WILSON IHRIG & ASSOCIATES
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TECHNICAL MEMORANDUM 8 March 2013

To: Susan Gustofson, P.E.
Staff Environmental Engineer
Valero Benicia Refinery
3400 East Second Street
Benicia, CA 94510,

Fr: Patrick G. Faner, Associate
Derek L. Watry, Principal

Re: Noise Study for Valero Crude-by-Rail Project

This memorandum presents the results of a noise study of the Valero Crude-by-Rail project. This project will provide the infrastructure necessary to bring 50-tanker-car consists into the refinery and to pump crude oil from them via an unloading rack into an existing tank. The primary new noise sources introduced by the project are the movement of rail cars and the operation of the pumps. The unloading rack uses two Goulds VIC-T pumps driven by General Electric motors. The 50-car consists will be divided into 25-car consists on each side of the unloading rack, unloaded, moved to the railcar departure spur and then transported off-site.

This study estimates noise levels from the new operations and puts them in the context of existing noise levels measured near local residences. The environmental impact assessment of the new noise levels will be done by others using the technical information in this memorandum.

Existing Noise Measurements

Long-term noise measurements were made at six locations between Wednesday, February 20, and Monday, February 25, 2013. Precision, calibrated, Type 1 logging sound level meters measured noise continuously and logged hourly statistical noise data continually over the entire measurement period. Four of the measurements locations represent noise-sensitive residential receivers in the area. The other two characterize existing noise levels near and inside the refinery.

The measurement locations are described below and are shown in Figure 1.

- Location L-1: Proposed project site at stair next to Tank 1720.
- Location L-2: Pole on hill next to repeater tower.

- Location L-3: Backyard of residence on 400 block of Lansing Circle, bordering open space.
- Location L-4: Light pole between 337 and 339 Columbia Circle.
- Location L-5: Backyard of residence on 300 block of Allen Way, bordering open space.
- Location L-6: Utility pole at southwestern edge of open space, near West Tennys Drive.

The noise loggers were programmed to store various statistical, A-weighted (dBA) noise levels at hourly intervals. The statistical noise levels included the L_{eq} (the energy average noise level) and the L_1, L_{10}, L_{50}, and L_{90}. The L_n is the noise level exceeded for n% of the time during the hour. For example, the L_{10} is the noise level exceeded 10% of the time; 10% of an hour is 6 minutes, so the noise level would be louder than the L_{10} for 6 minutes and quieter than the L_{10} for 54 minutes.

The hourly L_{eq} values for daytime, evening, and nighttime periods are summarized in Table 1 and plotted by day in Figure 2 through Figure 6. The *daytime* period is from 7:00 A.M. to 7:00 P.M., the *evening* period is from 7:00 P.M. to 10:00 P.M., and the *nighttime* period is from 10:00 P.M. to 7:00 A.M., corresponding to time periods specified in the Benicia Municipal Code. The Noise Element in the Benicia General Plan only considers two periods - *daytime* (7:00 AM and 10:00 PM) and *nighttime* (10:00 PM to 7:00 AM). The Noise Element's *nighttime* period is the same as that of the municipal code, whereas the Element *daytime* period combines the *daytime* and *evening* periods of the Municipal Code. Detailed graphs showing the hourly equivalent and statistical noise levels for each monitoring location are presented in the Appendix (Figures A1-1 through A6-6).

The following information can be gleaned from the L_{eq} data:

- Data for Location L-1 was used primarily to compare with the residential measurement locations (L-3, L-4, L-5, and L-6). Peaks in the L-1 data fairly correlate well with peaks at the residential measurement locations, indicating that the Valero refinery is the primary contributor to the existing noise environment.

- Data for Location L-2 (near the repeater tower) are not shown in Figure 2 through Figure 6 because the hourly L_{eq} noise levels are dominated by a constant, local noise source (possibly the repeater tower equipment). As such, it does not provide useful information about the overall noise environment in the refinery. The Location L-2 L_{max} data shown in the appendix does correlate with the other data.

- The four measurement locations around the residential neighborhoods, L-3, L-4, L-5, and L-6, all have roughly the same noise exposure level. The daytime hourly L_{eq}'s ranged from 48 to 59 dBA, and, on average, were 53 to 56 dBA. The evening hourly L_{eq}'s ranged from 44 to 63 dBA, and were 51 to 55 dBA on average. The nighttime hourly L_{eq}'s ranged from 48 to 62 dbA, and, on average, were 52 to 54 dBA.

Estimated Project Noise

There will be two Gould pump and General Electric motor combinations installed for the Valero Crude-by-Rail project. The pumps, designated as P-1788A and P-1788B, will be located about midway along the unloading rack and will be behind and below a new 8' high containment wall. This wall will provide some acoustical shielding of pump noise as it will be between the pumps and the residences west of the refinery. In addition, the complex of large storage tanks will also provide some acoustical shielding between the pumps and the residences. Together, we estimate that the wall and tanks will provide 8 dB of sound attenuation for the residential receivers.

The pump and motor supplier has provided a source sound pressure level of 81 dBA at 5 feet for both the motor and, separately, the pump. Taken together, therefore, a single motor/pump combination should generate 84 dBA, and two such combinations should generate 87 dBA at a reference distance of 5 ft.

Train noises from the project will be similar to that found at a rail yard. This includes noises associated with a locomotive engine, train movement at 5 miles per hour or less, railcar slack and take-up action caused by the consist stopping and starting, and railcar coupling and uncoupling. The switching operation to move empty railcars to the departure spur is projected to take 1 hour; the delivery of loaded cars and removal of empty cars is projected to take 3 hours. These activities will occur between 10:00 P.M. and 5:00 A.M.

The Federal Railroad Administration (FRA) has developed a noise modeling spreadsheet for estimating freight train noises, and it uses a 118 dBA Sound Exposure Level (SEL) at 50 feet for rail yard operations with 20 trains per hour. This is equivalent to an hourly average level of 69 dBA for 1 train per hour. This is the basis of the calculations for the hourly average noise exposure for train movements. The calculations have been made for an hour in which there are train movements. There will be many hours during which there will be no train movements, but the "average" train movement noise calculation does not include these hours.

We refer to published noise studies to obtain maximum noise levels from train movements. A study of rail yard noise performed by Illingworth & Rodkin at the Port of Los Angeles Materials and Environmental Testing Lab in 2005 measured a maximum noise level of 79 dBA from train movements approximately 200 feet away. A study of slow moving trains with slack action noise was conducted by Arpeggio Acoustic Consulting at Georgia Tech in 2010 measured a maximum noise level of 94 dBA at approximately 50 feet from rail. This is roughly equivalent to 82 dBA at 200 feet. Finally, we also refer to a comprehensive noise survey of rail yards performed by and for the Environmental Protection Agency (EPA) in the late 1970s. Data from this report are somewhat difficult to interpret because the distances to various noise sources in the large rail yards vary widely, but they appear to be consistent with the Illingworth & Rodkin and Arpeggio data. For this study, we are using a maximum noise level of 81 dBA at 200 feet for calculations.

The 8' high containment wall and tank complex will not be as effective at blocking train movement noise as it will be at blocking pump noise because the sources are farther away and somewhat higher. We estimate that the wall and tanks will provide 5 dB of sound attenuation from train noise traveling in the direction of the residential receivers.

Most of the sound that travels towards the residential receivers will graze the sloping, undeveloped ground in the open space between E. 2nd St and the residences to the west. Because this is a "soft" ground cover and because the pumps and couples are essentially point sources, we have used an attenuation rate of 7.5 dB per doubling of distance as suggested by the FRA rail yard model. This is equivalent to a factor of $25\log_{10}(\text{distance}_{\text{reference}}/\text{distance}_{\text{receiver}})$.

The last factor used in estimating noise levels is the variable effect of wind speed and temperature gradients. This is a very complicated phenomenon that can be difficult to quantify at best and which, to be done precisely, needs more detailed wind and temperature information than is generally available. Because such information is not available for this study, we are using a factor of +/- 10 dB to account for this variability, resulting in a predicted noise level range of 20 dB. While this is large, it accords with measured fluctuations in environmental noise levels at the distances involved in this study (2,700 to 5,500 ft). Clearly, the upper end of the predicted range will be of most interest in evaluating the noise impacts from the project. It should also be borne in mind, however, that the noise level expected most of the time is the level in the middle of the predicted 20 dB range.

Table 2 shows example calculations for the nearest residential receiver, Lansing Circle.[1] Because the oil pumps and motors run continuously when operating, the maximum noise and the average noise levels from these are these are the same. In contract, the calculations for the average train noise are distinct from those for the maximum train noise. Note that the reference distance corresponding to the source sound pressure levels are different which is why the attenuation with distance differs even though the attenuation rate is the same for all three calculations.

Table 3 summarizes the estimated noise levels due to the project at nearby residential areas. The nearest group of residents is at Lansing Circle, which is approximately 2,700 feet northwest of the northern end of the project site. Here we estimate worst-case maximum noise levels of 21 dBA from the two motors and pumps and 58 dBA from train movements. Expected maximum noise levels are 11 dBA and 48 dBA, respectively. The expected hourly average noise level from train movements is 27 dBA less than the maximum.

[1] The estimated noise levels for a given road, e.g., Lansing Circle, are made at the residence nearest the Valero refinery which is typically not at the residence where existing ambient noise data were collected.

Conclusion

This technical study has measured existing noise levels near residences west of the Valero refinery. The noise levels were found to be very consistent throughout the area and to correlate fairly well with existing refinery noise levels. On an hourly average basis, the noise levels at the residences are 52 to 56 dBA throughout the day and night.

This technical study has also estimated noise levels from the two new noise sources introduced by the project: two oil pumps and rail car movements. Even under worst-case conditions, noise from the oil pumps is estimated to be 21 dBA at the nearest residence, well below the existing average noise level. Worst-case noise from the rail car movements, specifically coupling and slack take-up, is estimated to be 58 dBA, on par with the existing average. The noise level from rail car movements under typical atmospheric conditions will be 10 dB less than this, and noise levels at more distant residences will be 1 to 8 dB less.

* * * * *

Please contact us if you have any questions about this technical study.

Very truly yours,

WILSON, IHRIG & ASSOCIATES, INC.

Patrick G. Faner
Associate

Derek Watry
Principal

Table 1 Average Existing Hourly L_{eq} (dBA) for Daytime, Evening, and Nighttime Periods

Monitor Location		L1	L2	L3	L4	L5	L6
Description		Proposed Project Site	Pole near Repeater Tower	Lansing Circle	Light Pole on Columbia Circle	Allen Way	Open Space
Average	Day	60	72	54	56	54	53
	Eve	59	72	55	53	51	51
	Night	59	72	52	53	53	54
2/21/2013 Thursday	Day	59	71	53	56	54	53
	Eve	58	71	50	51	47	50
	Night	59	71	48	50	50	51
2/22/2013 Friday	Day	61	71	58	57	59	53
	Eve	66	71	60	60	63	55
	Night	62	71	55	55	55	53
2/23/2013 Saturday	Day	63	71	56	57	57	55
	Eve	56	72	49	52	50	57
	Night	62	71	50	54	56	54
2/24/2013 Sunday	Day	56	72	48	51	49	51
	Eve	57	72	62	50	47	44
	Night	57	72	54	56	56	62
2/25/2013 Monday	Day	60	73	53	58	53	53
	Eve	57	73	54	50	51	50
	Night	59	72	51	49	50	51

Table 2 Example Calculations (Lansing Circle)

	2 Motors/Pumps (Avg and Max)		Train Movement (Avg)		Train Movement (Max)	
	(ft)	(dB)	(ft)	(dB)	(ft)	(dB)
Source Sound Pressure Level (dBA)		87		69		81
Reference Distance	5		50		200	
Distance to Receiver	2,700		2,700		2,700	
Attenuation with Distance	7.5 dB/dd	- 68	7.5 dB/dd	- 43	7.5 dB/dd	- 28
Shielding from 8' Containment Wall and/or Tanks		- 8		- 5		- 5
Uncertainty due to Atmospheric Effects		+/- 10		+/- 10		+/- 10
Estimated Noise Levels (dBA)		**1 - 21**		**11 - 31**		**38 - 58**

Table 3 Estimated Project Noise Level at Nearby Residences

Street	Distance (ft)	Maximum Noise Levels from 2 Pumps with Motors (dBA)	Average Noise Levels from Train Movements (dBA)	Maximum Noise Levels from Train Movements (dBA
Lansing Circle	2,700	1 – 21	11 – 31	38 – 58
Piercy Dr	2,900	0 – 20	10 – 30	37 – 57
Columbia Circle	3,600	0 – 18	8 – 28	35 – 55
Allen Way	4,000	0 – 17	7 – 27	34 – 54
Carlisle Way	4,700	0 – 15	5 – 25	32 – 52
Tennys Drive	5,500	0 – 13	3 – 23	30 – 50
El Bonito Way	4,600	0 – 15	5 – 25	32 – 52

Note: Levels less than 0 dB are shown as 0 dB even though negative decibels are viable

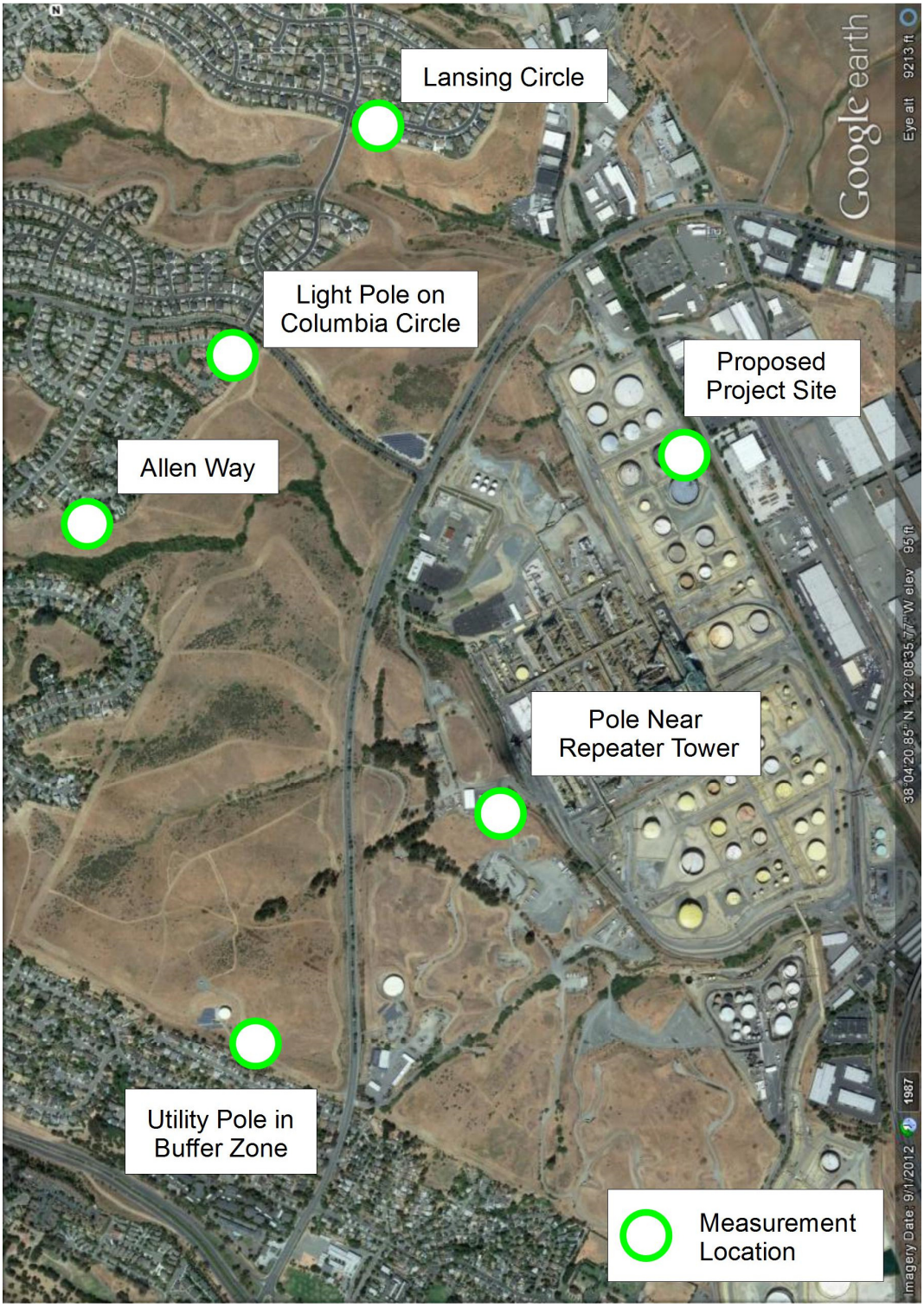


Figure 1 Existing Ambient Noise Measurement Locations

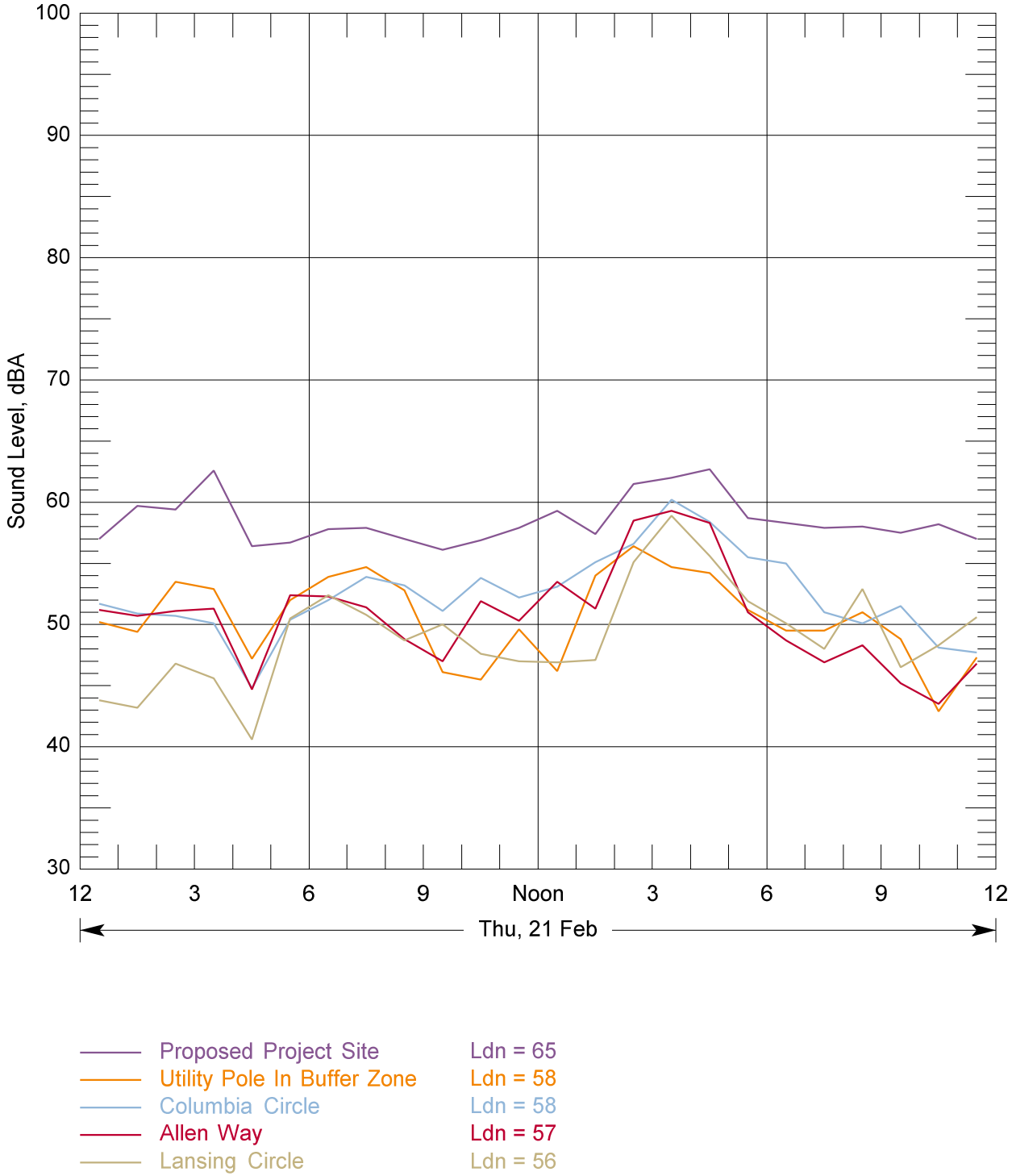


Figure 2 Thursday, Feb. 21

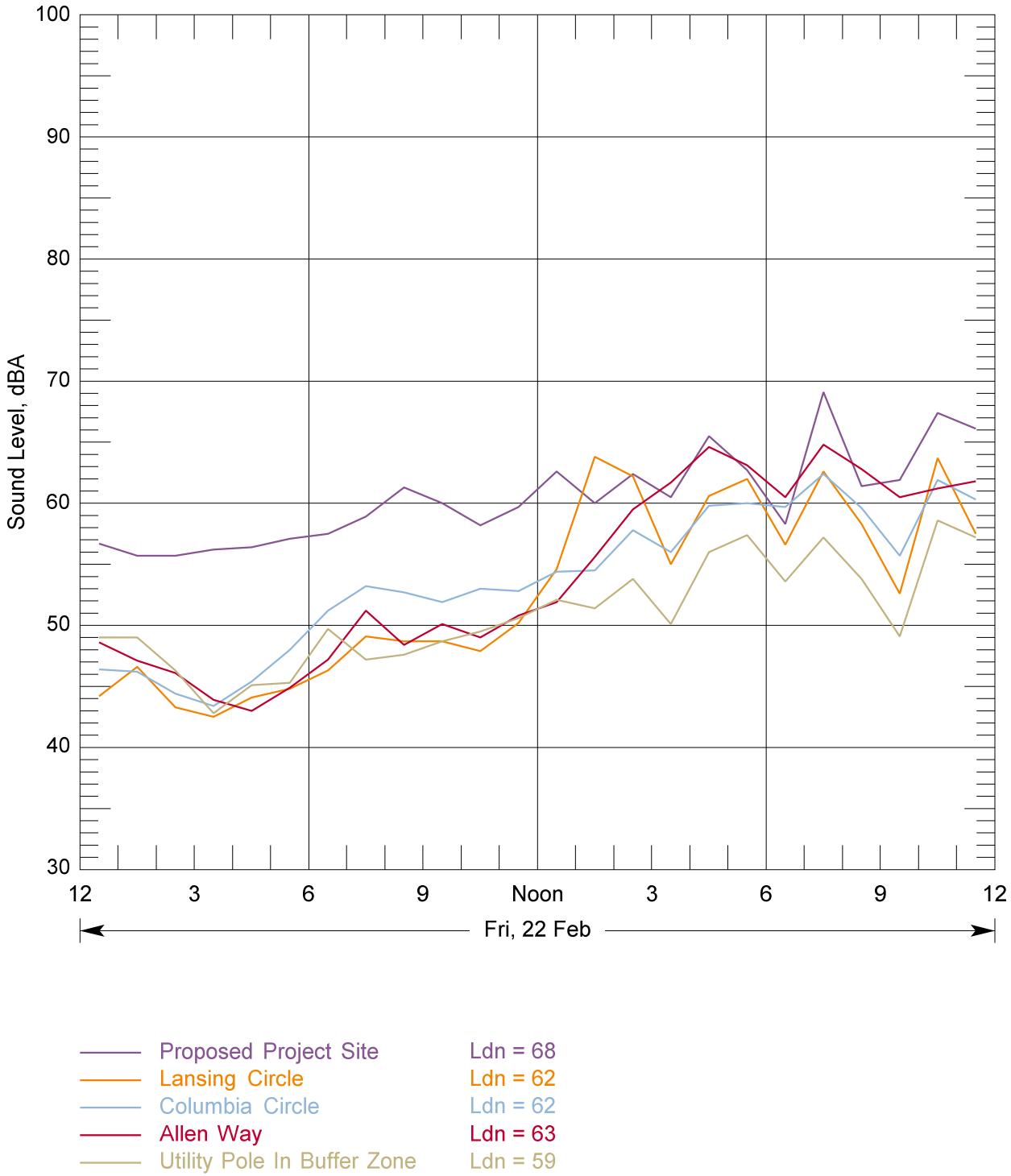
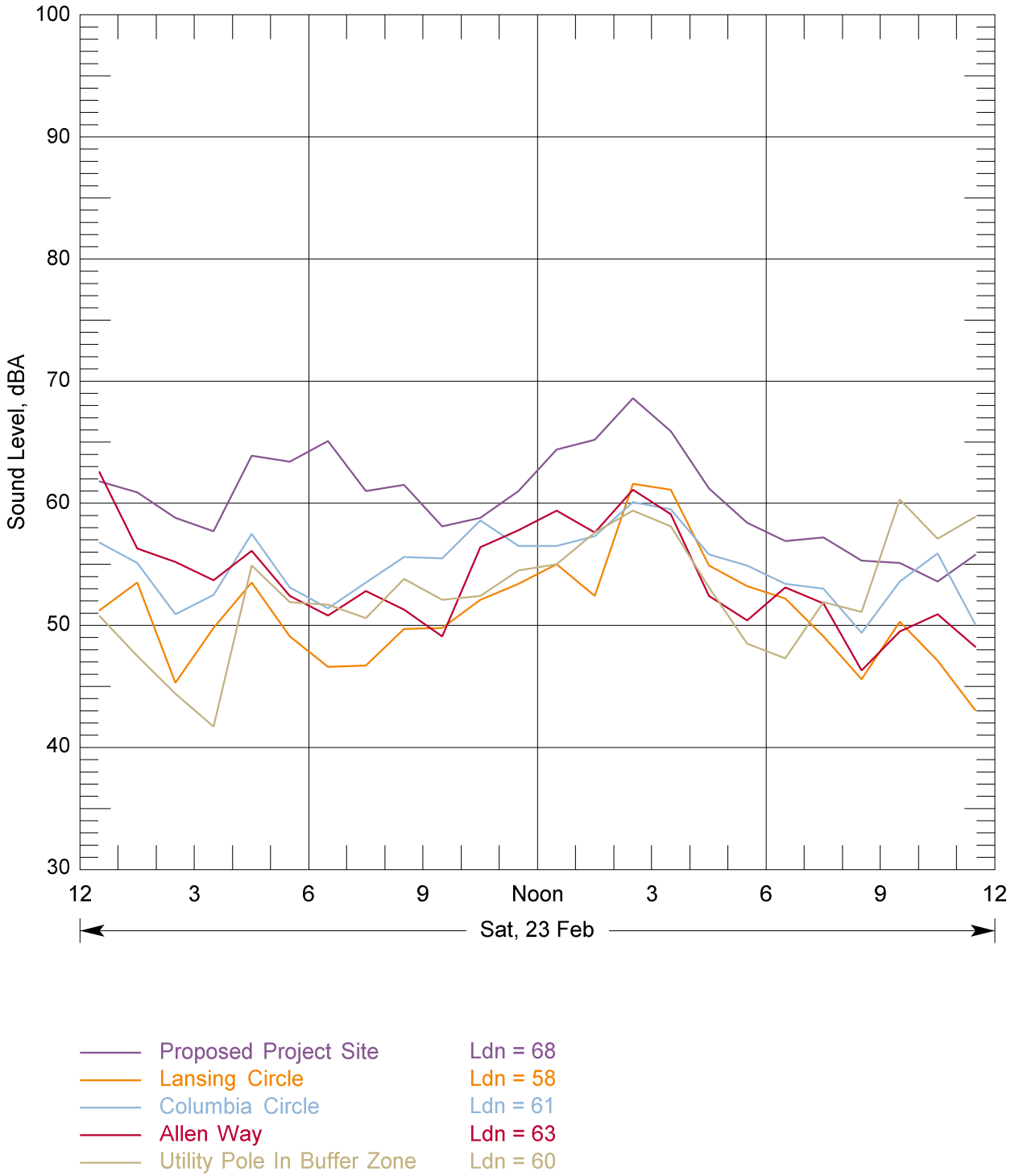


Figure 3 Friday, Feb. 22



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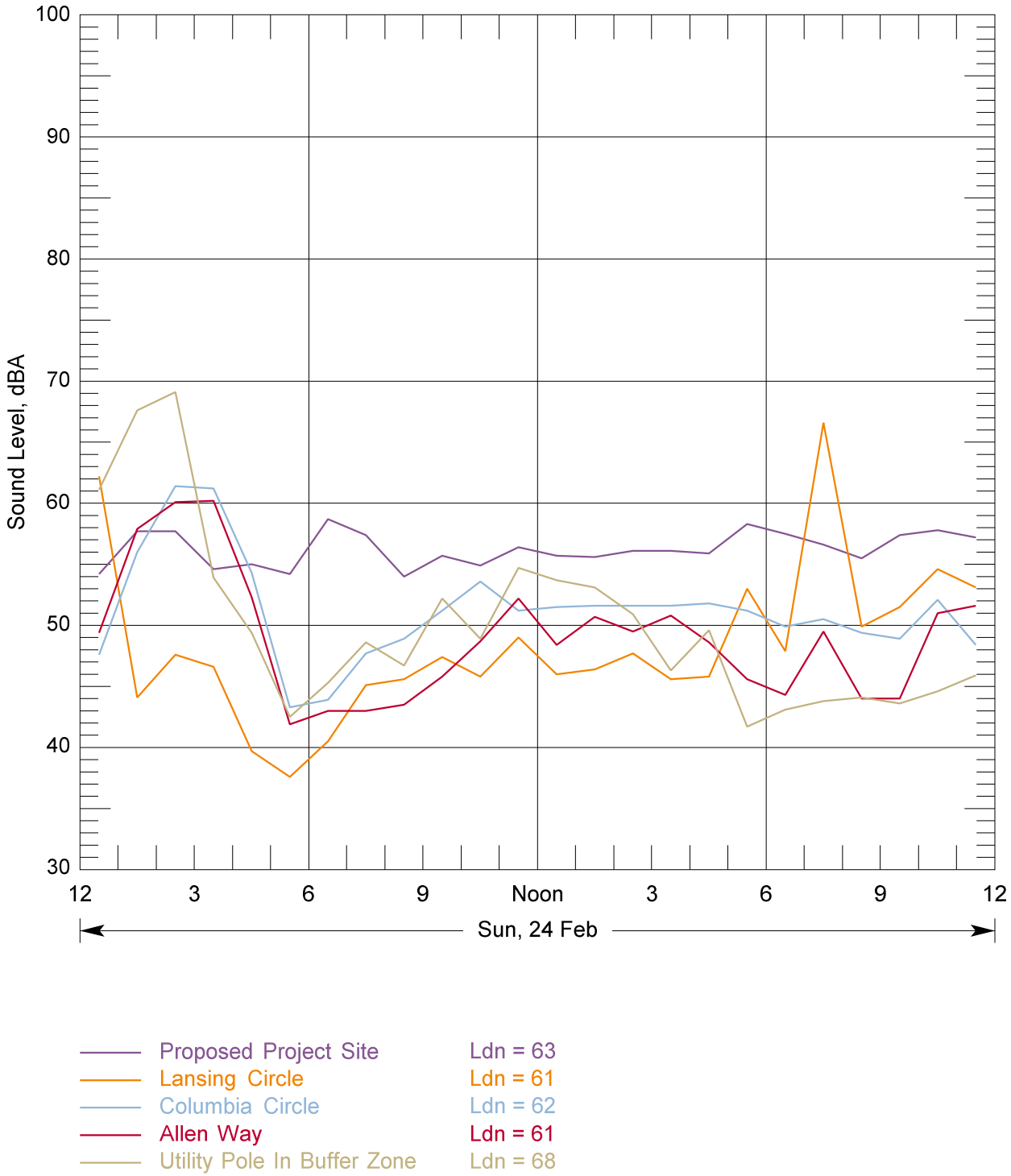

Figure 5 Sunday, Feb. 24

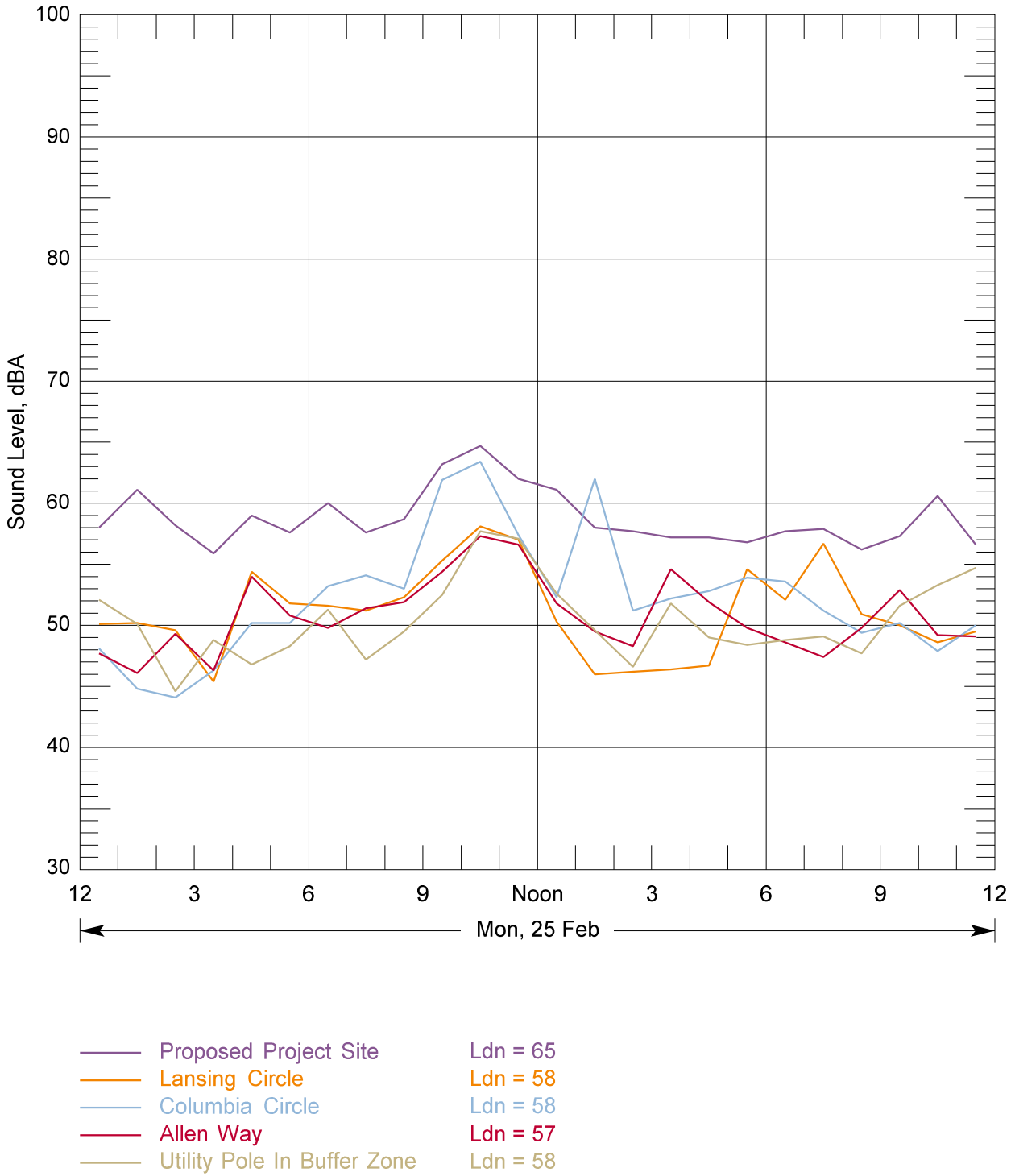

Figure 6 Monday, Feb. 25

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Ehnert, Jesse J. *Georgia Institute of Technology Carbon-Neutral Energy Solutions Laboratory Site Ambient Noise Assessment*. Tech. 2010. Print.

Harris, Cyril M. *Handbook of Acoustical Measurements and Noise Control.* New York: McGraw-Hill, 1991.

Harris Miller Miller & Hanson, Inc. *CREATE Railroad Noise Model User Guide*. Tech. 2006. Web. 4 March 2013. < http://www.fra.dot.gov/eLib/Details/L03728>

Illingworth & Rodkin, Inc. *Berths 136-147 [TraPac] Container Terminal Project Final Environmental Impact Statement / Final Environmental Impact Report (FEIS/FEIR) Chapter 3.9*. Tech. 2005. Web. 4 March 2013. <http://www.portoflosangeles.org/EIR/TraPac/FEIR/FEIR_3G_Chapter%20_3.9_Noise.pdf>

U.S. Environmental Protection Agency Office of Noise Abatement and Control. *Background Document for Proposed Revision to Rail Carrier Noise Emission Regulation*. Tech. 1979. Web. 4 March 2013. < nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100OOE0.txt>

Appendix: Detailed Noise Measurement Data

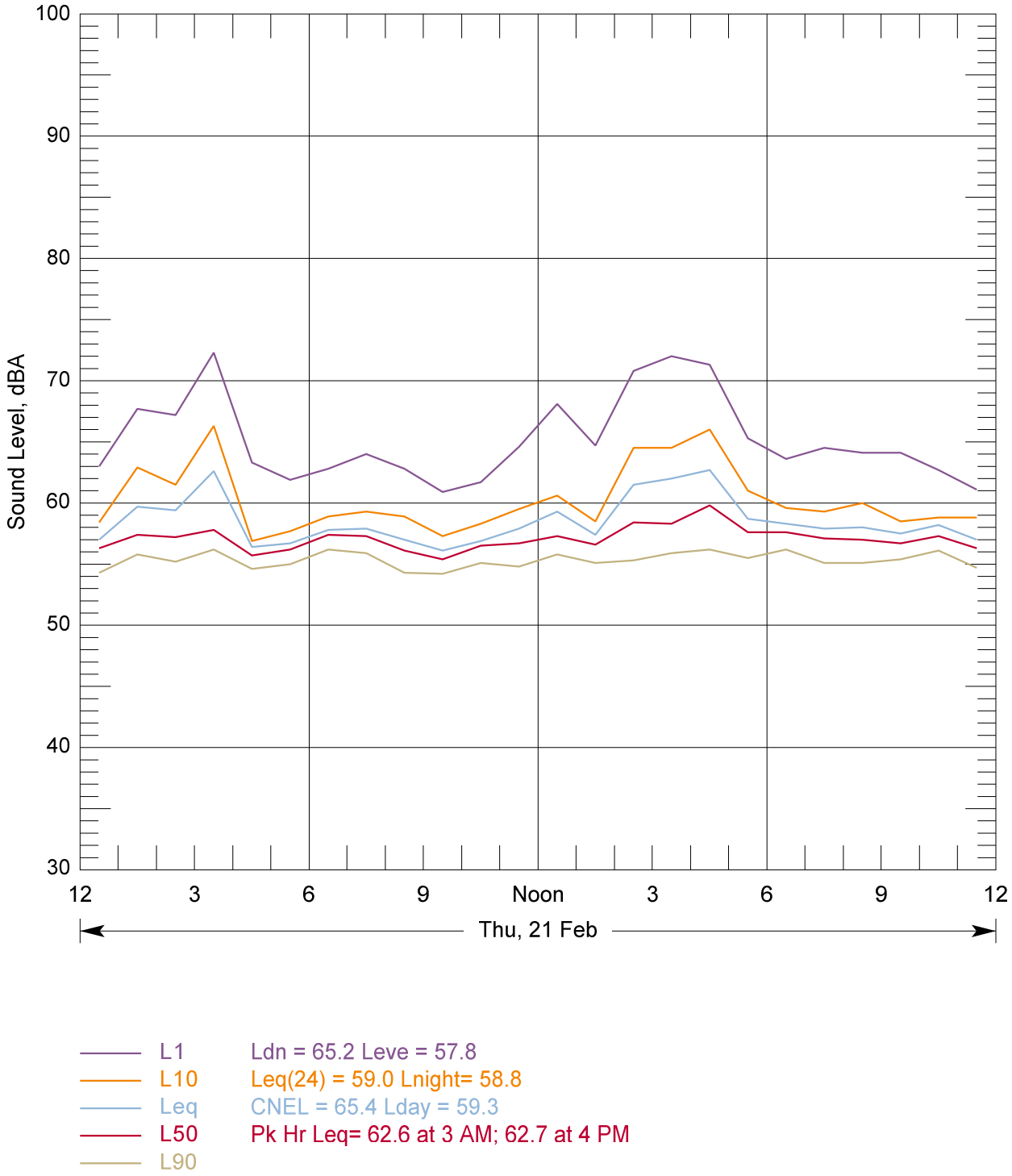


Figure A1-1: Proposed Project Site - Feb. 21, 2013

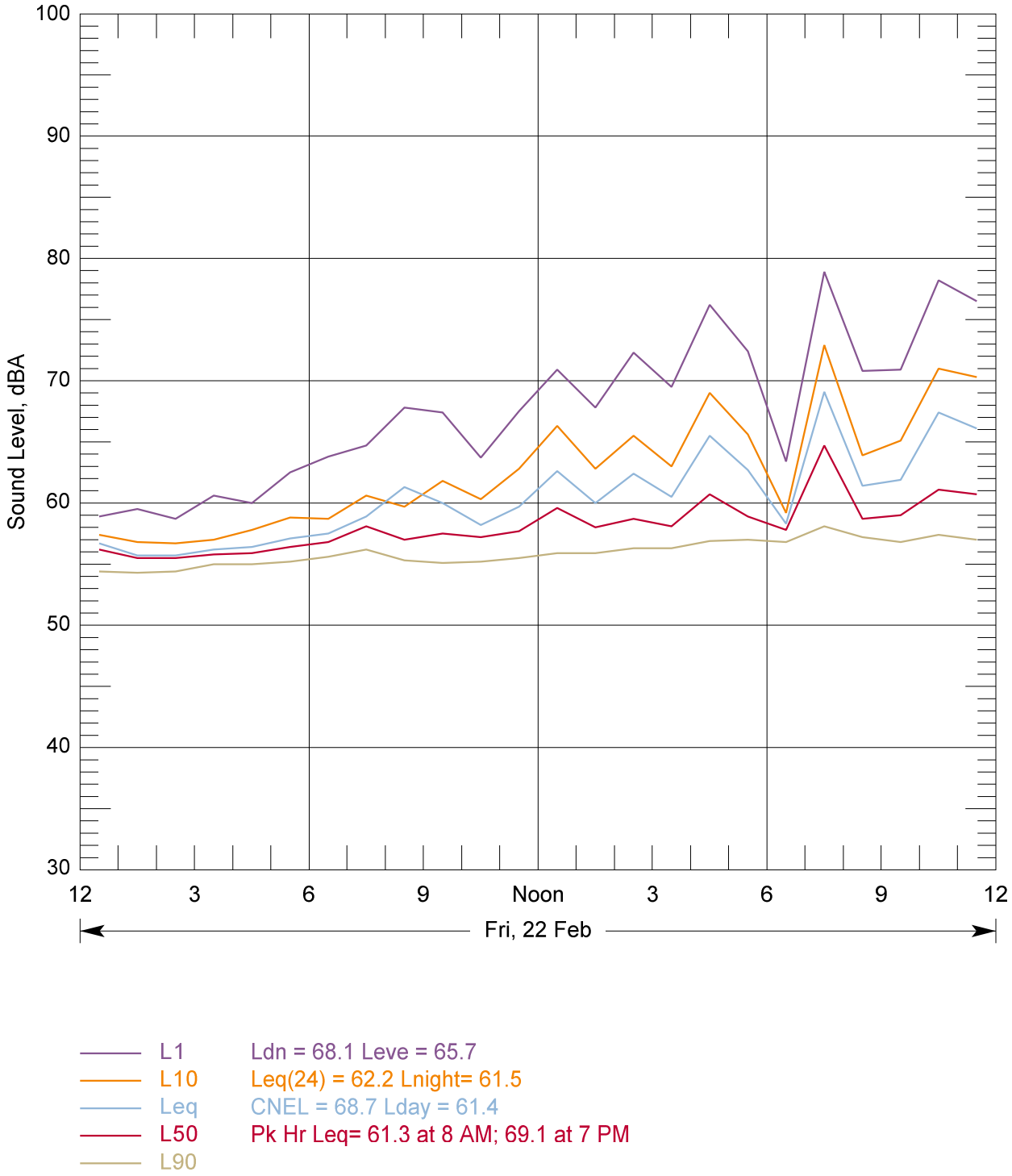


Figure A1-2: Proposed Project Site - Feb. 22, 2013

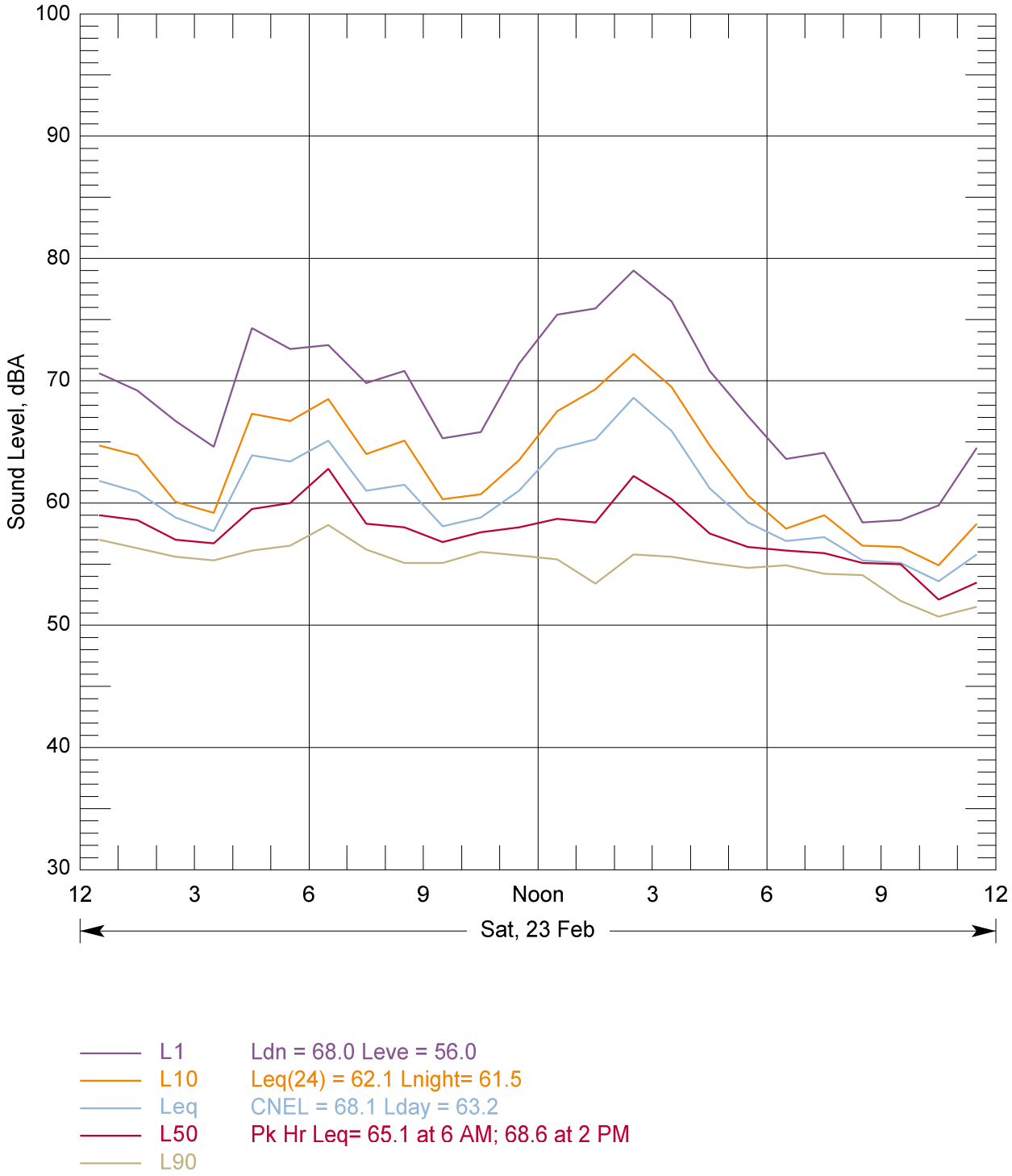


Figure A1-3: Proposed Project Site - Feb. 23, 2013

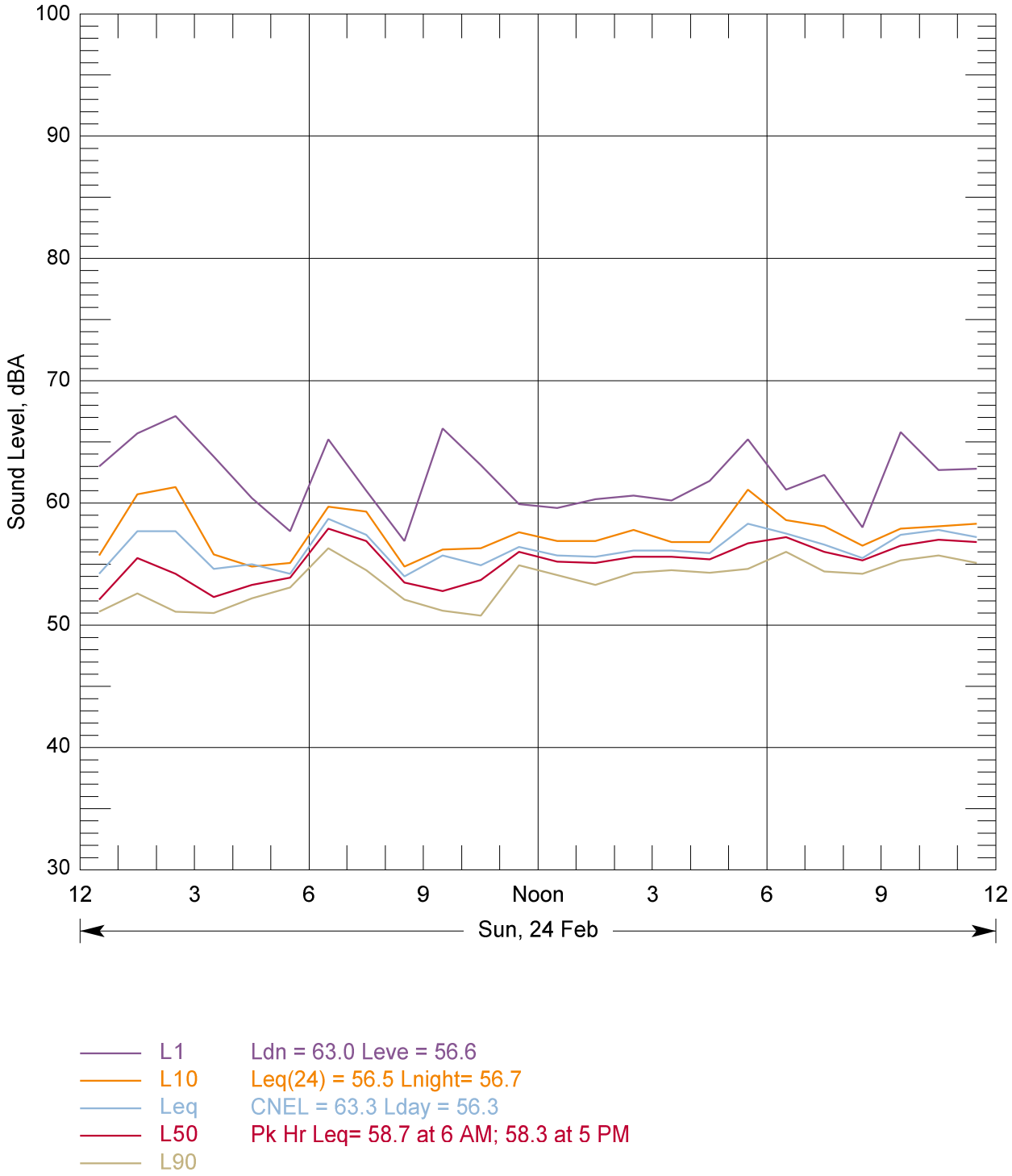


Figure A1-4: Proposed Project Site - Feb. 24, 2013

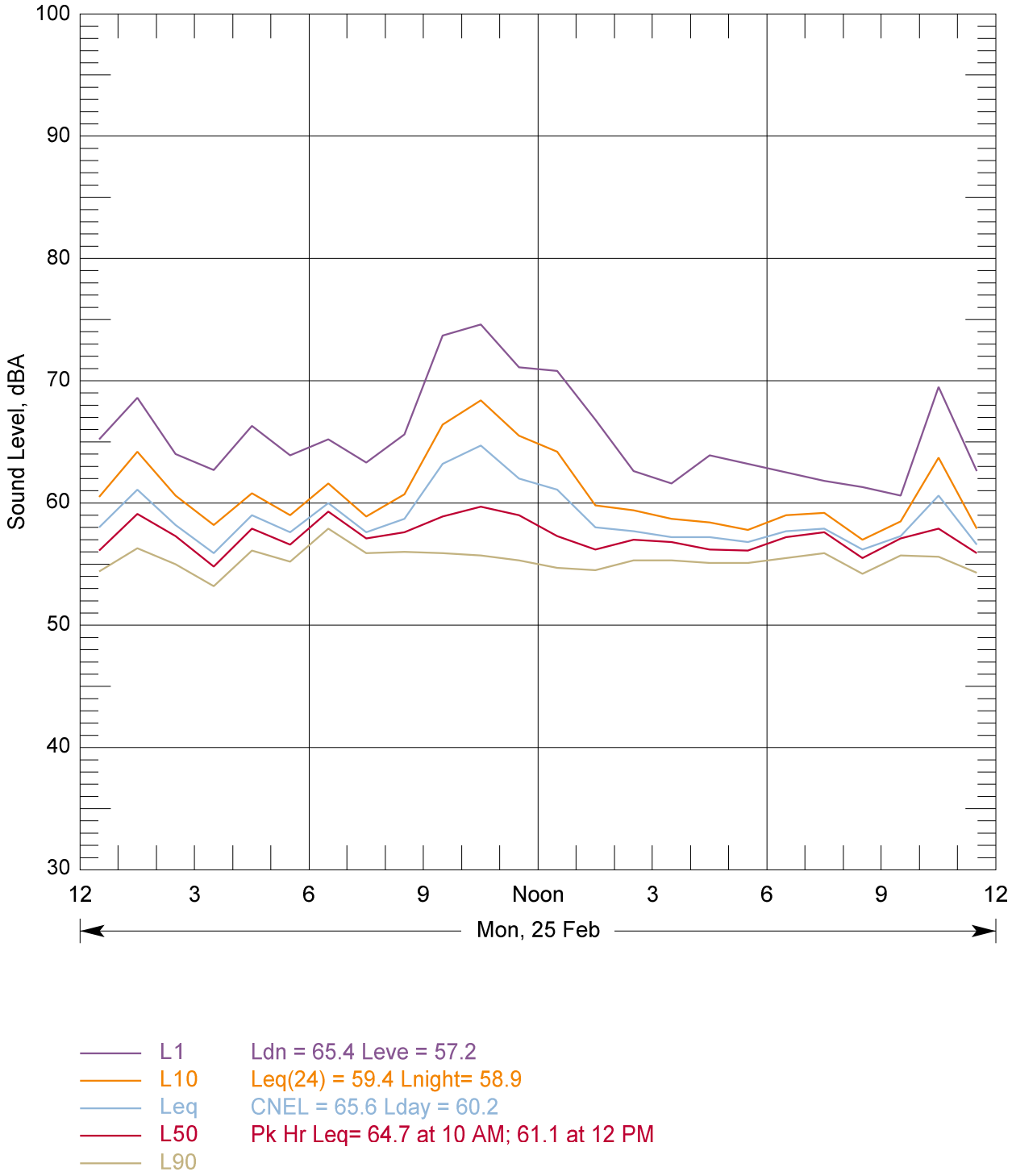


Figure A1-5: Proposed Project Site - Feb. 25, 2013

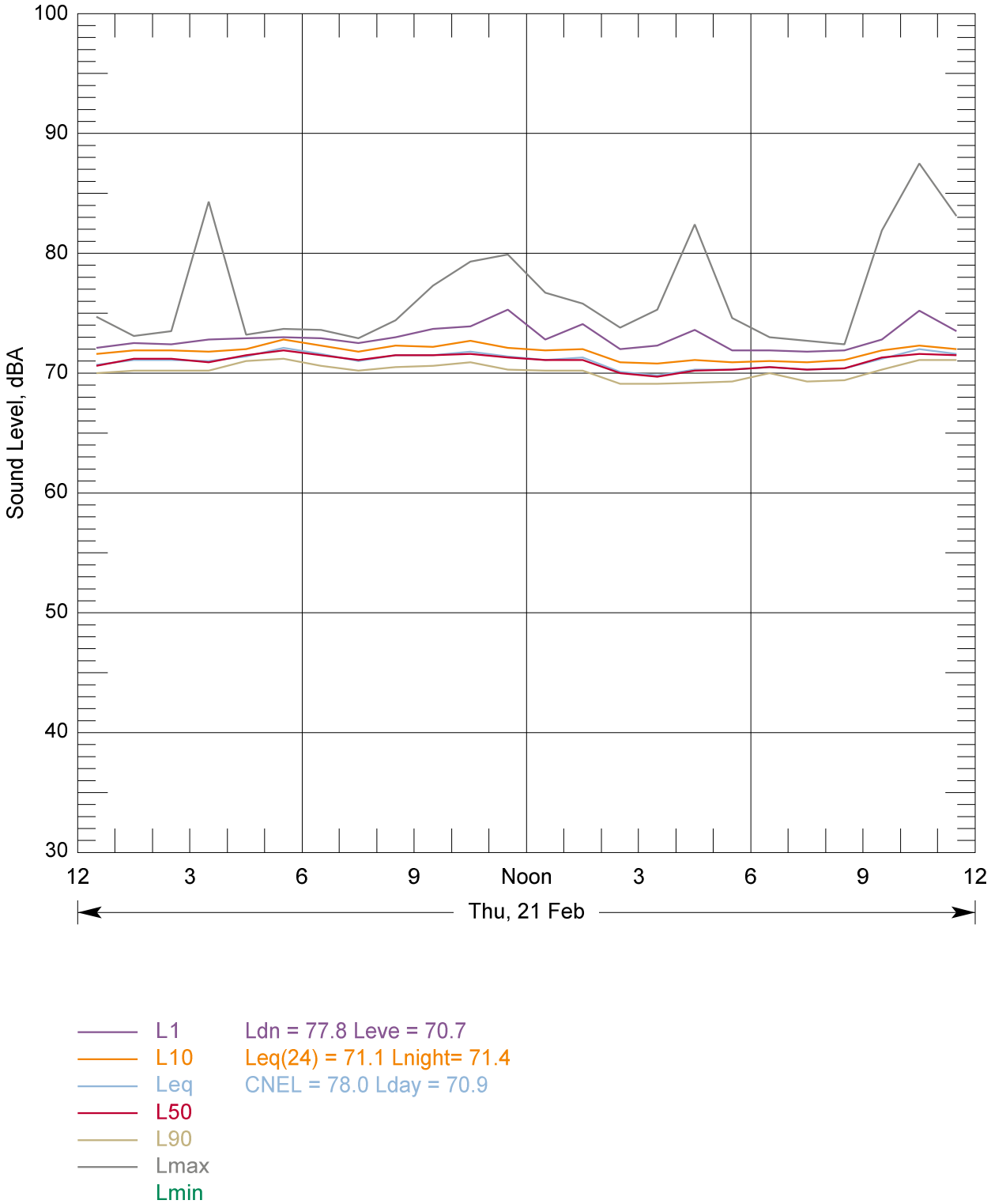
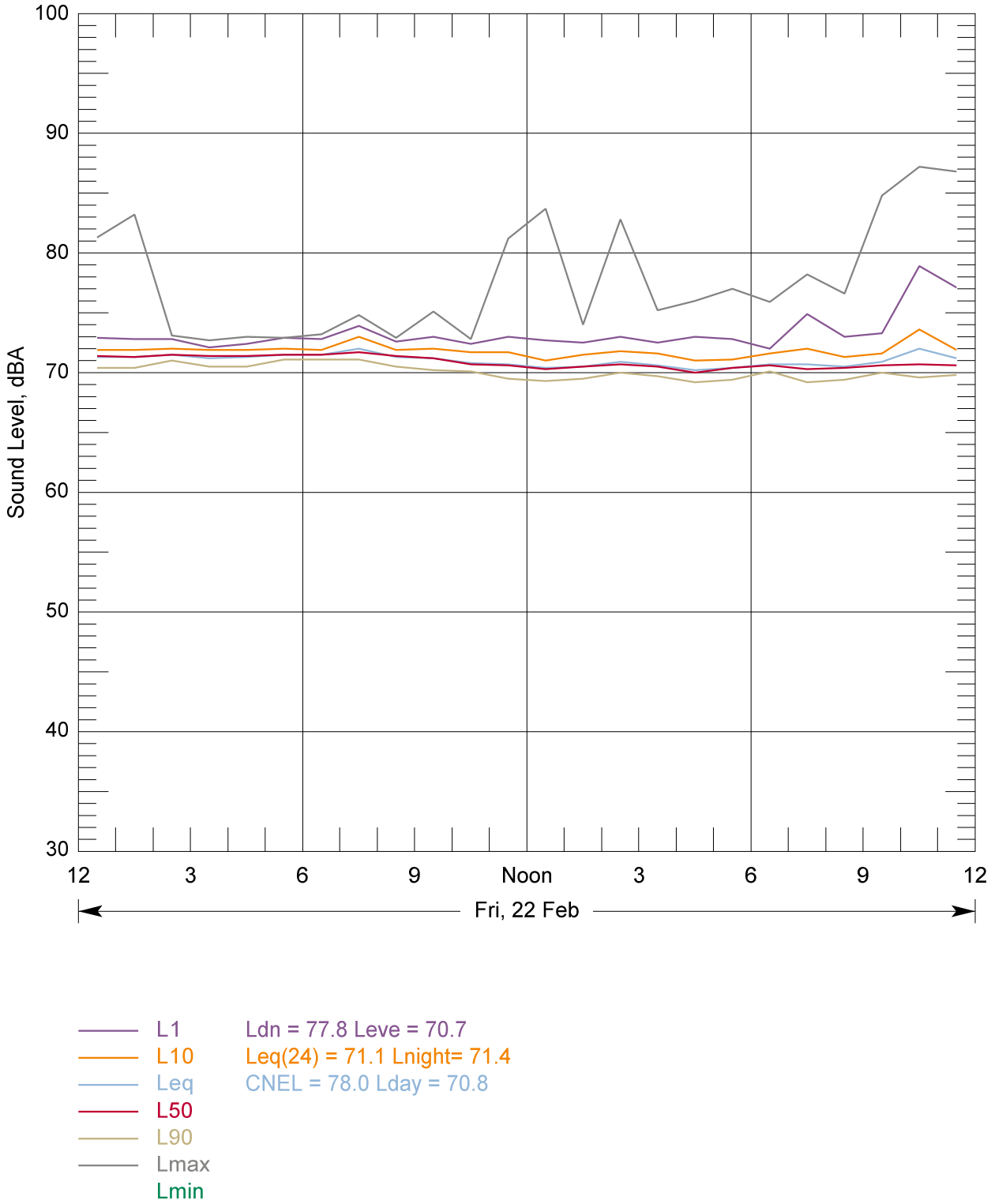


Figure A2-1: Pole Near Repeater Tower - Feb. 21, 2013



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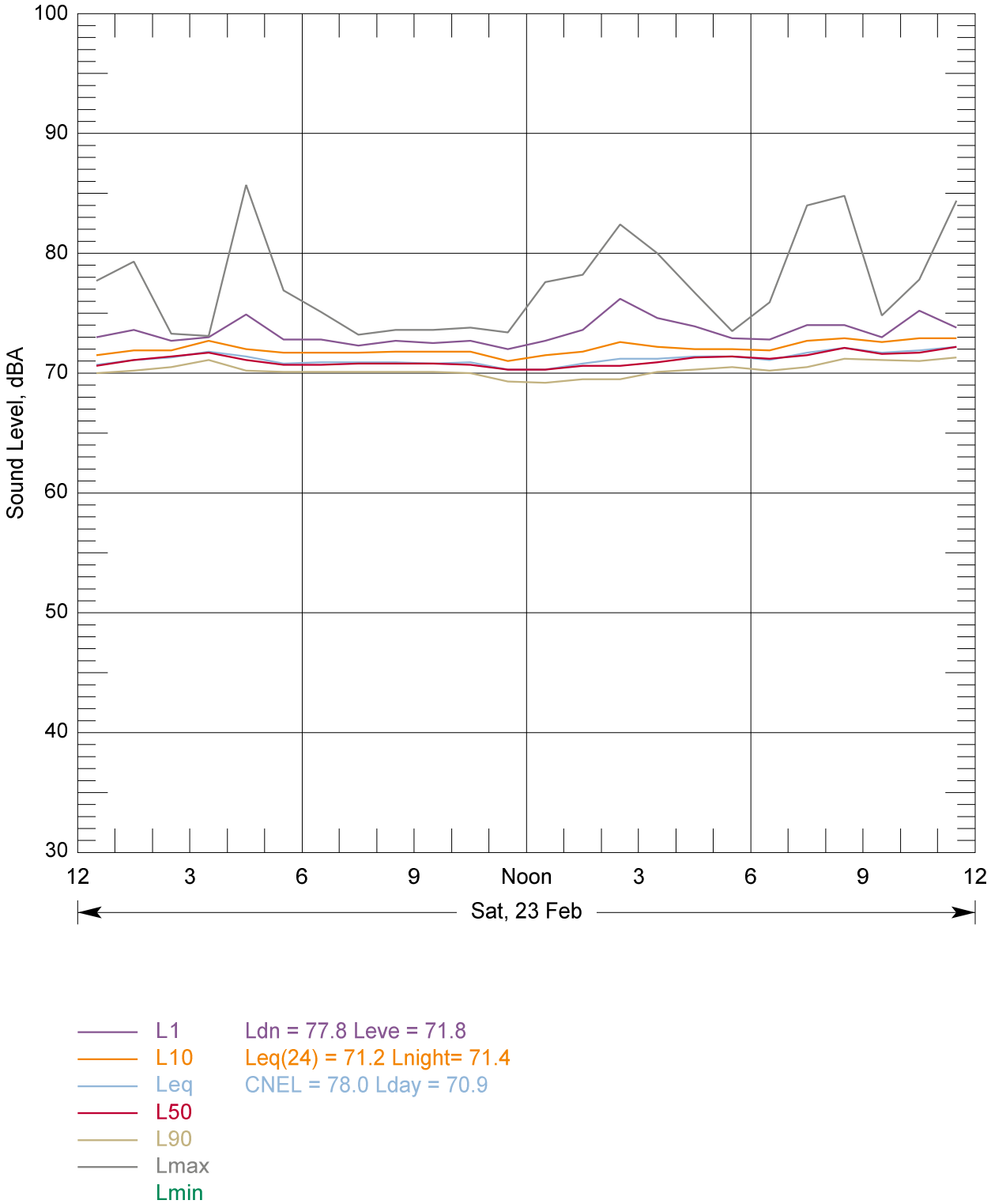

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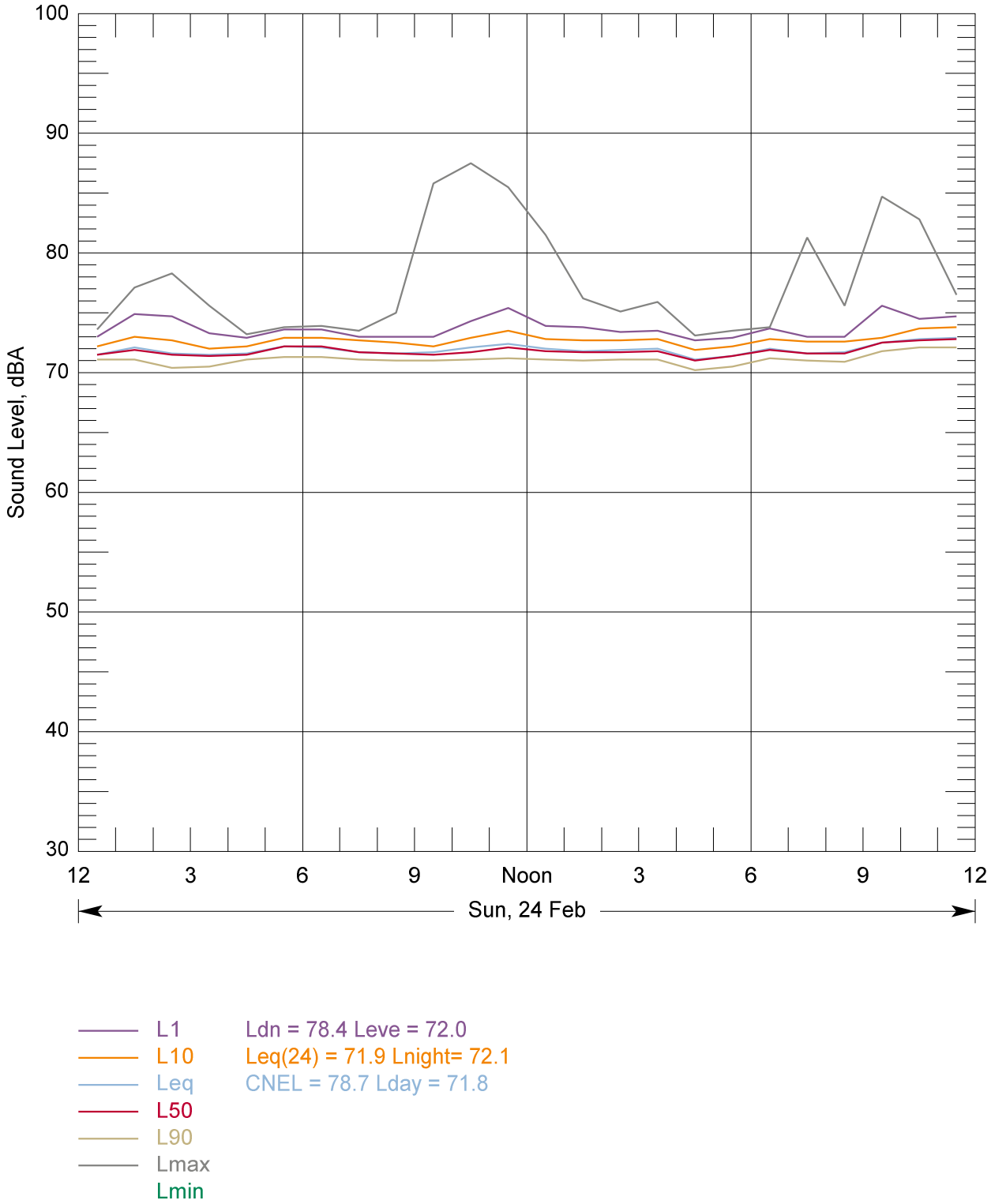

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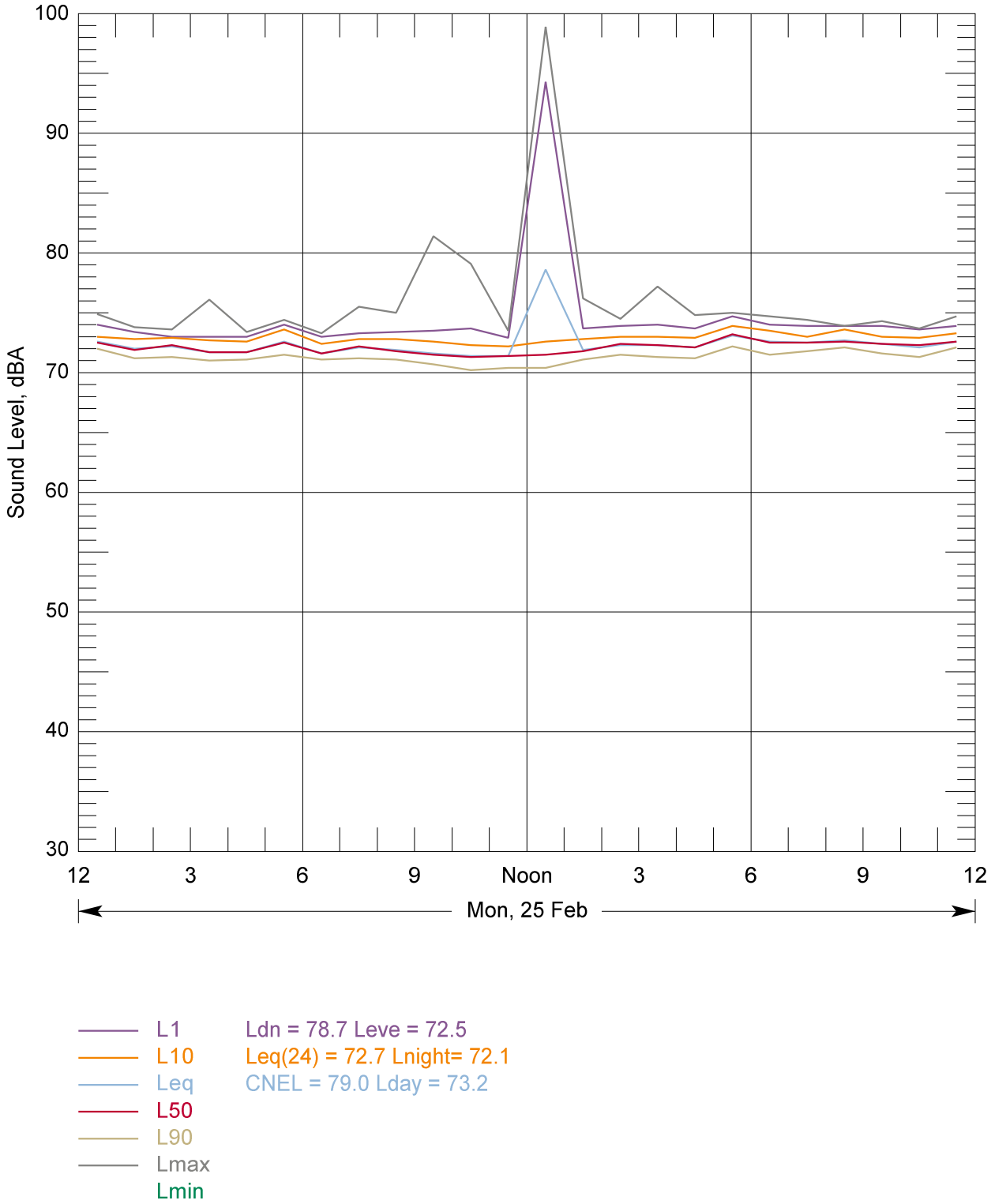

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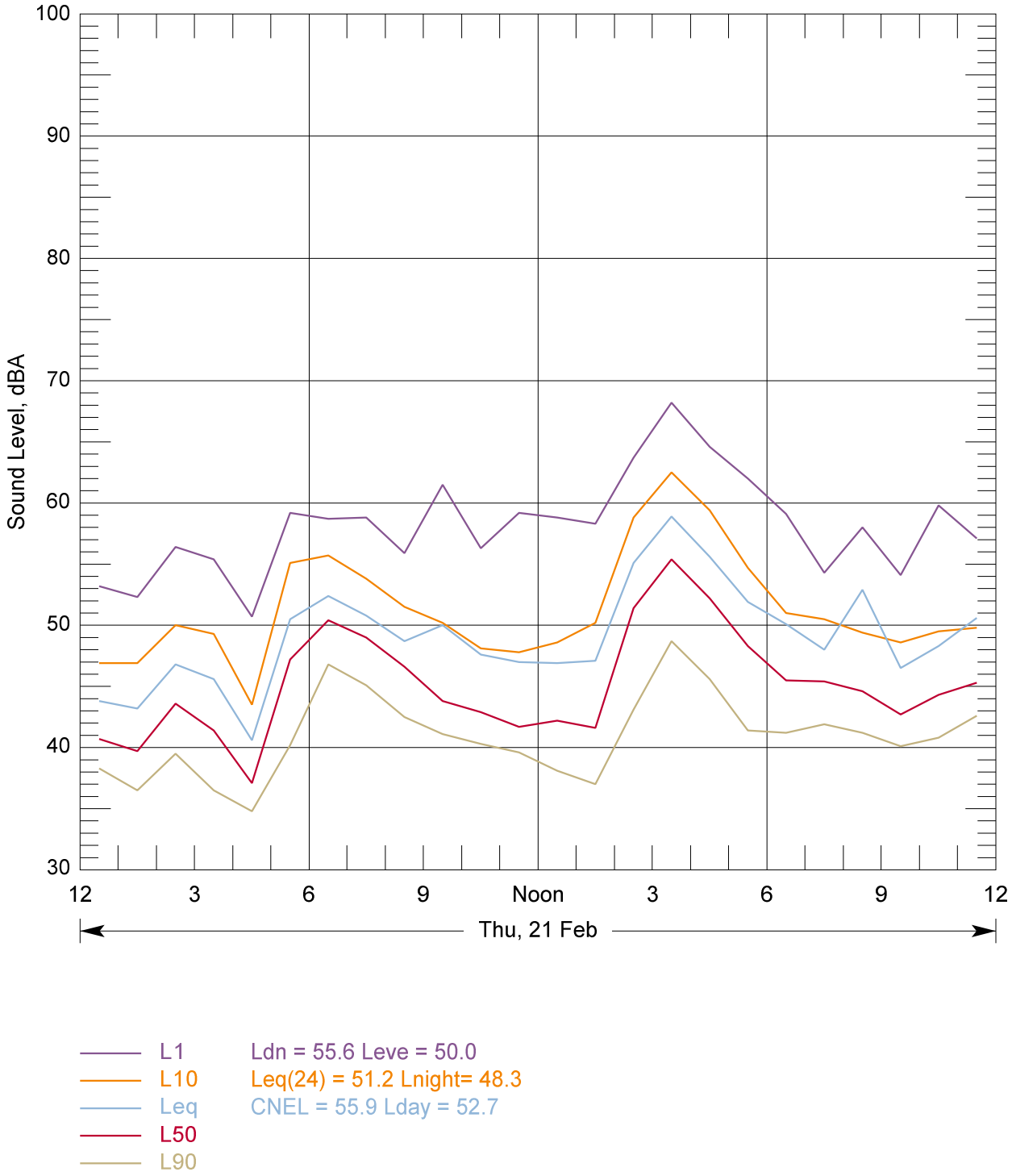
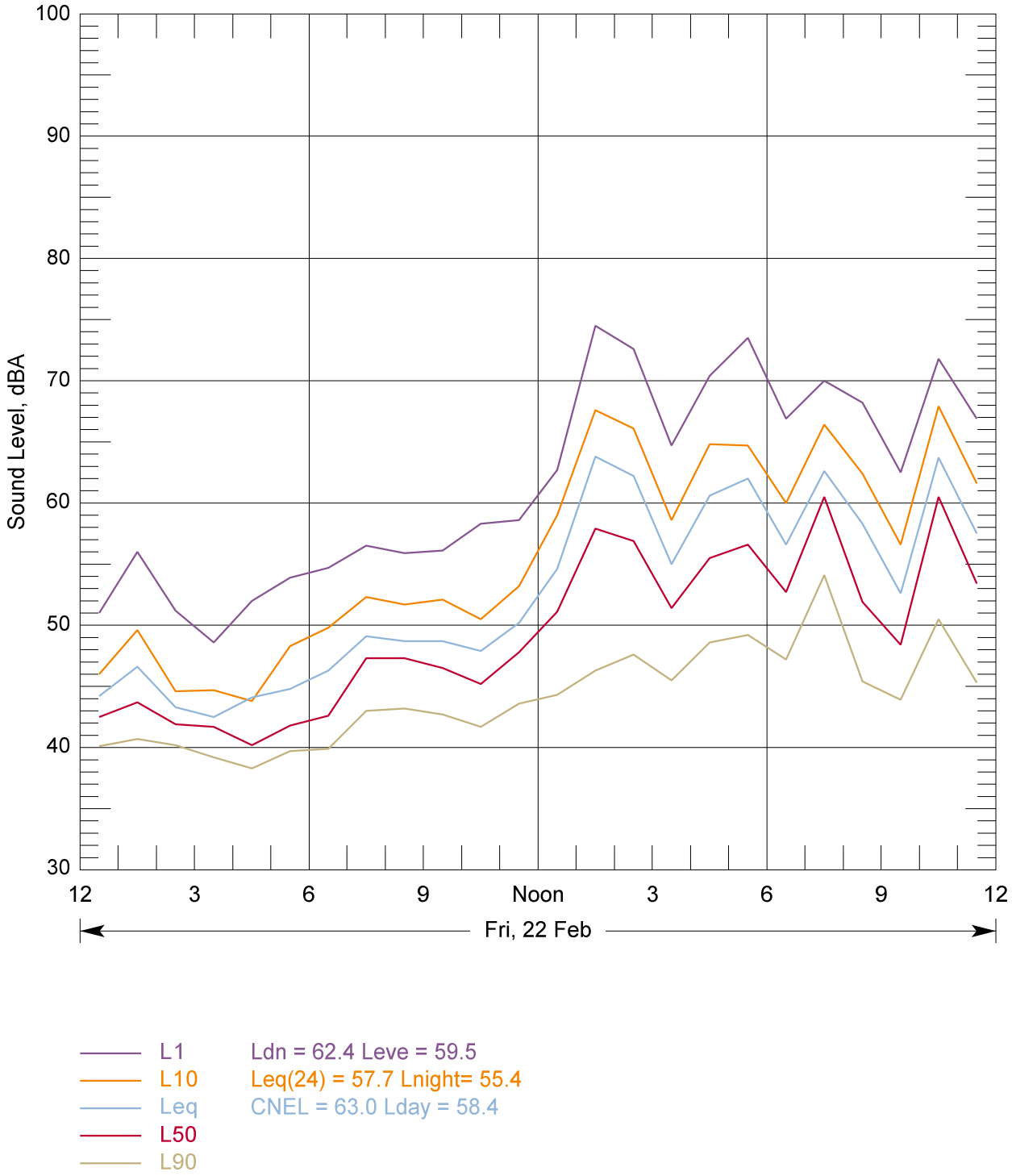


Figure A3-1: Lansing Circle - Feb. 21, 2013



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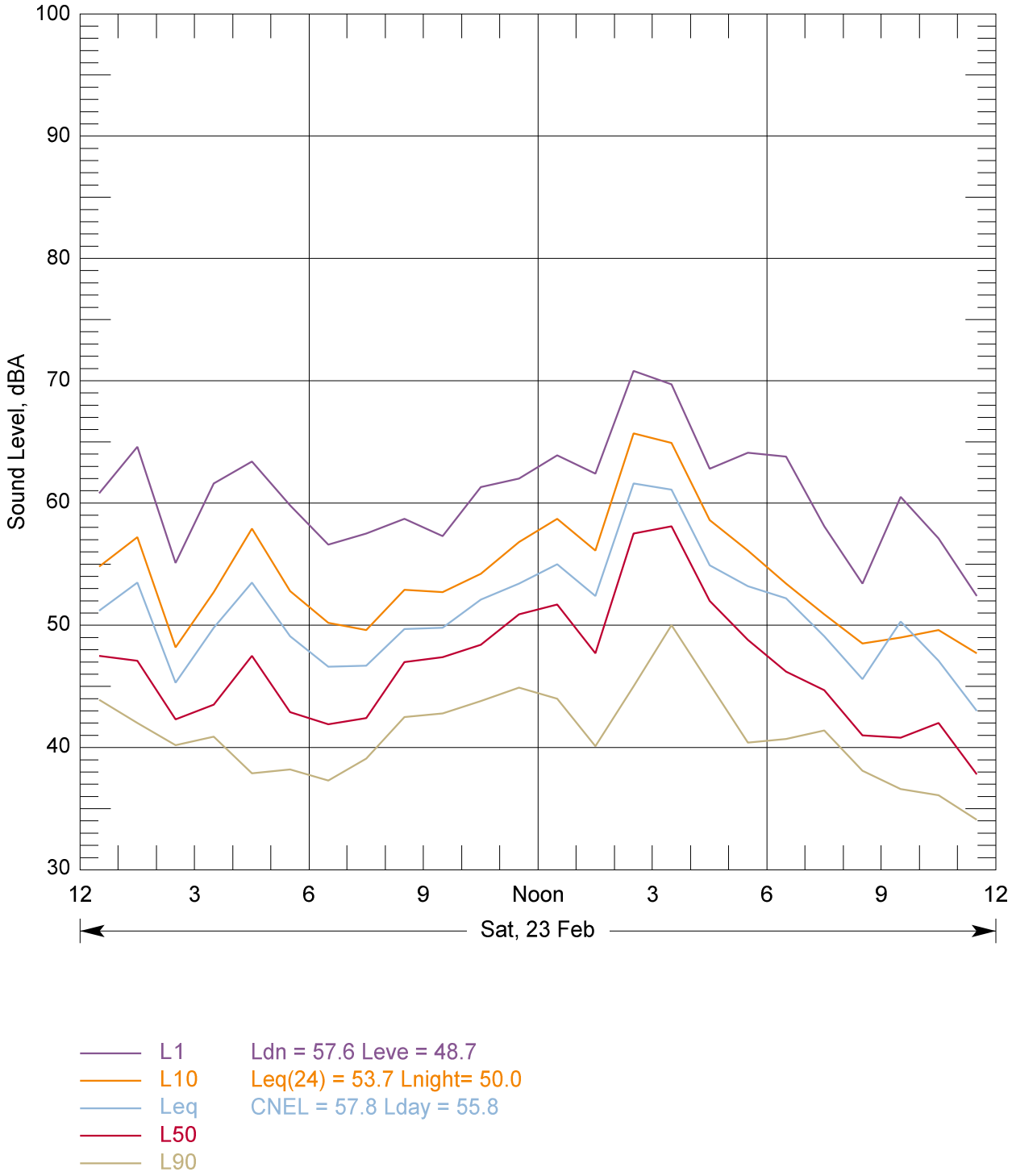

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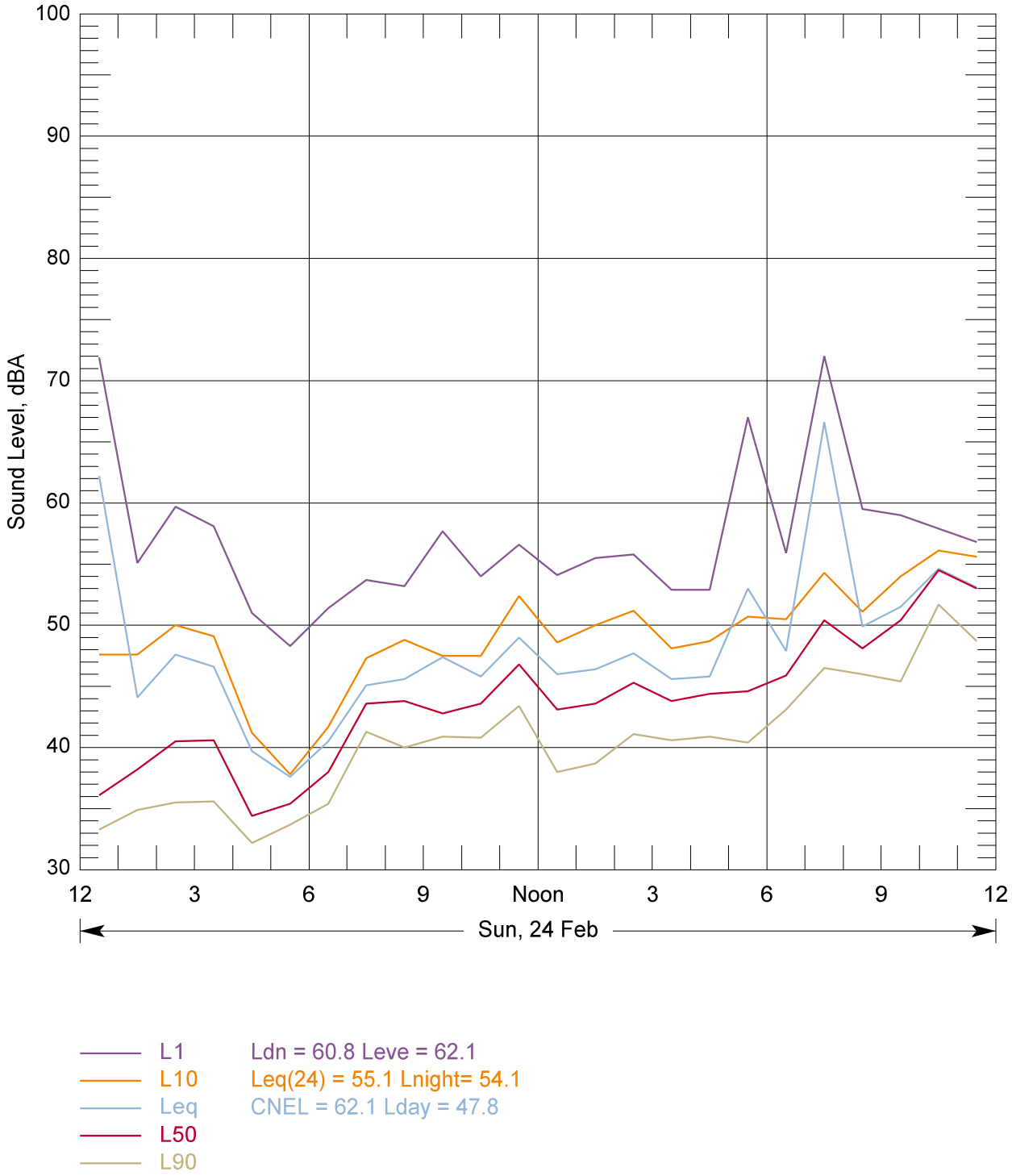

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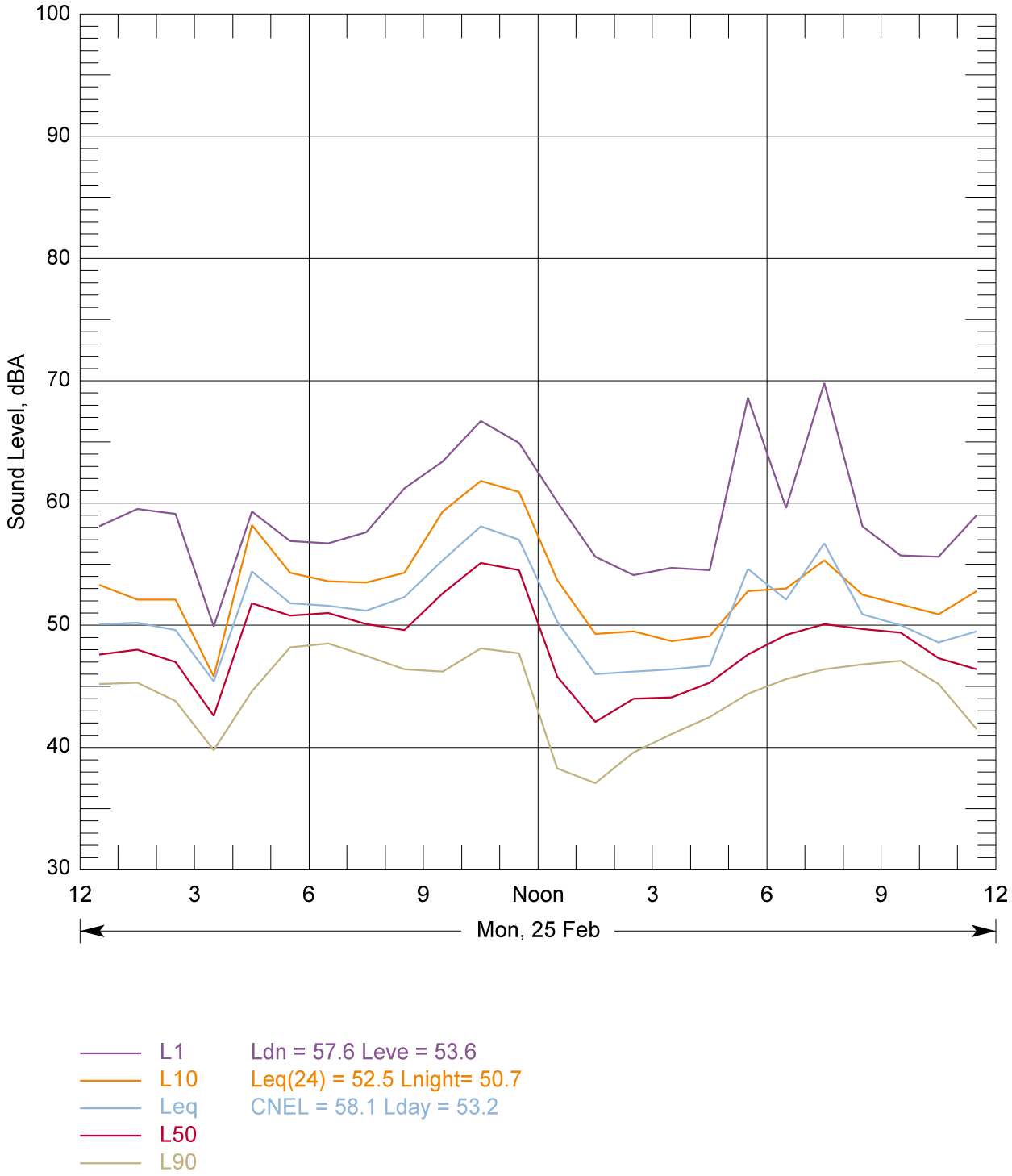

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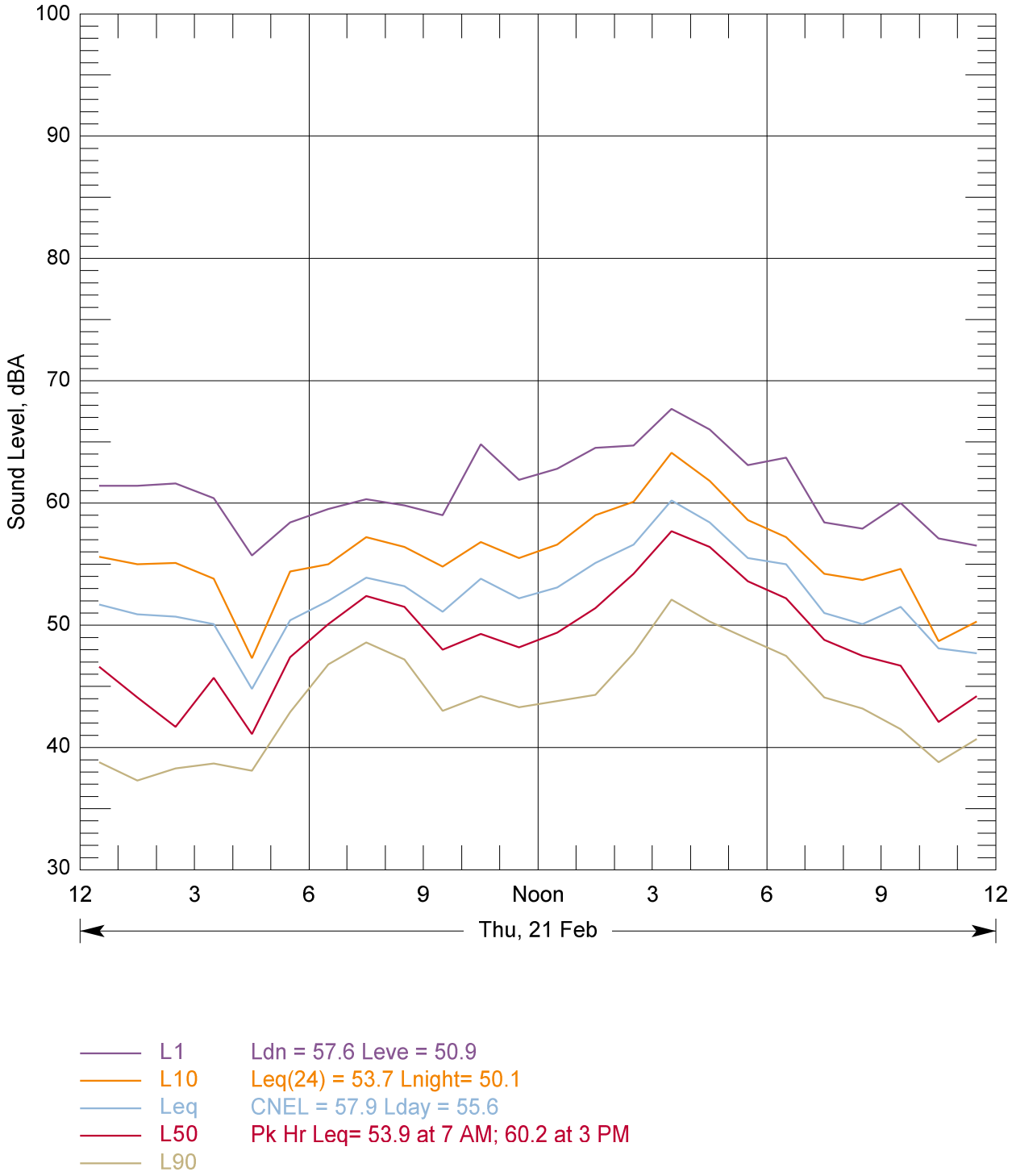

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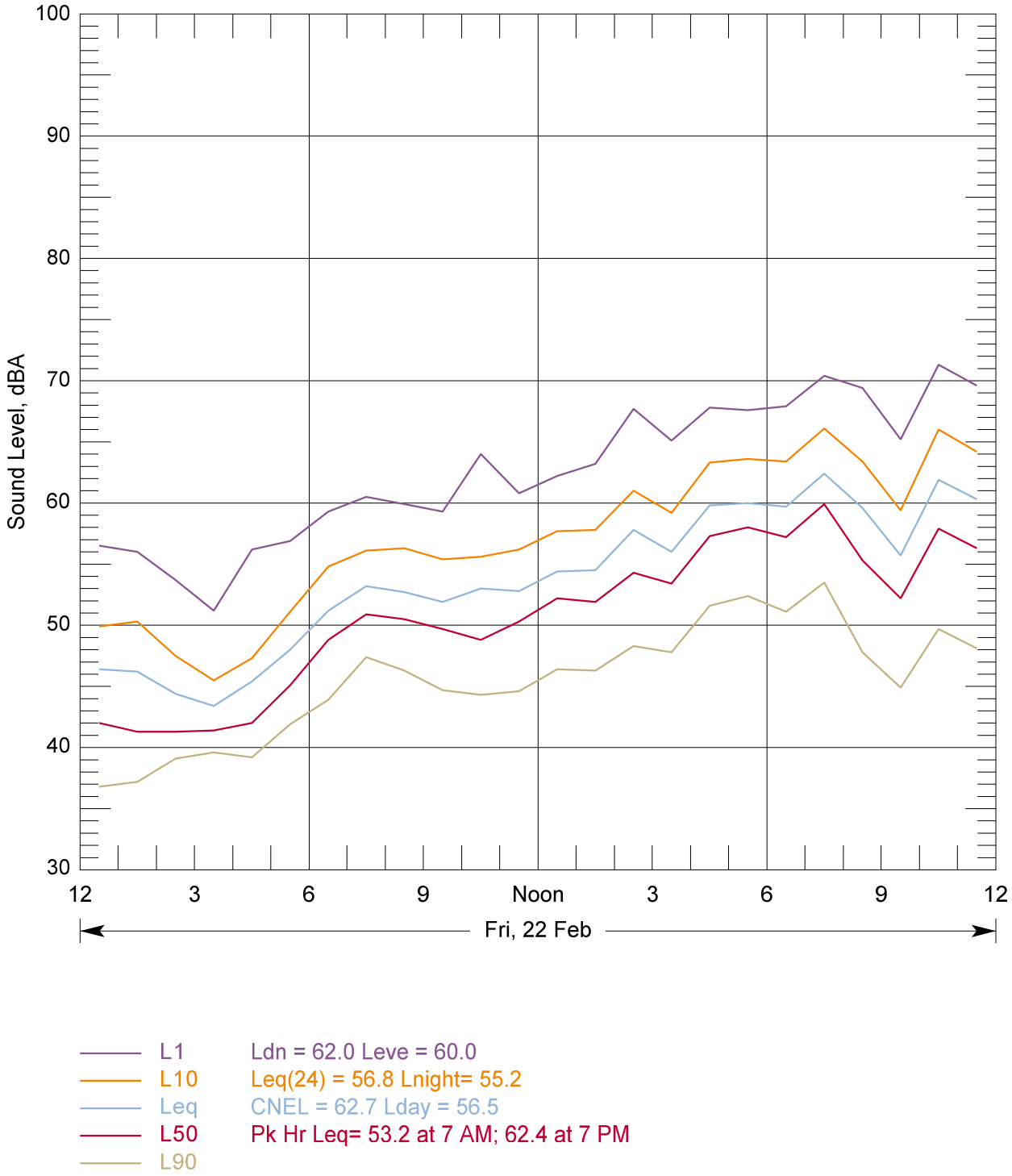

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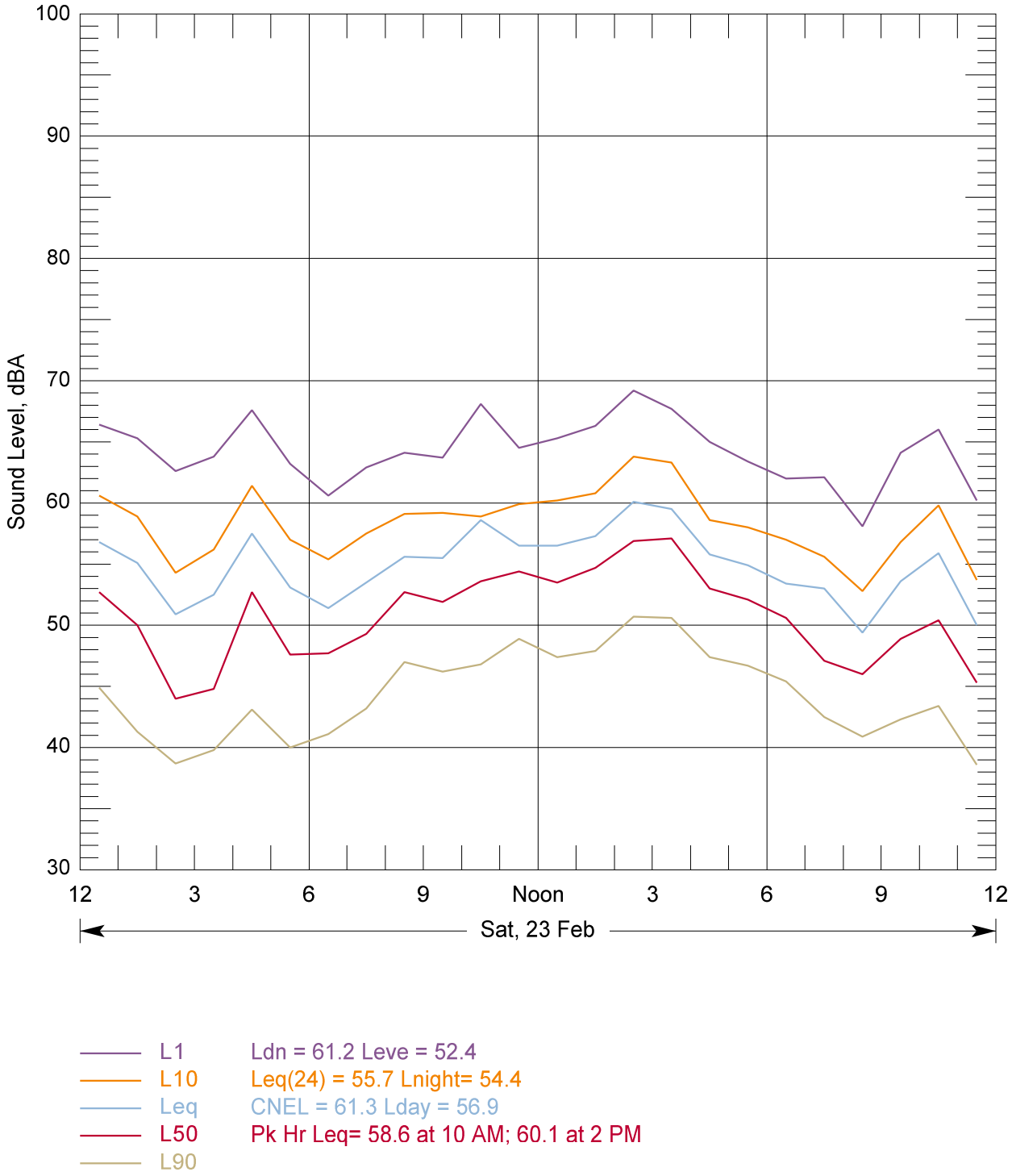

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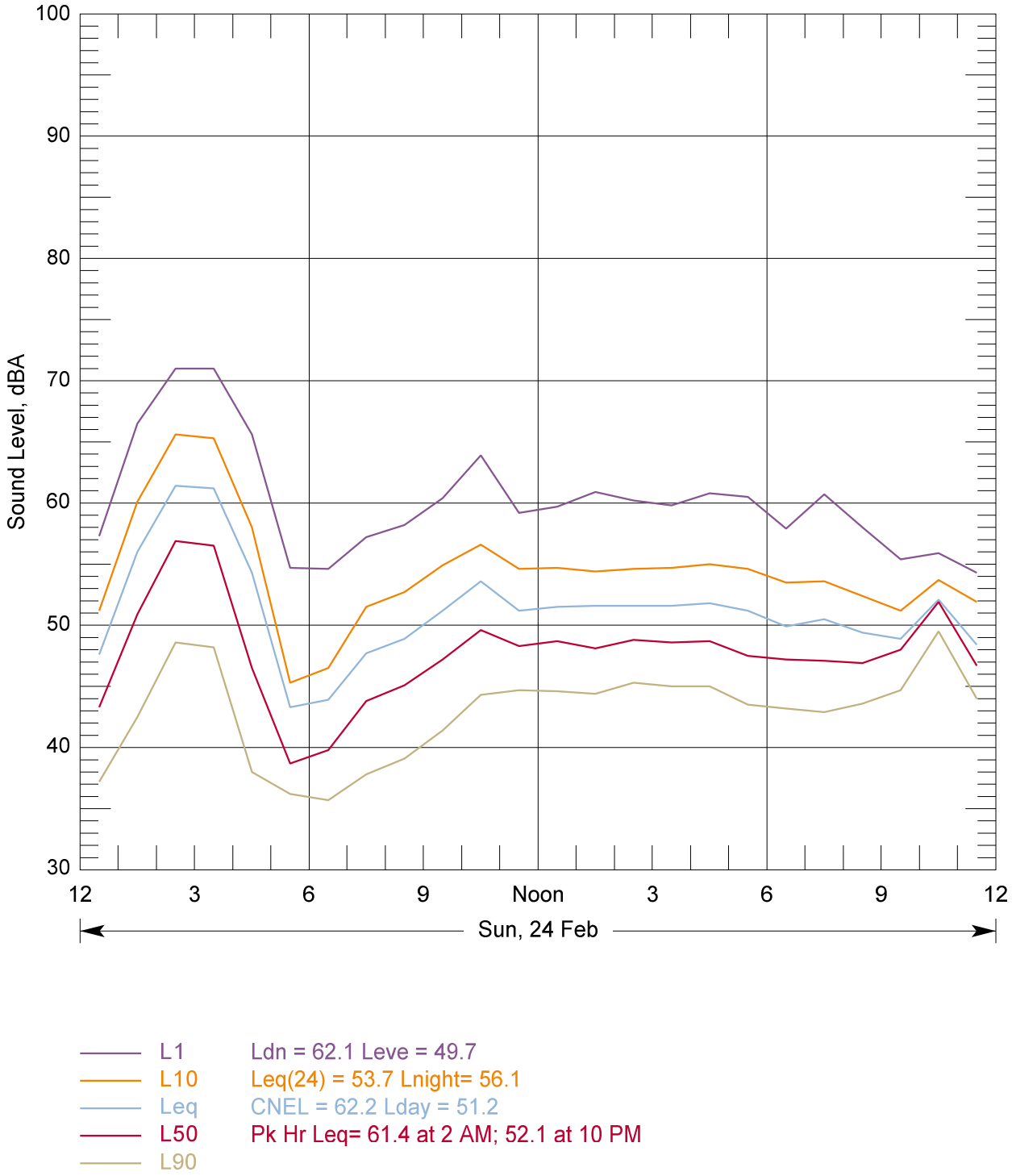

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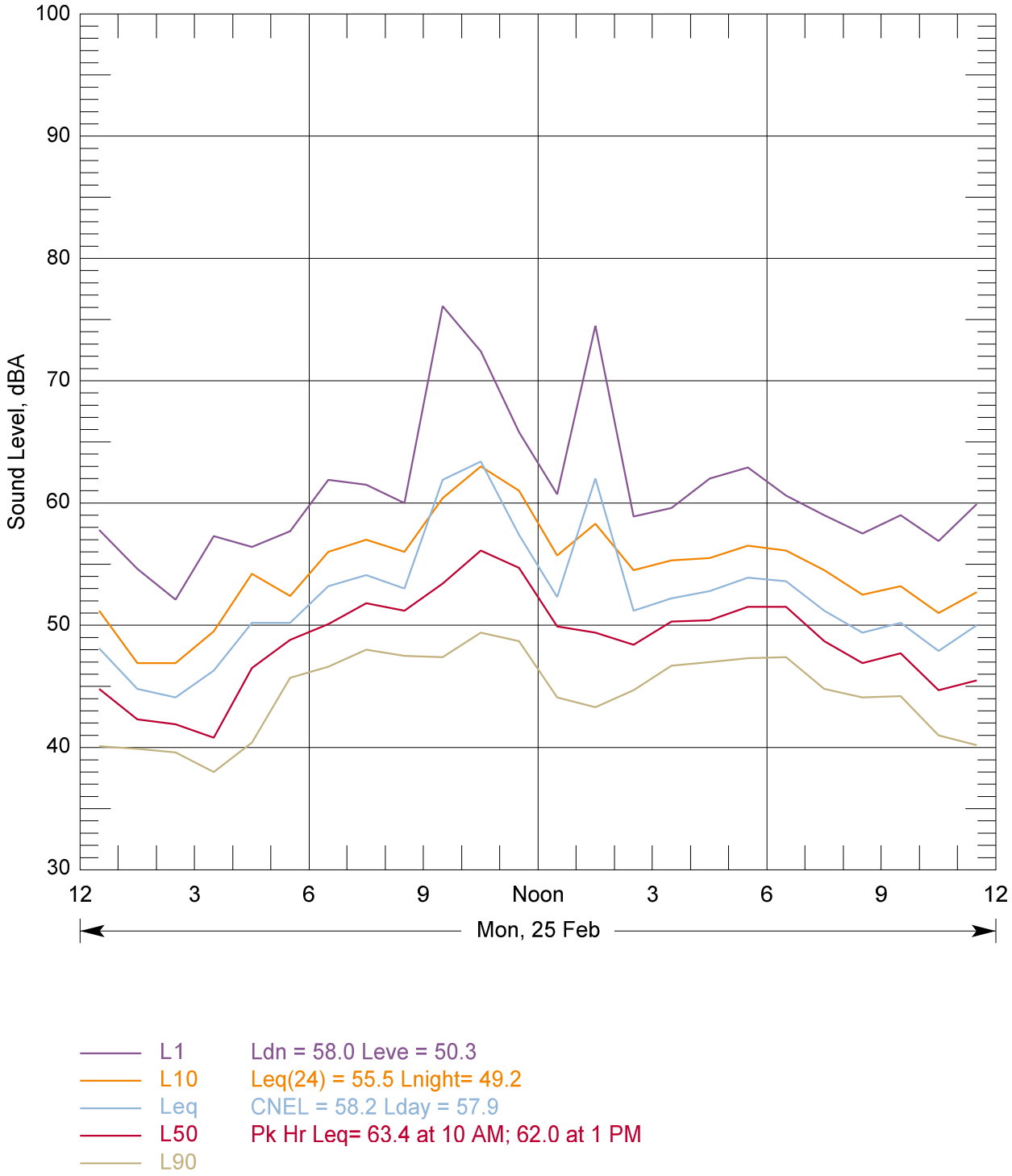

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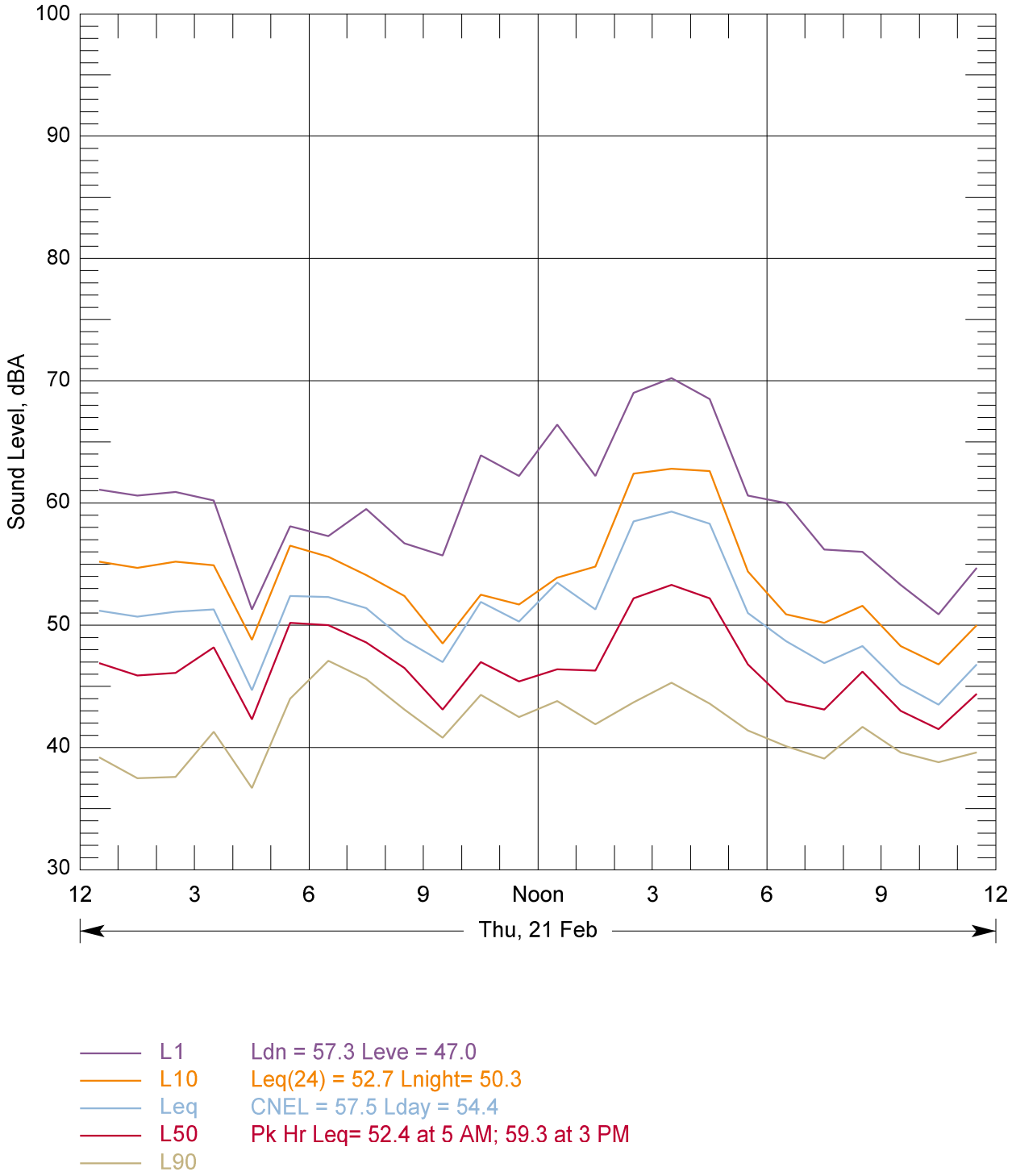

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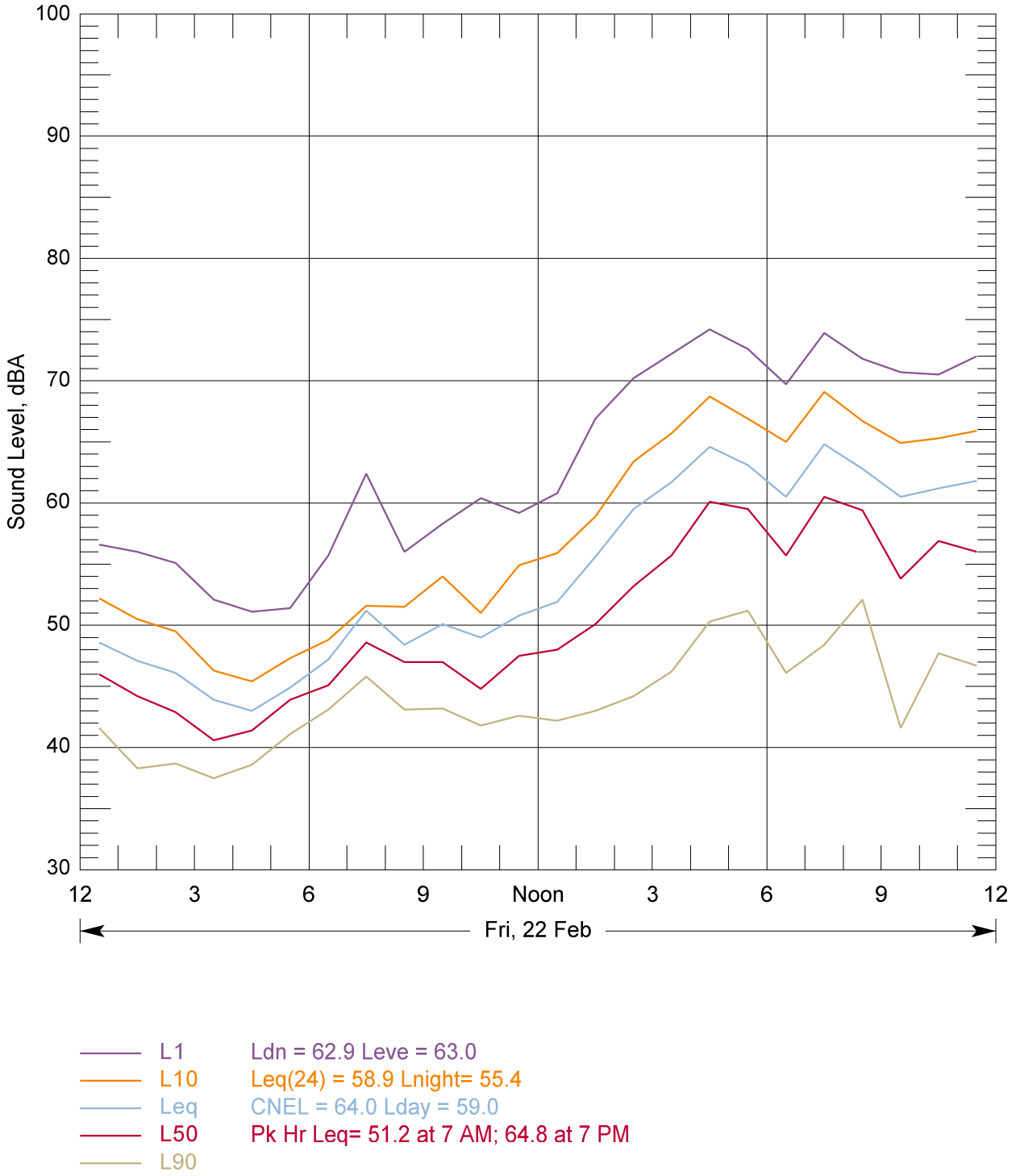

Figure A5-2: Allen Way - Feb. 22, 2013

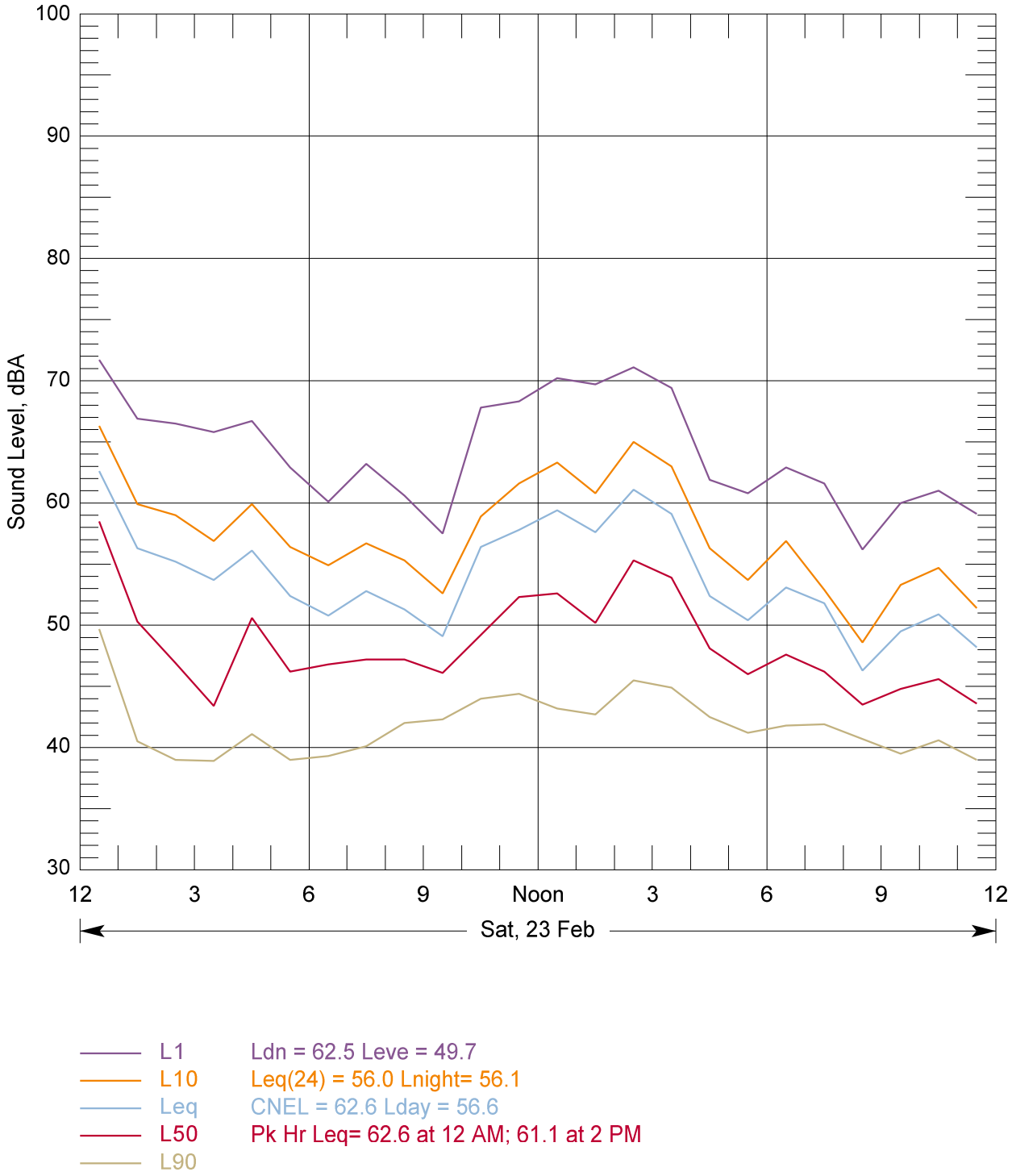

Figure A5-3: Allen Way - Feb. 23, 2013

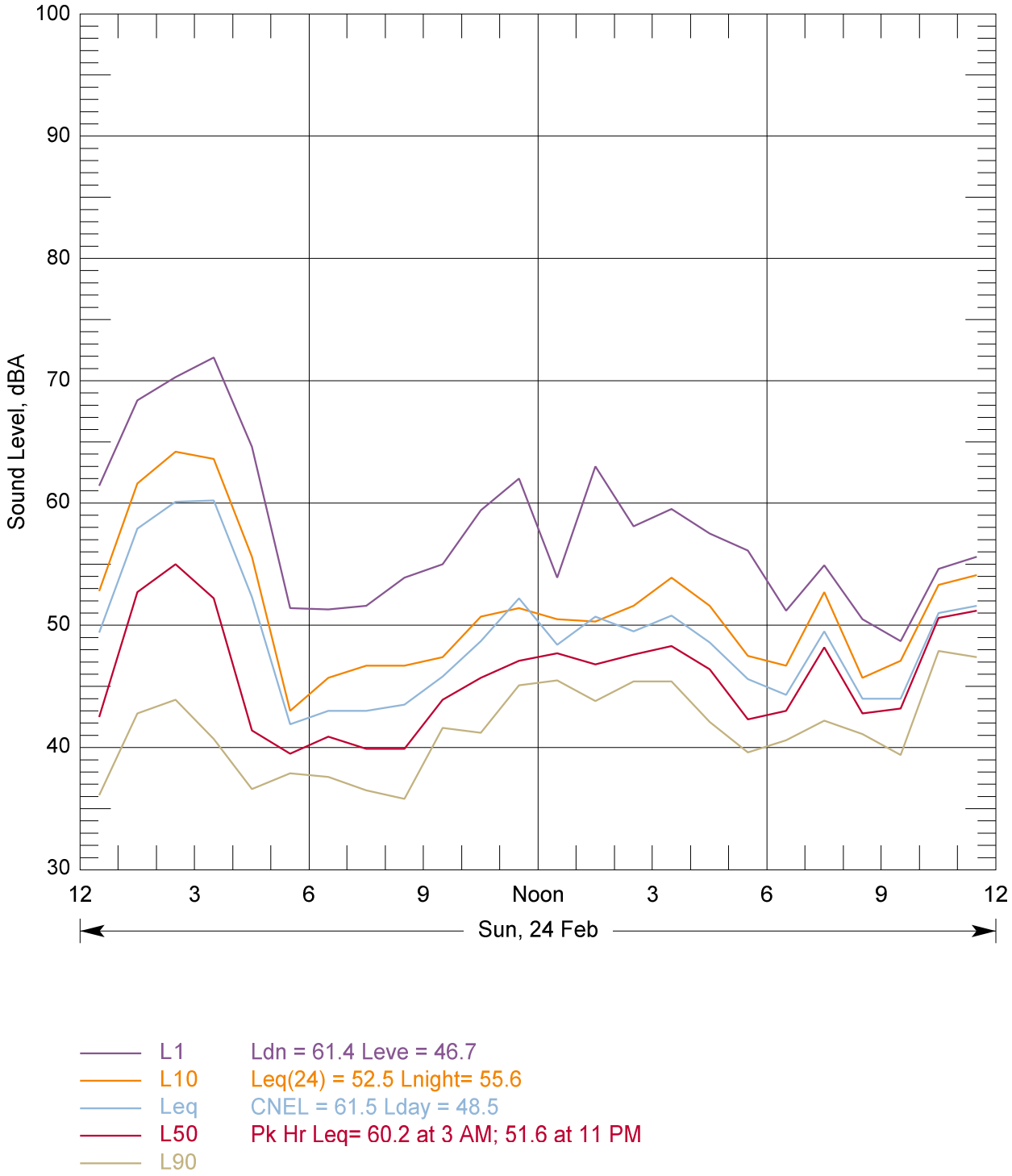

Figure A5-4: Allen Way - Feb. 24, 2013

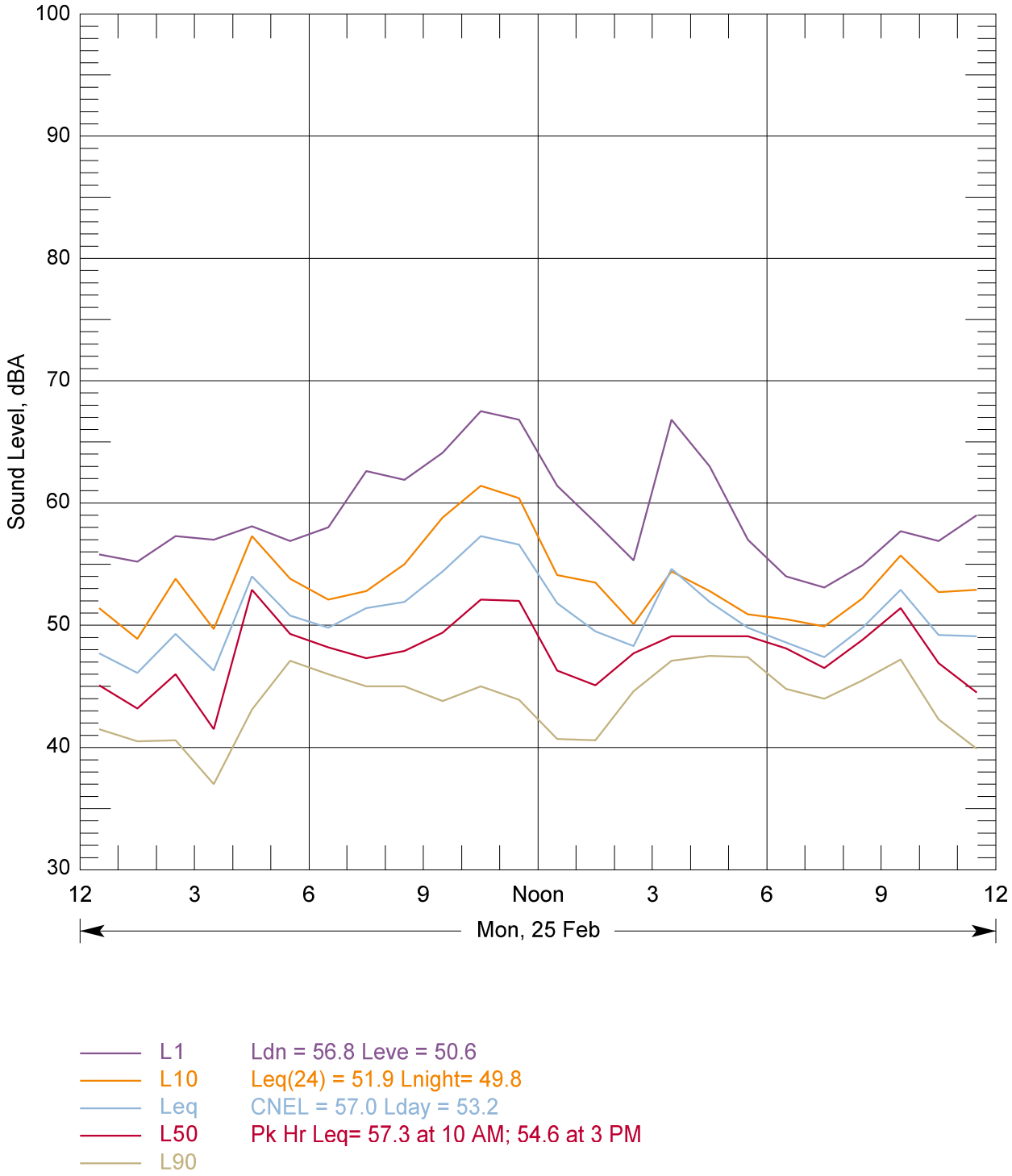

Figure A5-5: Allen Way - Feb. 25, 2013

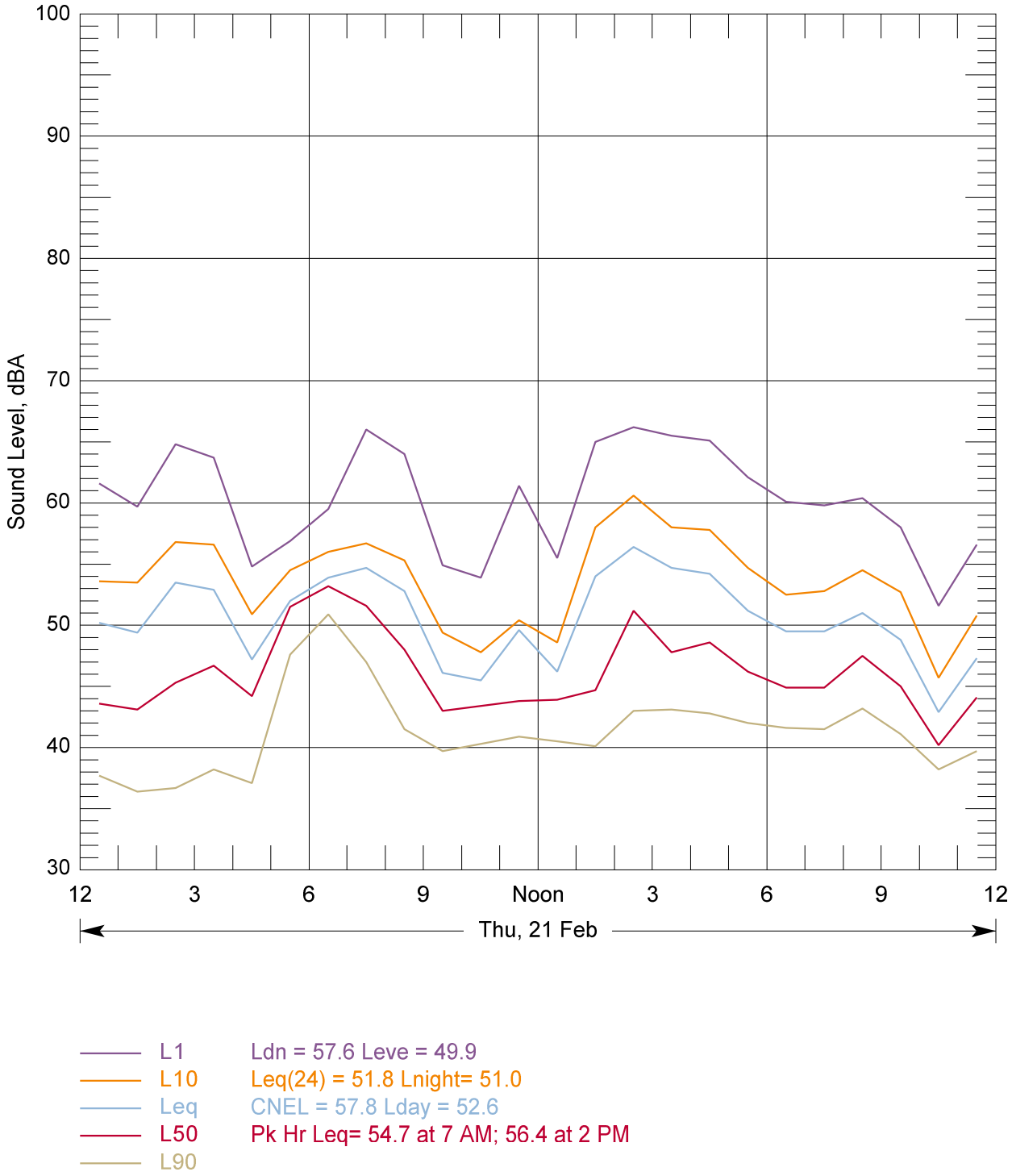

Figure A6-1: Utility Pole In Open Space - Feb. 21, 2013

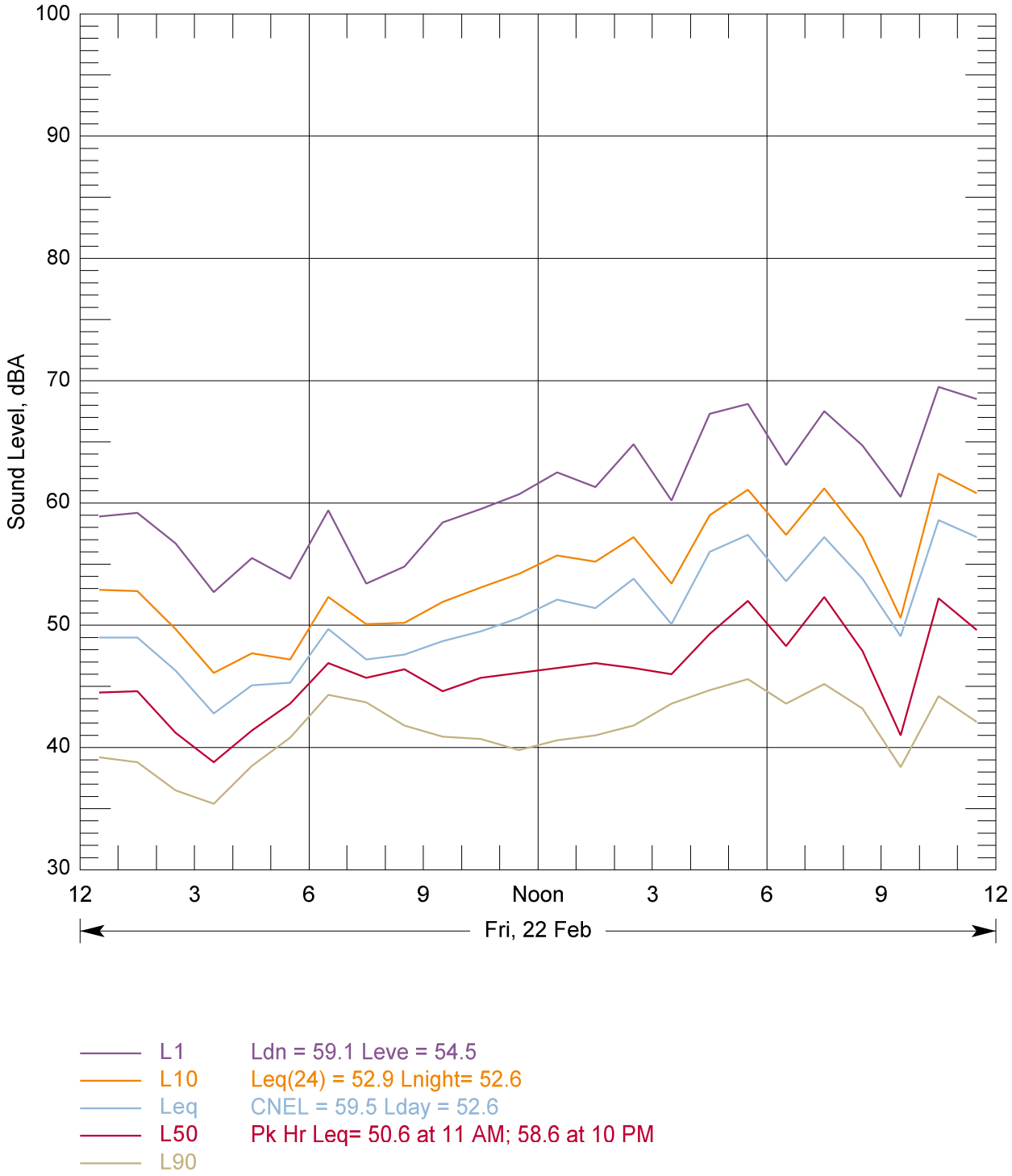

Figure A6-2: Utility Pole In Open Space - Feb. 22, 2013

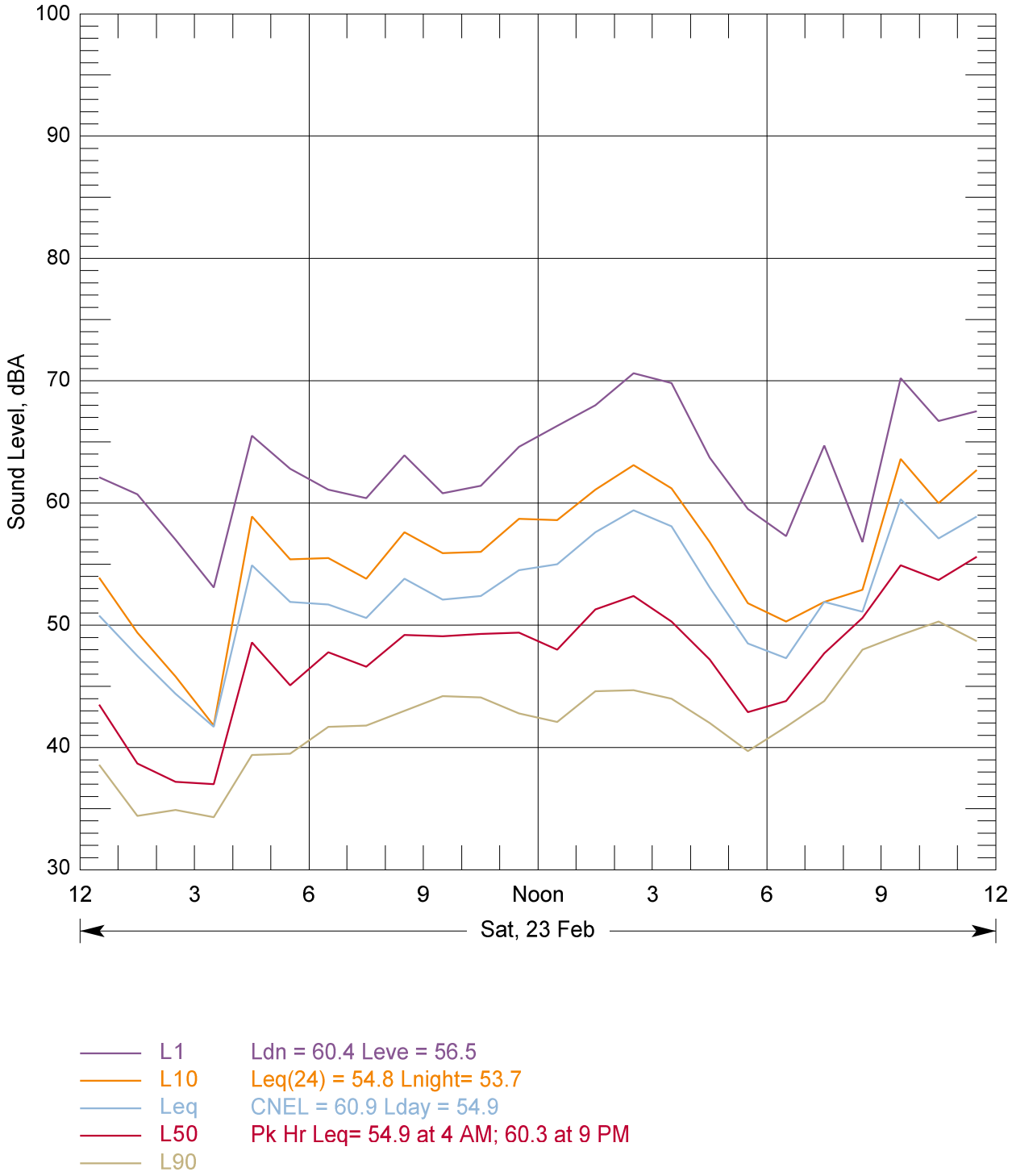

Figure A6-3: Utility Pole In Open Space - Feb. 23, 2013

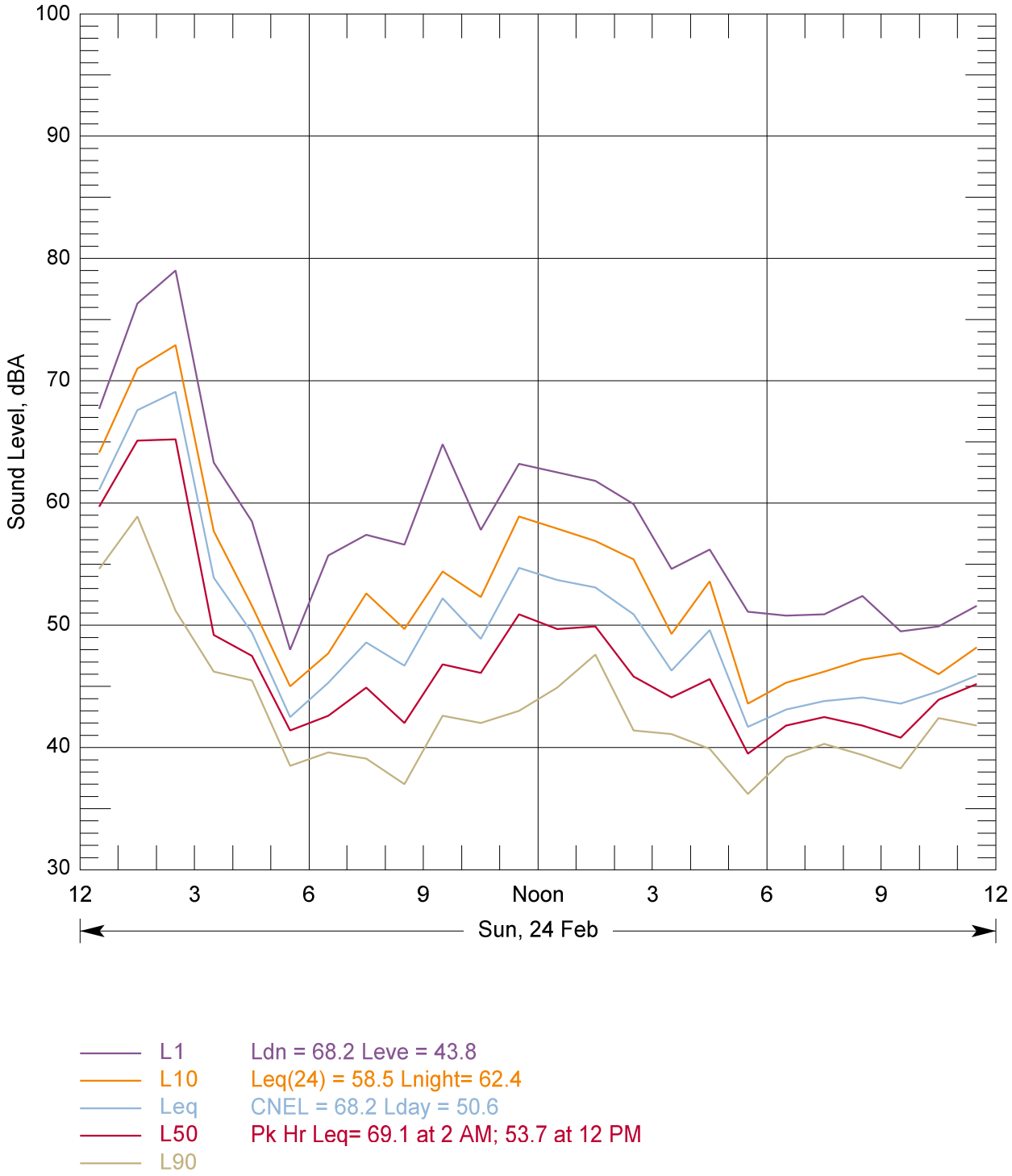

Figure A6-4: Utility Pole In Open Space - Feb. 24, 2013

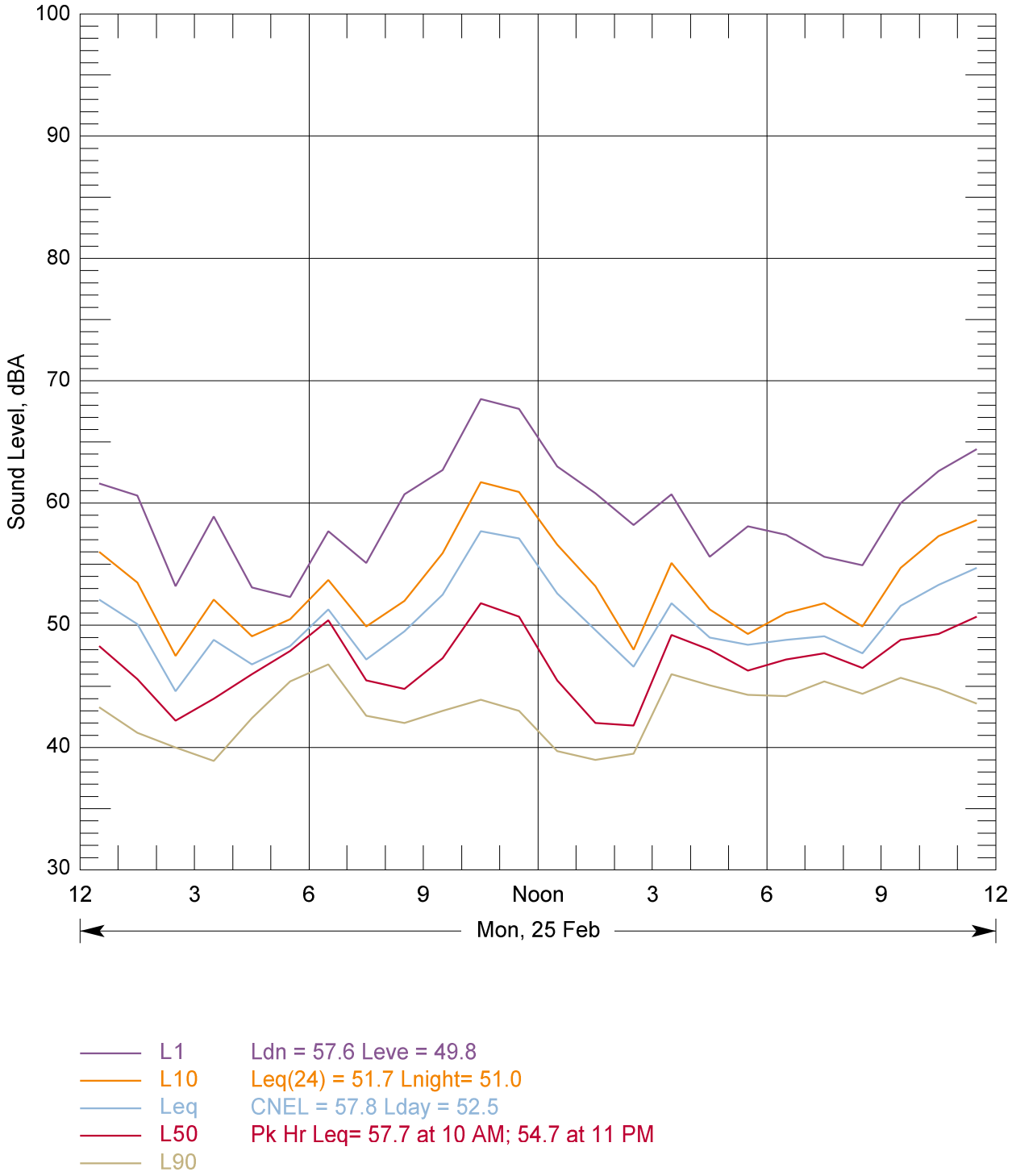

Figure A6-5: Utility Pole In Open Space - Feb. 25, 2013