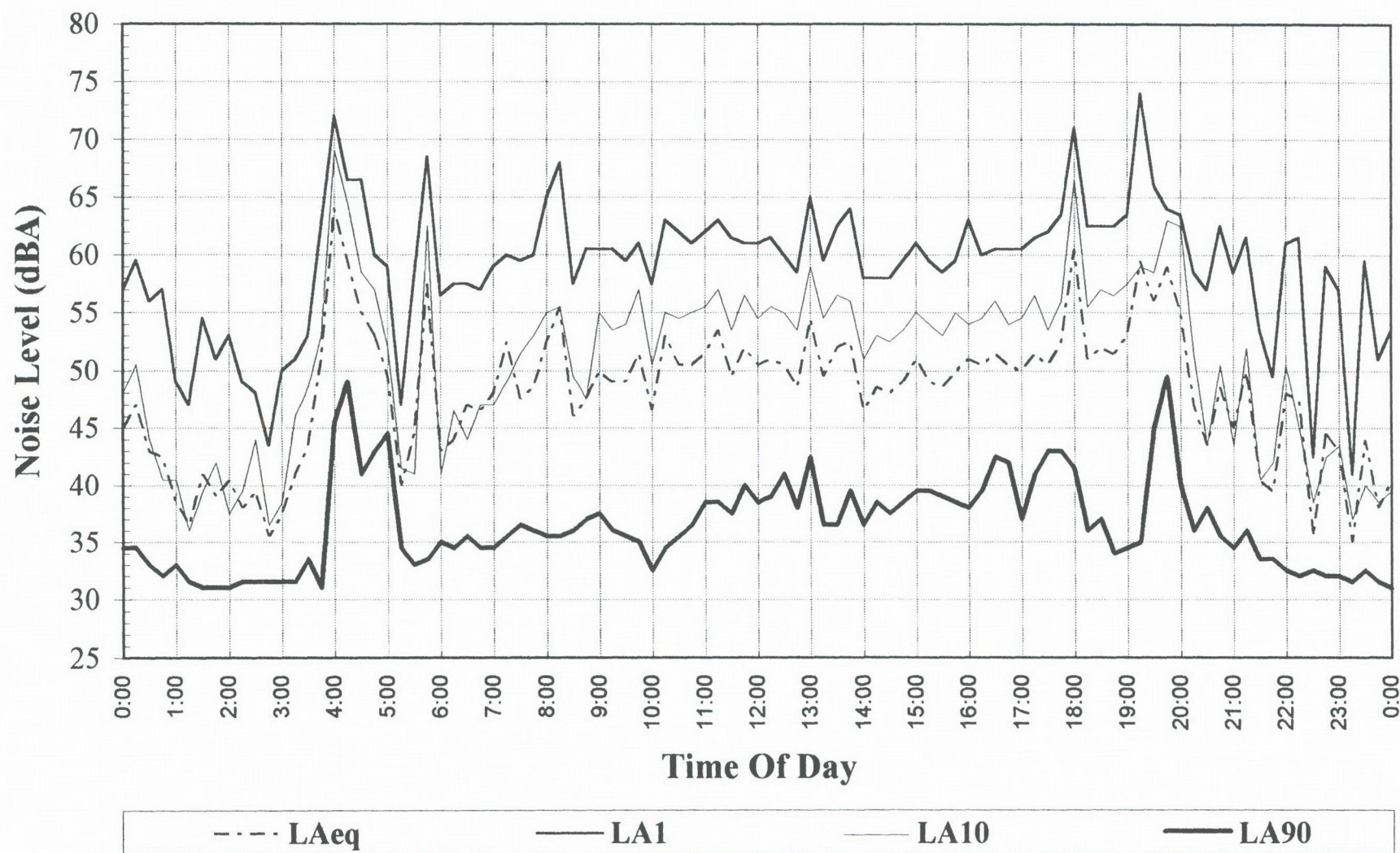
## Noise Levels at Location 25 - "Poiciana Place", Cudgen Road

Saturday, 28 February, 1998



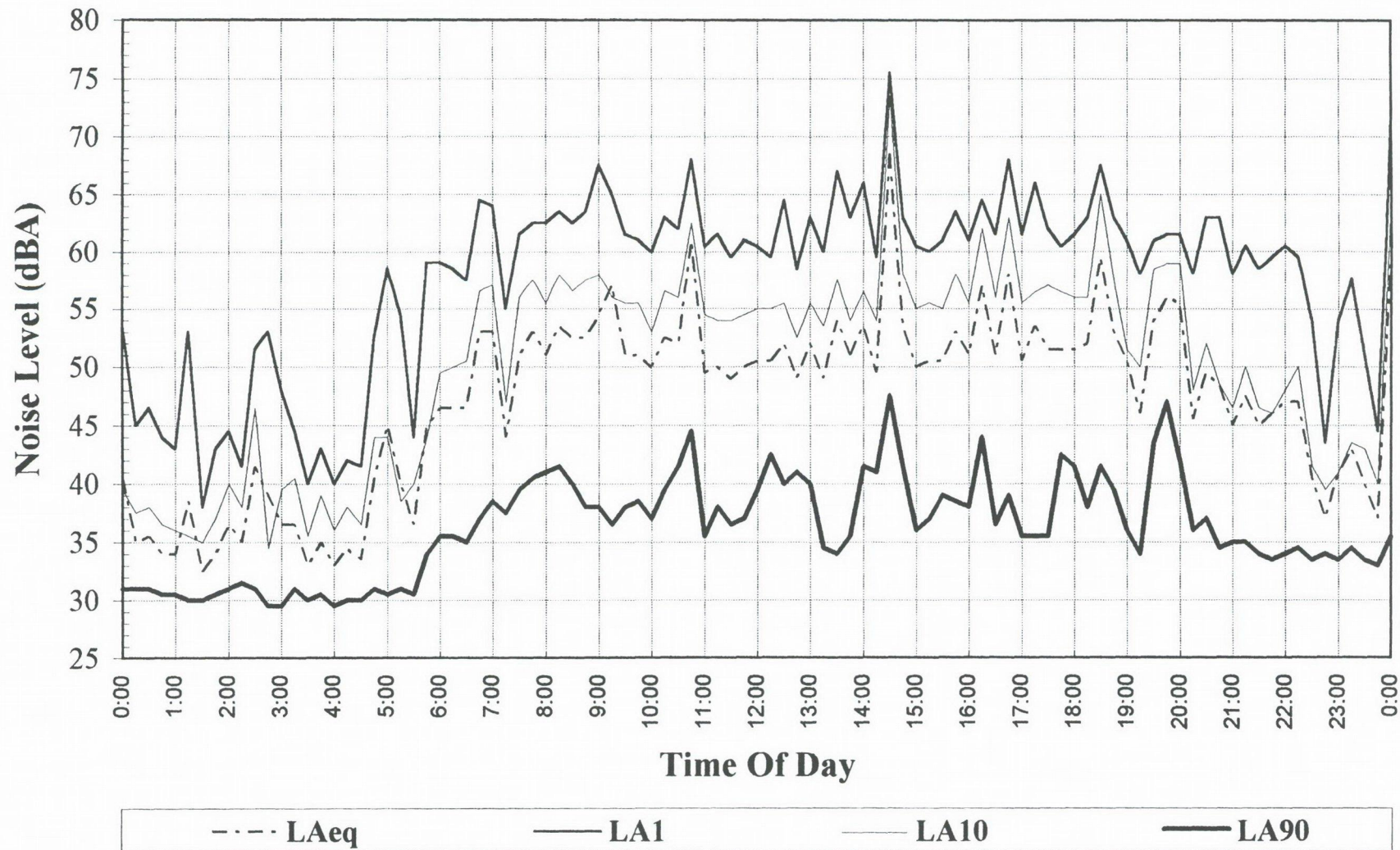
## Noise Levels at Location 25 - "Poiciana Place", Cudgen Road

Sunday, 1 March, 1998



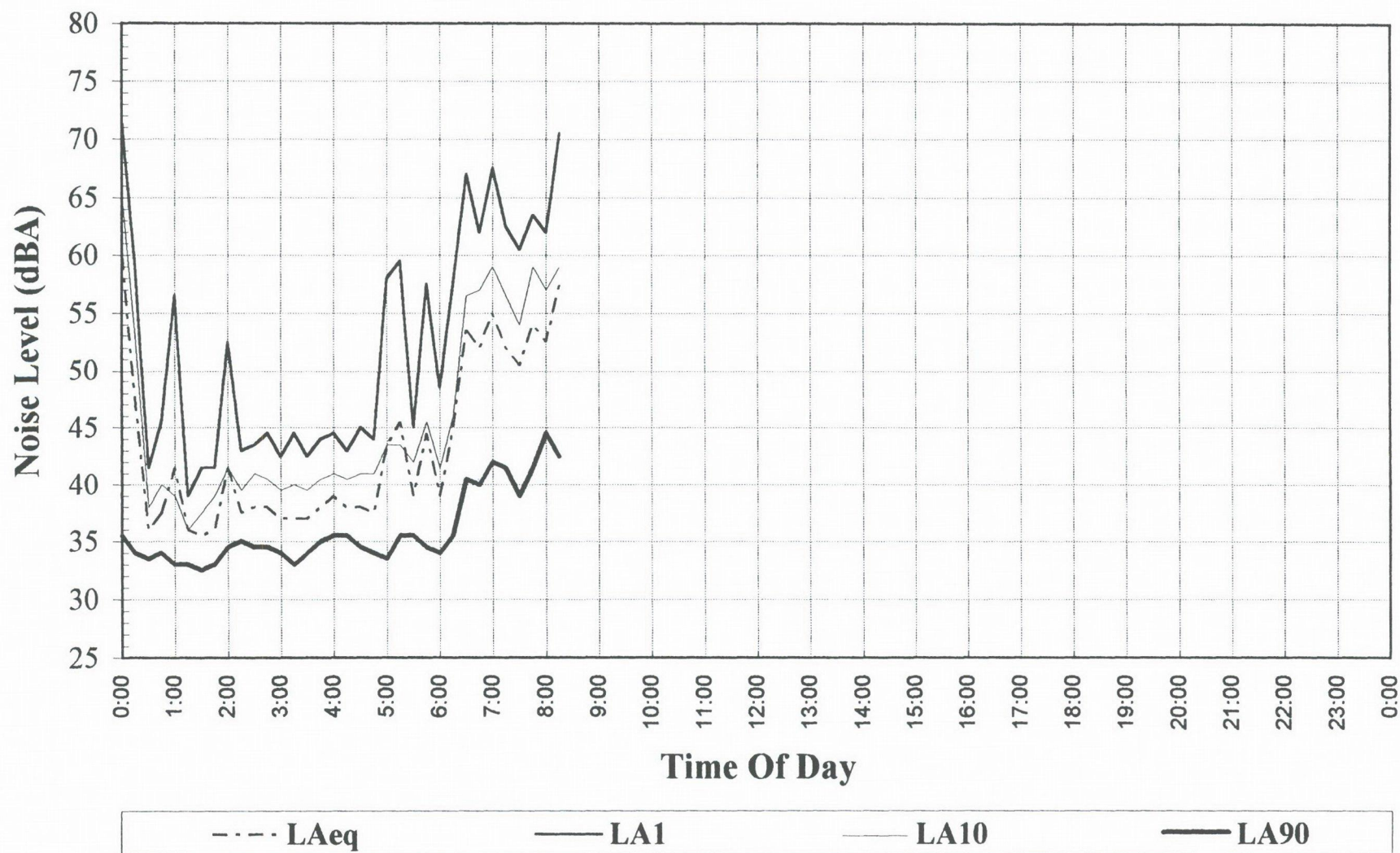


**Noise Levels at Location 25 - "Poiciana Place", Cudgen Road**  
**Monday, 2 March, 1998**



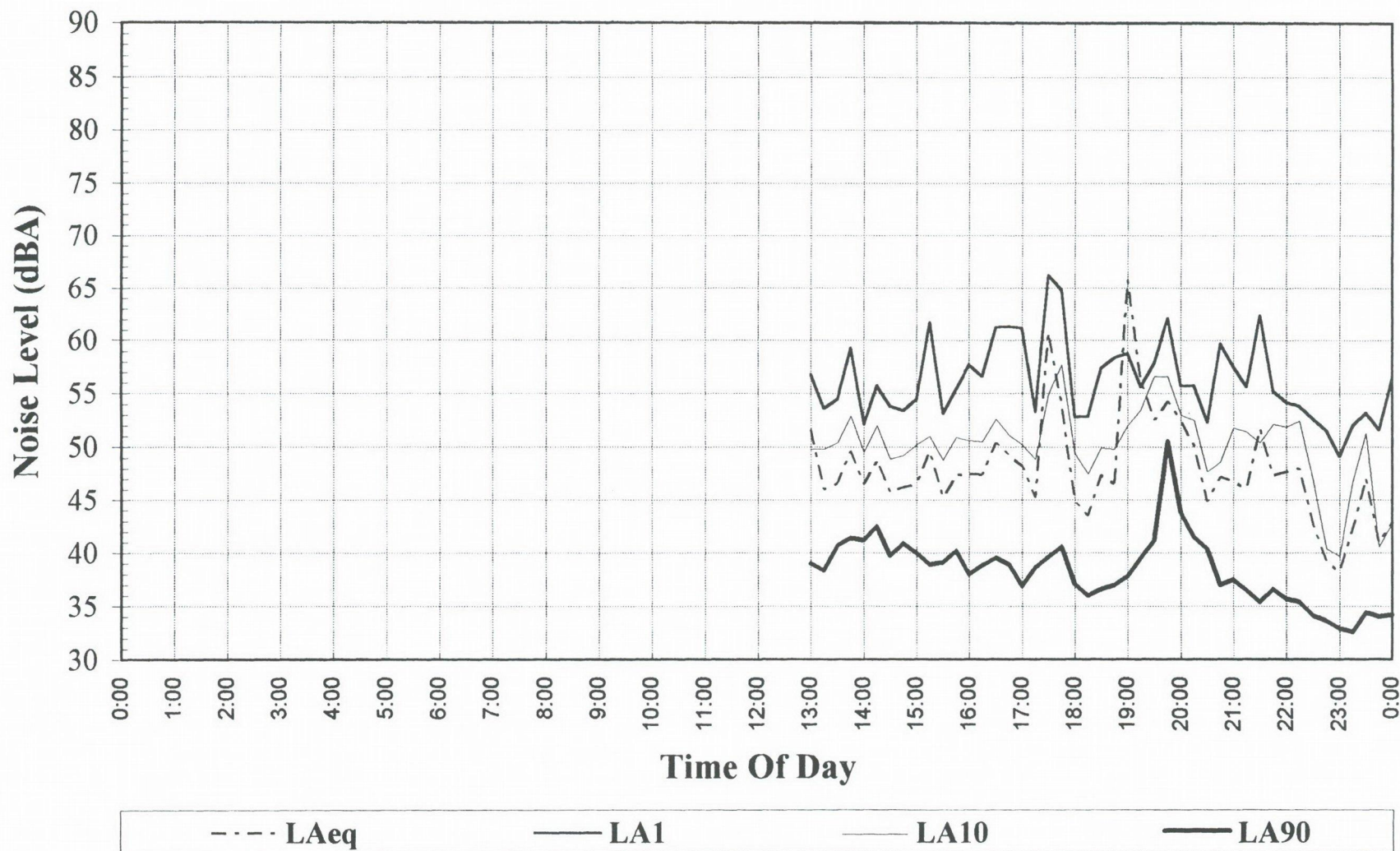
## Noise Levels at Location 25 - "Poiciana Place", Cudgen Road

Tuesday, 3 March, 1998



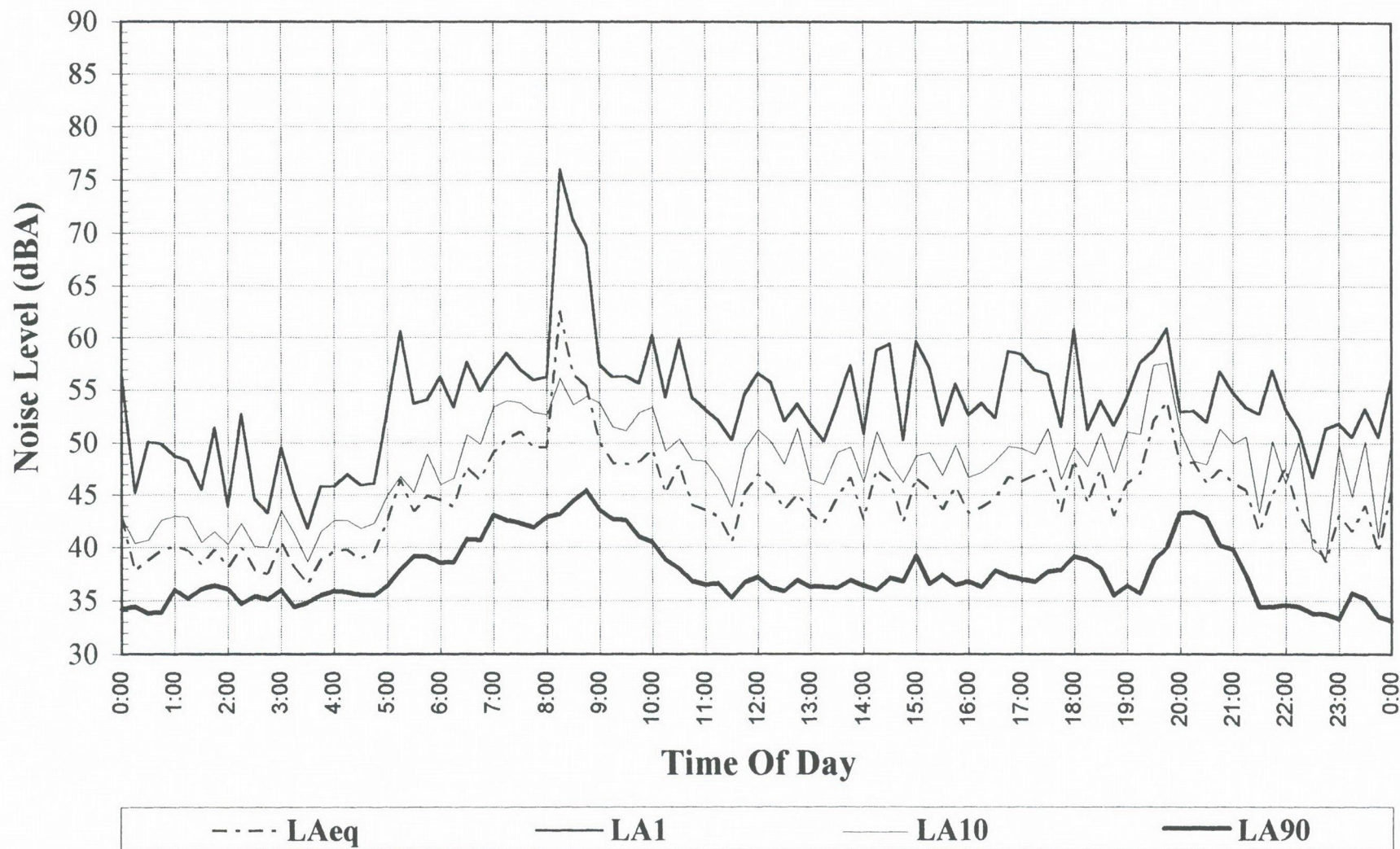


**Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah**  
**Thursday, 26 February, 1998**



## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

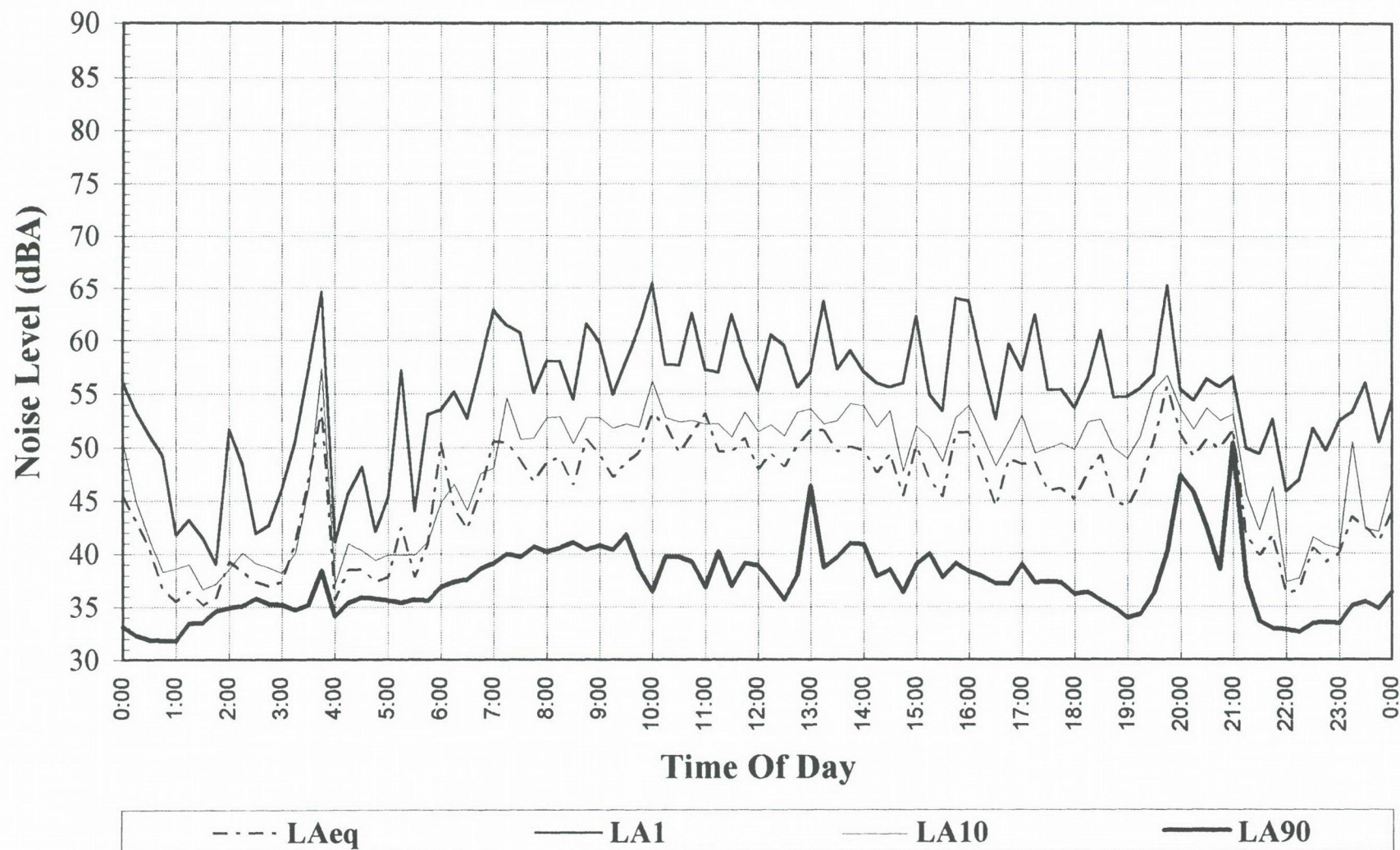
Friday, 27 February, 1998





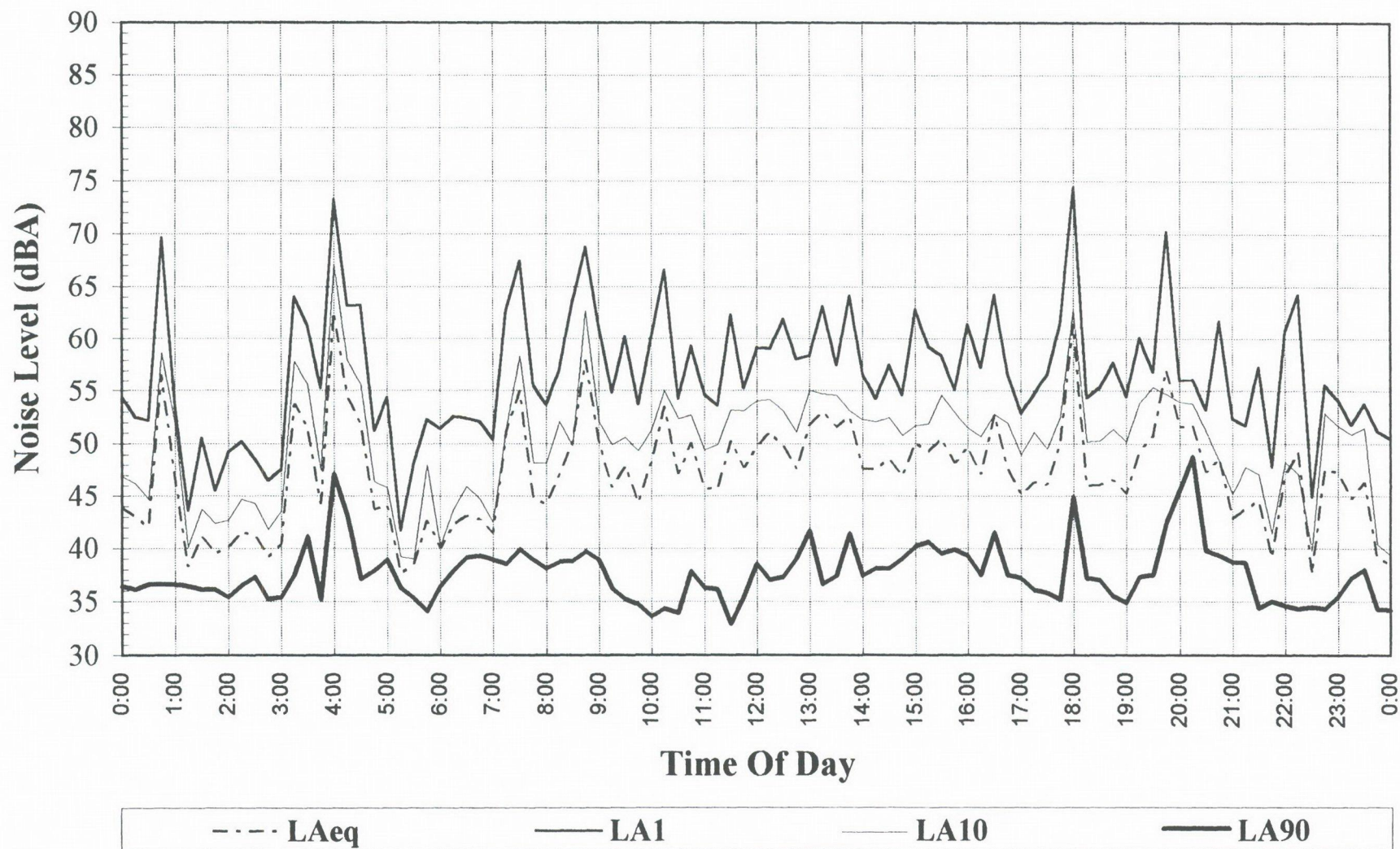
## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

Saturday, 28 February, 1998



## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

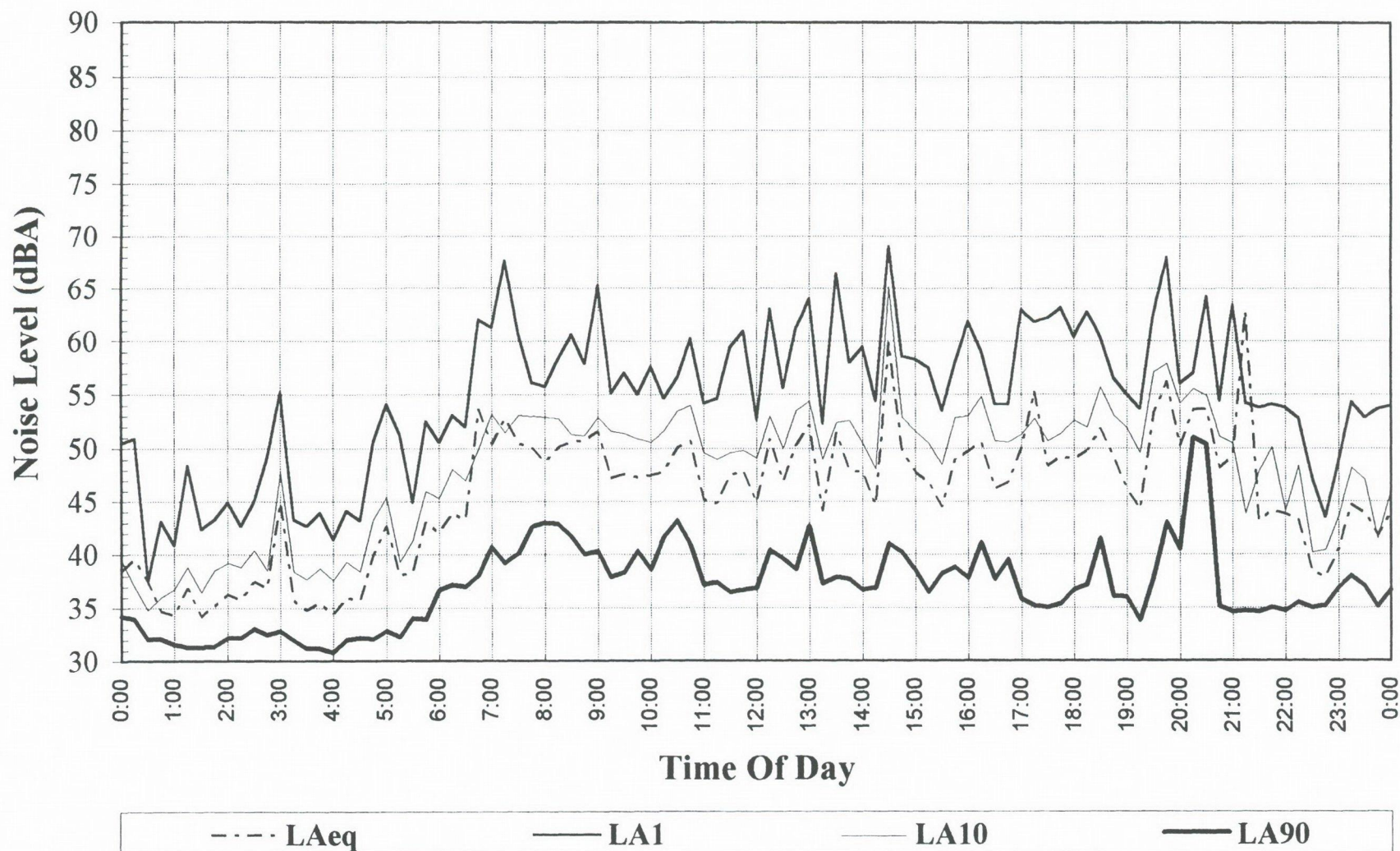
Sunday, 1 March, 1998



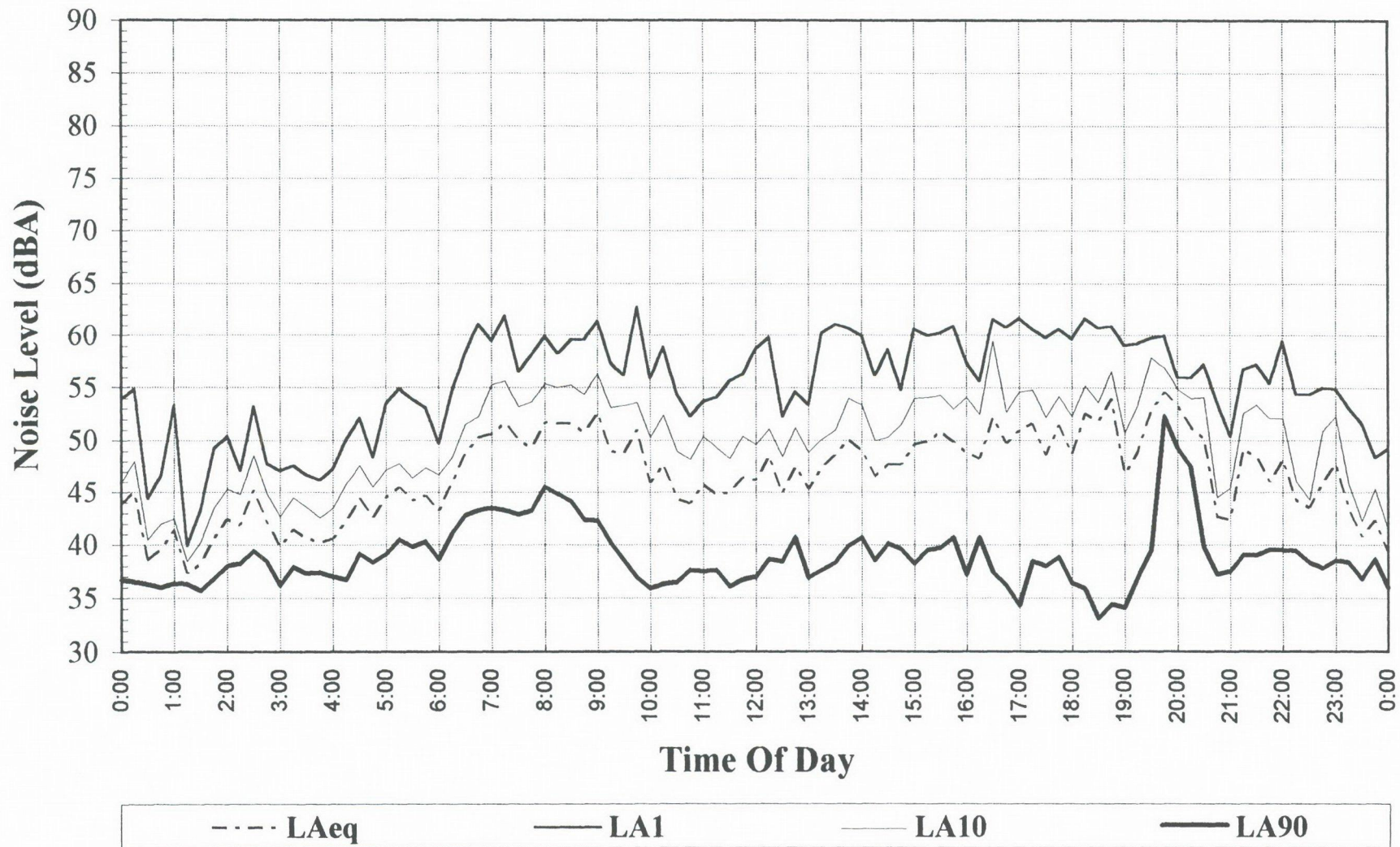


## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

Monday, 2 March, 1998

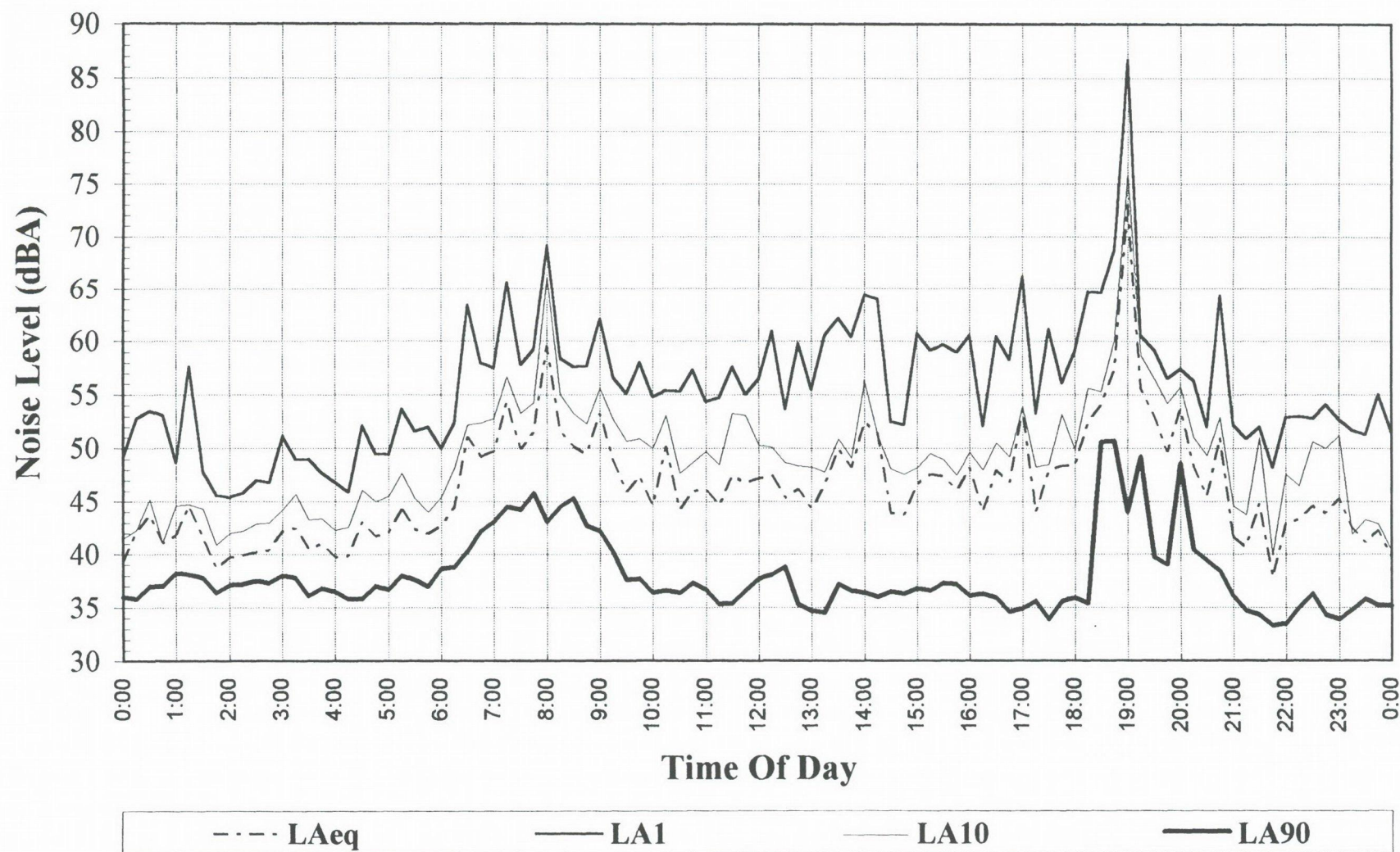


**Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah**  
**Tuesday, 3 March, 1998**



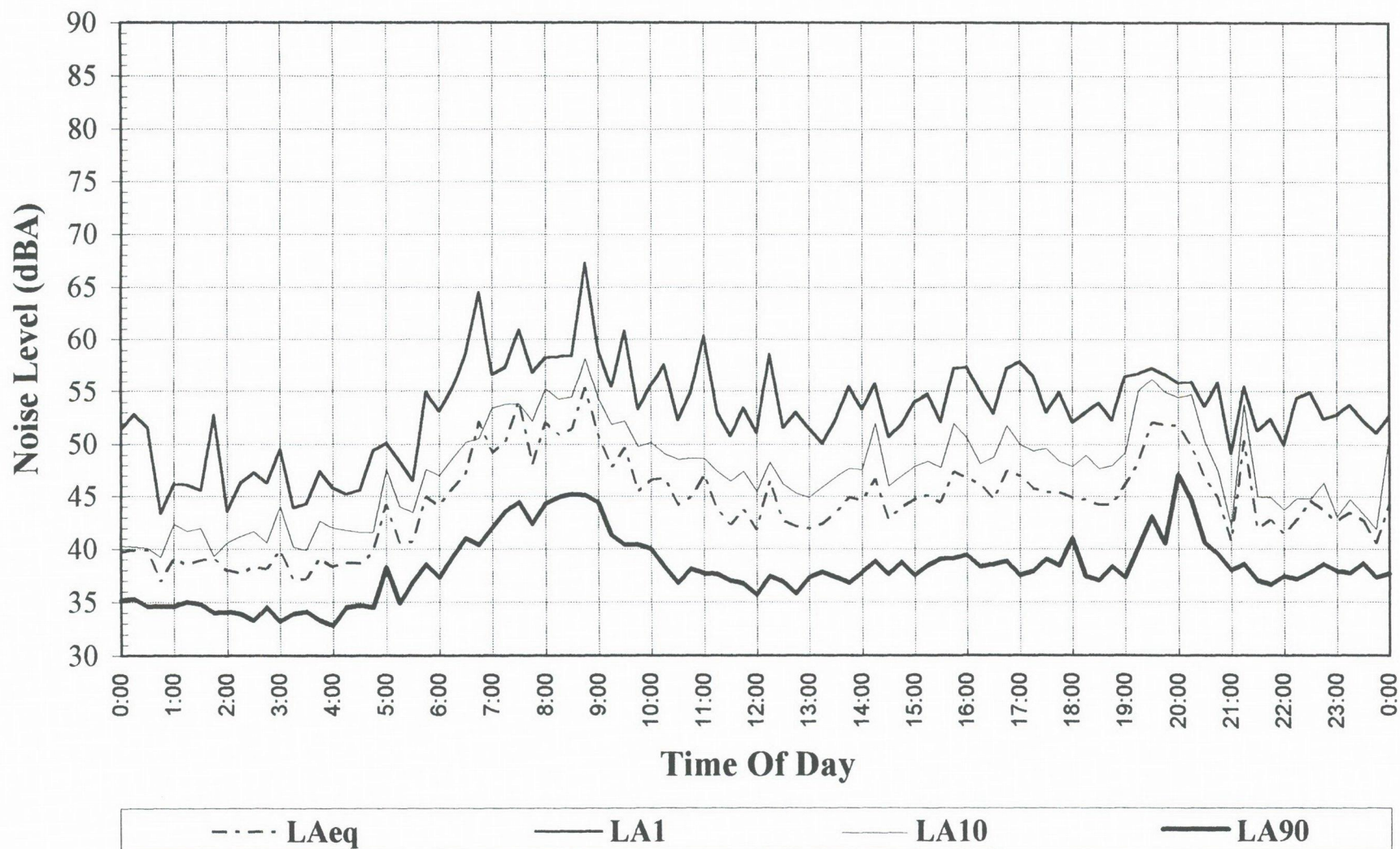


**Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah**  
**Wednesday, 4 March, 1998**



## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

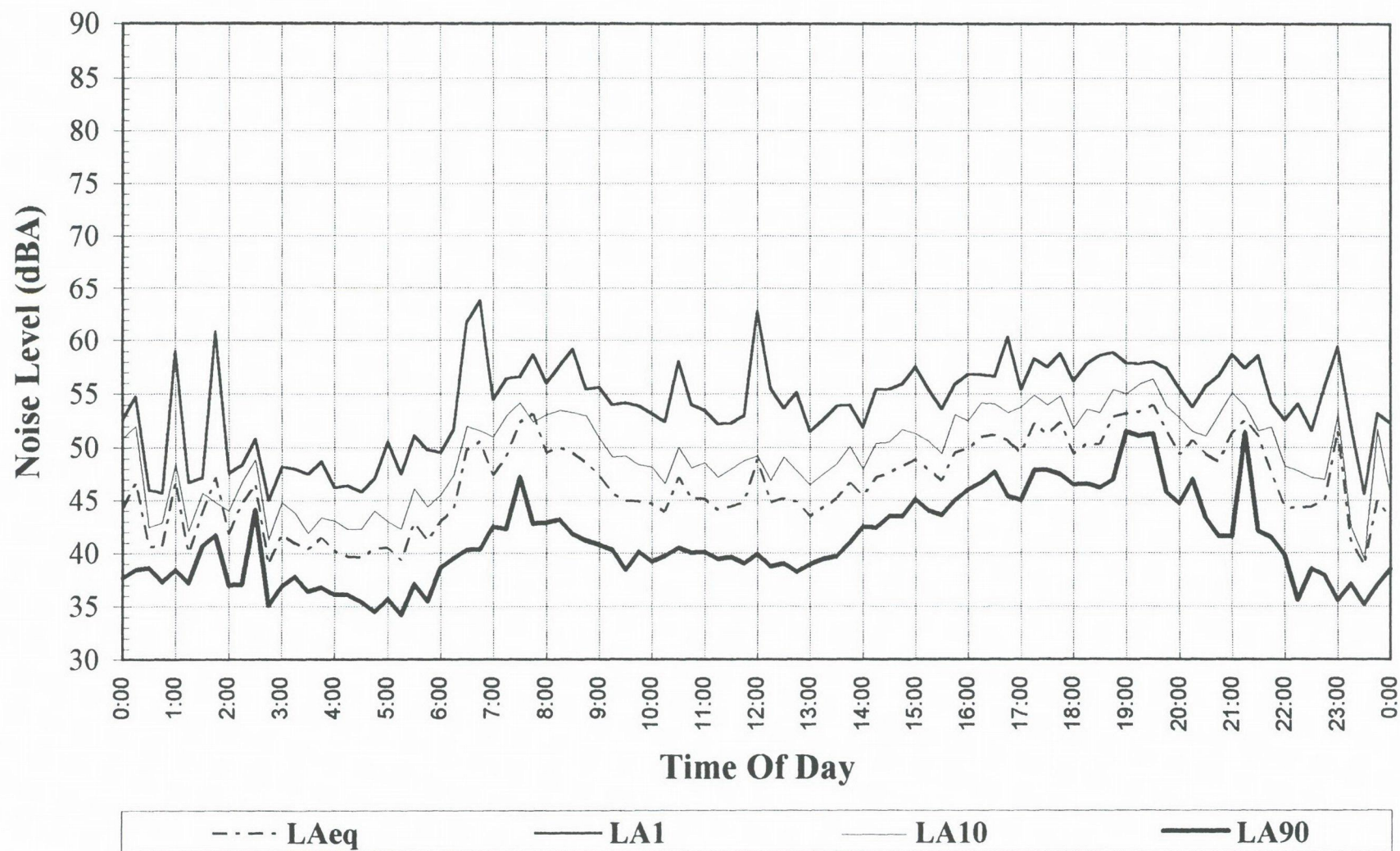
Thursday, 5 March, 1998





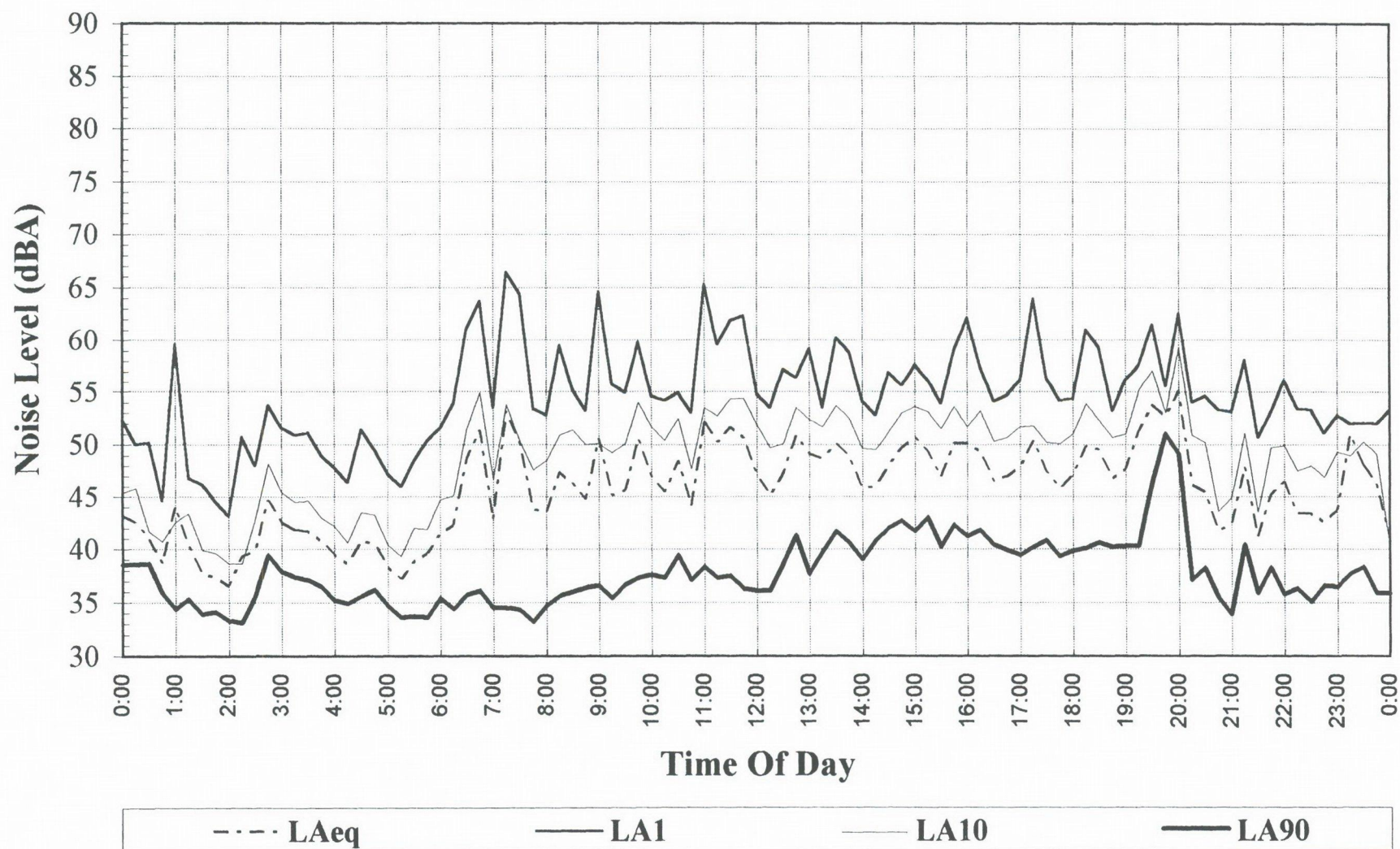
## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

Friday, 6 March, 1998



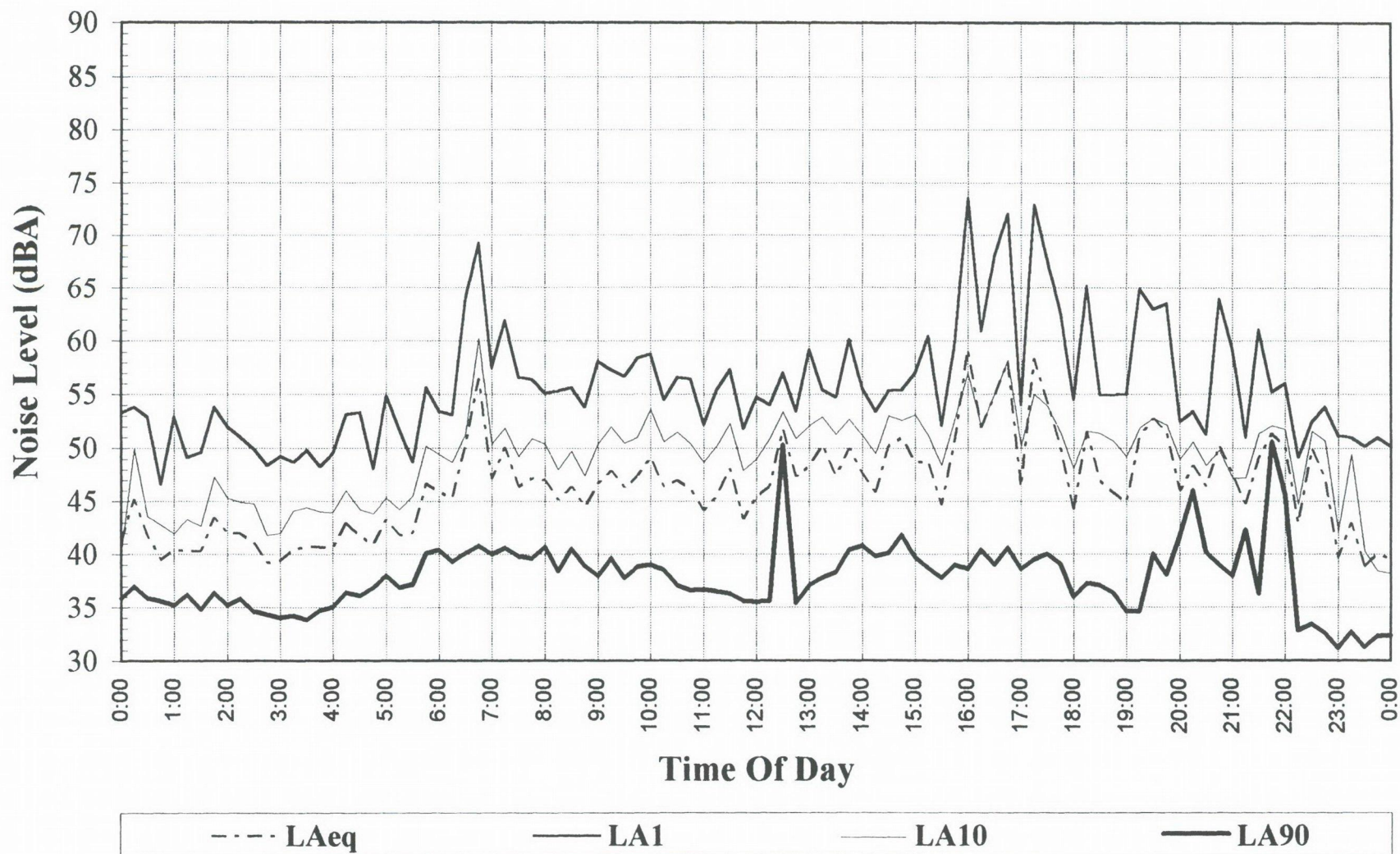
## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

Saturday, 7 March, 1998

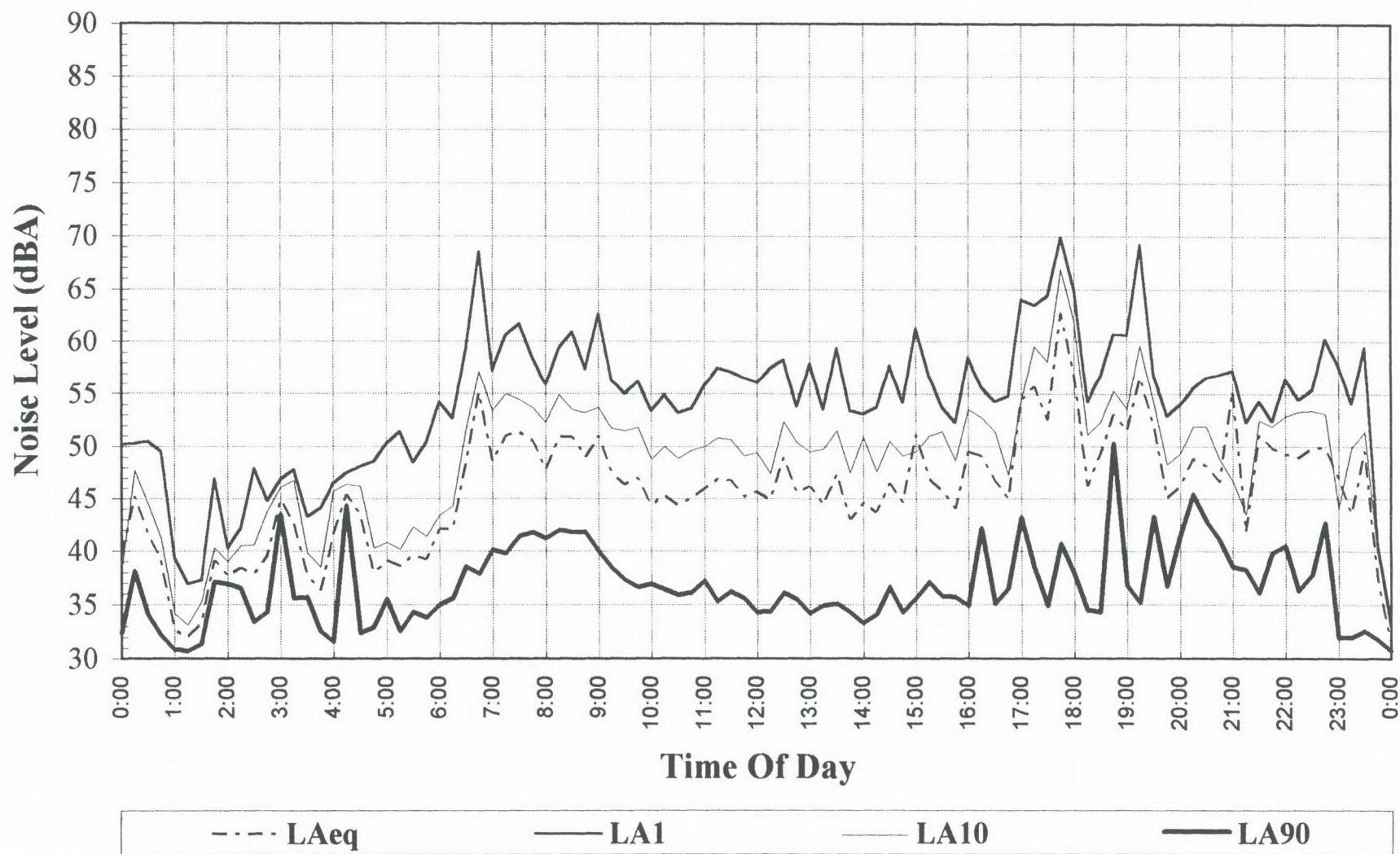




**Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah**  
**Sunday, 8 March, 1998**

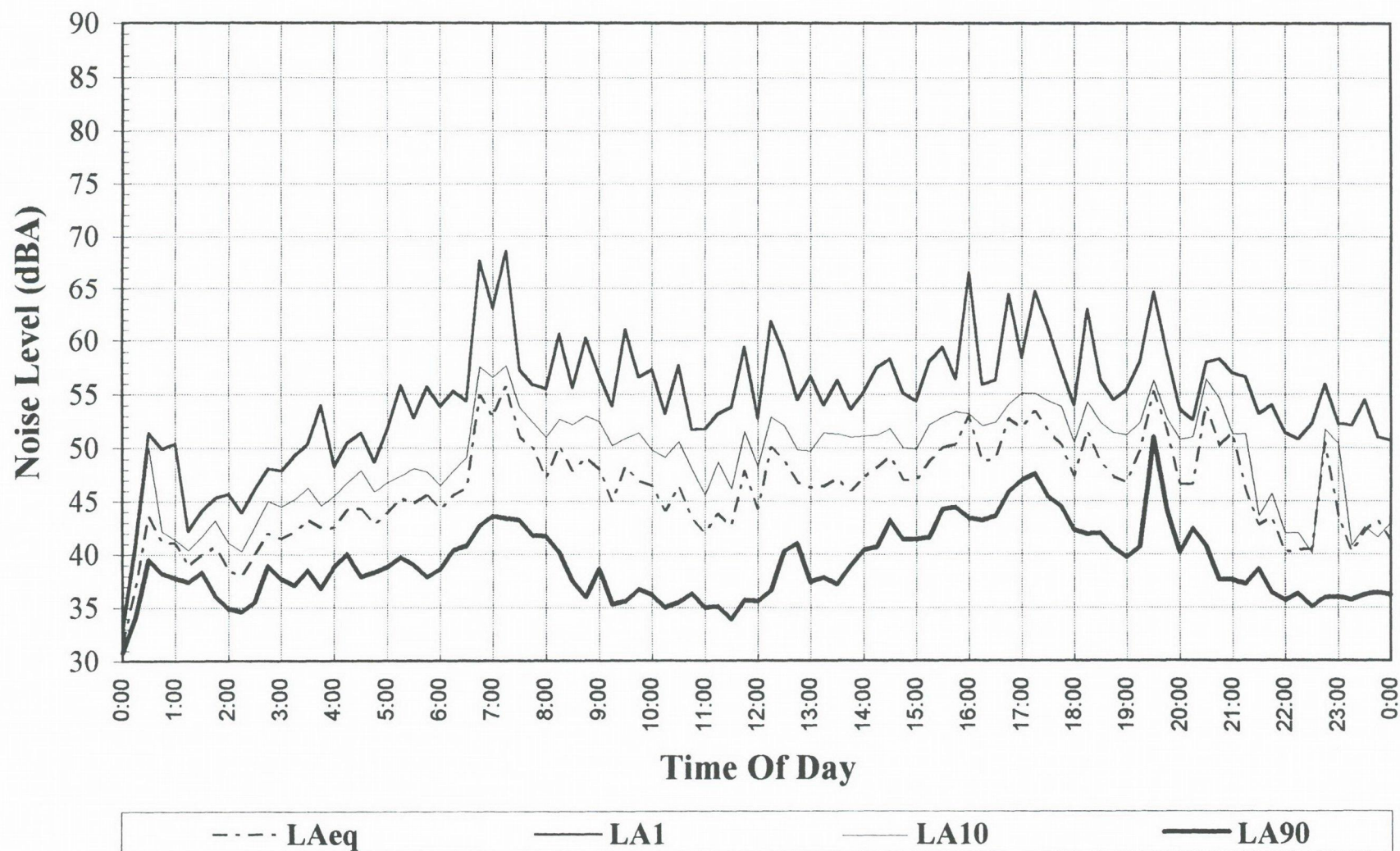


**Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah**  
**Monday, 9 March, 1998**



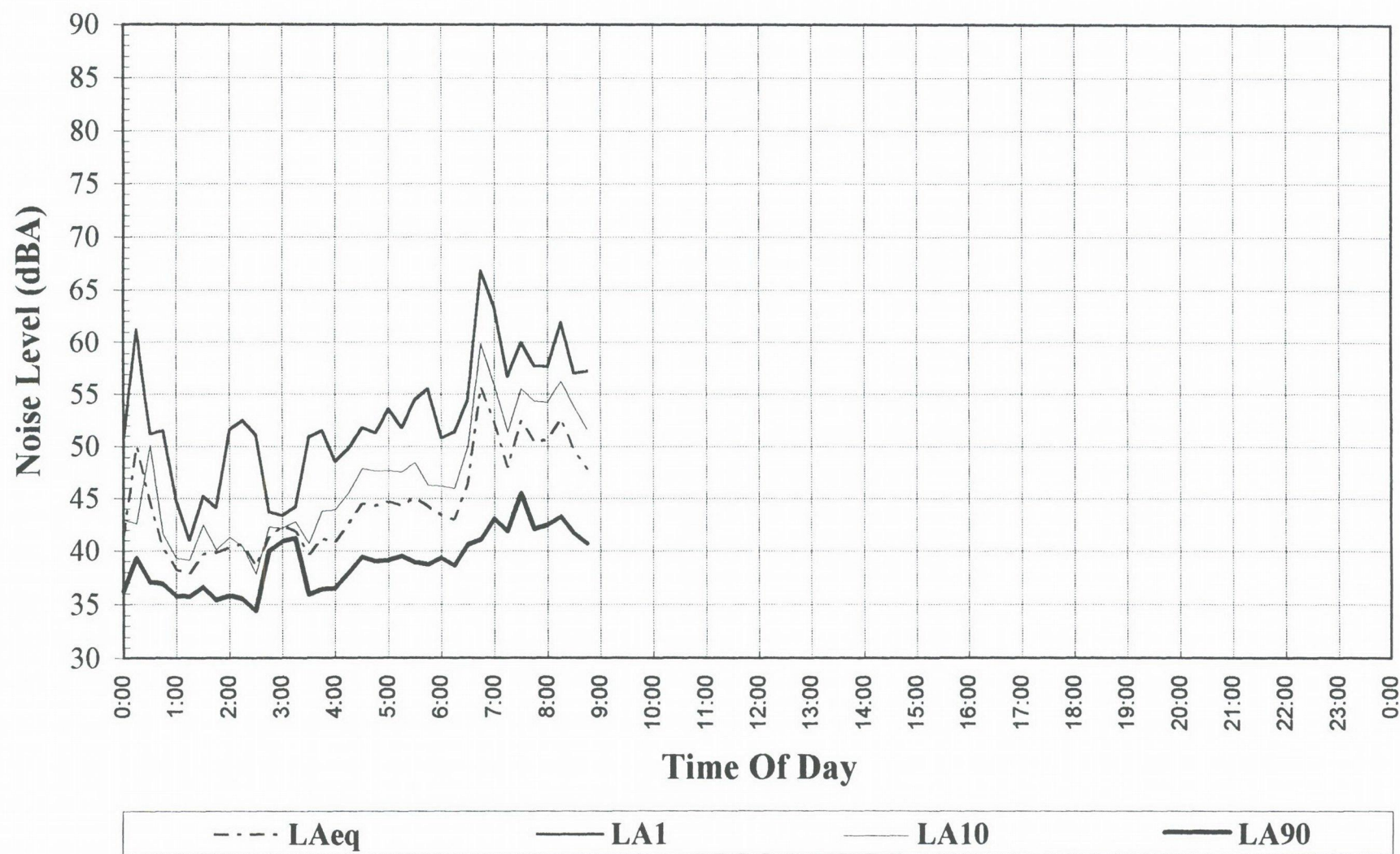


**Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah**  
**Tuesday, 10 March, 1998**

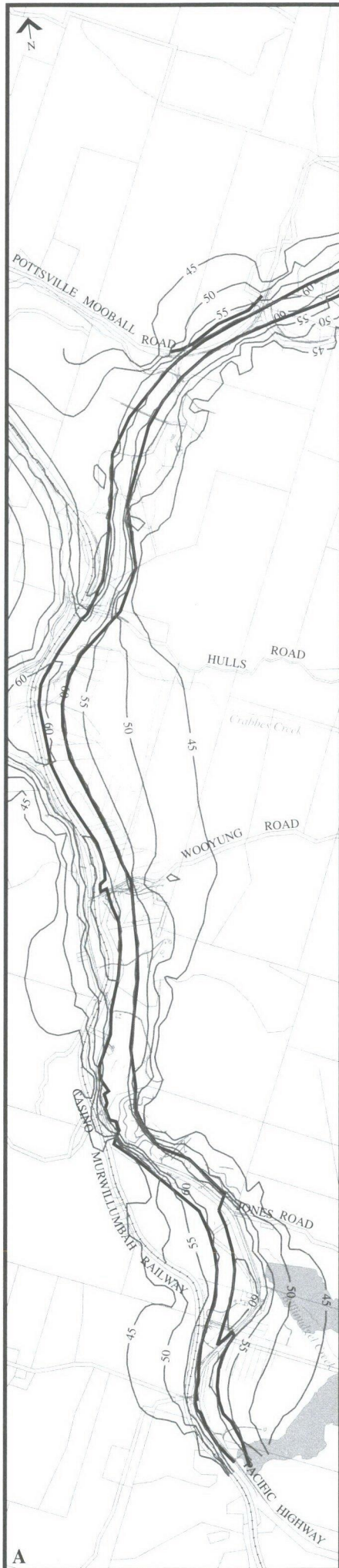


## Noise Levels at Location 26 - RMB 63, Cudgen Rd, Duranbah

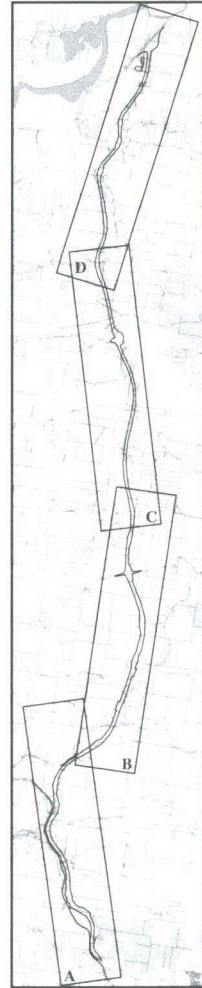
Wednesday, 11 March, 1998

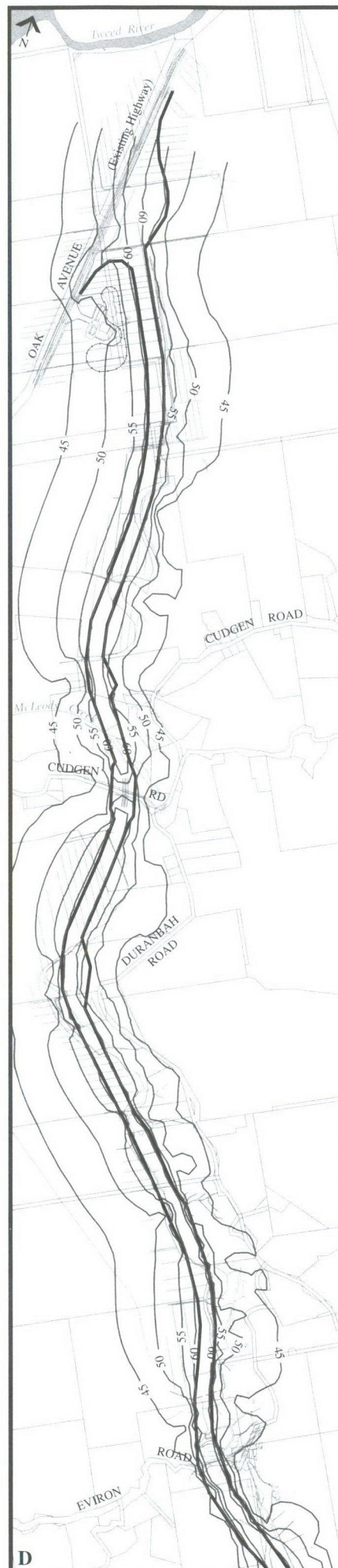






0 100 500 1km





● Sedimentation Basin  
—50— Noise Contours -50dBA

*Figure 28*  
**NOISE CONTOURS**