

# Appendix 12

## *Supporting Chapter 12 – Noise and Vibration*

Appendix 12.1 – Terminology

Appendix 12.2 – Construction Noise

Appendix 12.3 – Noise Modelling

Appendix 12.4 – Baseline Noise Modelling

## Appendix 12.1 – Terminology

### Noise Terminology

Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in sound pressure (measured in pascals, Pa). Because of this wide range a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB.

The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' (and commonly annotated as dB(A)). Table A12-1 'Sound Pressure Levels for a Range of Situations' below, lists the A-weighted sound pressure level in dB for common situations.

**Table A12-1 Sound Pressure Levels for a Range of Situations**

**Typical A-weighted Sound Pressure Levels dB Example**

0	Threshold of hearing
30	Rural area at night, still air
40	Public library Refrigerator humming at 2 m
50	Quiet office, no machinery. Boiling kettle at 0.5 m
60	Normal conversation
70	Telephone ringing at 2 m. Vacuum cleaner at 3 m
80	General factory noise level
100	Pneumatic drill at 5 m
120	Discotheque – 1 m in front of loudspeaker
140	Threshold of pain

The noise level at a measurement point is rarely steady, even in rural areas, and varies over a range dependent upon the effects of local noise sources. Close to a busy road, the noise level may vary over a range of 5 dB, whereas in a suburban area this may increase up to 40 dB and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.) and their variable operation. Furthermore, the range of night time noise levels will often be smaller and the levels significantly reduced compared to daytime levels.

The equivalent continuous A-weighted sound pressure level,  $L_{Aeq}$ , is the single number that represents the average sound energy measured over that period. The  $L_{Aeq}$  is the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period.

With regards to road traffic noise the parameter  $L_{A10}$  is prescribed by the relevant guidance and legislation.  $L_{A10}$  is the A-weighted noise level exceeded for 10% of the measurement period. The  $L_{A10,18h}$  is defined in the Calculation of Road Traffic Noise as the arithmetic average of the individual 1 hour  $L_{A10,1h}$  levels between 06:00 - 00:00.

A parameter that is widely accepted as reflecting human perception of the ambient noise is the background noise level,  $L_{A90}$ . This is the A-weighted noise level exceeded for 90 % of the measurement period and generally reflects the noise level in the lulls between individual noise events. Over a one hour period, the  $L_{A90}$  will be the A-weighted noise level exceeded for 54 minutes.

The  $L_{Amax}$  noise level is a measure of the maximum A-weighted noise level during the monitoring period.

Human subjects are generally only capable of noticing changes in steady levels of no less than 3 dB. It is generally accepted that a change of 10 dB in an overall, steady noise level is perceived to the human ear as a

doubling or halving of the noise level. These findings do not necessarily apply to transient or non-steady noise sources.

Most environmental noise measurements and assessments are undertaken for 'free-field', away from any existing reflecting surfaces (other than the ground). However, it is sometimes necessary to consider noise levels immediately external to a façade when considering the impact on residents inside properties and this requires the addition of 2.5 or 3.0 dB (as appropriate to the standard being used) to the predicted or measured free-field level due to noise reflection from the façade.

## Vibration Terminology

BS 5228 advises that vibrations, even of very low magnitude can be perceptible to people. It is often assumed that if vibration can be felt then building damage will occur, however much higher levels of vibration are required to damage buildings. Therefore vibration from construction works can cause anxiety as well as annoyance. Some individuals are more sensitive to vibration than others.

Vibration from construction is commonly described in terms of the Peak Particle Velocity (PPV) measured in  $\text{mms}^{-1}$ . This is a measurement of the maximum ground particle movement speed during a given time interval. If measurements are made in 3-axis then the resultant PPV is the vector sum of the maximum velocity components, i.e. the square root of the summed squares of the maximum velocities, regardless of when in the time history those occur.

## Appendix 12.2 – Construction

### Predicted Construction Noise Levels

The predicted weekly noise levels at each receptor during the construction phase are shown in to Figure A12.2.1 to Figure A12.2.20. Receptor locations are marked on Figure 12.1 'Noise Location Plan'. For single storey residential properties ground floor results are provided for all time periods. For two storey residential properties ground floor results are provided for the daytime, and top floor results for the evening and night. The criteria for the onset of a potentially significant effect for each receptor and time period are shown on the Figures. The predicted construction noise levels shown are based on the area over which each activity is likely to occur over the course of each week. As detailed in Section 12.2, to define the criteria for the onset of a potentially significant effect ambient noise levels at the relevant façade of each of the selected receptors has been determined based on predicted 2017 baseline traffic flows.

There are some periods of the programme where no activities take place during the evening/weekend and night.

Figure A12.2-1 R01 (Burnside) - Day - Ground Floor

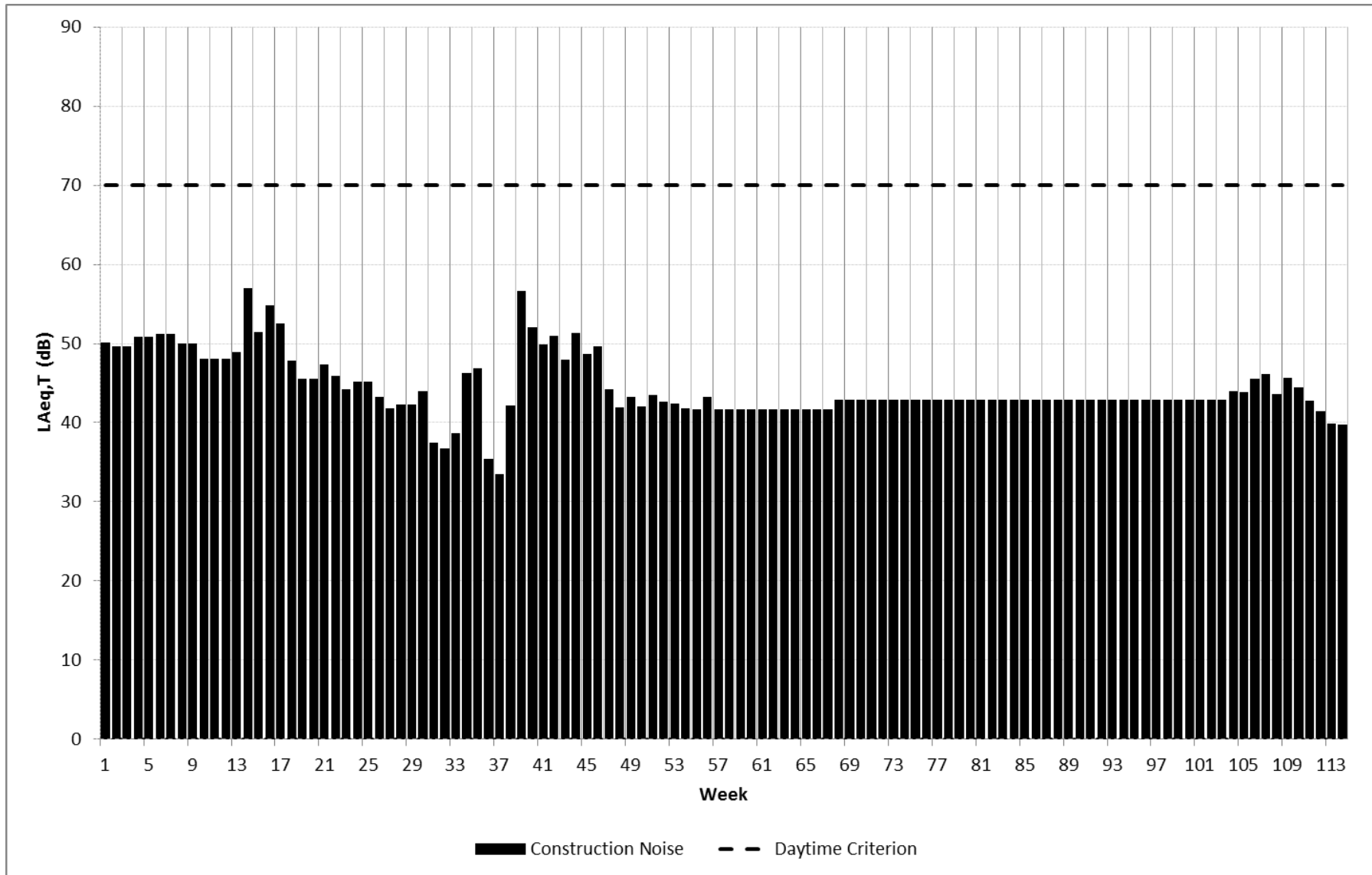


Figure A12.2-2 R01 (Burnside) – Evening and Night - Ground Floor

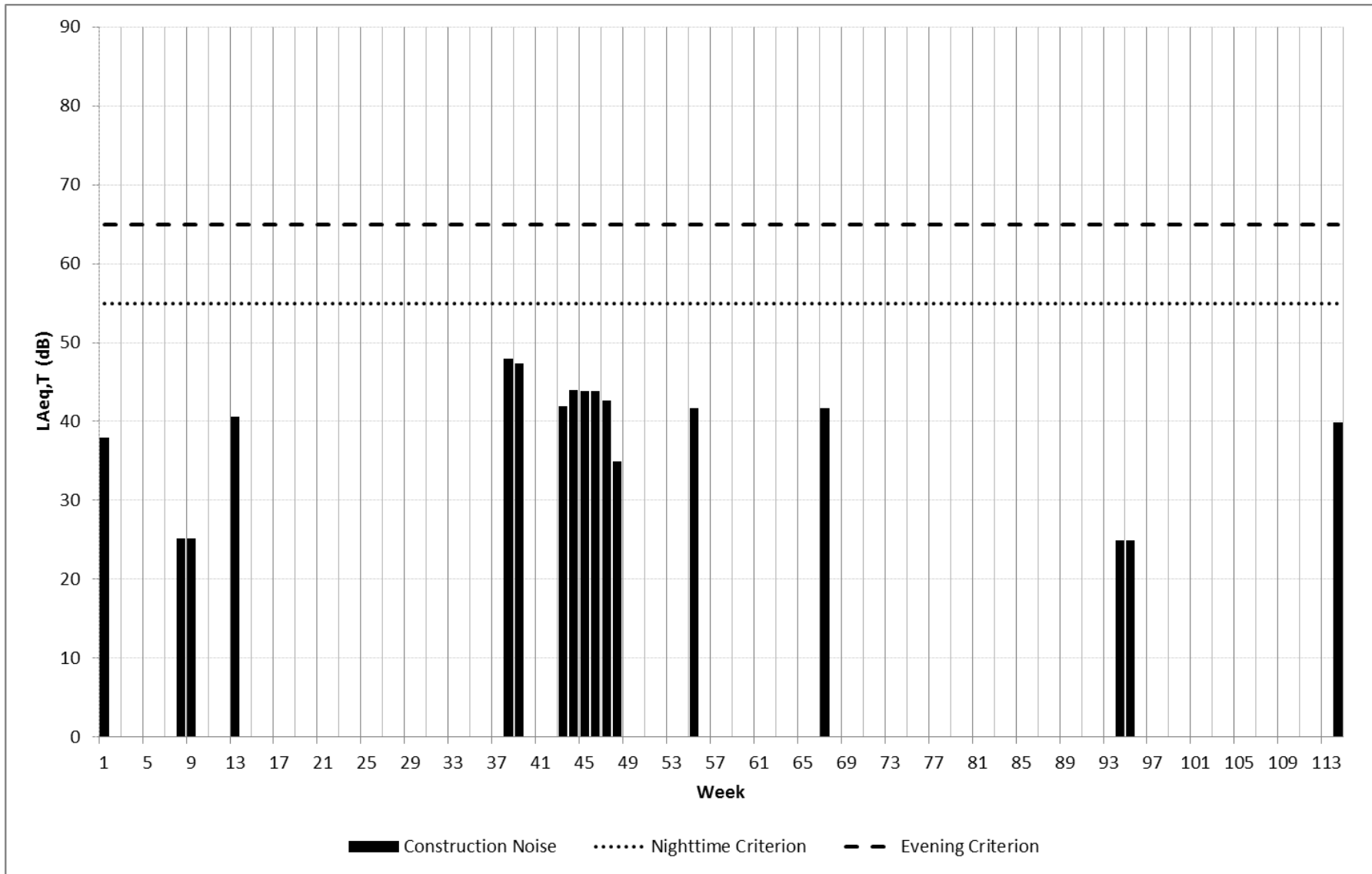


Figure A12.2-3 R02 (Melville Cottages) - Day - Ground Floor

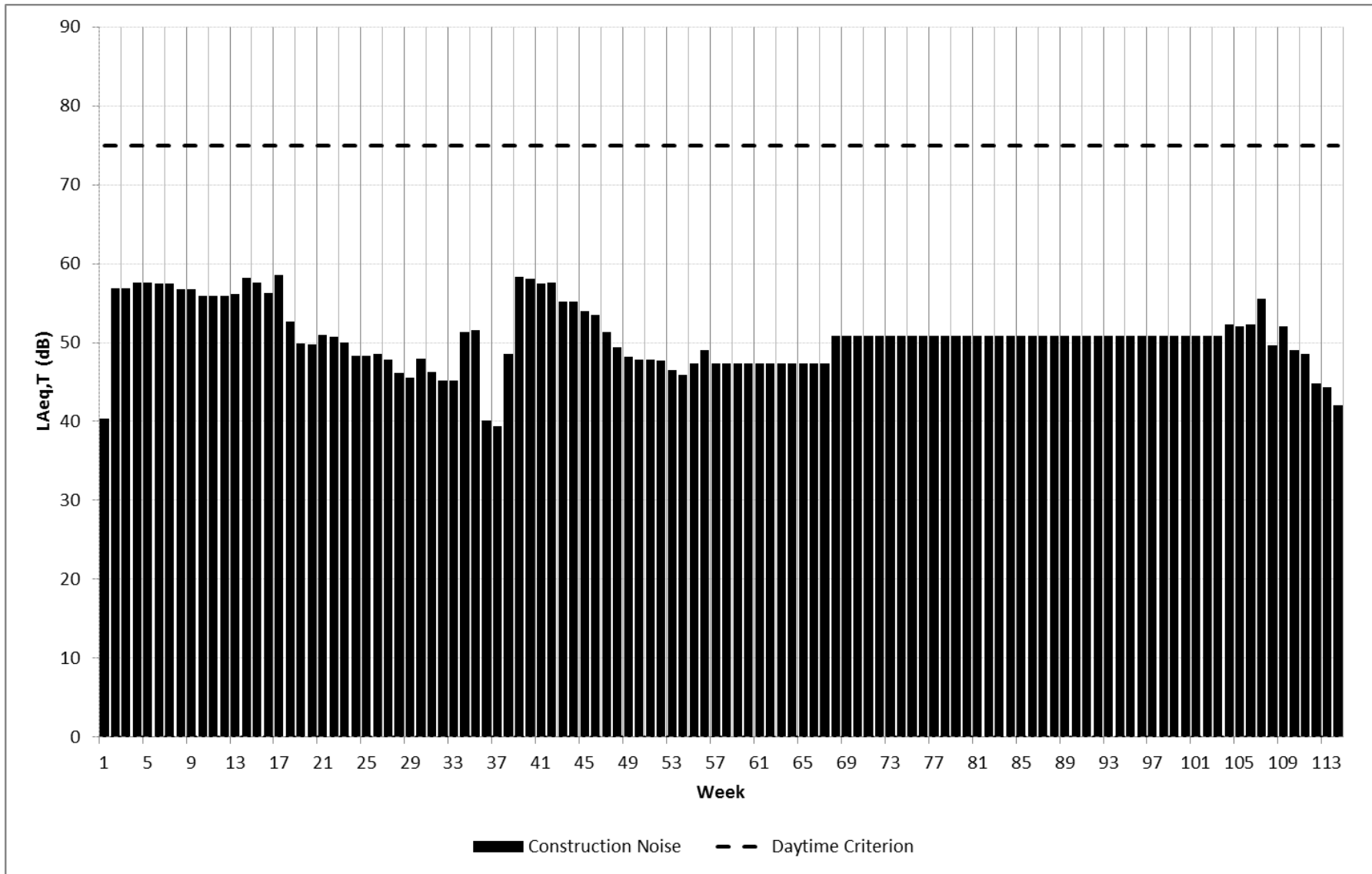


Figure A12.2-4 R02 (Melville Cottages) – Evening and Night - Top Floor

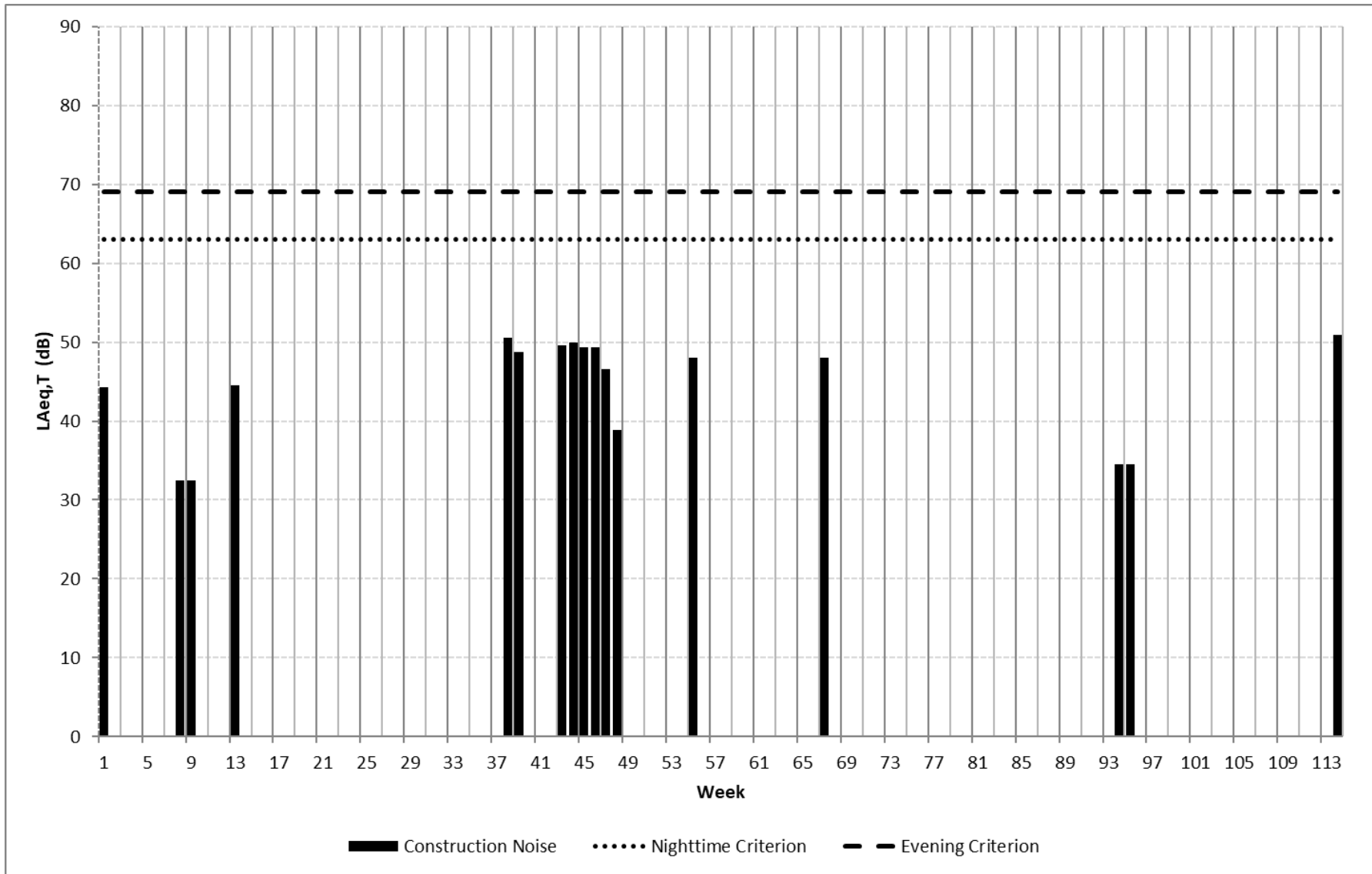




Figure A12.2-5 R03 (Melville Inn (Manager's Flat)) - Day - Ground Floor

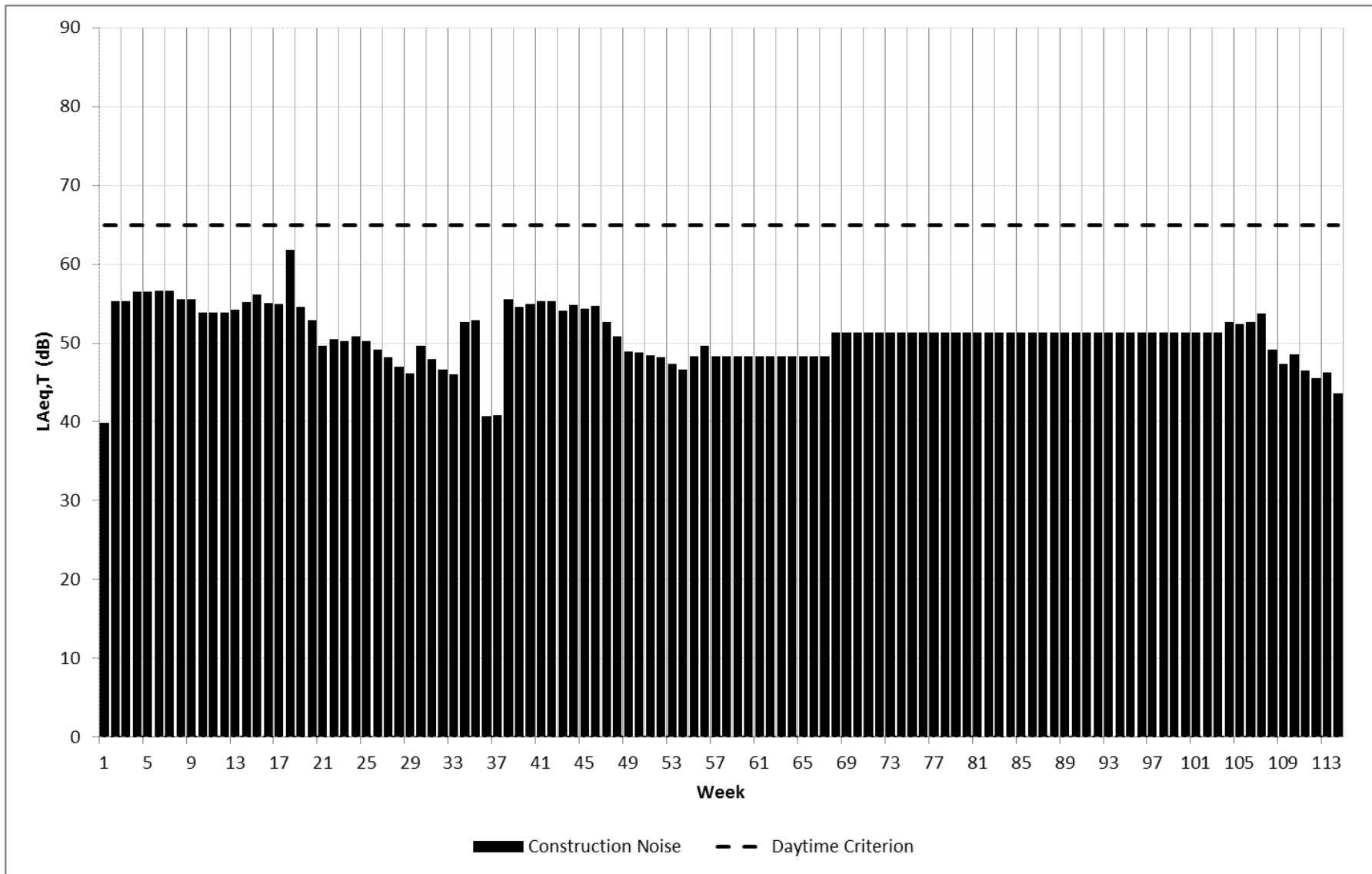


Figure A12.2-6 R03 (Melville Inn (Manager's Flat)) – Evening and Night - Top Floor

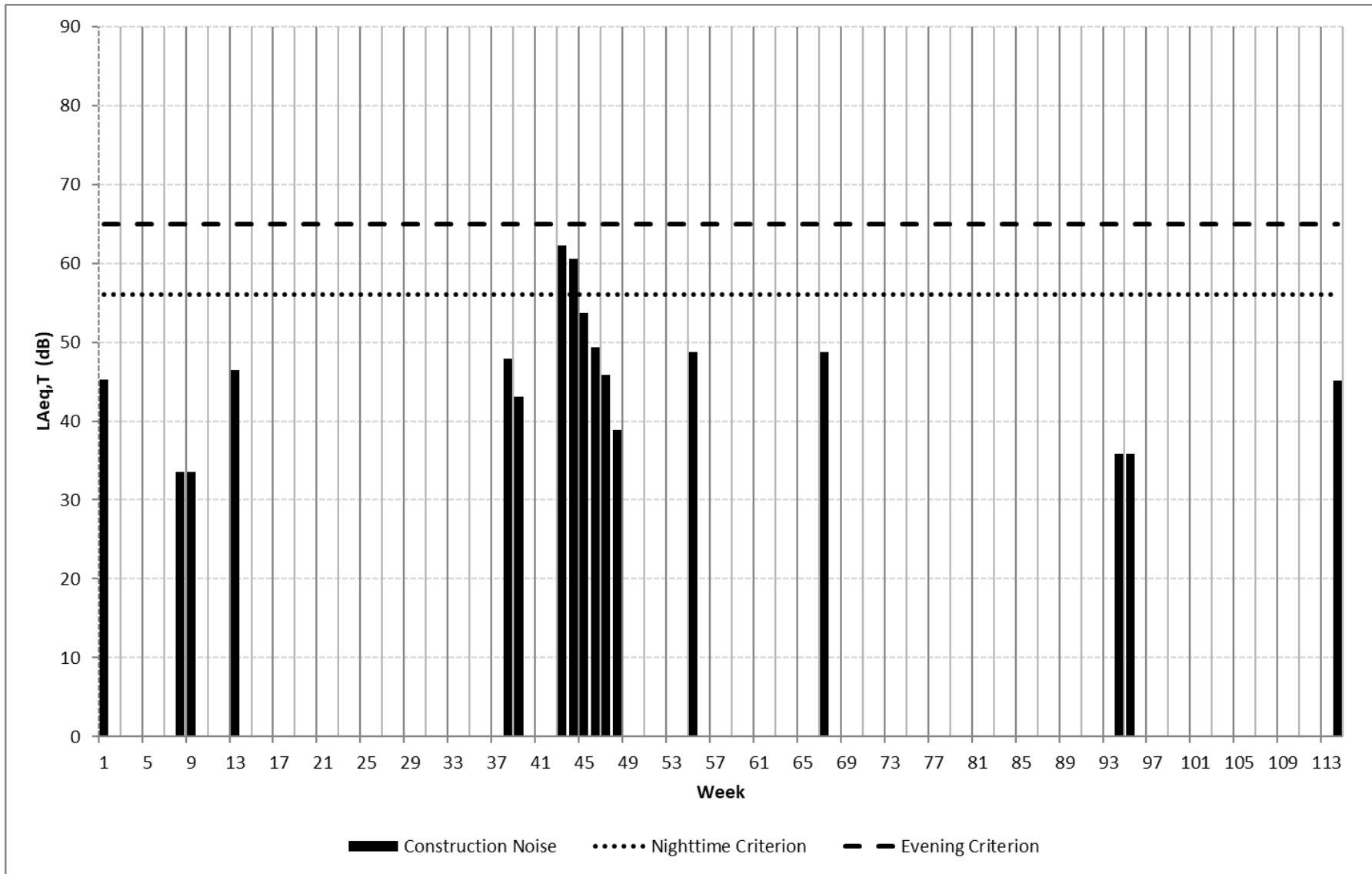


Figure A12.2-7 R04 (Melville Castle East Lodge) - Day - Ground Floor

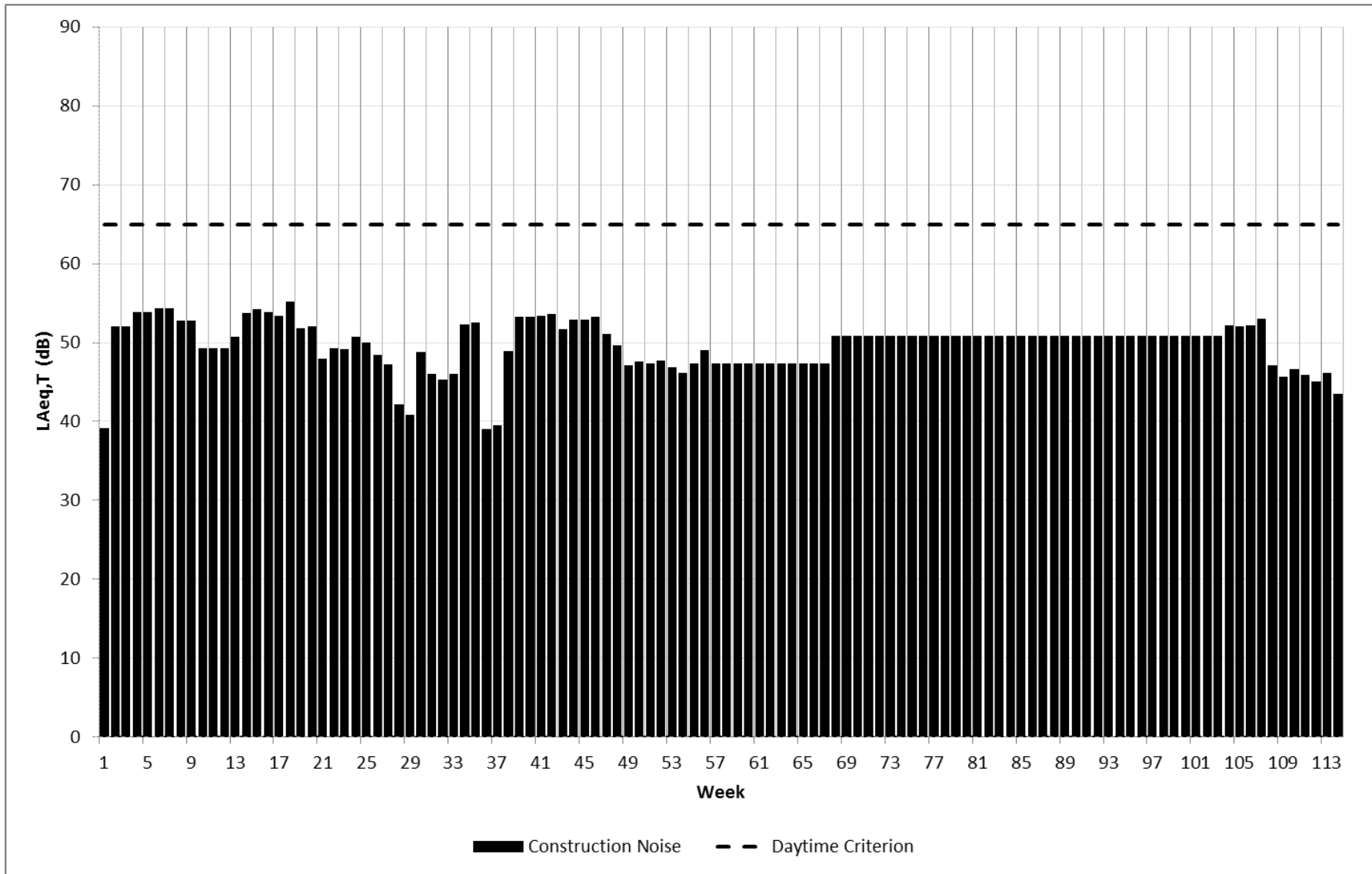


Figure A12.2-8 R04 (Melville Castle East Lodge) – Evening and Night - Ground Floor

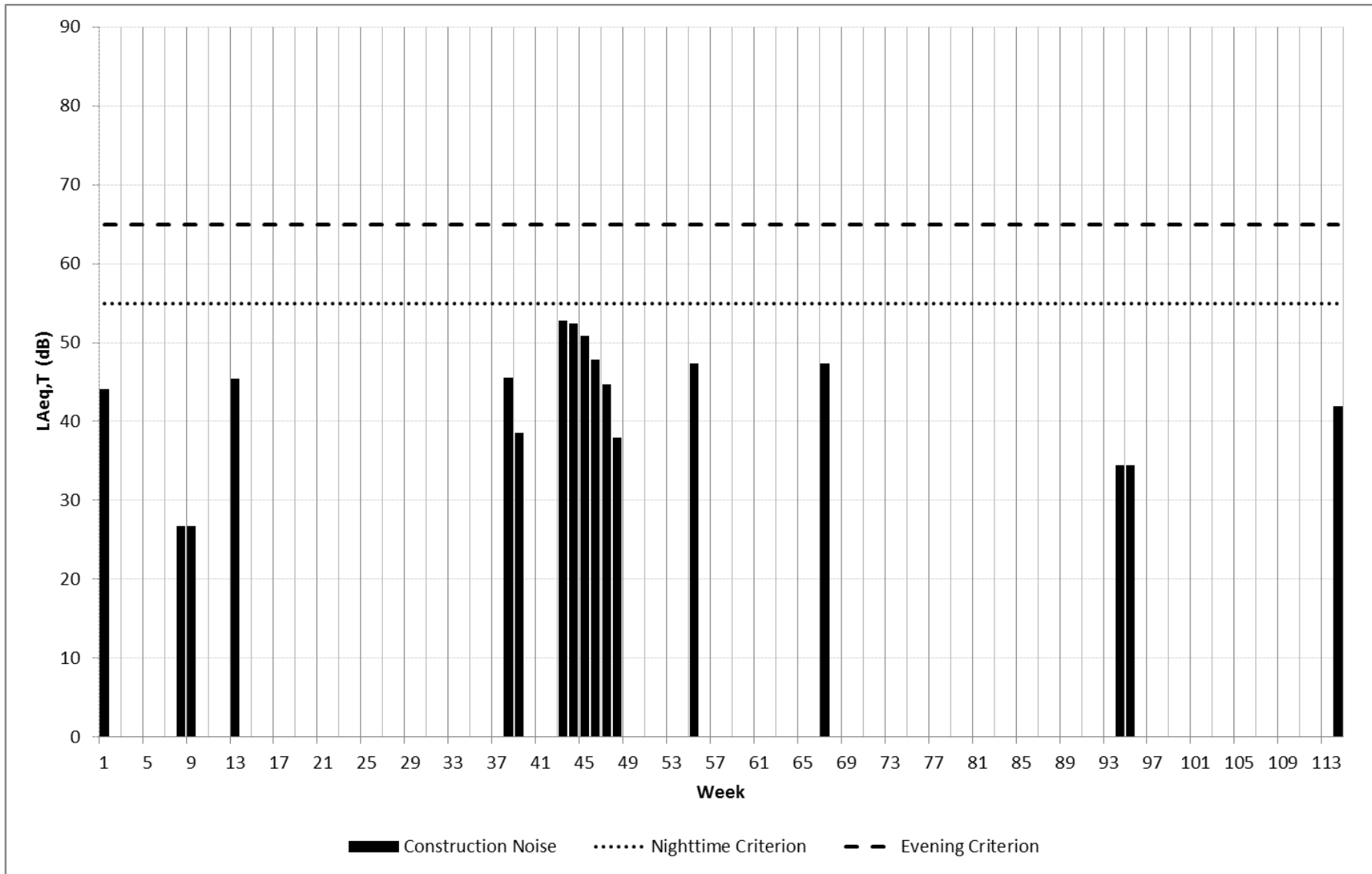


Figure A12.2-9 R05 (Kings Gate Lodge) - Day - Ground Floor

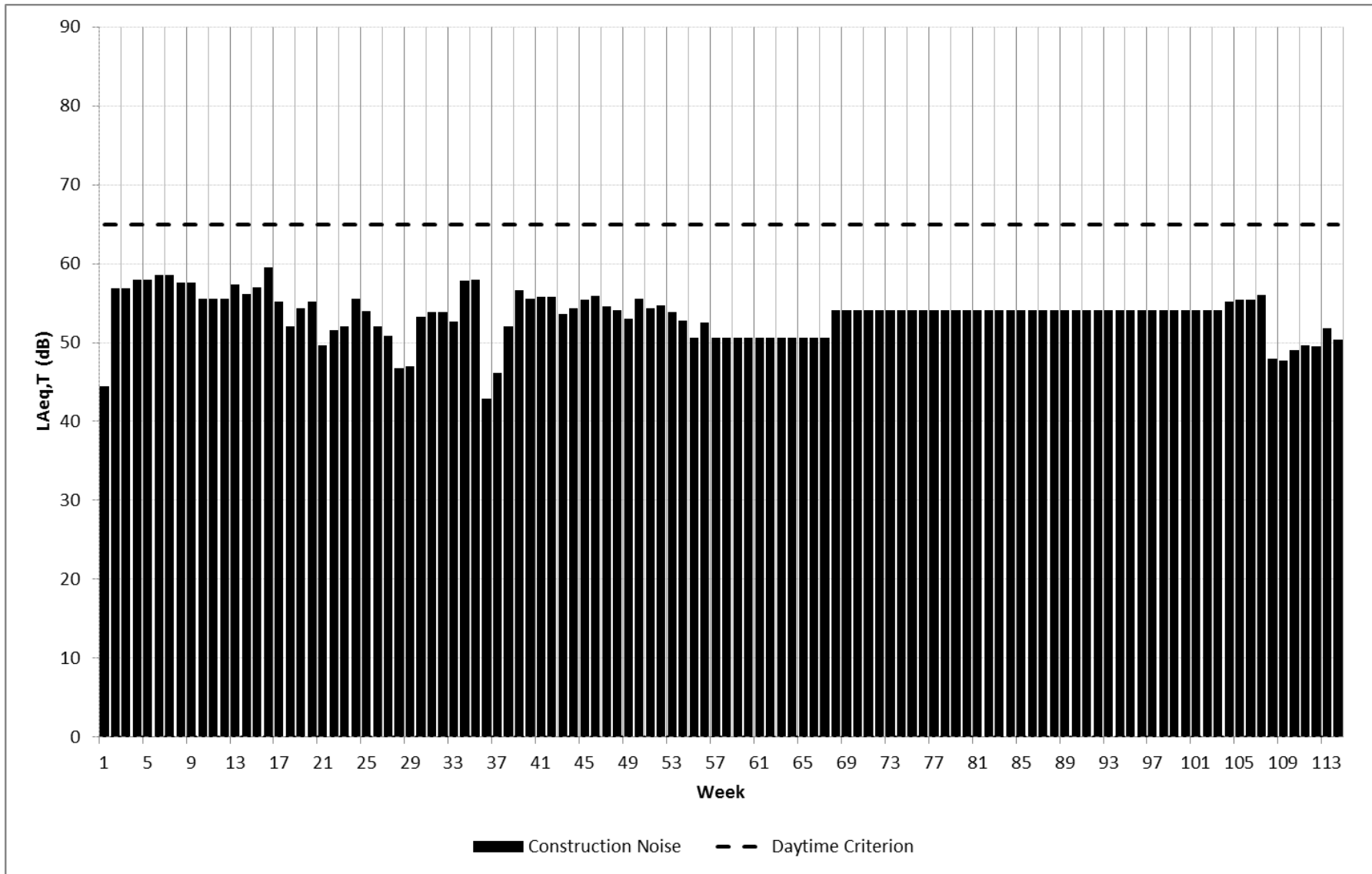


Figure A12.2-10 R05 (Kings Gate Lodge) – Evening and Night - Top Floor

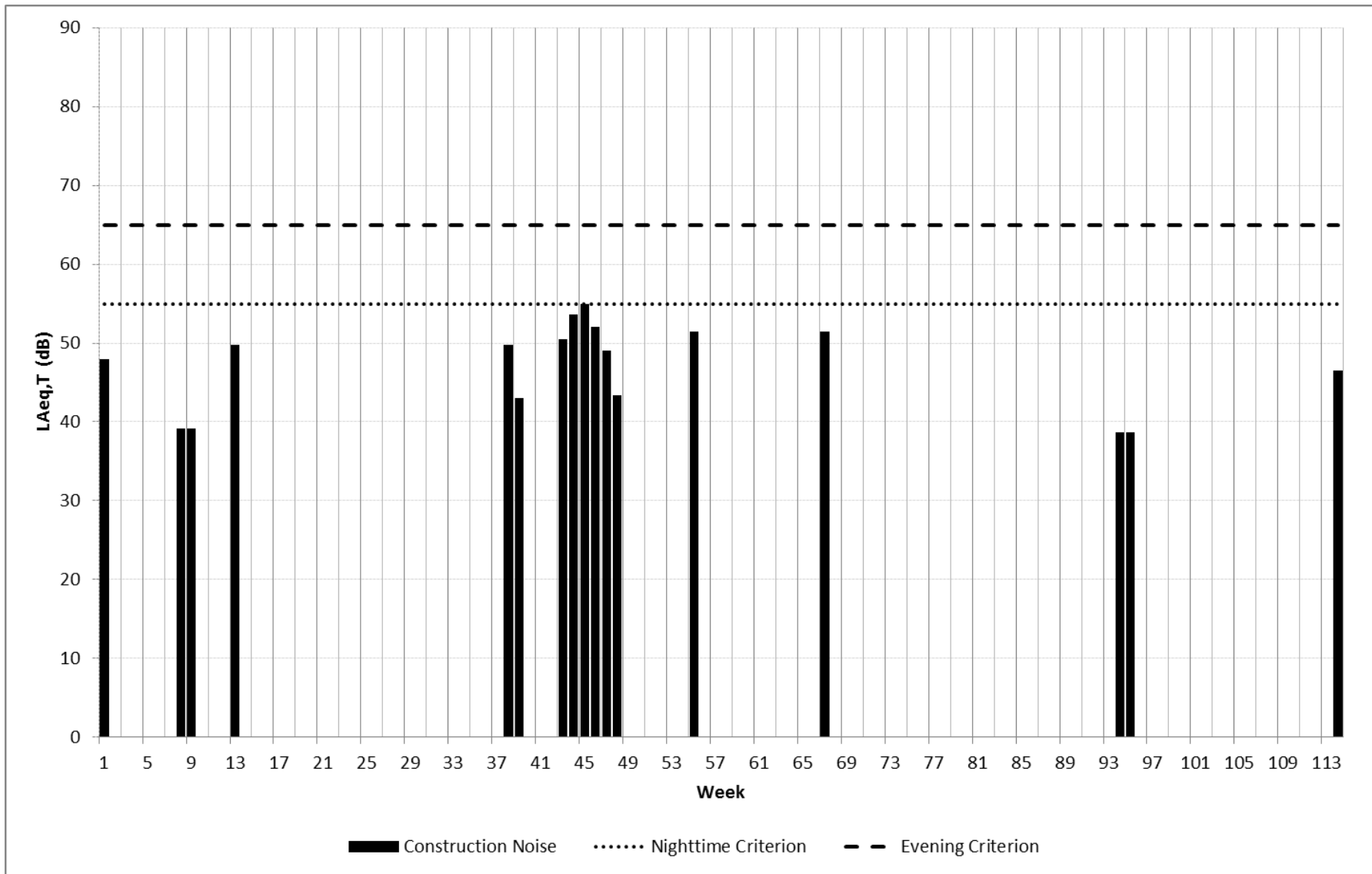


Figure A12.2-11 R06 (Old Sheriffhall Farmhouse) - Day - Ground Floor

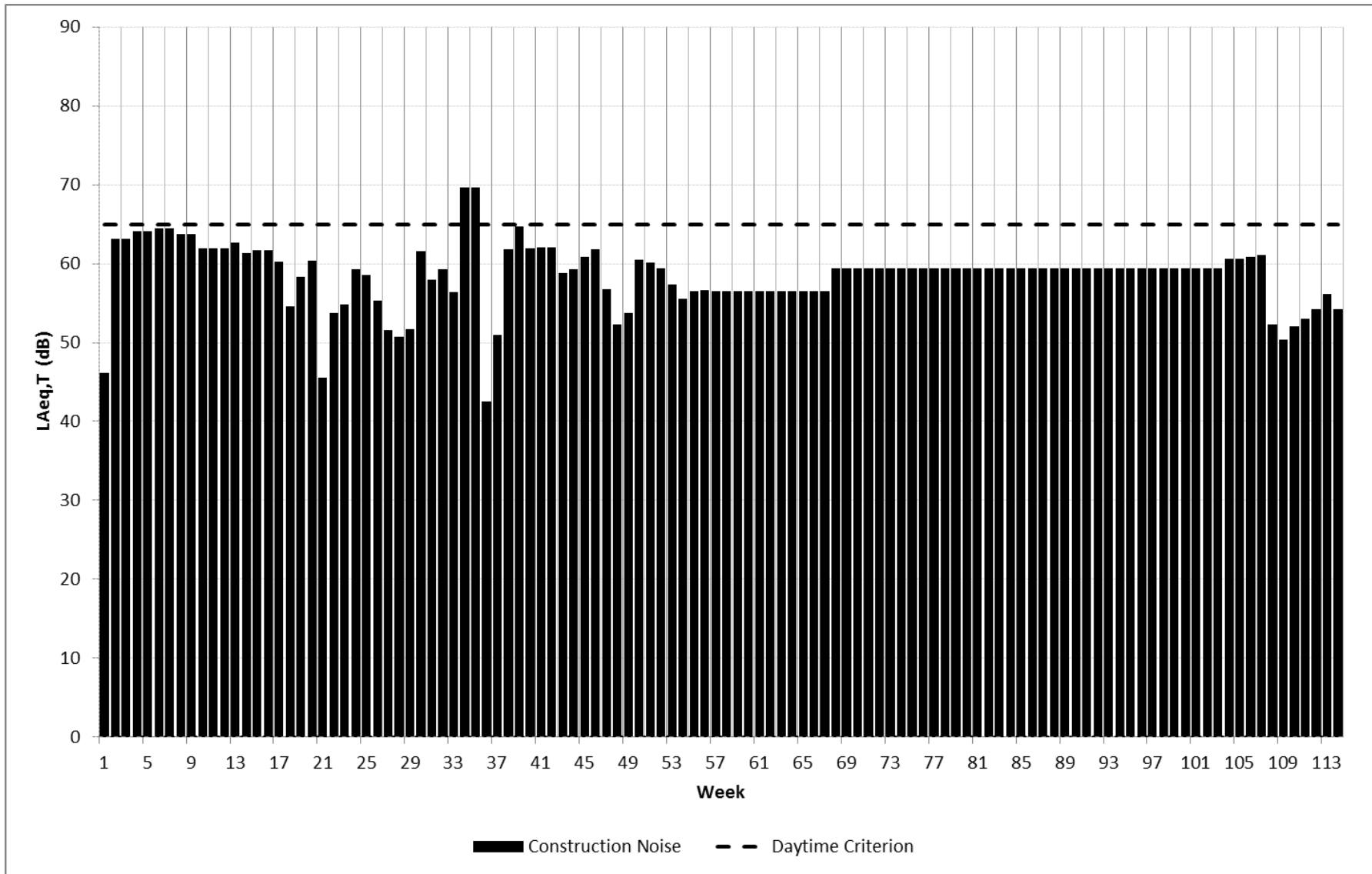


Figure A12.2-12 R06 (Old Sheriffhall Farmhouse) – Evening and Night - Top Floor

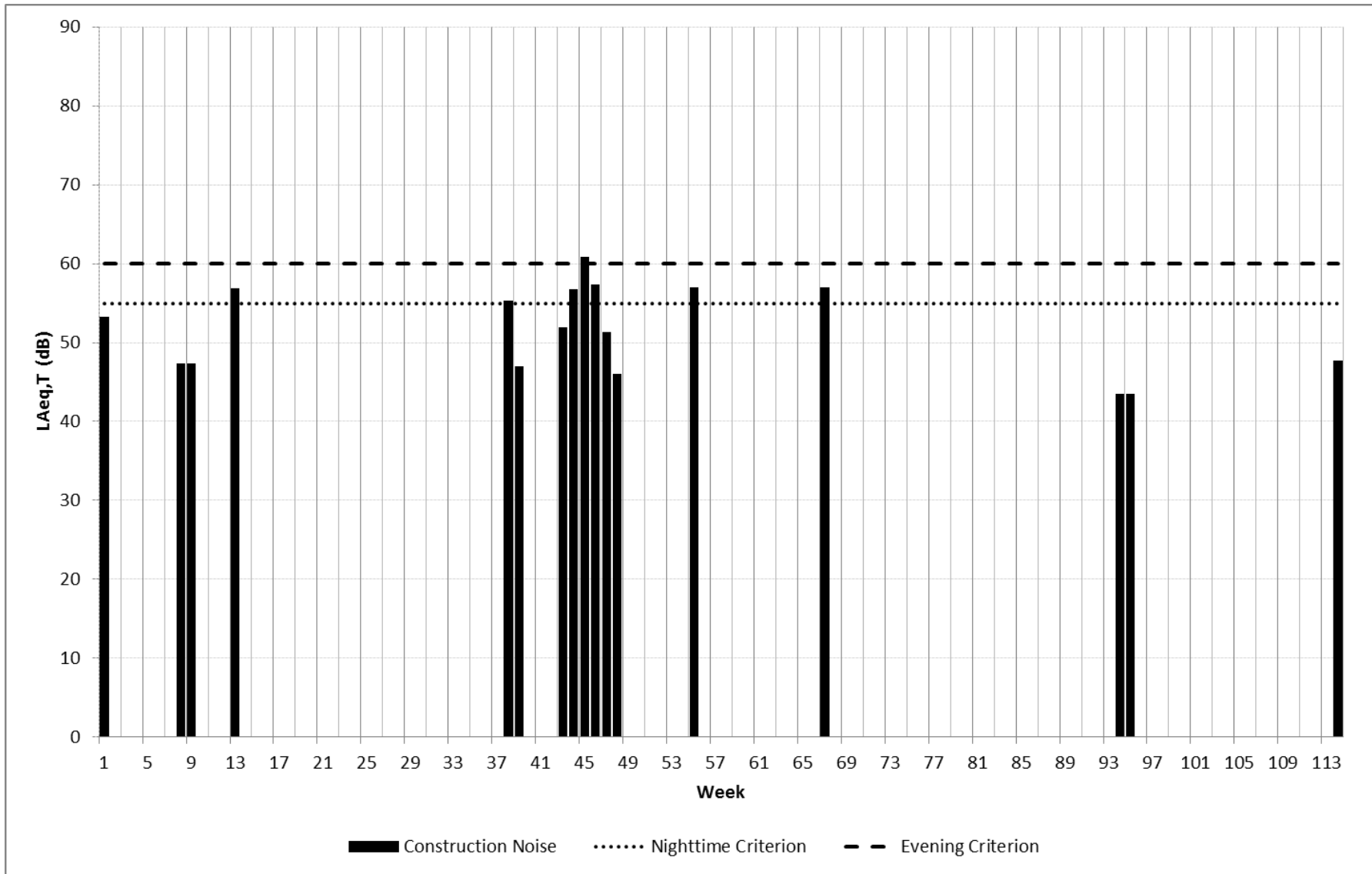




Figure A12.2-13 R07 (Sheriffhall House) - Day - Ground Floor

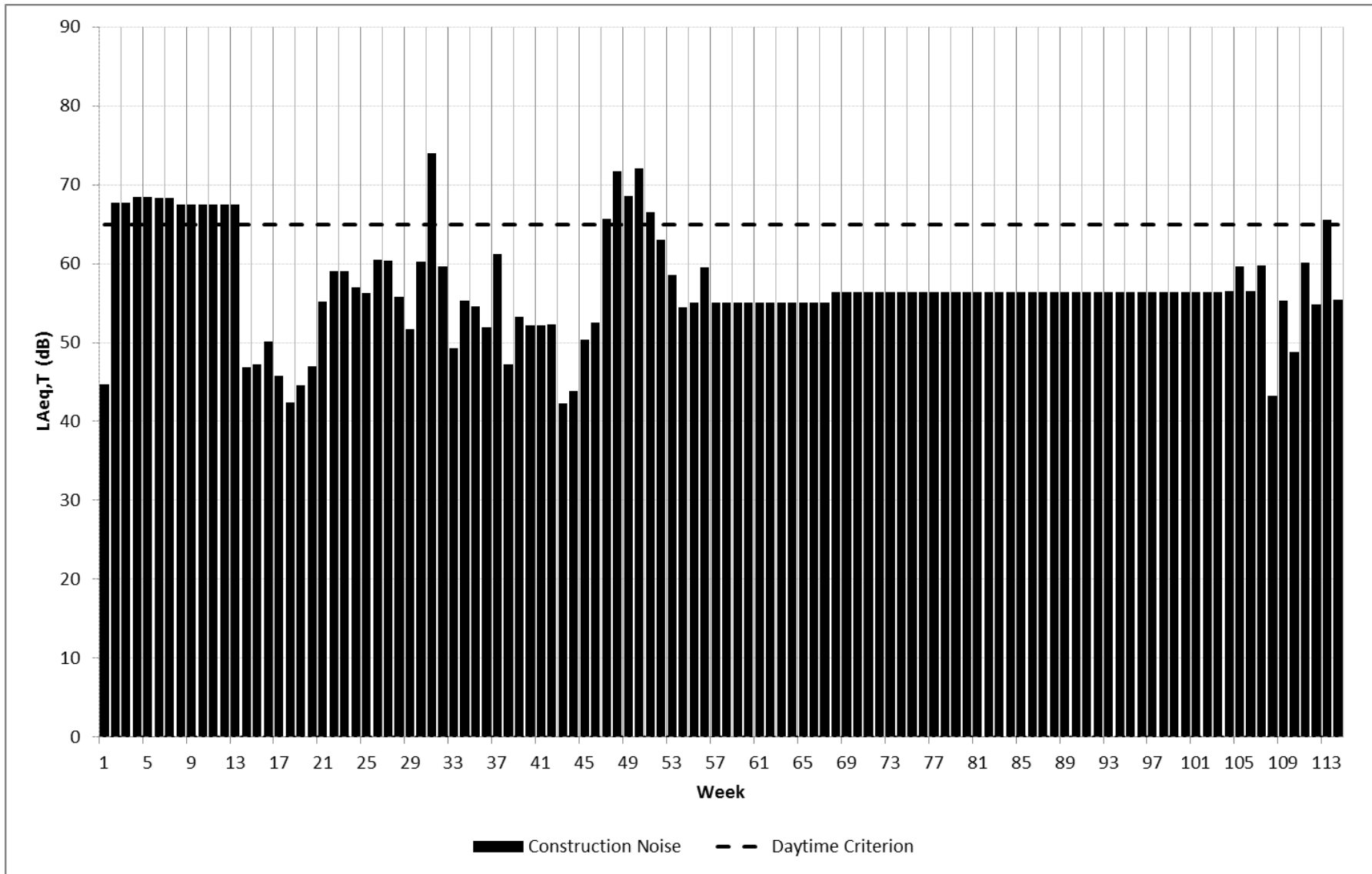


Figure A12.2-14 R07 (Sheriffhall House) – Evening and Night - Top Floor

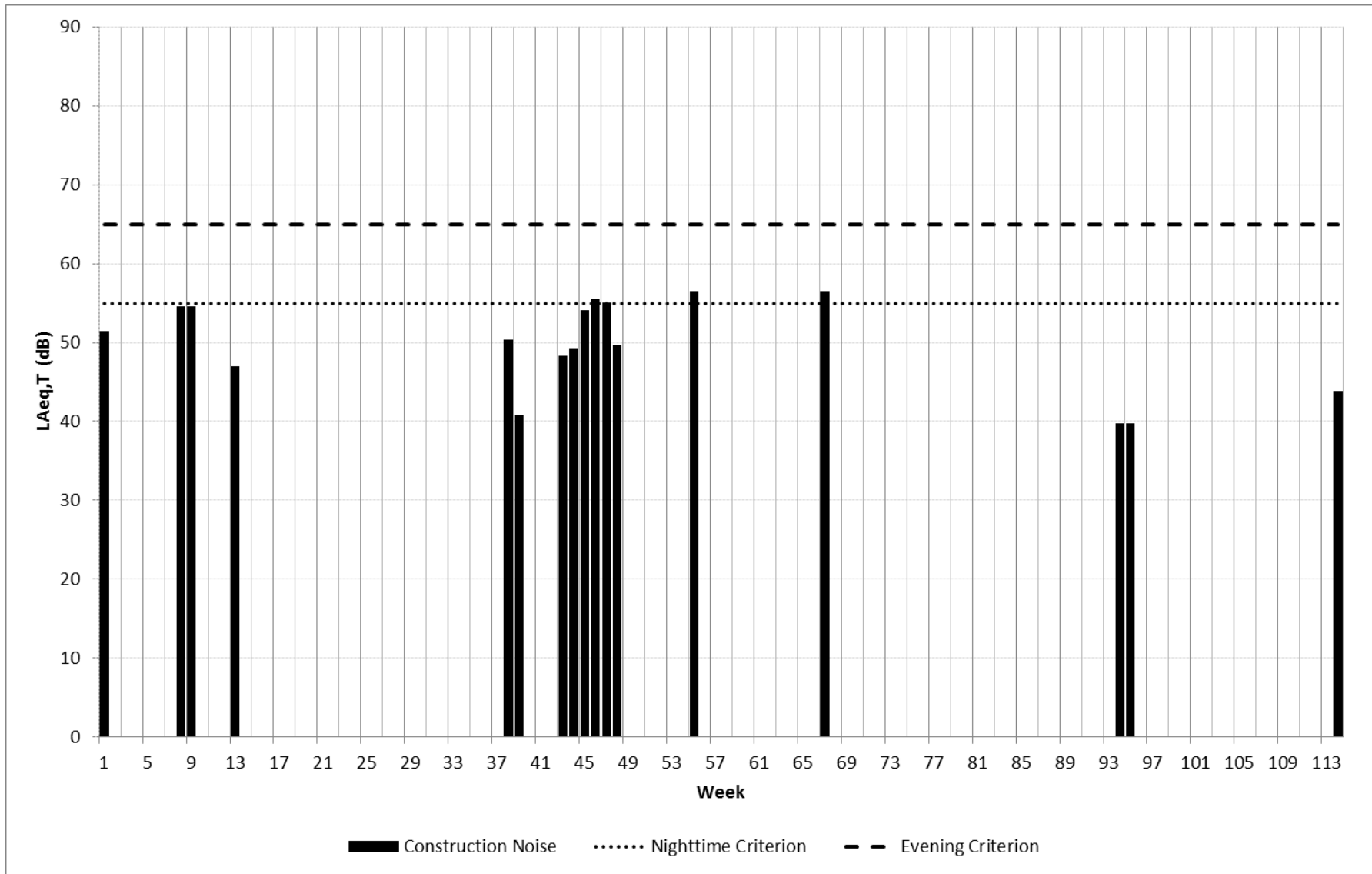


Figure A12.2-15 R08 (Old Dalkeith Road) - Day - Ground Floor

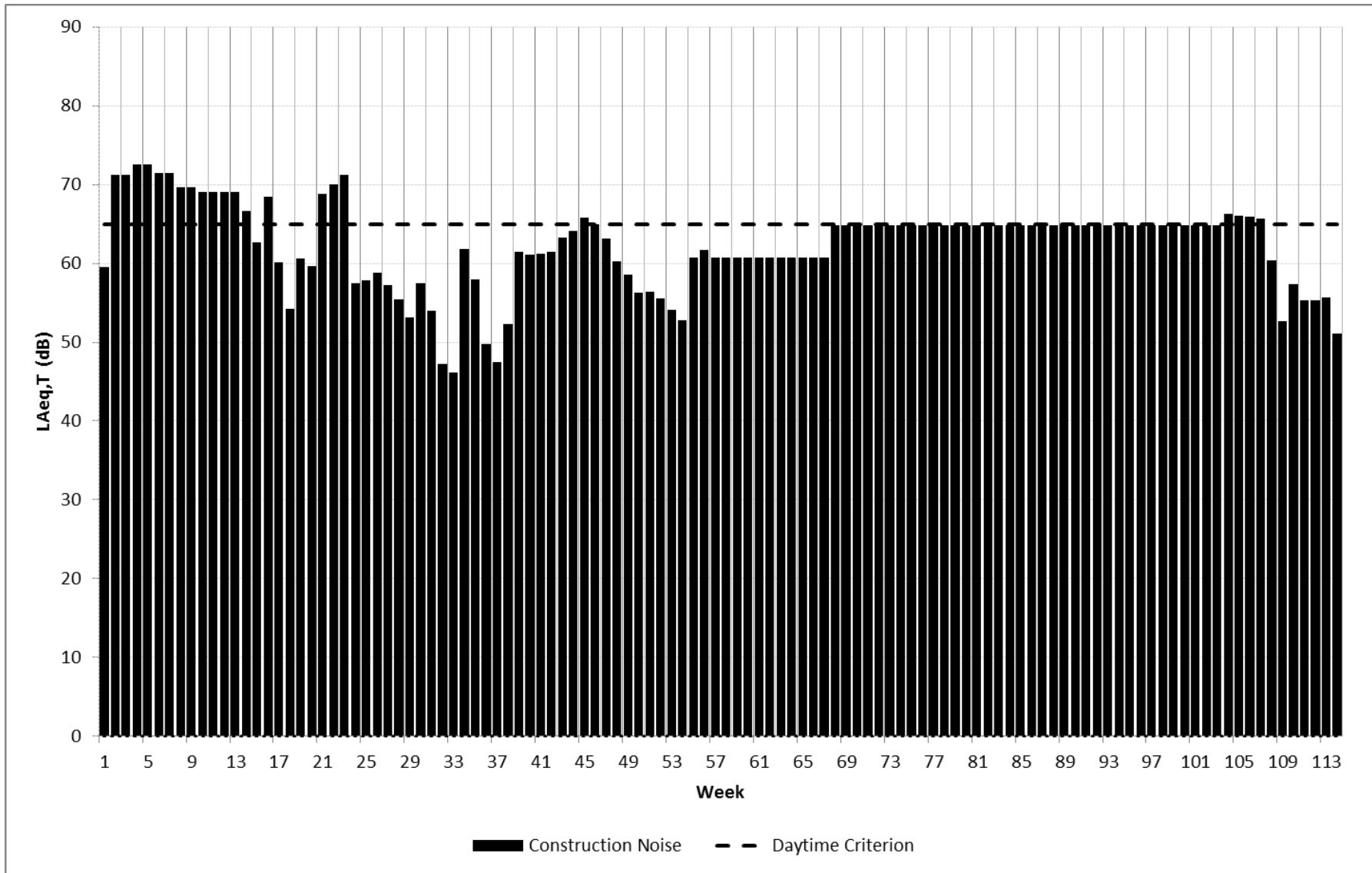


Figure A12.2-16 R08 (Old Dalkeith Road) – Evening and Night - Ground Floor

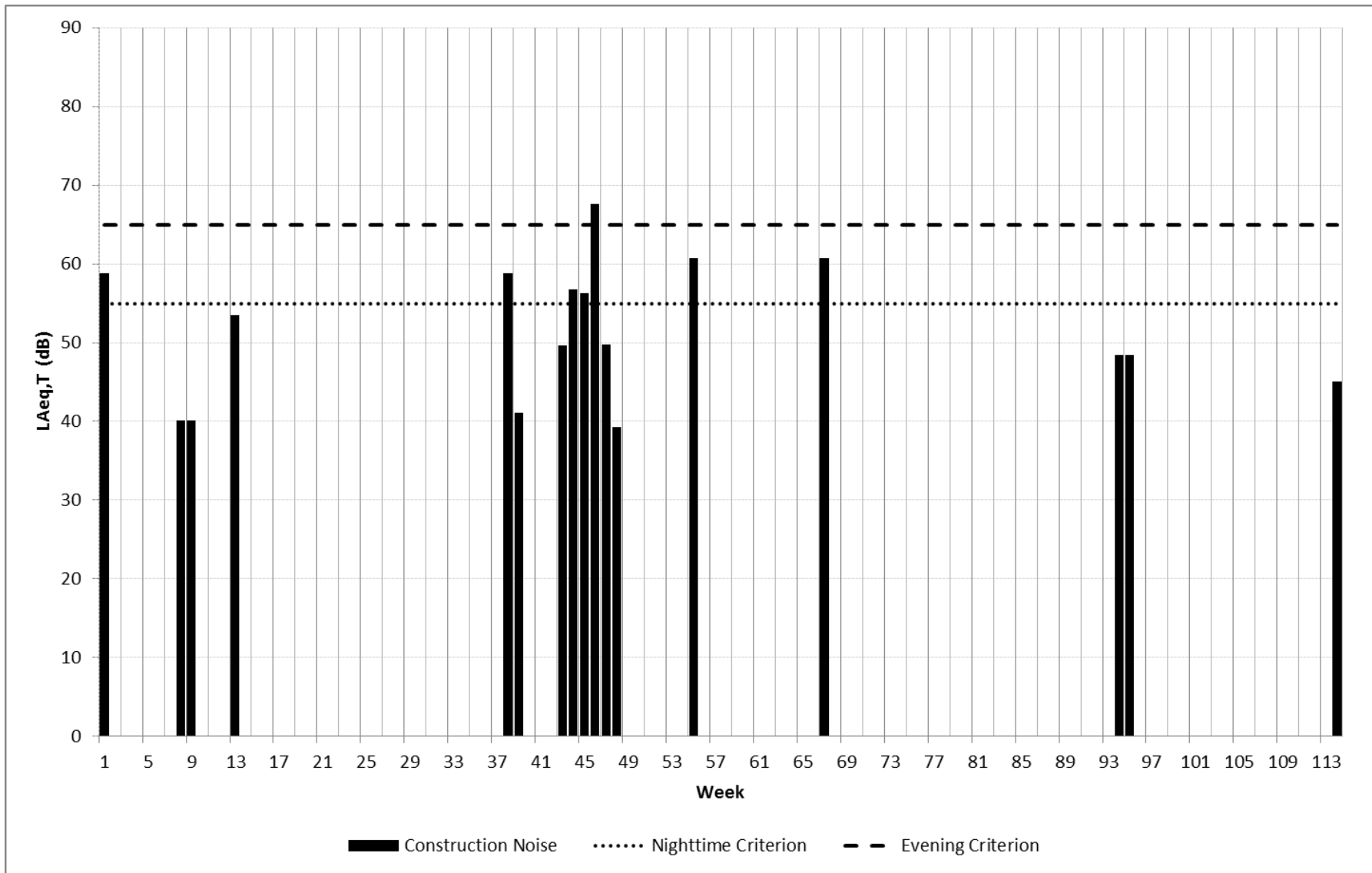
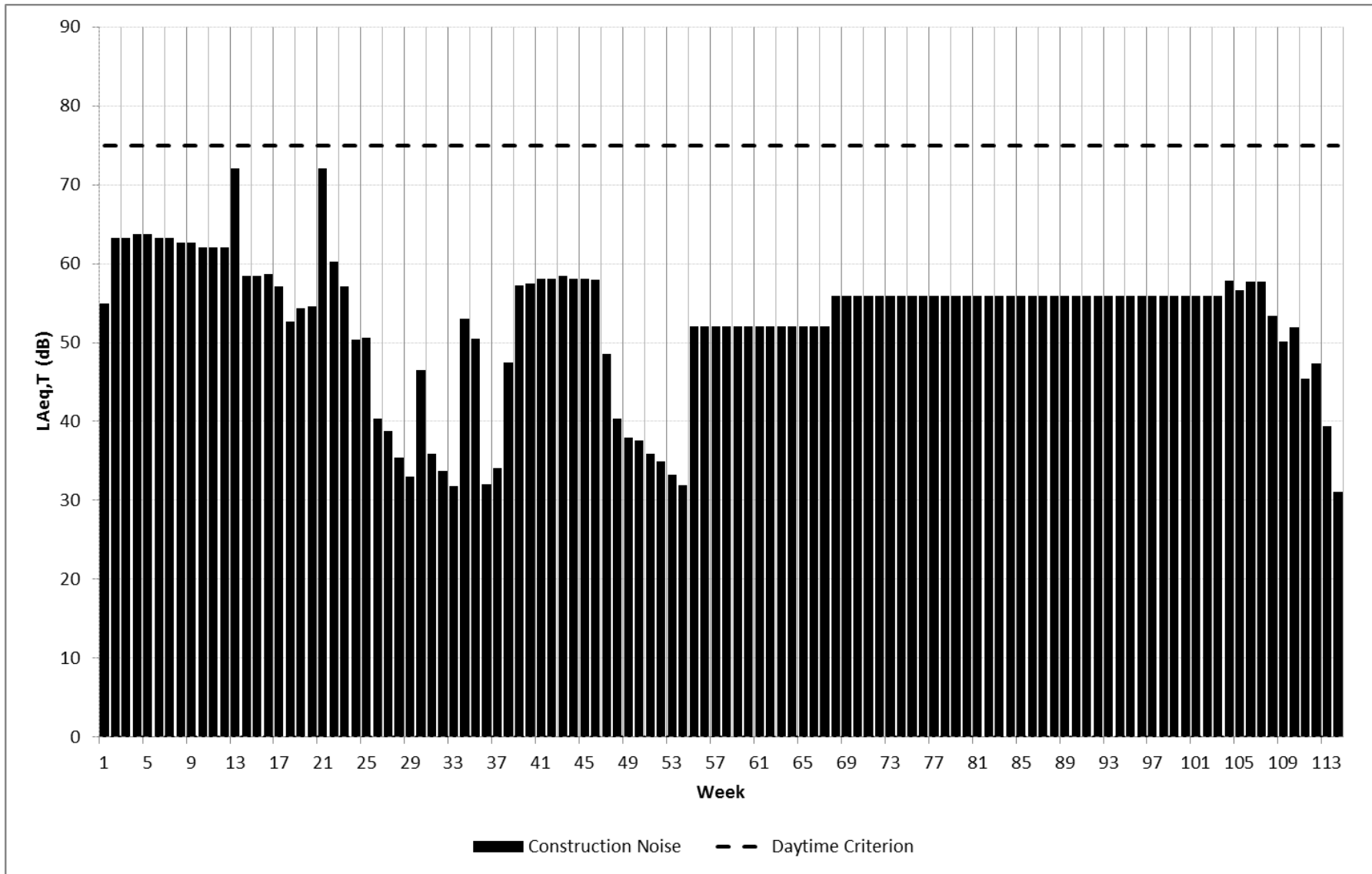


Figure A12.2-17 R09 (Campend Cottages) - Day - Ground Floor



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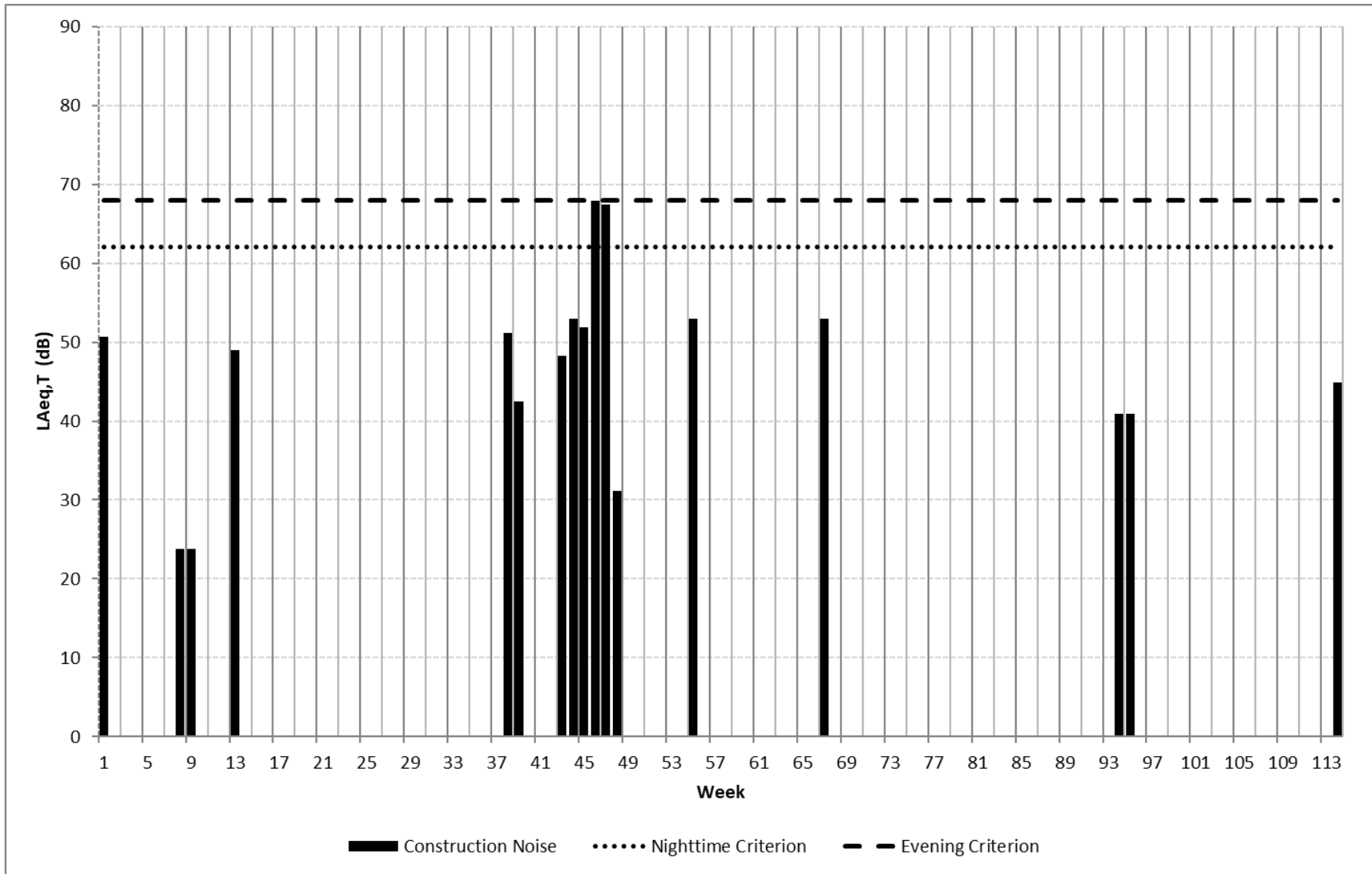


Figure A12.2-18 R10 (Sheriffhall Mains Cottage) - Day - Ground Floor

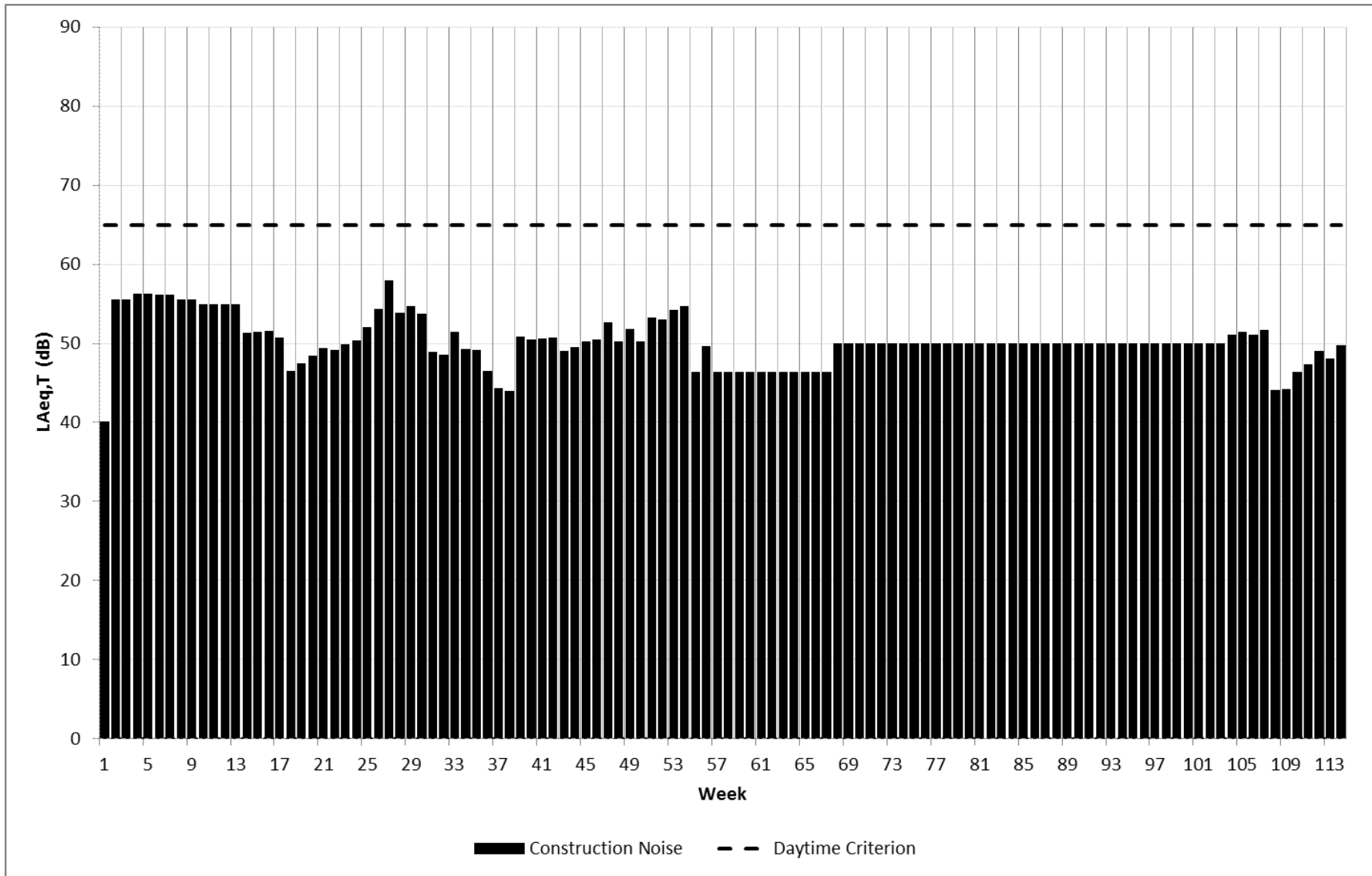
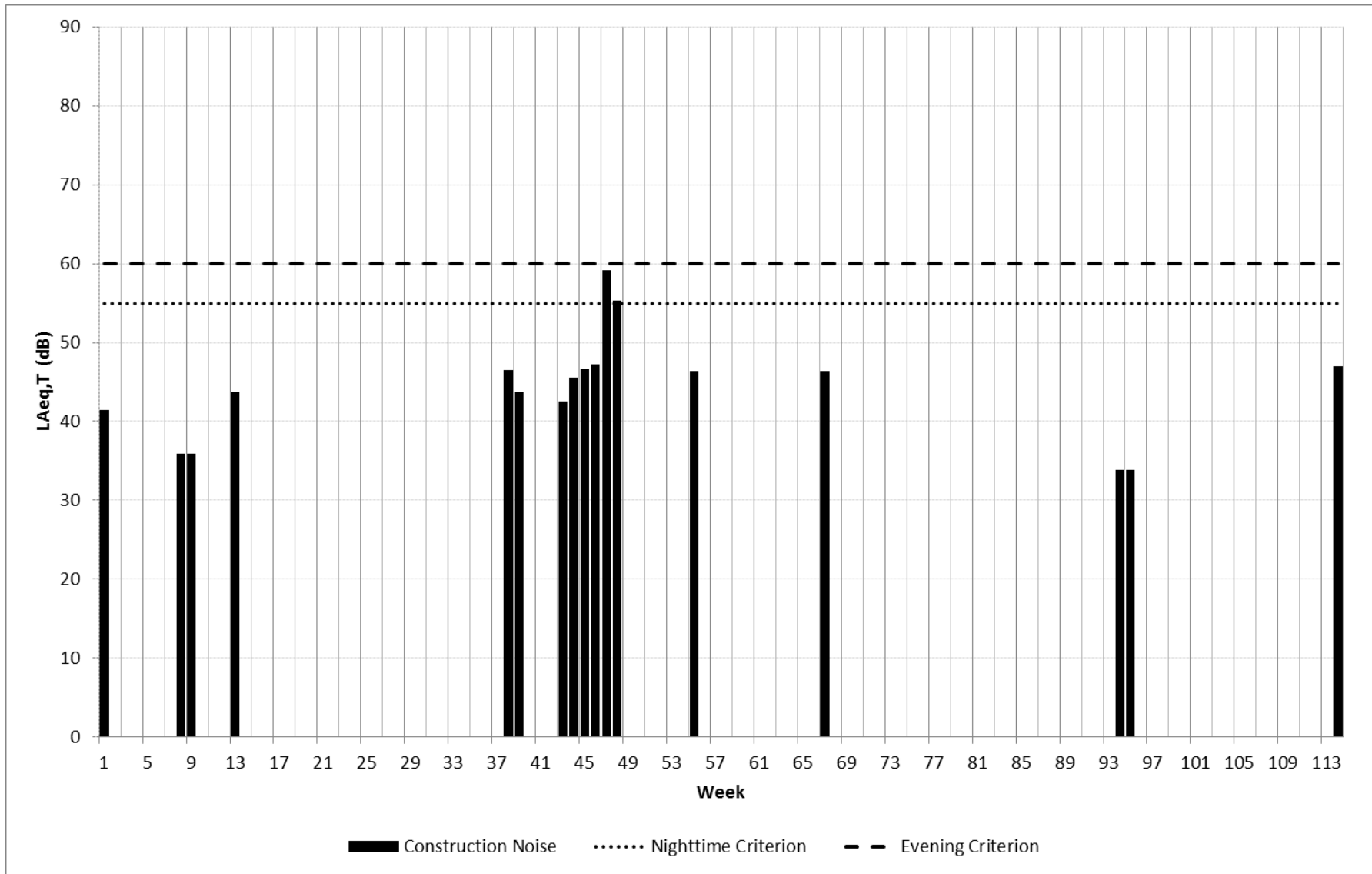


Figure A12.2-19 R10 (Sheriffhall Mains Cottage) – Evening and Night - Ground Floor





## Plant Equipment Assumptions

**Table A12.2-1 Plant Equipment Assumptions**

Phase	Activity	Operation	Main Plant	Number	% On time	BS5228 Ref.	Sound Power Level $L_{WA}$ dB
Phase 1	Temporary Works	Pavement Widening	Small excavator	1	80	C.2.21	99
			Roller	1	80	C.5.19	108
			Asphalt paving machine	1	80	C.5.31	105
		Install Temporary RRS	Dropside van	2	50	C.2.26	107
			Sheet Piling	Piling rig	1	100	C.3.11
		Construction site access road	Small excavator	2	100	C.2.21	99
			Roller	2	100	C.5.19	108
			Asphalt paving machine	1	80	C.5.31	105
		Rail Bridge Widening	Sheet Piling	Piling rig	1	100	C.3.14
	Excavate		Large excavator	2	100	C.5.18	108
			Tipper lorry	2	100	C.2.34	108
	Lift precast sections		Large crane	1	50	C.4.38	106
	Fill		Large excavator	2	100	C.5.18	108
			Tipper lorry	2	100	C.2.34	108
			Roller/ compactor	2	100	C.2.38	101
Mining Works	Excavate		Small excavator	2	100	C.2.21	99
			Tipper lorry	2	100	C.2.34	108
	Grouting	Drill rig	2	100	C.3.15	110	
		Grout pump & mixer	2	100	C.4.29	108	

Phase	Activity	Operation	Main Plant	Number	% On time	BS5228 Ref.	Sound Power Level $L_{WA}$ dB
		Capping	Small excavator	2	100	C.2.21	99
			Tipper lorry	2	100	C.2.34	108
			Concrete pump	1	100	C.4.29	108
Construct Subway 1	Excavate		Large excavator	2	100	C.2.21	99
			Tipper lorry	2	100	C.2.34	108
	Lift precast sections	Large crane	1	50	C.4.38	106	
	Fill	Large excavator	2	100	C.5.18	108	
		Tipper lorry	2	100	C.2.34	108	
		Roller/ compactor	1	100	C.2.38	101	
Construct Subway 2	Excavate		Large excavator	2	100	C.2.21	99
			Tipper lorry	2	100	C.2.34	108
	Lift precast sections	Large crane	1	50	C.4.38	106	
	Fill	Large excavator	2	100	C.5.18	108	
		Tipper lorry	2	100	C.2.34	108	
		Roller/ compactor	1	100	C.2.38	101	
Construct Subway 5	Excavate		Large excavator	2	100	C.2.21	99
			Tipper lorry	2	100	C.2.34	108
	Lift precast sections	Large crane	1	50	C.4.38	106	
	Fill	Large excavator	2	100	C.5.18	108	
		Tipper lorry	2	100	C.2.34	108	
		Roller/ compactor	1	100	C.2.38	101	

Phase	Activity	Operation	Main Plant	Number	% On time	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	
Phase 2	Temporary Works	Pavement Widening	Small excavator	2	100	C.2.21	99	
			Roller	1	100	C.5.19	108	
			Asphalt paving machine	1	100	C.5.31	105	
		Install Temporary RRS	Dropside van	2	50	C.2.26	107	
			Sheet Piling	Piling rig	1	100	C.3.11	87
			Construct site access roads	Small excavator	2	100	C.2.21	99
		Roller		2	100	C.5.19	108	
		Asphalt paving machine		1	80	C.5.31	105	
		Offline Earthworks	Spread level	Large excavator	2	100	C.5.18	108
	Tipper lorry			2	100	C.2.34	108	
	Roller/ compactor			2	100	C.2.38	101	
	Construct Subway 3	Excavate	Large excavator	2	100	C.5.18	108	
			Tipper lorry	2	100	C.2.34	108	
		Lift precast sections	Large crane	1	50	C.4.38	106	
		Fill	Large excavator	2	100	C.5.18	108	
Tipper lorry			2	100	C.2.34	108		
Roller/ compactor			1	100	C.2.38	101		
Construct Drainage Ponds	Excavate	Large excavator	1	100	C.5.18	108		
		Tipper lorry	2	100	C.2.34	108		
Pavement	Construct road box	Small excavator	2	100	C.2.21	99		
		Roller	1	100	C.5.19	108		

Phase	Activity	Operation	Main Plant	Number	% On time	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	
		Surface	Asphalt paving machine	1	100	C.5.31	105	
Phase 3	Temporary Works	Pavement widening	Small excavator	2	100	C.2.21	99	
			Roller	1	100	C.5.19	108	
			Asphalt paving machine	1	100	C.5.31	105	
			Install Temporary RRS	Dropside van	2	50	C.2.26	107
			Sheet Piling	Piling rig	1	100	C.3.11	87
		Construction site access roads		Small excavator	2	100	C.2.21	99
	Roller			2	100	C.5.19	108	
	Asphalt paving machine			1	80	C.5.31	105	
	Mainline Embankment Earthworks		Spread and level	Large excavator	2	100	C.5.18	108
				Tipper lorry	2	100	C.2.34	108
Roller/ compactor				2	100	C.2.38	101	
Construct Subway 4	Excavate		Large excavator	2	100	C.5.18	108	
			Tipper lorry	2	100	C.2.34	108	
		Lift precast sections	Large crane	1	50	C.4.38	106	
	Fill		Large excavator	2	100	C.5.18	108	
			Tipper lorry	2	100	C.2.34	108	
			Roller/ compactor	1	100	C.2.38	101	
Tie-in Earthworks	Spread level		Large excavator	2	100	C.5.18	108	
			Tipper lorry	2	100	C.2.34	108	
			Roller/ compactor	2	100	C.2.38	101	

Phase	Activity	Operation	Main Plant	Number	% On time	BS5228 Ref.	Sound Power Level $L_{WA}$ dB
	Tie-in Pavement	Construct road box	Small excavator	2	100	C.2.21	99
			Roller	1	100	C.5.19	108
			Surface	Asphalt paving machine	1	100	C.5.31
Phase 4	Central Island Embankment Earthworks	Spread and level	Large excavator	2	100	C.5.18	108
			Tipper lorry	2	100	C.2.34	108
			Roller/ compactor	2	100	C.2.38	101
	Construct Drainage Ponds	Excavate	Large excavator	1	100	C.5.18	108
			Tipper lorry	2	100	C.2.34	108
	Phase 5	Bridge Construction	Piling	Piling rig	1	100	C.3.14
Concrete pump				1	100	C.4.29	108
Construct Pile Caps			Concrete pump	1	100	C.4.29	108
Construct Columns			Large Crane	1	50	C.4.38	106
			Concrete pump	1	100	C.4.29	108
Construct Abutment Bankseats			Large excavator	1	100	C.5.18	108
			Tipper lorry	2	100	C.2.34	108
			Large Crane	1	50	C.4.38	106
			Concrete pump	1	100	C.4.29	108
Install Bearings			Large Crane	1	50	C.4.38	106
Install Structural Steelwork			Large Crane	1	50	C.4.38	106
Install Permanent Formwork			Large Crane	1	50	C.4.38	106
Construct Concrete Deck Slab			Large Crane	1	50	C.4.38	106

Phase	Activity	Operation	Main Plant	Number	% On time	BS5228 Ref.	Sound Power Level $L_{WA}$ dB
			Concrete pump	1	100	C.4.29	108
		Construct Concrete Coping	Concrete pump	1	100	C.4.29	108
	Pavement	Construct road box	Small excavator	1	100	C.2.21	99
			Roller	1	100	C.5.19	108
		Surface	Asphalt paving machine	1	100	C.5.31	105
			Roller	1	100	C.5.19	108
Phase 6	Complete roadworks	Kerbing	Dropside van	1	50	C.2.26	107
		Pavement completion	Small excavator	1	100	C.2.21	99
			Roller	2	100	C.5.19	108
			Asphalt paving machine	1	100	C.5.31	105
		Street furniture	Dropside van	1	50	C.2.26	107

## Appendix 12.3 – Noise Modelling

### Data Sources

- OS Mastermap files 'MM\_Anno\_A720.shp', 'MM\_Area\_A720.shp', 'MM\_Bnd\_A720.shp', 'MM\_Line\_A720.shp', 'MM\_Pnt\_A720.shp', 'MM\_Sym\_A720.shp', provided by Transport Scotland 18/12/2018
- OS Addressbase plus land use data file: 'A720\_ADDR\_new.shp', provided by Transport Scotland 15/02/2019
- OS Mastermap Building Height Attribute (BHA) dataset OS provided by Transport Scotland 11/03/2019
- Existing ground heights in the vicinity of the Proposed Scheme: file 'ACAD-60572241-ACM-VTO-SW\_GN\_000\_Z-M3-CH-0001-Model.dwg', provided by AECOM Highways Team 03/01/2019
- Existing wider area ground heights file: 2m LIDAR spot heights 'LIDAR\_Composite\_2m\_Scotland' downloaded from Environment Agency website 25/02/2019. For areas not covered by this dataset NextMap 5m DTM spot heights file: 'NextMap\_Britain\_5m\_DTM\_405611\_703417\_NextMap\_Britain\_5m\_DTM.xyz' purchased from emapsite 26/2/19
- 3D Proposed Scheme design file: '2018-12-21\_A720 Sheriffhall Roundabout\_Full Scheme Strings\_3D.dwg' provided by AECOM Highways Team 03/01/2019
- Traffic data files: 'A720 SRb Paramics Env Data - 25Oct2019.xlsx' and 'A720 SRb SRM12 Env Data Values 10Feb2019 issued.xlsx', provided by AECOM Traffic Team 25/10/2019 and 10/02/2019
- Road surfacing existing and proposed: agreed with AECOM Highways Team 03/01/2019, based on information from Transport Scotland and Mid Lothian Council

### Modelling Assumptions

- Ground absorption: 1.0 for soft ground (vegetated), 0.0 for hard ground including water and road surfaces, based on OS Mastermap Topographic layer 12/09/18. Areas of less than 10 m<sup>2</sup> or 1m width removed.
- Building heights for residential buildings standardized to 4.0 m: 1 storey 6.0 m: 2 storey, 9.0 m: 3 storey etc. based on initial information from OS Mastermap BHA. Non-residential buildings used height direct from OS Mastermap. Some adjustments required to estimate missing heights.
- Road surfacing corrections in accordance with the requirements of DMRB:
  - Standard HRA
    - speed <75 km/hr: -1 dB,
    - speed ≥75 km/hr: -0.5 dB;
  - Low noise thin surfacing
    - speed <75 km/hr: -1 dB,
    - speed ≥75 km/hr: -3.5 dB;

For links on the A720 mainline at which a small change in speed occurs between scenarios, but which takes the speed above or below the 75km/hr boundary and therefore the application of the additional benefit of low noise surfacing, the same surface correction has been used for each scenario to avoid a step change in the predicted traffic noise levels which would not occur in reality.

- 10 m x 10 m grid used to produce noise change contour plots at height of 4.0 m above ground.

## Appendix 12.4 – Baseline Noise Monitoring

Table A12.4-2 Noise Monitoring Equipment

Ref	Name	LT/ST	Start Date/ Time	Finish Date/ Time	Sound Level Meter (SLM)	SLM Serial Number	Calibrator	Calibrator Serial Number	Free-field/ Facade
M1	700 Old Dalkeith Road, Summerside	LT	03/12/2018 14:02	11/12/2018 10:38	SLM3	B&K 2238 2381585	2	B&K 4231 2061469	2.5m from stone wall
M2	Sheriffhall House	LT	03/12/2018 17:00	11/12/2018 09:24	SLM44	NL-52 00386762	2	B&K 4231 2061469	Free-field
M3	Campend Cottages	LT	03/12/2018 19:00	11/12/2018 10:02	SLM45	NL-52 00386763	2	B&K 4231 2061469	Free-field
M4	626 Gilmerton Road	LT	04/12/2018 09:41	10/12/2018 11:38	SLM39	B&K 2250 2827273	2	B&K 4231 2061469	Free-field
M5	Sheriffhall Mains Cottage	ST	04/12/2018 10:15	04/12/2018 13:15	SLM15	NOR 140 1403080	2	B&K 4231 2061469	Free-field
M6	Elginhaugh Farm Pub	ST	04/12/2018 13:59	04/12/2018 17:00	SLM15	NOR 140 1403080	2	B&K 4231 2061469	Free-field

LT = long-term

ST = Short-term (3 hours daytime)

Table A12.4-3 Summary of Weather Data

Day	Date	Average Temperature °C	Average Wind Speed m/s	Typical Wind Direction	Rain mm	Notes
Monday	03/12/2018	1.8	0.3	NNE, S	0.0	Not a full day, starts 14:00
Tuesday	04/12/2018	2.7	0.9	NNW	0.0	
Wednesday	05/12/2018	2.6	0.4	NE, ENE	2.8	
Thursday	06/12/2018	9.3	1.5	N	0.0	
Friday	07/12/2018	7.1	2.8	N	1.9	
Saturday	08/12/2018	7.1	1.8	NNE	0.0	
Sunday	09/12/2018	3.9	0.6	NNE	0.0	
Monday	10/12/2018	3.1	0.5	SW	0.0	
Tuesday	11/12/2018	5.7	0.9	SW	0.0	Not a full day, ends at 11:00

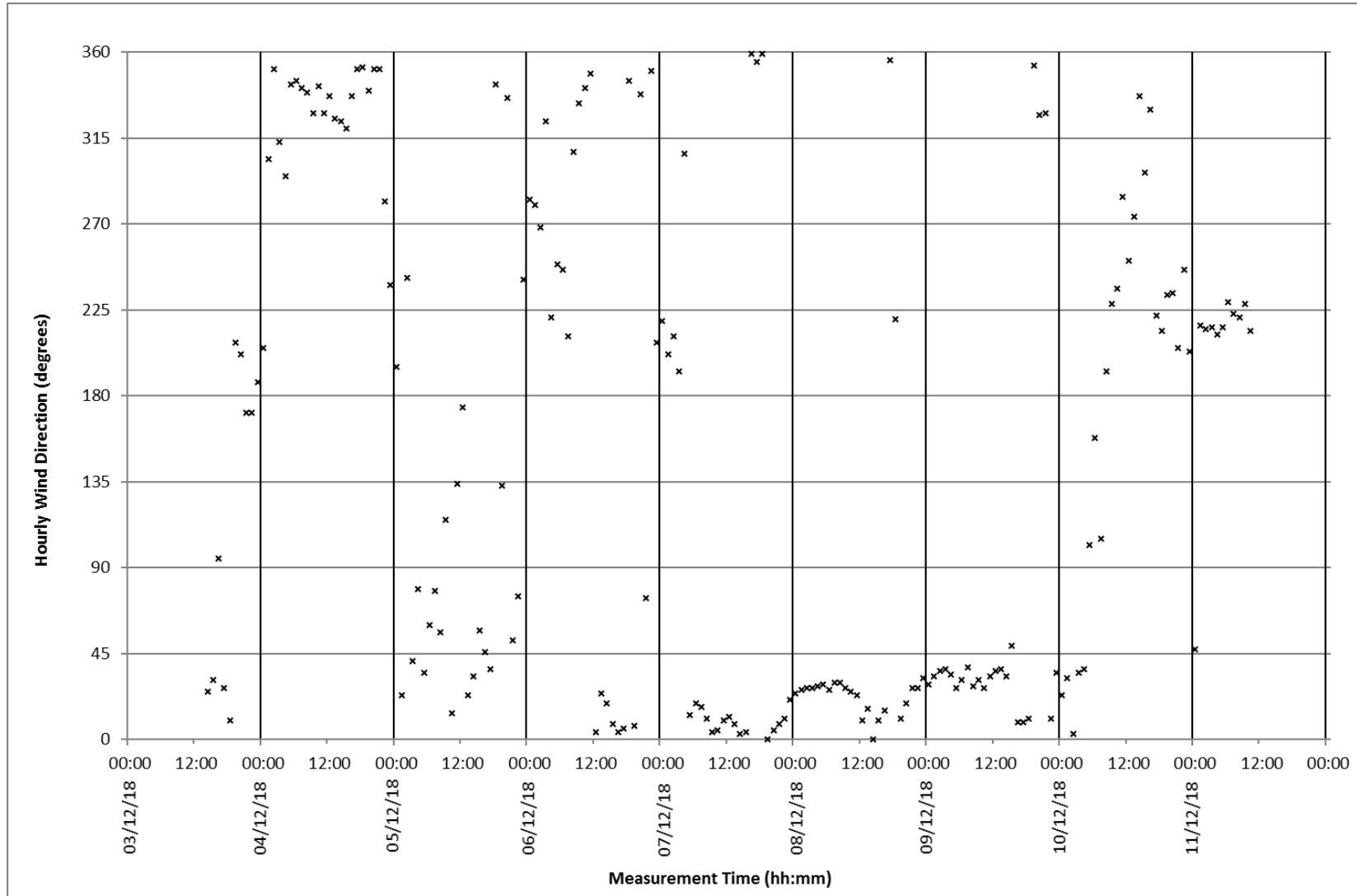
Weather data was recorded at monitoring location M1, 700 Old Dalkeith Road, Summerside.



Average daily wind speeds throughout the monitoring were largely low, with periods of higher wind speeds seen between Thursday 6th December and Saturday 8th December. Figure A12.4-2 illustrates that hourly average wind speeds were below 5 m/s throughout the monitoring period, although higher wind speeds were noted in particular overnight on the 7/8th December. Some rainfall occurred in the daytime of Wednesday 5th December and again during the early morning, evening and night of Friday 7th December. Time history graphs of the monitored levels at the long-term sites are provided in Figure A12.4-5 to

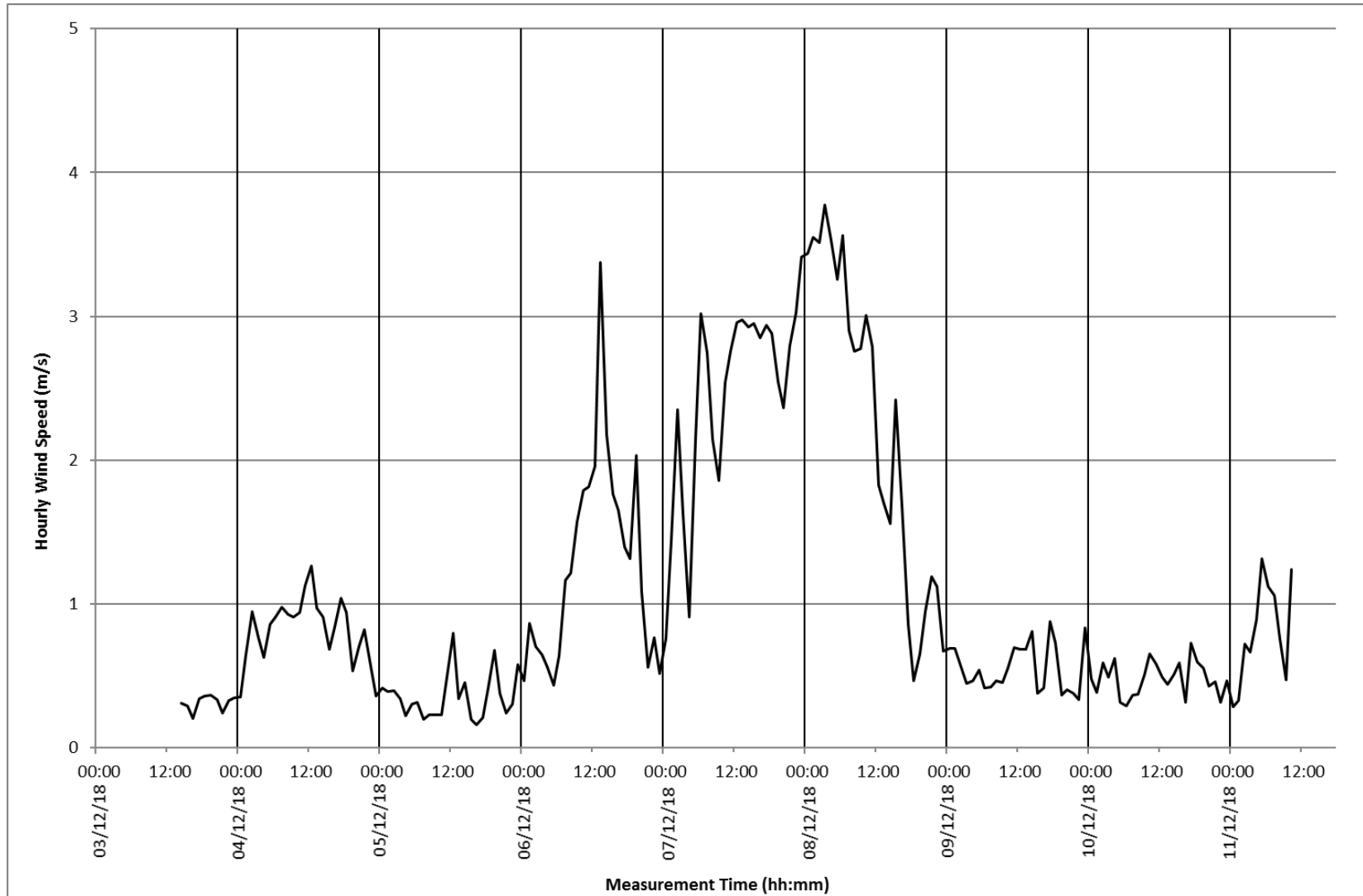
Figure A12.4-8 **Error! Reference source not found.** Consideration of the measured noise levels indicates that the period of rainfall and higher wind speeds overnight on the 7/8th December may have prevented noise levels from falling overnight as much as on other nights during the monitoring period.

Figure A12.4-1 Hourly Wind Direction



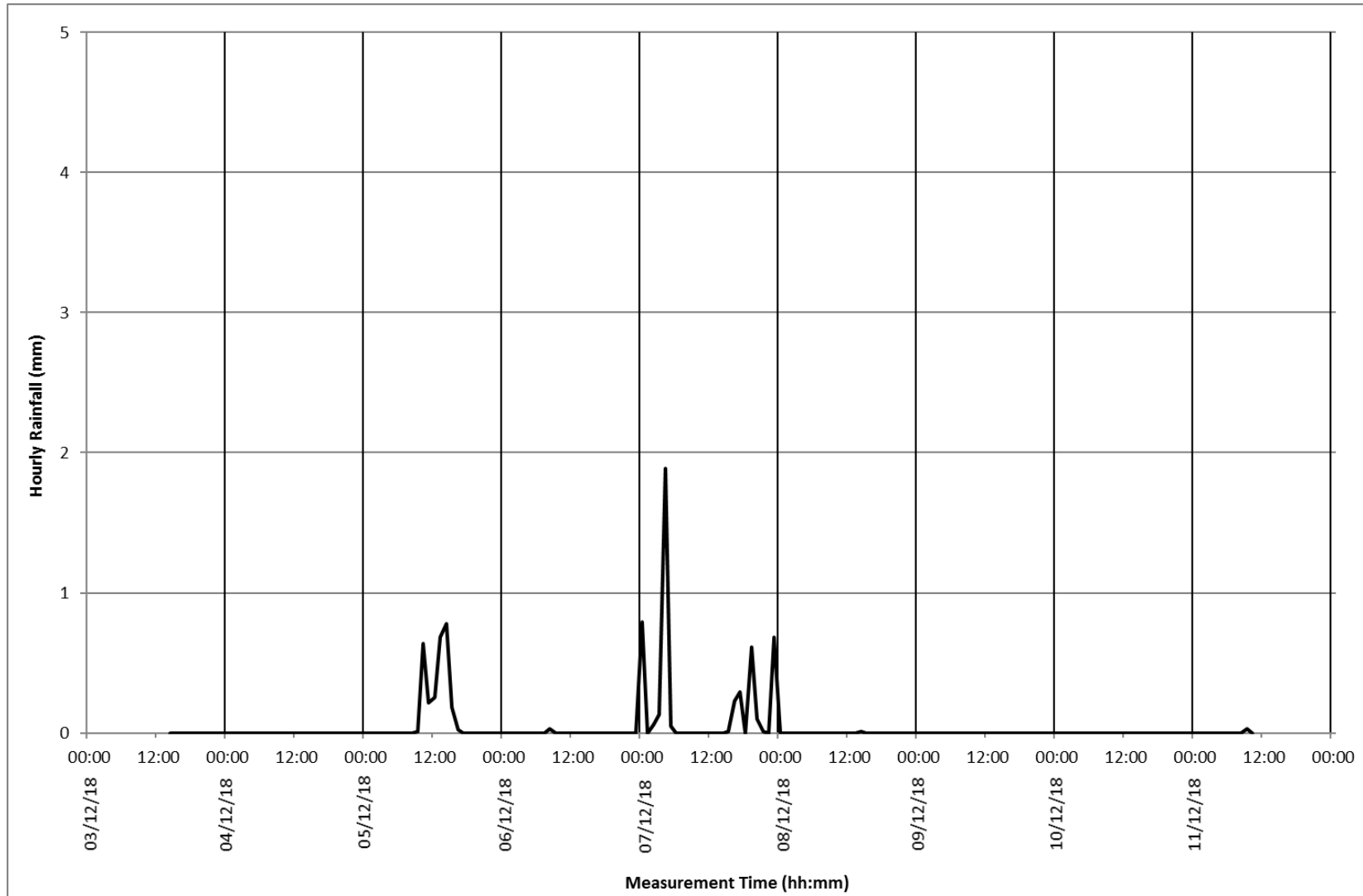
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Figure A12.4-2 Average Hourly Wind Speed



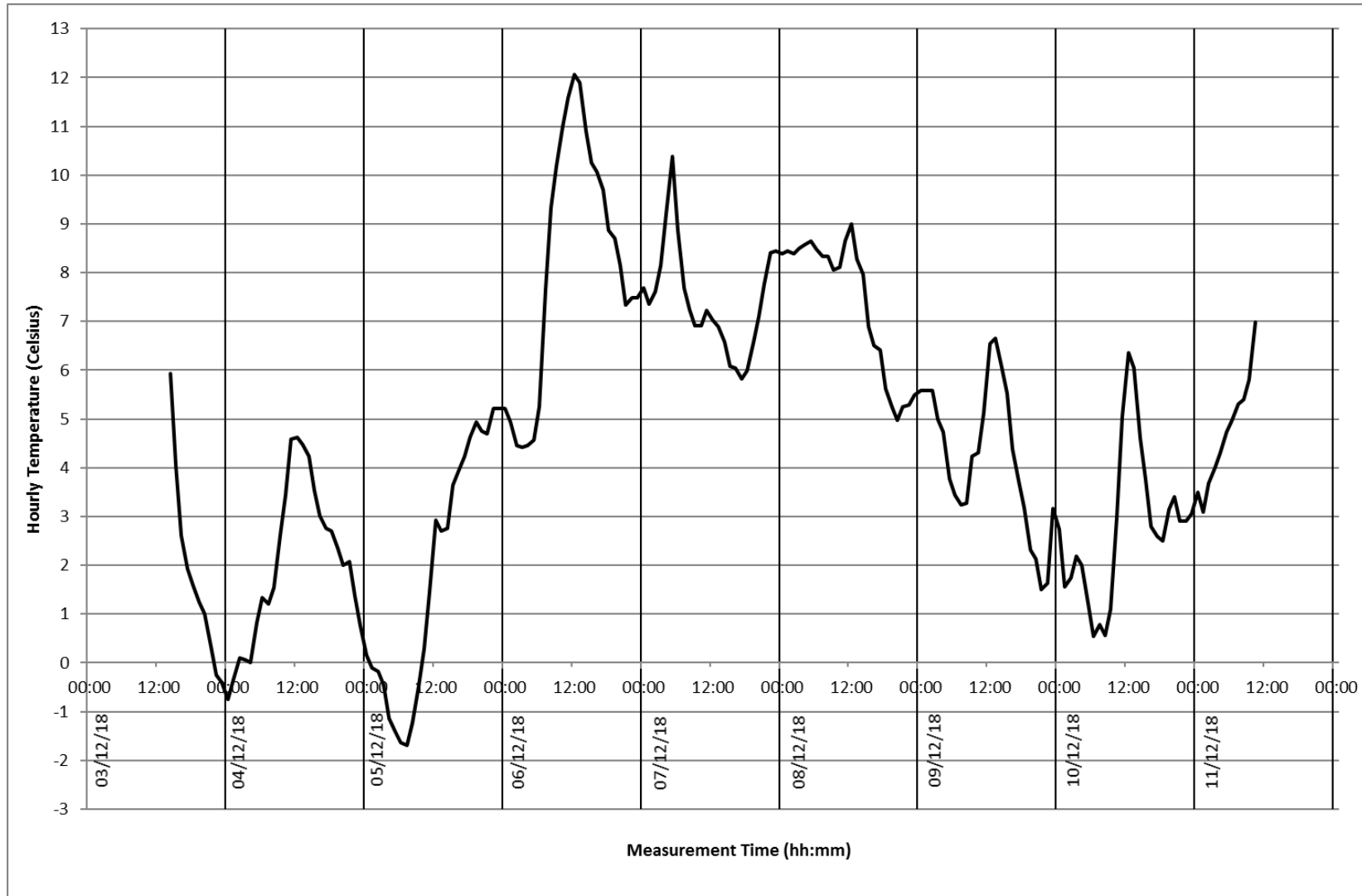
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Figure A12.4-3 Hourly Rainfall



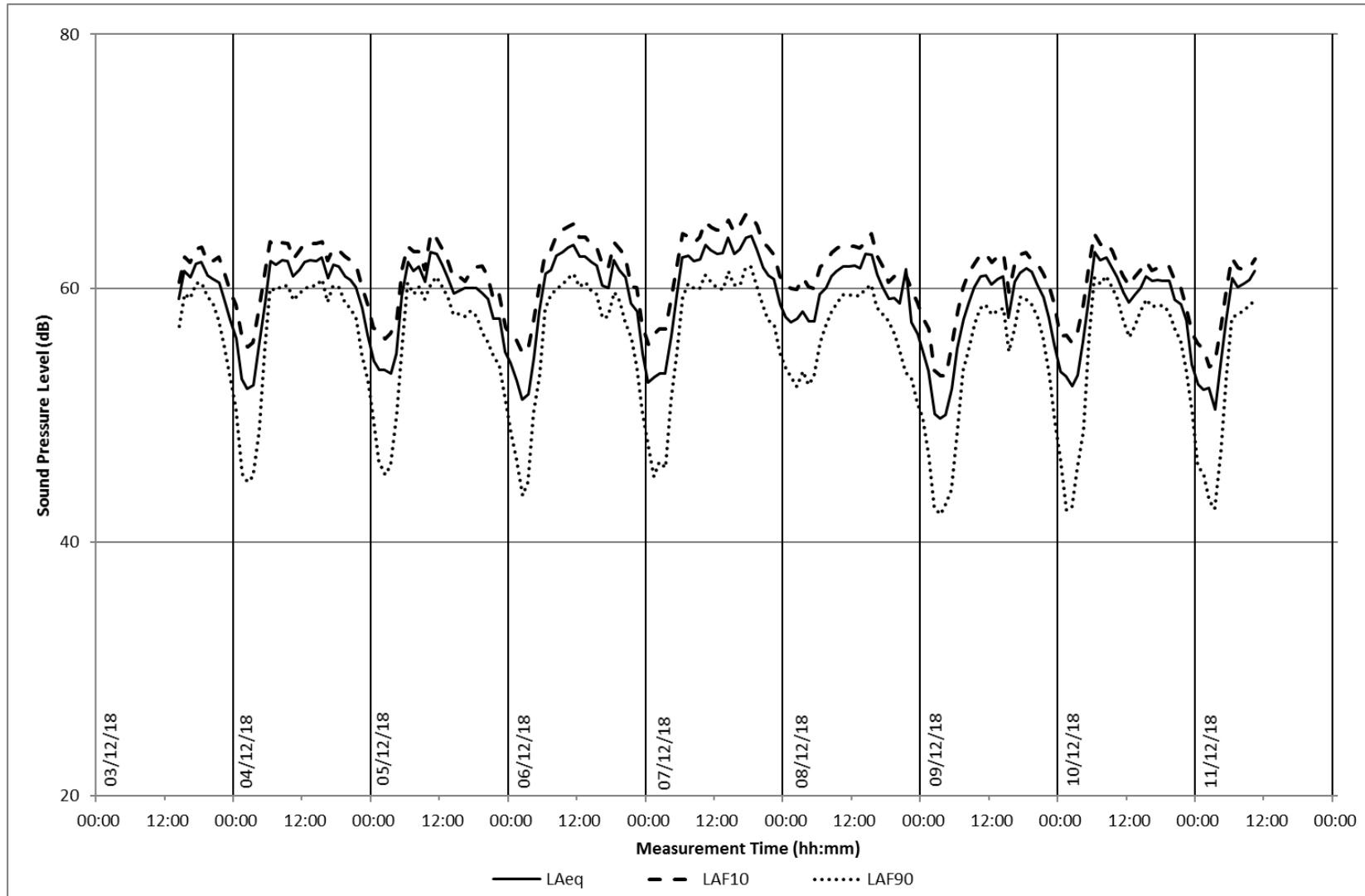
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Figure A12.4-4 Hourly Temperature



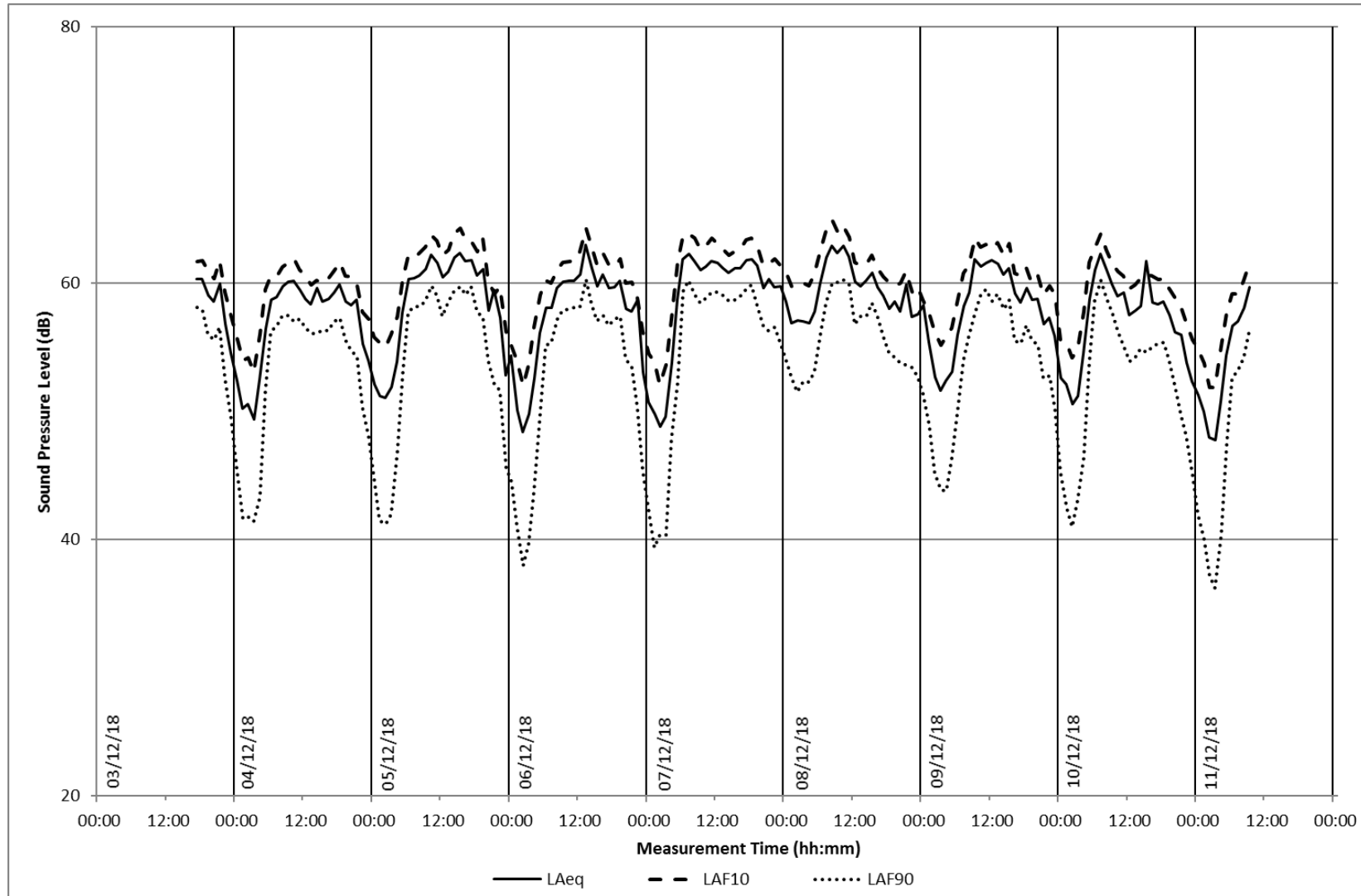
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Figure A12.4-5 Location 1 - 700 Old Dalkeith Road, Summerside



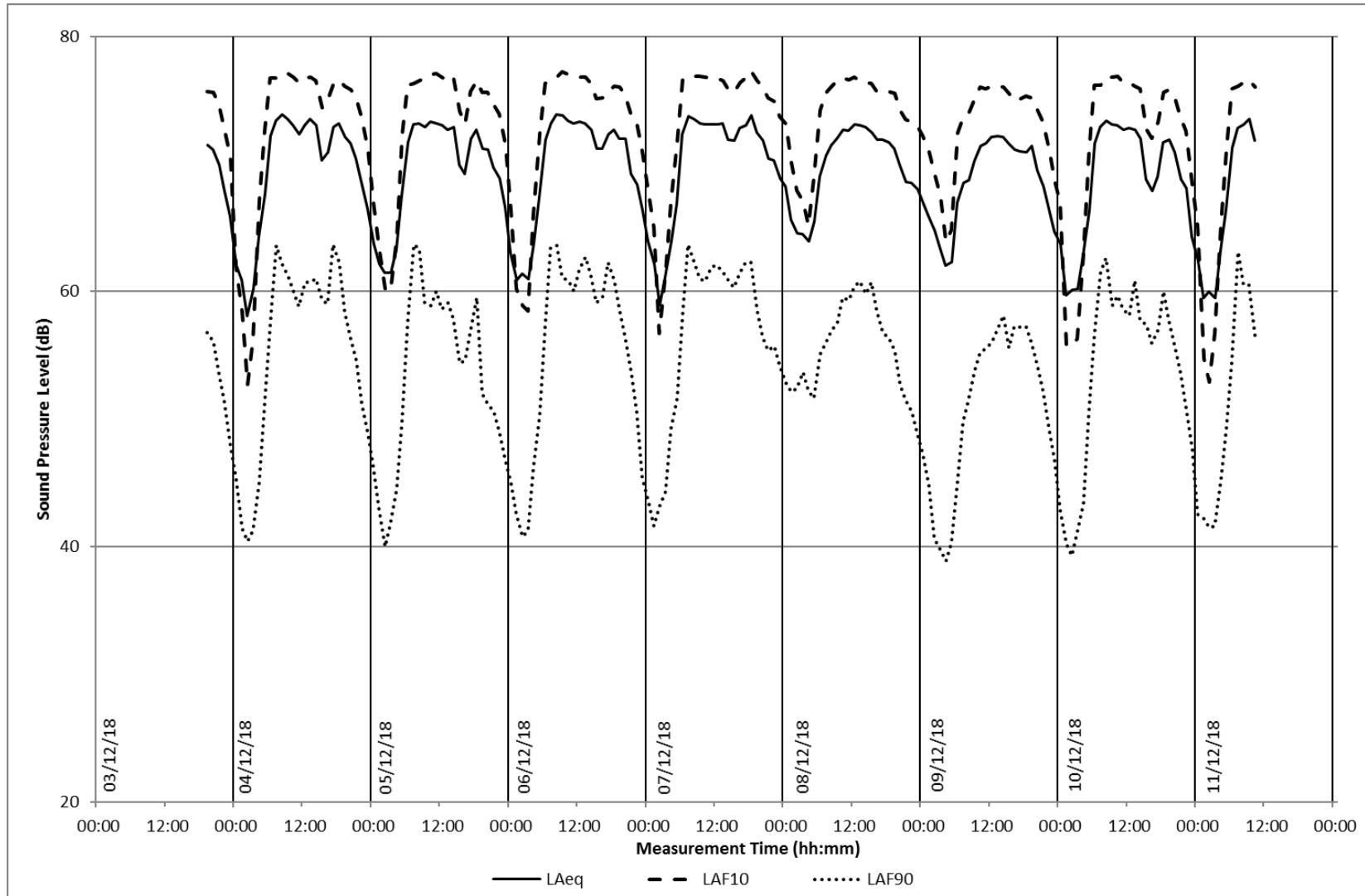
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Figure A12.4-6. Location 2 - Sheriffhall House



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Figure A12.4-7 Location 3 – Campend Cottages





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Figure A12.4-8 Location 4 - 626 Gilmerton Road

