AIRCRAFT NOISE MONITORING REPORT
LIVERMORE MUNICIPAL AIRPORT
LIVERMORE, CALIFORNIA

BBA Report No. 14-050

PREPARED FOR

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INTRODUCTION

This report presents the findings of an aircraft noise monitoring study conducted by Brown-Buntin Associates, Inc. (BBA) for the Livermore Municipal Airport (LVK) in Livermore, California. Noise monitoring was conducted during two week-long periods, one occurring in the fall of 2014 (November) and the other in the spring of 2015 (April). The objectives of the study were to document existing levels of noise from aircraft and other sources at representative locations around LVK and to compare measured noise levels to the results of previous noise monitoring studies.

The noise level descriptors used in this analysis are described in Appendix A. The primary descriptor utilized is the Community Noise Equivalent Level (CNEL), which is the energy average sound level for a 24-hour period determined after addition of penalties of 10 dB for aircraft operations at night between the hours 10:00 p.m. and 7:00 a.m. and 4.8 dB for operations during the evening between the hours of 7:00 p.m. and 10:00 p.m. The CNEL is calculated based upon the sound energy generated by individual aircraft events, the number of events occurring during a 24-hour period and the time of day in which the events occur.

As applied to the assessment of long-term (or cumulative) exposure to aircraft noise, the CNEL represents annual average noise exposure. This means that the noise exposure on a particular day is likely to be either higher or lower than the annual average for a given location. The State of California requires use of the annual average CNEL for the analysis of potential noise impacts associated with airport improvement projects. The FAA requires use of the annual average CNEL for FAR Part 150 noise compatibility planning studies at airports within California.

Appendix B provides examples of noise levels from a variety of familiar sources along with a ranking of subjective loudness. The chart is useful when making a relative comparison of the noise levels reported by this analysis for maximum noise levels during aircraft single events to noise generated by other common sources within a developed area.

AIRCRAFT NOISE MEASUREMENT PROGRAM

Continuous measurements of noise from aircraft and other sources were conducted during the seven-day periods of November 18-24, 2014 and April 7-13, 2015 at five (5) locations using automated noise monitoring equipment. The noise monitoring sites were selected by BBA and the City of Livermore to represent areas of the community potentially impacted by aircraft noise and to be comparable to locations used for previous noise monitoring studies around the airport. Short-term measurements of aircraft single event noise levels were conducted at four of the sites.

Weather conditions during the fall 2014 noise measurement period consisted of mostly overcast skies, with several days receiving low to moderate levels of precipitation. Temperatures ranged from approximately 40° to 50°F during the early morning hours to approximately 60° to 70°F during the mid-afternoon. Winds were light to moderate with speeds of 5-15 miles per hour during most of the monitoring period, and humidity was in the range of 75-100%.

During the spring 2015 noise measurement period, weather consisted of overcast skies with light rain during the early portion of the period, with mostly sunny skies during the latter portion of the study period. Temperatures ranged from approximately 40° to 50°F during the early morning hours and approximately 60° to 70°F during the mid-afternoon. Winds were in the range of 5-20 miles per hour during most of the monitoring period. Humidity was in the range of 30-100%.

Noise Monitoring Locations:

Noise monitoring sites are described below long with their locations relative to sites used during the 2007-2008 noise monitoring study. Site locations relative to the airport are shown in Figure 1.

Site 1 - This site was located in the backyard of a residence at 1386 Arlington Road in Livermore, east of the airport. This site is located between the approach flight paths to Runways 25L and 25R, about 0.7 nautical miles from the east end of Runway 07L/25R. Aircraft approaching Runways 25L and 25R pass nearly overhead. The site is located within approximately one-half block of sites used for aircraft noise monitoring in the fall of 2007 and spring of 2008. The aircraft noise event threshold for this site was set at 65 dBA.

Site 2 - This site was located in the backyard of a residence at 1322 Le Havre Circle in Livermore, east of the airport. This home is located between the approach flight paths to Runways 25L and 25R, about 1.2 nautical miles from the east end of Runway 07L/25R. Many aircraft approaching Runways 25L and 25R pass nearly overhead, though some arrivals turn to runway heading between this site and the airport. The site is located within approximately one-half block of sites used for aircraft noise monitoring in the fall of 2007 and spring of 2008. The aircraft noise event threshold for this site was set at 60 dBA.

Site 3 - This site was located in the backyard of a residence at 3318 Vermont Street in Pleasanton, west of the airport. This home is located slightly north of the extended centerline of Runway 07L/25R, approximately 1.2 nautical miles from the west end of the runway. The site is primarily affected by aircraft departing from Runways 25L and 25R, but is also affected by aircraft arrivals to Runways 07L and 07R when wind conditions dictate an easterly aircraft flow. The site is located within approximately one-half block of sites used for aircraft noise monitoring in the fall of 2007 and spring of 2008. The aircraft noise event threshold for this site was set at 60 dBA.

Site 4 - This site was located in the backyard of a residence at 2849 Chocolate Street in Pleasanton, west of the airport. This home is located beneath the extended centerline of Runway 07L/25R, approximately 1.2 nautical miles from the west end of the runway. The site is primarily affected by aircraft departing from Runways 25L and 25R, but is also affected by aircraft arrivals to Runways 07L and 07R when wind conditions dictate an easterly aircraft flow. The site is located approximately four blocks east of a site used for aircraft noise monitoring

in the fall of 2007 and spring of 2008. The aircraft noise event threshold for this site was set at 60 dBA.

Site 5 - This site was located at the north edge of the taxiway about 1,200 feet east of the west end of Runway 7L/25R. The primary purpose of noise monitoring at this site was to provide an additional means for identifying aircraft noise events west of the airport due to departures from Runways 25L and 25R. This is the same site utilized during the fall of 2007 and spring of 2008 noise measurement study. The event threshold was set to 65 dBA.

Noise Monitoring Equipment:

Noise monitoring equipment utilized for continuous and short-term measurements consisted of Larson-Davis Laboratories Model LDL 820 sound level analyzers equipped with Bruel & Kjaer (B&K) Type 4176 ½" microphones. The monitors were calibrated with a B&K Type 4230 acoustical calibrator to ensure the accuracy of the measurements. Microphones were located on tripods or booms at approximately 5-10 feet above the ground. Microphones were situated so that they had an unobstructed view of the aircraft noise source and so that they were as far as possible from reflective surfaces.

The LDL Model 820 sound level analyzers have the capability of measuring noise continuously for extended periods of time. The analyzers may be programmed to distinguish between aircraft noise and noise from other sources using sound level and event duration thresholds. Noise measurement threshold settings for this study were in the range of 60-65 dBA for a minimum of 5 seconds. This means that the noise level had to equal or exceed the threshold noise level for at least 5 seconds in order for the noise event to be considered aircraft-related. The LDL Model 820 analyzers are effective in discriminating between aircraft noise events and noise from other sources provided monitoring sites are carefully chosen and measurement thresholds are appropriate for the monitoring sites.

Cumulative Aircraft Noise Exposure:

Table I provides a summary of measured aircraft noise exposure at Sites 1-5 as defined by the CNEL metric. Shown by Table I are the energy mean (average) aircraft CNEL values for the entire noise monitoring periods and the range of daily CNEL values measured during the fall 2014 and spring 2015 noise monitoring periods. Seven full days of noise monitoring data were collected at all of the sites during both the fall 2014 and spring 2015 monitoring periods

The aircraft noise exposure values reported by Table I were determined from the noise event data collected by the LDL 820 sound level analyzers using the pre-programmed event noise level and duration thresholds. The noise event data collected by the instrumentation were further analyzed by BBA to remove noise level data that were clearly not aircraft-related using LDL noise event discrimination software. This procedure may be relied upon to define aircraft noise exposure

where there is a clear distinction between the noise levels caused by aircraft operations and the noise levels caused by other sources such as roadway traffic or commercial and/or construction activities. Data from the monitor at Site 5 next to the departure end of Runway 25R were utilized to help confirm aircraft noise events at sites west of the airport.

Appendix C contains bar charts summarizing *aircraft* and *community* (non-aircraft) CNEL values for each measurement day at the noise monitoring sites. Also shown by the bar charts are the *total* measured CNEL values for each of the measurement days. Community noise levels were determined by subtracting the aircraft CNEL from the total CNEL for each noise measurement day. Noise levels resulting from over-flights by small propeller-driven aircraft were in some cases too low to be identified by the monitors as aircraft-related. This is especially true for arrivals and for aircraft that may have turned before over-flying the noise monitoring sites. It is therefore acknowledged that reported background noise levels may contain some small contribution from aircraft noise. The noise levels generated by individual aircraft operations are discussed in the following section.

TABLE I

SUMMARY OF MEASURED AIRCRAFT CNEL VALUES
LIVERMORE MUNICIPAL AIRPORT

Site	Description	Date	Measured Aircraft CNEL,dB[1]	
			Range	Mean
1	1386 Arlington Road, Livermore	November 18-24, 2014	50.8-54.6	53.0
		April 7-14, 2015	50.7-55.7	53.6
2	1322 La Havre Circle, Livermore	November 18-24, 2014	45.7-50.7	47.8
		April 16-22, 2015	47.1-58.2	51.0
3	3318 Vermont Street, Pleasanton	November 18-24, 2014	46.1-55.3	49.7
		April 7-14, 2015	41.1-54.6	48.9
4	2849 Chocolate Street, Pleasanton	November 18-24, 2014	44.7-49.7	47.4
		April 7-14, 2015	40.5-49.9	46.5
5	Next to airport taxiway north of Runway 07L/25R	November 18-24, 2014	56.4-61.9	58.7
		April 7-14, 2015	56.2-62.8	59.8

[1]Shown are the range of daily CNEL values and mean (average) CNEL for the entire measurement period.

Source: Brown-Buntin Associates, Inc.

Single Event Noise Level Measurements:

Tables II and III summarize the results of detailed single event noise level measurements at Sites 1-4 for the fall 2014 and spring 2015 monitoring periods, respectively. Detailed single event

measurements were not conducted at Site 5 as that site is not located within an area where off-airport noise-sensitive uses are located. Detailed single event monitoring consisted of placing a trained observer at the site for a minimum of eight (8) hours to record the type of aircraft, type of operation (arrival or departure), runway used, maximum noise level (L_{max}), Sound Exposure Level (SEL) and azimuth for each observed flight. The azimuth is the angle between the aircraft flight path and the microphone at the point when the aircraft is closest to the microphone. An azimuth of 90º means that the aircraft passed directly over the microphone.

The mean (L_{max}) values shown in Table II were determined by arithmetic averaging, whereas the mean SEL values were determined by logarithmic (energy) averaging. The SEL for a particular aircraft noise event is a numerically higher value than the (L_{max}) for the same event. That is because the SEL consolidates the energy of the entire noise event into a reference duration of one second. The SEL is not "heard", but is a derived value used for calculation of cumulative aircraft noise exposure as defined by the CNEL.

TABLE II

SUMMARY OF AIRCRAFT SINGLE EVENT NOISE LEVEL MEASUREMENTS
LIVERMORE MUNICIPAL AIRPORT
FALL 2014

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Site 1 - Arrivals on Runway 25L (11/18/14 and 11/20/14)				
Helicopter	7	80.1 (67.9-86.0)	67.4 (58.5-77.9)	10°W-45°S
Single Engine Prop.	8	78.9 (50.4-87.9)	61.1 (56.3-87.9)	45°S-90°
Twin Turboprop	1	62.2	54.7	45°S
Site 1 - Arrivals on Runway 25R (11/18/14, 11/20/14 and 11/24/14)				
Bizjet	2	91.7 (91.1-92.2)	86.5 (85.1-87.9)	90°
Helicopter	6	90.8 (76.7-97.7)	76.0 (67.5-90.8)	30°W-90°
Single Engine Prop.	26	80.7 (55.6-92.5)	64.8 (48.6-88.8)	45°N-90°
Twin Engine Prop.	2	86.5 (85.5-87.3)	81.6 (80.9-82.3)	75°N
Single Turboprop	1	92.0	86.0	75°N
Site 1 – Departures on Runway 07L (11/18/14)				
Single Engine Prop.	7	80.7 (55.6-92.5)	64.8 (48.6-88.8)	30°W-60°W
Twin Engine Prop.	1	79.5	72.1	45°W
Site 1 – Departures on Runway 07R (11/18/14)				
Single Engine Prop.	3	67.9 (65.6-69.4)	59.7 (57.2-61.1)	30°W-45°W
Site 2 - Arrivals on Runway 25L (11/19/14)				
Single Engine Prop.	2	64.6 (60.2-66.7)	54.1 (52.2-55.9)	30°S-45°S
Site 2 - Arrivals on Runway 25R (11/19/14 and 11/24/14)				
Bizjet	3	83.1 (82.2-83.6)	75.2 (72.7-76.7)	45°N-90°

TABLE II (concluded)

SUMMARY OF AIRCRAFT SINGLE EVENT NOISE LEVEL MEASUREMENTS
LIVERMORE MUNICIPAL AIRPORT
FALL 2014

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Helicopter	1	61.0	76.0 (67.5-90.8)	60°N
Single Engine Prop.	13	71.9 (64.1-80.1)	61.0 (55.0-72.6)	60°N-90°
Twin Turboprop	1	84.1	77.1	60°N
Site 2 – Departures on Runway 07L (11/19/14 and 11/24/14)				
Bizjet	1	82.2	74.9	90°
Single Engine Prop.	14	80.1 (64.1-90.1)	64.5 (55.8-84.0)	75°N
Twin Engine Prop.	1	87.6	79.0	45°W
Site 2 – Departures on Runway 07R (11/24/14)				
Single Engine Prop.	1	69.3	60.9	45°S
Site 3 - Arrivals on Runway 07L (11/18/14 and 11/24/14)				
Single Engine Prop.	9	70.4 (54.2-74.9)	58.0 (46.8-66.6)	30°E-90°
Twin Turboprop	1	82.6	73.1	90°
Site 3 – Arrivals on Runway07R (11/18/14 and 11/24/14)				
Bizjet	1	74.5	66.6	45°S
Single Engine Prop.	3	59.9 (50.4-64.2)	48.1 (42.0-57.2)	30°S-45°S
Site 3 – Departures on Runway 25L (11/18/14)				
Single Engine Prop.	1	75.3	67.7	45°S
Site 3 – Departures on Runway 25R (11/18/14 and 11/24/14)				
Bizjet	1	81.1	71.9	75°E
Single Engine Prop.	10	77.5 (61.9-82.8)	66.3 (55.9-75.9)	30°E-60°N
Twin Turbo Prop.	1	82.2	74.8	75°E
Site 4 – Departures on Runway 25L (11/21/14 and 11/24/14)				
Helicopter	1	76.7	66.4	60°S
Single Engine Prop.	3	71.0 (65.1-74.7)	61.0 (56.3-66.7)	45°S-60°S
Site 4 – Departures on Runway 25R (11/21/14 and 11/24/14)				
Bizjet	1	77.9	68.4	75°N
Single Engine Prop.	21	81.1 (65.3-88.4)	67.4 (56.2-84.4)	45°N-75°N
Twin Turbo Prop.	2	79.8 (77.2-81.4)	70.9 (67.9-73.8)	75°E

Source: Brown-Buntin Associates, Inc.

TABLE III

SUMMARY OF AIRCRAFT SINGLE EVENT NOISE LEVEL MEASUREMENTS
LIVERMORE MUNICIPAL AIRPORT
SPRING 2015

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Site 1 - Arrivals on Runway 25L (4/7/15)				
Single Engine Prop.	2	62.0 (61.3-62.6)	55.3 (55.0-55.6)	45°S
Site 1 - Arrivals on Runway 25R (4/7/15 and 4/14/15)				
Single Engine Prop.	14	84.6 (65.8-93.6)	71.4 (58.6-90.1)	45°N-90°
Twin Engine Prop.	2	86.5 (85.5-87.3)	81.6 (80.9-82.3)	75°N
Site 1 – Departures on Runway 07L (4/7/15)				
Single Engine Prop.	7	81.7 (67.7-88.4)	68.9 (58.7-78.2)	45°N-90°
Site 1 – Departures on Runway 07R (11/18/14)				
Single Engine Prop.	18	76.2 (59.4-81.4)	64.4 (52.4-72.6)	45°S-90°
Site 1 – Overflights (4/7/15)				
Helicopter	1	81.8	70.6	45°S-90°
Site 2 - Arrivals on Runway 25L (4/6/15 and 4/16/15)				
Single Engine Prop.	3	77.5 (63.7-82.1)	62.6 (55.4-74.6)	60°S-75°S
Site 2 - Arrivals on Runway 25R (4/6/15 and 4/16/15)				
Bizjet	2	86.3 (84.7-87.5)	79.3 (77.6-81.0)	75°N
Single Engine Prop.	33	79.6 (60.0-90.5)	65.2 (50.9-81.8)	75°N
Twin Turboprop	3	87.3 (84.4-89.7)	79.8 (77.1-81.5)	60°N
Site 2 – Departures on Runway 07L (4/16/15)				
Single Engine Prop.	1	83.1	73.7	75°N
Site 3 - Arrivals on Runway 07L (4/15/15)				
Single Engine Prop.	2	67.3 (64.9-68.8)	56.8 (53.8-59.7)	30°E-90°
Site 3 – Arrivals on Runway07R (4/8/15)				
Single Engine Prop.	2	57.2 (55.7-58.3)	47.0 (45.2-48.7)	45°E
Site 3 – Departures on Runway 25L (4/8/15)				
Single Engine Prop.	1	64.7	55.4	45°S
Twin Turbo Prop.	1	79.8	71.4	60°S
Site 3 – Departures on Runway 25R (4/7/15, 4/8/15 and 4/15/15)				
Single Engine Prop.	15	79.9 (57.3-87.0)	60.7 (49.2-79.5)	45°N-90°
Site 4 - Arrivals on Runway 07L (4/15/15)				
Single Engine Prop.	1	64.4	52.9	60°S
Site 4 – Arrivals on Runway 07R (4/15/15)				
Single Engine Prop.	5	75.3 (63.4-81.8)	60.6 (52.9-70.7)	60°N-90°

TABLE III (concluded)

SUMMARY OF AIRCRAFT SINGLE EVENT NOISE LEVEL MEASUREMENTS
LIVERMORE MUNICIPAL AIRPORT
SPRING 2015

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Twin Turbo Prop.	1	85.7	80.7	75°N
Site 4 – Departures on Runway 25L (4/9/15)				
Single Engine Prop.	5	75.5 (57.5-80.6)	61.0 (49.1-72.6)	30°E-90°
Site 4 – Departures on Runway 25R (4/9/15)				
Single Engine Prop.	21	75.6 (60.7-83.9)	62.2 (52.8-74.1)	45°E-90°
Twin Turbo Prop.	2	81.4 (76.4-83.7)	72.8 (67.6-77.9)	75°N-90°
Source: Brown-Buntin Associates, Inc.				

Aircraft Operations:

The numbers aircraft noise events occurring at Sites 3 and 4 west of the airport were compared to those occurring at Site 5 next to the airport runways. Aircraft noise events at Sites 3 and 4 could have been caused by aircraft arrivals to Runways 07L/R or aircraft departures from Runways 25L/R, depending upon the runways in use on any given day. Aircraft noise events at Site 5 could have been caused by landings or takeoffs on any airport runway or by any other type of aircraft movement near the site. It is also possible that aircraft could land or depart without exceeding the aircraft noise discrimination thresholds at that site. This would especially be true for landings by small propeller-driven aircraft on Runways 07L/R. The numbers of aircraft noise events recorded at the sites are presented in Table IV.

As noted above, not every aircraft passing over a site will trigger a noise event at the site. In most cases, the reason is that the aircraft noise level is very low, so that it cannot be isolated from background noise sources, such as traffic. Generally, fewer aircraft noise events were recorded at Sites 3 and 4 than at Site 5 next to the airport.

TABLE IV
MEASURED NUMBERS OF AIRCRAFT NOISE EVENTS - WEST OF AIRPORT
LIVERMORE MUNICIPAL AIRPORT
FALL 2014 AND SPRING 2015

Date	Day	Potential Aircraft Noise Events		
		Site 5 (Airport)	Site 3	Site 4
Fall 2014:				
11/18/2014	Tuesday	88	20	30
11/19/2014	Wednesday	63	48	18
11/20/2014	Thursday	34	43	12
11/21/2014	Friday	104	133	45
11/22/2014	Saturday	40	9	16
11/23/2014	Sunday	93	14	31
11/24/2014	Monday	87	52	35
Spring 2015:				
4/7/2015	Tuesday	59	10	9
4/8/2015	Wednesday	108	30	34
4/9/2015	Thursday	109	38	37
4/10/2015	Friday	151	127	44
4/11/2015	Saturday	171	41	48
4/12/2015	Sunday	150	121	44
4/13/2015	Monday	100	32	29
4/14/2015	Tuesday	52	18	10
Average:		**94**	**49**	**29**

Source: Brown-Buntin Associates, Inc.

COMPARISON OF PRESENT AND PREVIOUS AIRCRAFT NOISE STUDIES

Table V compares measured aircraft CNEL values from the fall 2014 and spring 2015 noise monitoring periods to those obtained during noise monitoring studies conducted by BBA during the fall of 2007 and spring of 2008. Although Sites 1-4 were not in the exact locations used for the 2007-2008 measurements, they are generally within approximately one-half block of the previously utilized noise monitoring sites. An exception to this occurred at Site 4 which ended up being located approximately four blocks east of the site utilized during the 2007-2008 noise measurements.

Table V shows that the aircraft noise levels measured during the fall 2014 and spring 2015 noise monitoring periods were lower than those measured during the fall of 2007 and spring of 2008 by 1.2-4.3 dB. Average measured aircraft CNEL values ranged from 50.4 dB at Site 4 to 55.6 dB at Site 1 during the 2007-2008 noise monitoring periods. During the 2014-2015 noise monitoring periods, average measured aircraft CNEL values ranged from 47.0 dB at Site 4 to 53.3 dB at Site 1. At all off-airport noise monitoring sites, measured aircraft CNEL values were well below 65 dB. An aircraft noise exposure less than 65 dB CNEL is considered by the State of California and FAA as compatible with noise-sensitive land uses located in the vicinity of an airport for noise compatibility planning purposes.

TABLE V

COMPARISON OF MEASURED AIRCRAFT CNEL VALUES
LIVERMORE MUNICIPAL AIRPORT

Site	Measured Aircraft CNEL, dB					
	Measured Fall 2007 Mean (Range)	**Measured Spring 2008 Mean (Range)**	**2007-2008 Average**	**Measured Fall 2014 Mean (Range)**	**Measured Spring 2015 Mean (Range)**	**2014-2015 Average**
1	53.8 (53.1-54.9)	57.3 (53.6-62.4)	55.6	53.0 (50.8-54.6)	53.6 (50.7-55.7)	53.3
2	52.3 (47.7-58.0)	55.1 (52.7-57.4)	53.7	47.8 (45.7-50.7)	51.0 (47.1-58.2)	49.4
3	49.0(44.9-51.9)	52.0 (48.4-57.8)	50.5	49.7 (46.1-55.3)	48.9 (41.1-54.6)	49.3
4	50.3 (46.3-49.8)	50.5 (47.3-54.2)	50.4	47.4 (44.7-49.7)	46.5 (40.5-49.9)	47.0

Source: Brown-Buntin Associates, Inc.

Changes in aircraft noise exposure may be expected over time due to fluctuations in the volume of aircraft operations, the aircraft fleet mix and runway use. Also, aircraft operators have introduced newer technology aircraft and older-technology aircraft have been retired, resulting in a generally quieter aircraft fleet mix.

Figure 1: Noise Monitoring Sites

APPENDIX A

ACOUSTICAL TERMINOLOGY

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ACOUSTICAL TERMINOLOGY

AMBIENT NOISE LEVEL: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

DECIBEL, dB: A unit for describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

CNEL: Community Noise Equivalent Level. The average equivalent sound level during a 24-hour day, obtained after addition of ten decibels to sound levels in the night after 10:00 p.m. and before 7:00 a.m. and 4.8 decibels to sound levels in the evening after 7:00 p.m. and before 10:00 p.m.

L_{eq}: Equivalent Sound Level. The sound level containing the same total energy as a time varying signal over a given sample period. L_{eq} is typically computed over 1, 8 and 24-hour sample periods.

NOTE: The CNEL represents daily levels of noise exposure averaged on an annual basis, while the L_{eq} represents the average noise exposure for a shorter time period, typically one hour.

L_{max}: The maximum noise level recorded during a noise event.

L_n: The sound level exceeded "n" percent of the time during a sample interval (L_{90}, L_{50}, L_{10}, etc.). For example, L_{10} equals the level exceeded 10 percent of the time.

NOISE EXPOSURE CONTOURS: Lines drawn about a noise source indicating constant levels of noise exposure. CNEL contours are frequently utilized to describe community exposure to noise.

NOISE LEVEL REDUCTION (NLR): The noise reduction between indoor and outdoor environments or between two rooms that is the numerical difference, in decibels, of the average sound pressure levels in those areas or rooms. A measurement of "noise level reduction" combines the effect of the transmission loss performance of the structure plus the effect of acoustic absorption present in the receiving room.

ACOUSTICAL TERMINOLOGY

SEL or SENEL: Sound Exposure Level or Single Event Noise Exposure Level. The level of noise accumulated during a single noise event, such as an aircraft over-flight, with reference to a duration of one second. More specifically, it is the time-integrated A-weighted squared sound pressure for a stated time interval or event, based on a reference pressure of 20 micropascals and a reference duration of one second.

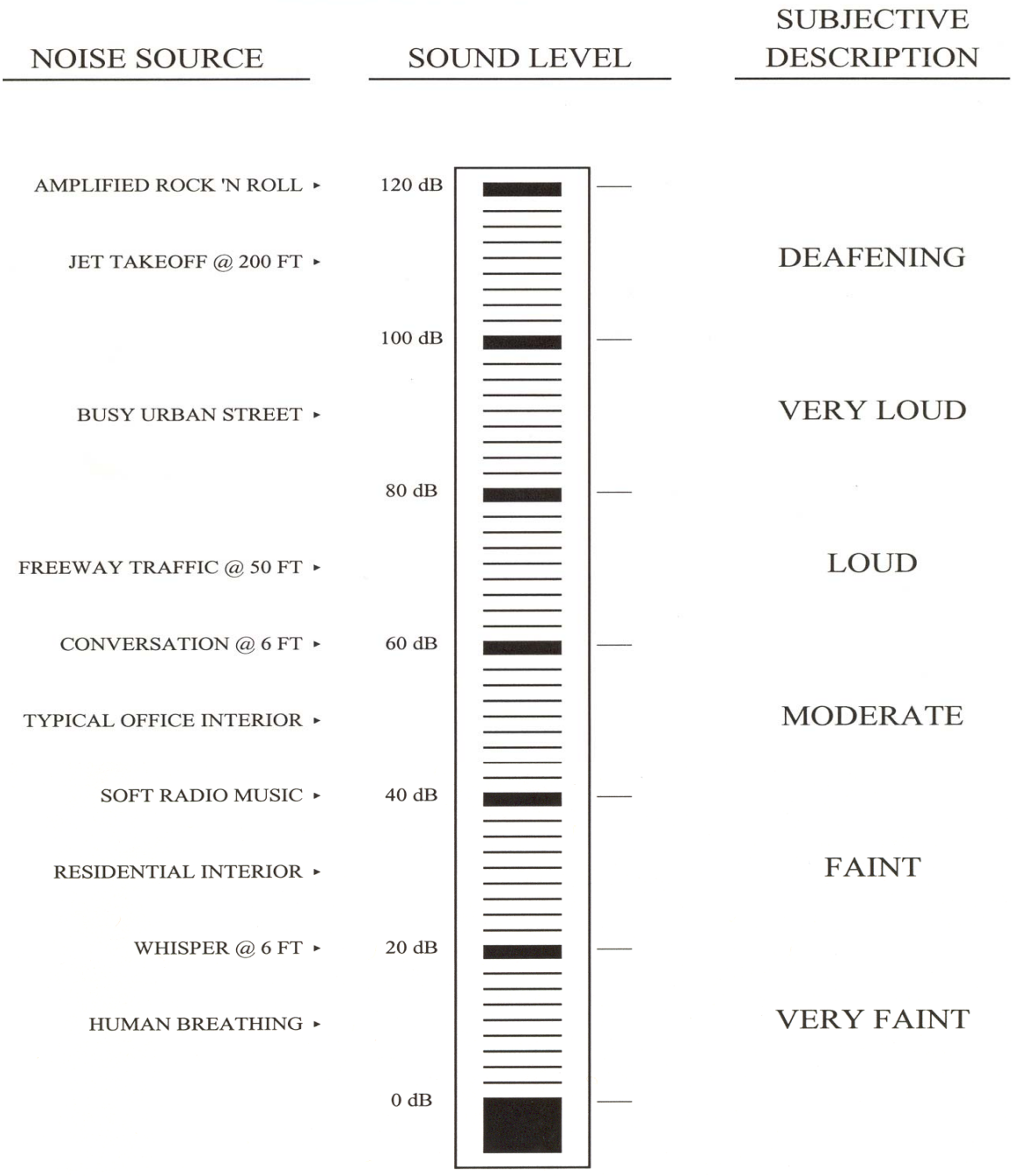
SOUND LEVEL: The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

SOUND TRANSMISSION CLASS (STC): The single-number rating of sound transmission loss for a construction element (window, door, etc.) over a frequency range where speech intelligibility largely occurs.

APPENDIX B

EXAMPLES OF SOUND LEVELS

APPENDIX B
EXAMPLES OF SOUND LEVELS



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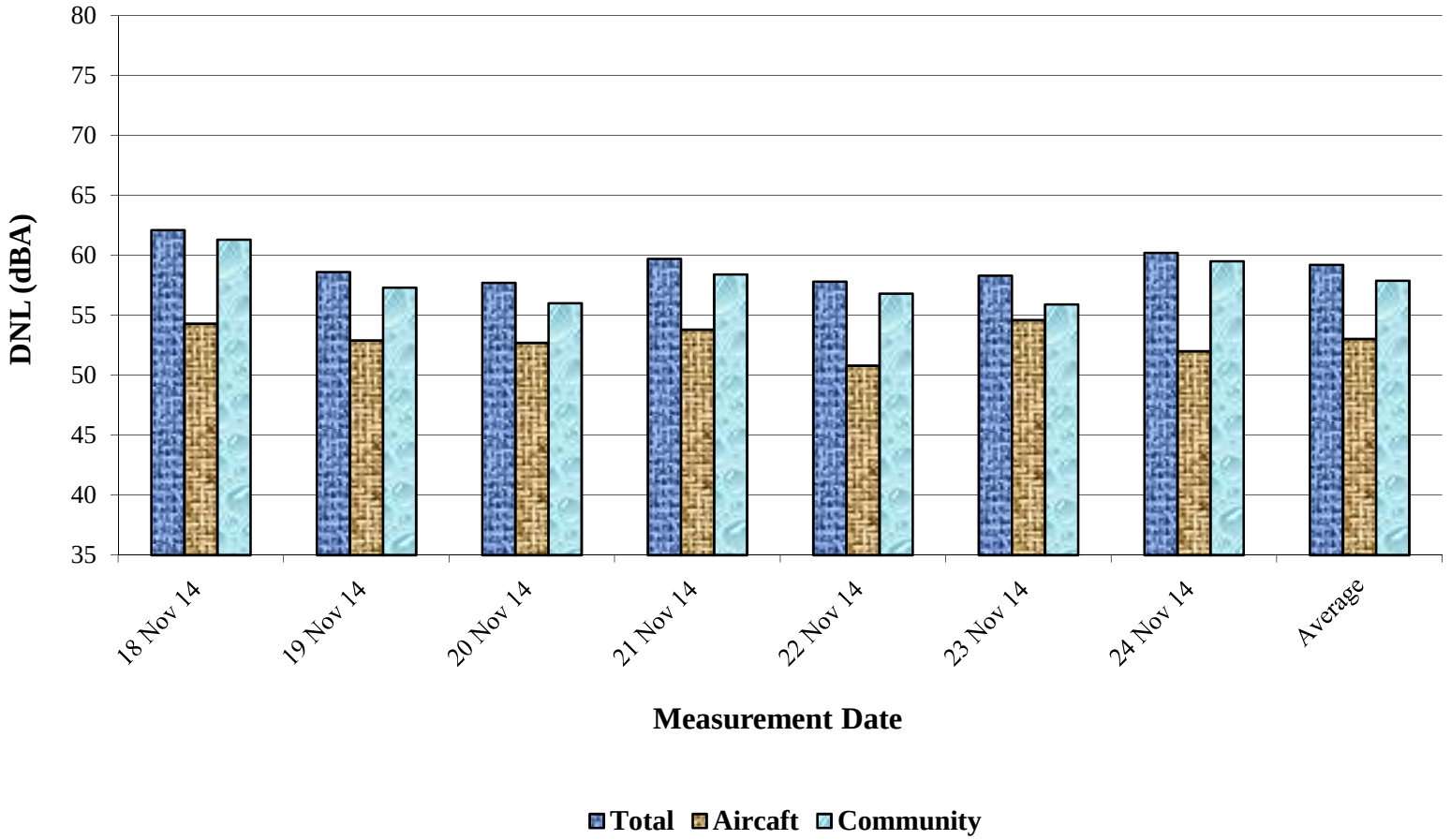
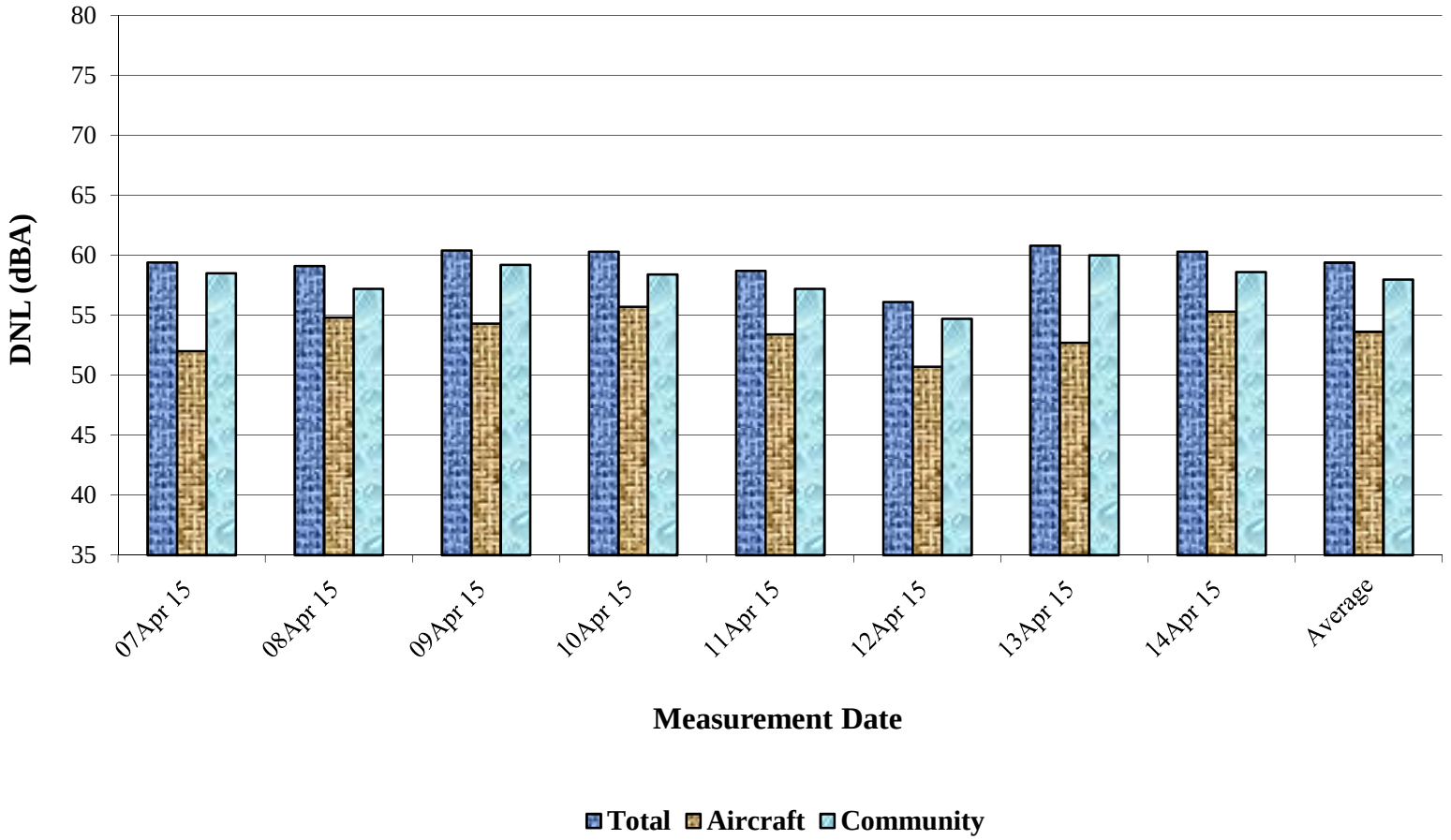
APPENDIX C

DAILY MEASURED CNEL VALUES
LIVERMORE MUNICIPAL AIRPORT
FALL 2014 AND SPRING 2015

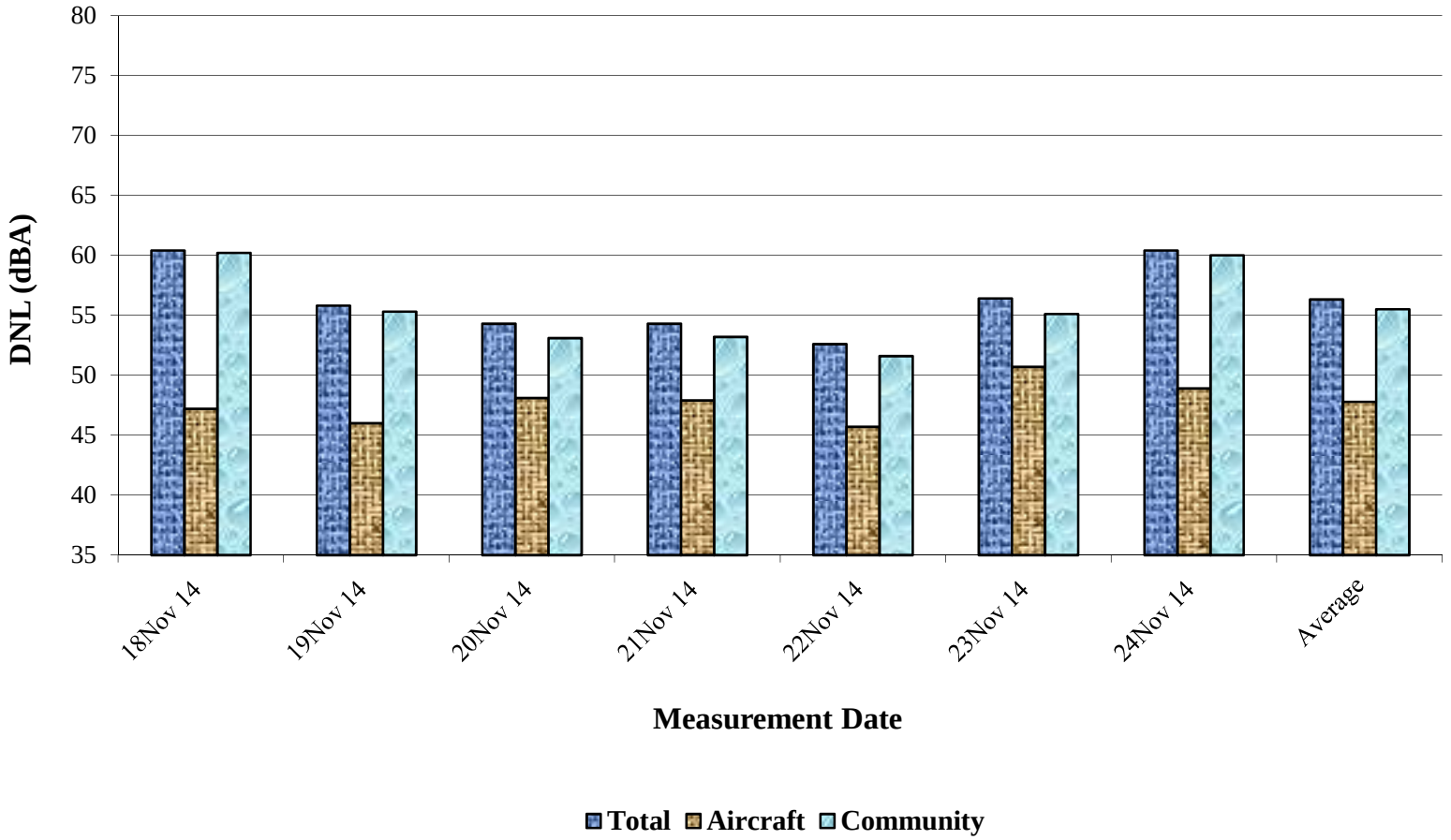
C-1
Daily Measured DNL Values
Livermore Municipal Airport
Site 1: Fall 2014



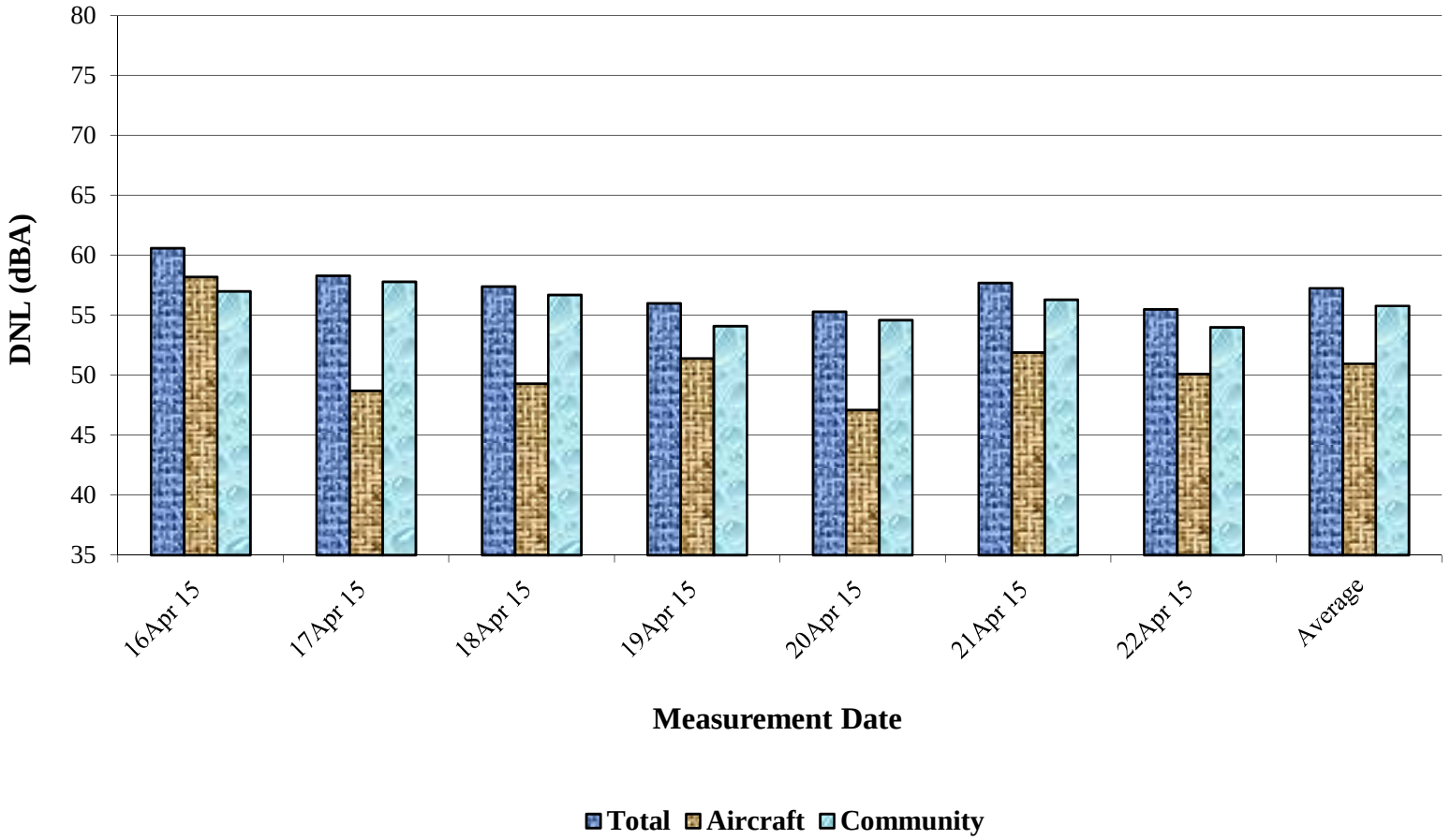
C-2
Daily Measured DNL Values
Livermore Municipal Airport
Site 1: Spring 2015



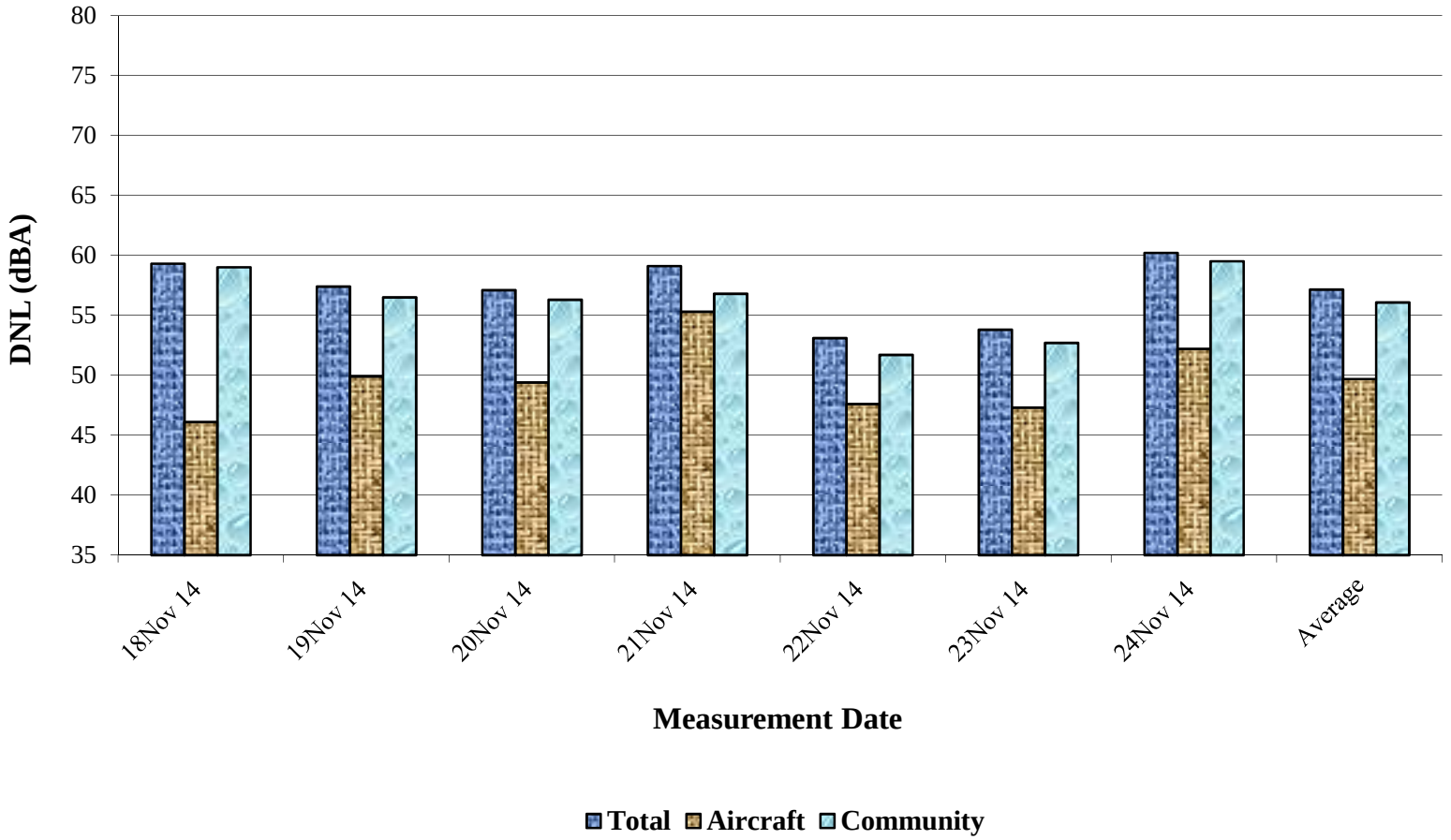
C-3
Daily Measured DNL Values
Livermore Municipal Airport
Site 2: Fall 2014



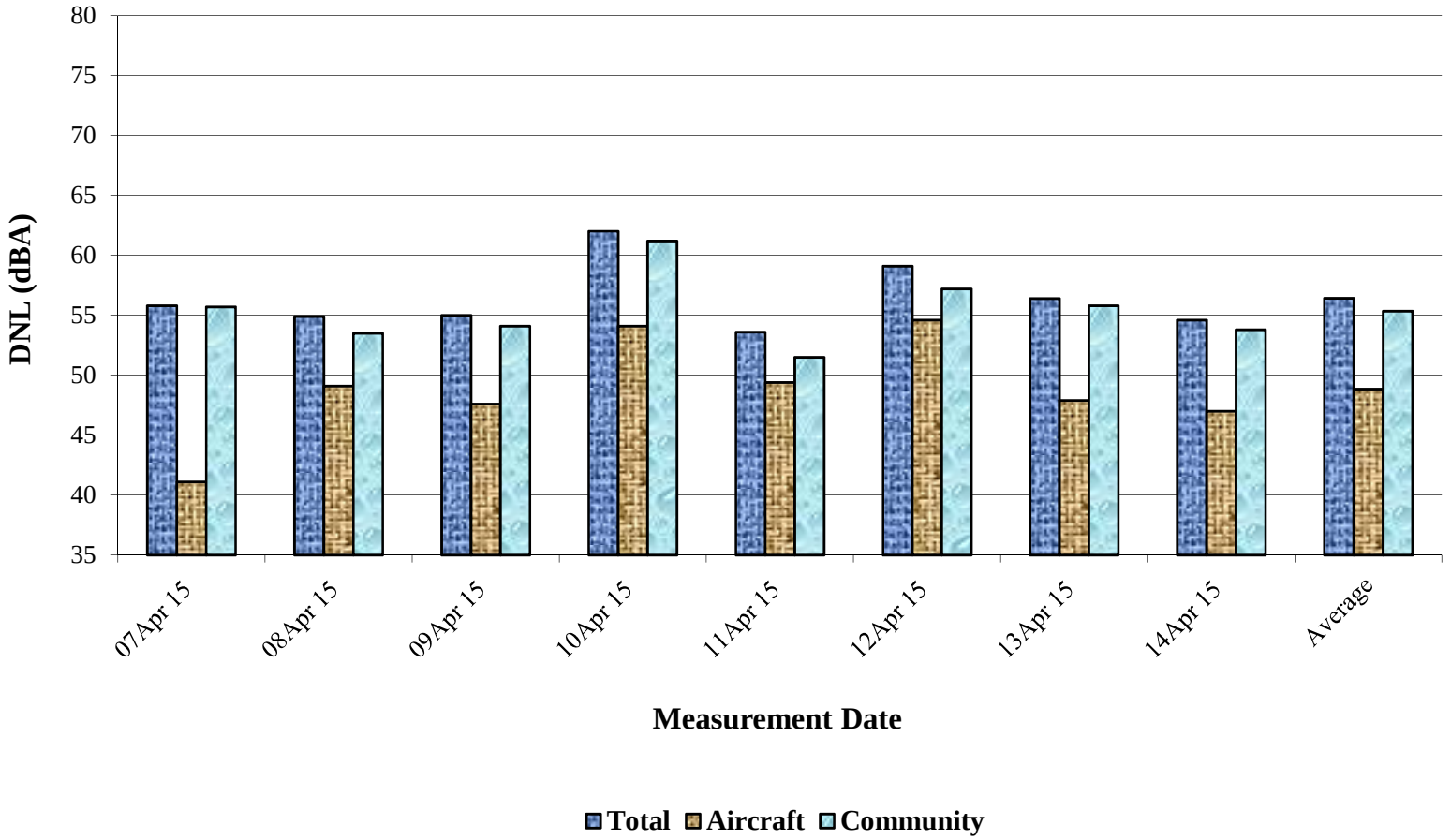
C-4
Daily Measured DNL Values
Livermore Municipal Airport
Site 2: Spring 2015



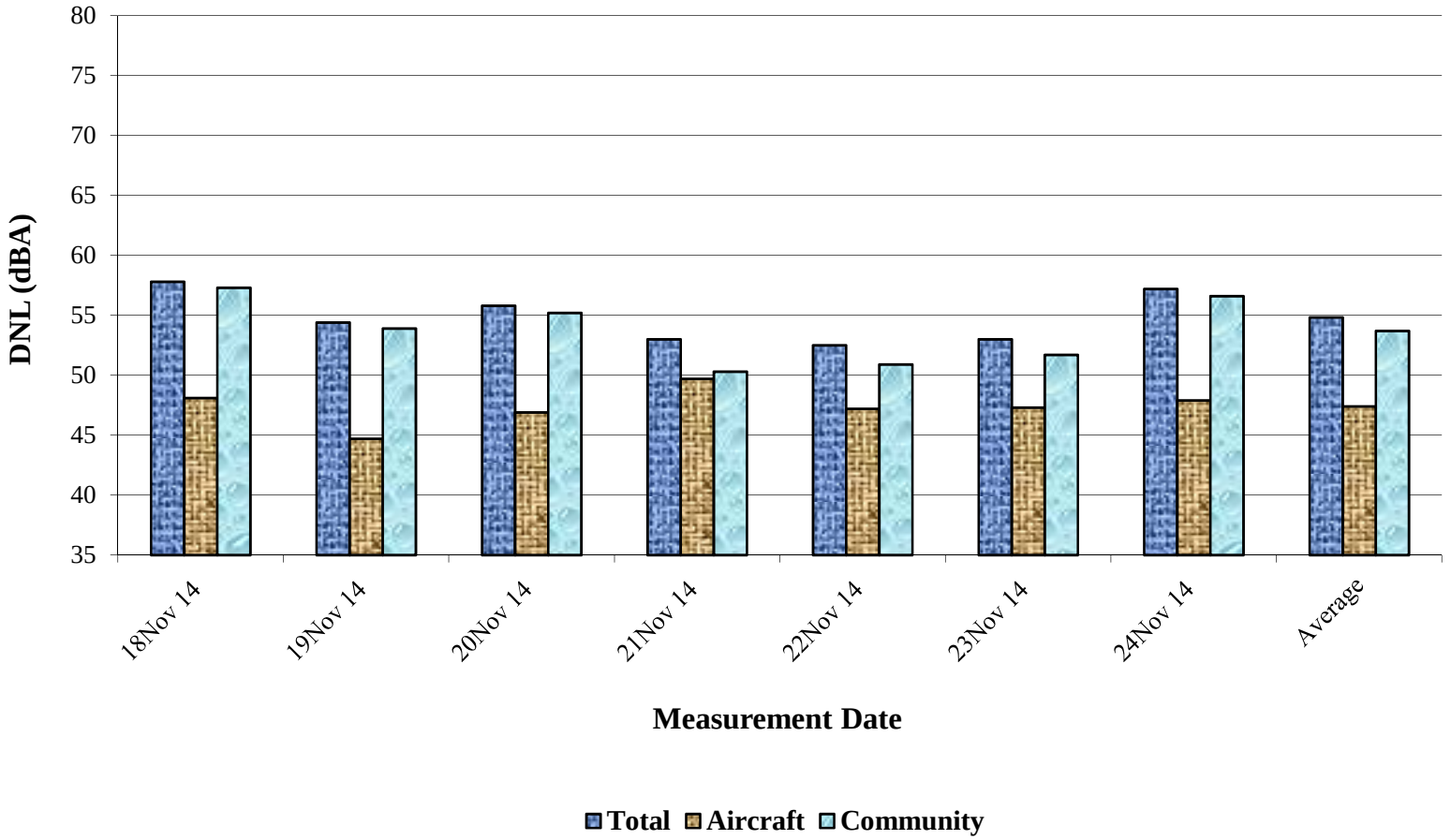
C-5
Daily Measured DNL Values
Livermore Municipal Airport
Site 3: Fall 2014



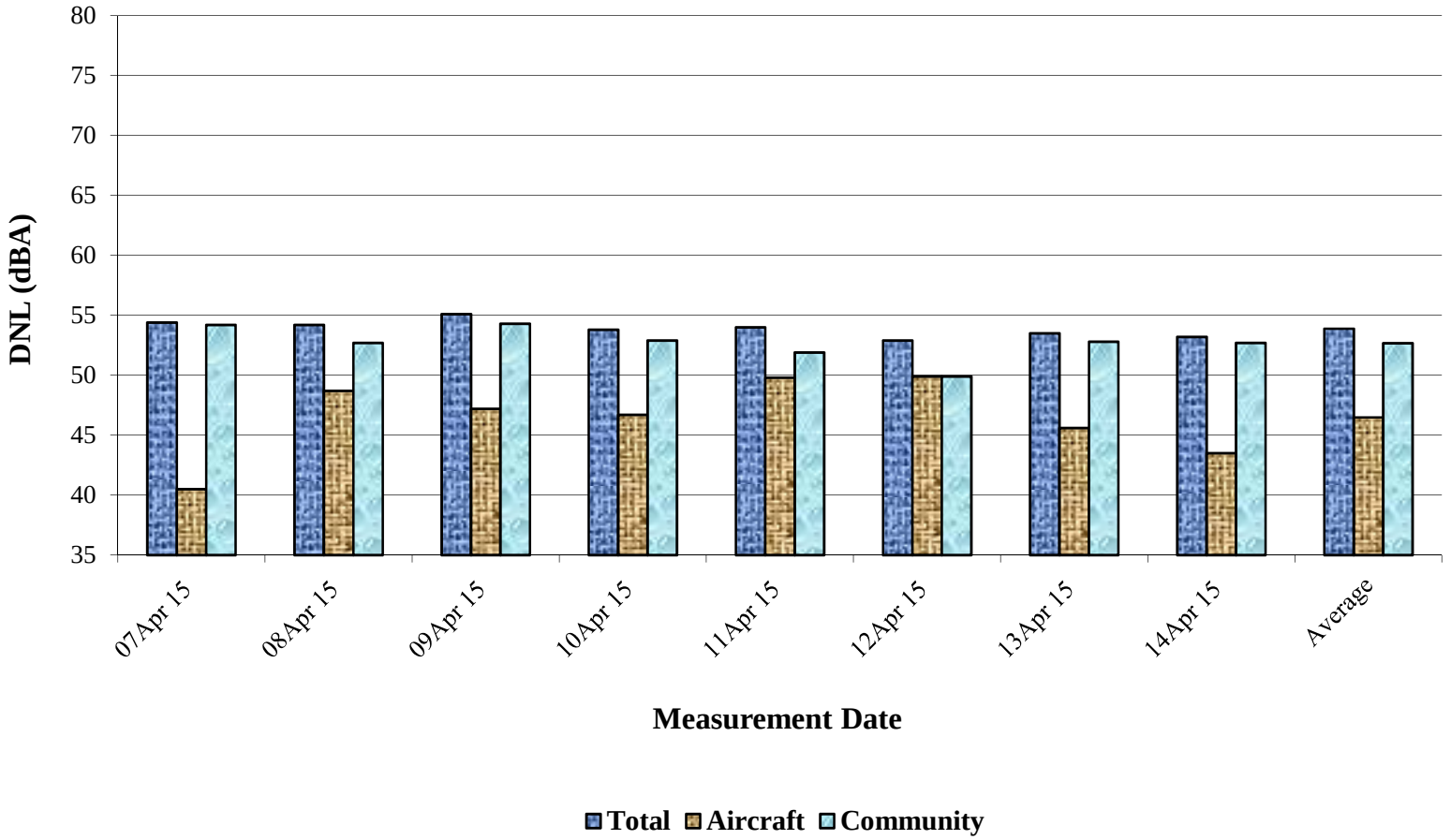
C-6
Daily Measured DNL Values
Livermore Municipal Airport
Site 3: Spring 2015



C-7
Daily Measured DNL Values
Livermore Municipal Airport
Site 4: Fall 2014



C-8
Daily Measured DNL Values
Livermore Municipal Airport
Site 4: Spring 2015



C-9
Daily Measured DNL Values
Livermore Municipal Airport
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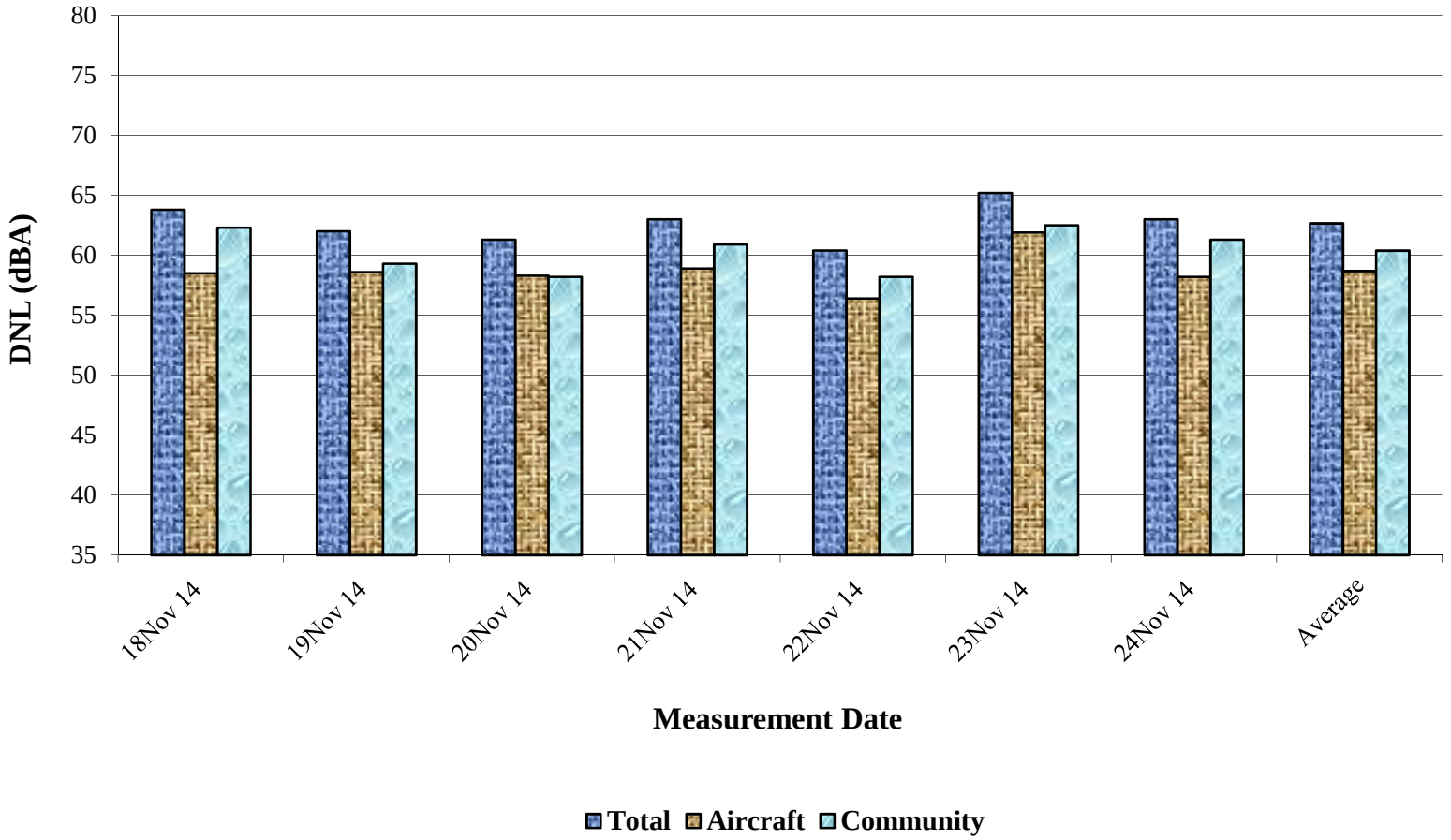
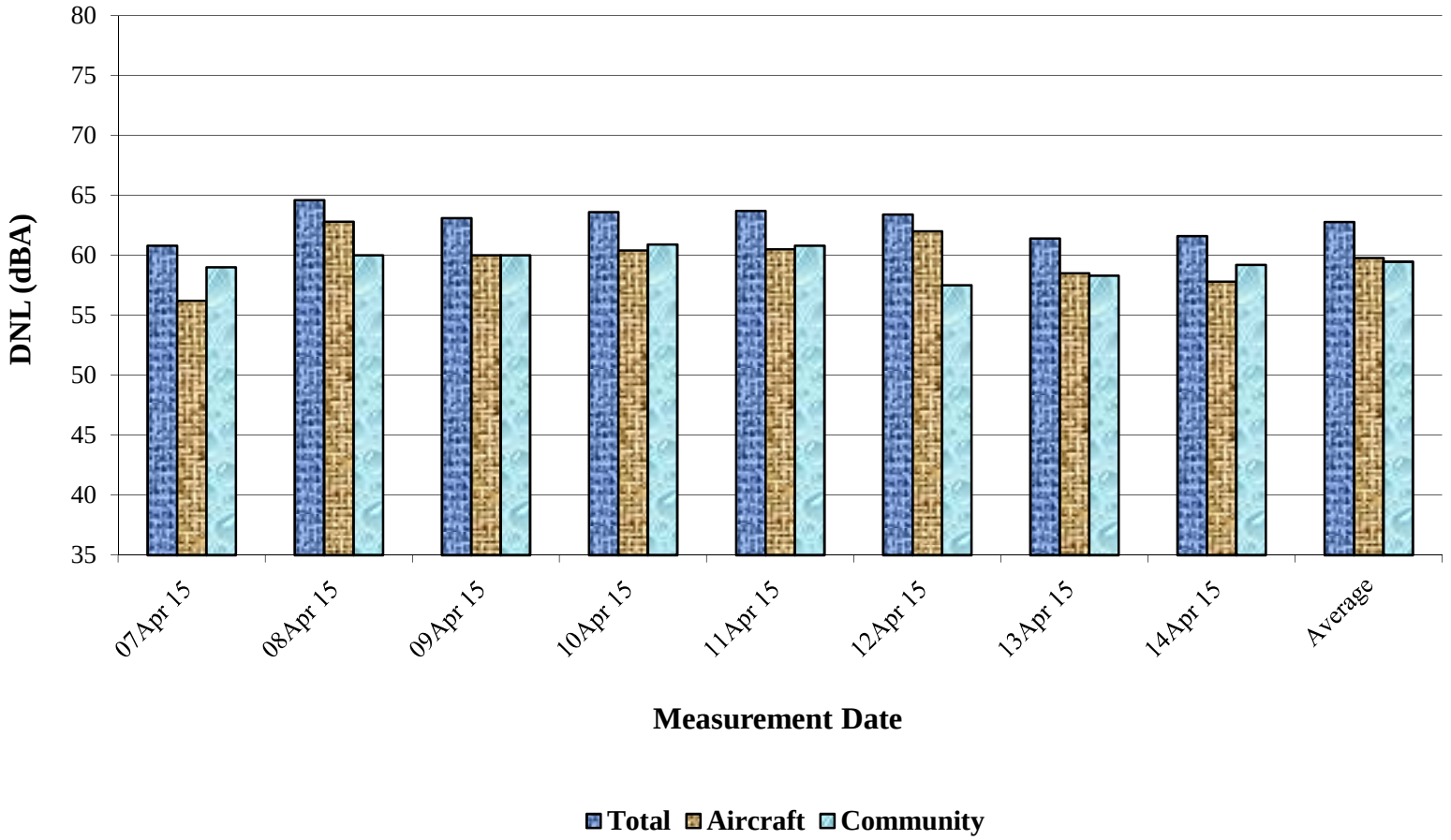
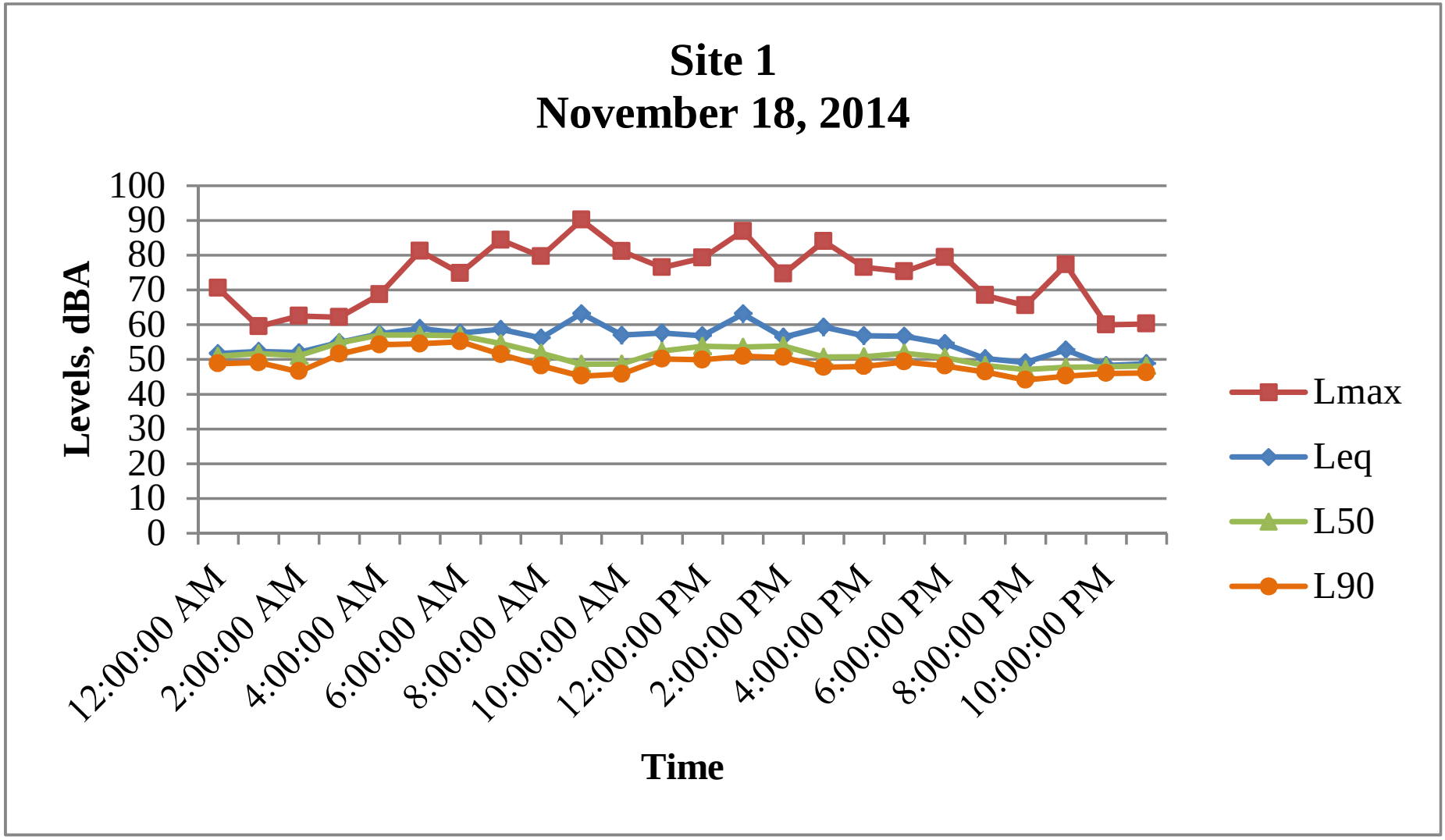


C-10
Daily Measured DNL Values
Livermore Municipal Airport
Site 5: Spring 2015



APPENDIX D

MEASURED HOURLY NOISE LEVELS
LIVERMORE MUNICIPAL AIRPORT
FALL 2014 AND SPRING 2015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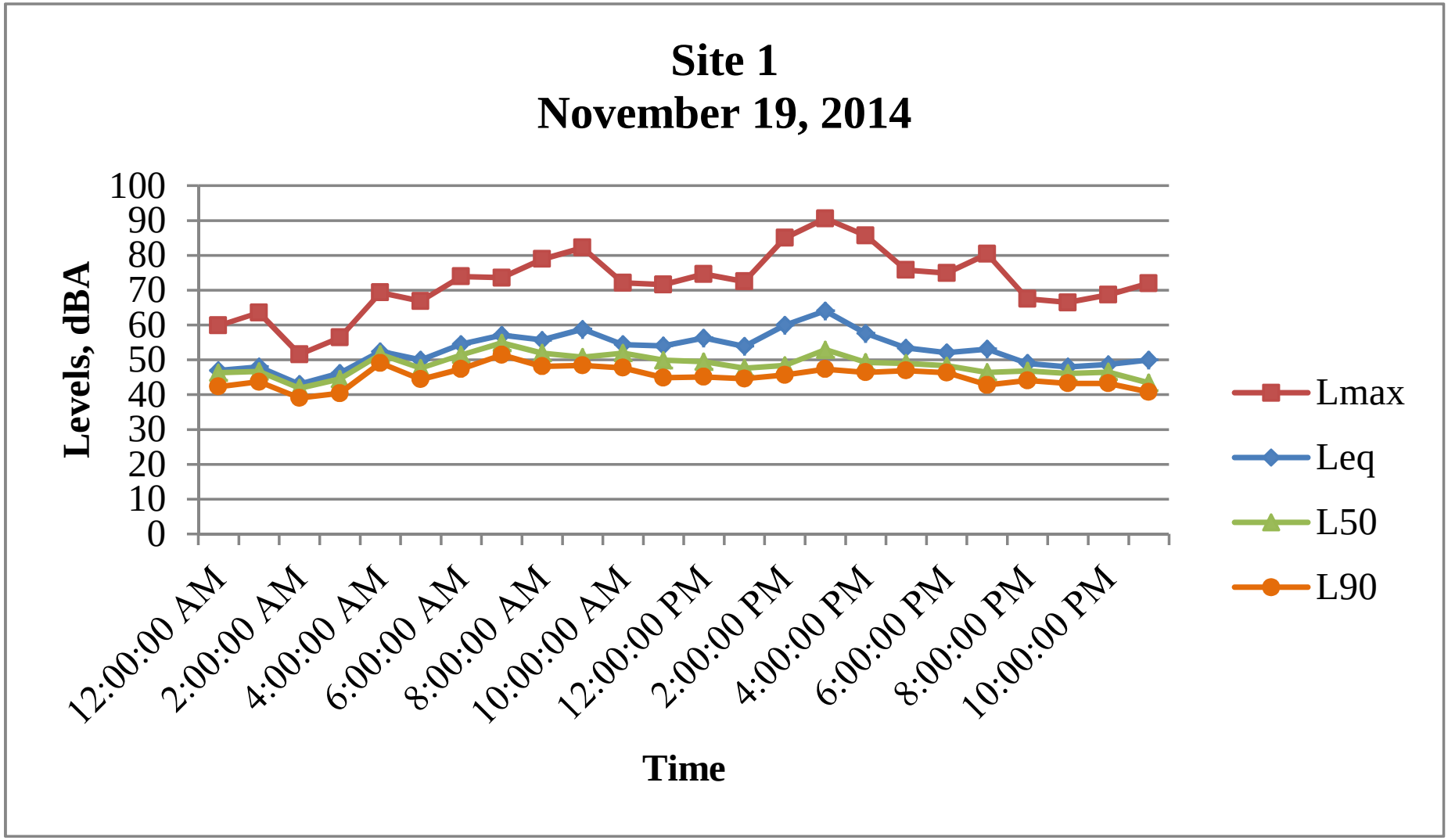
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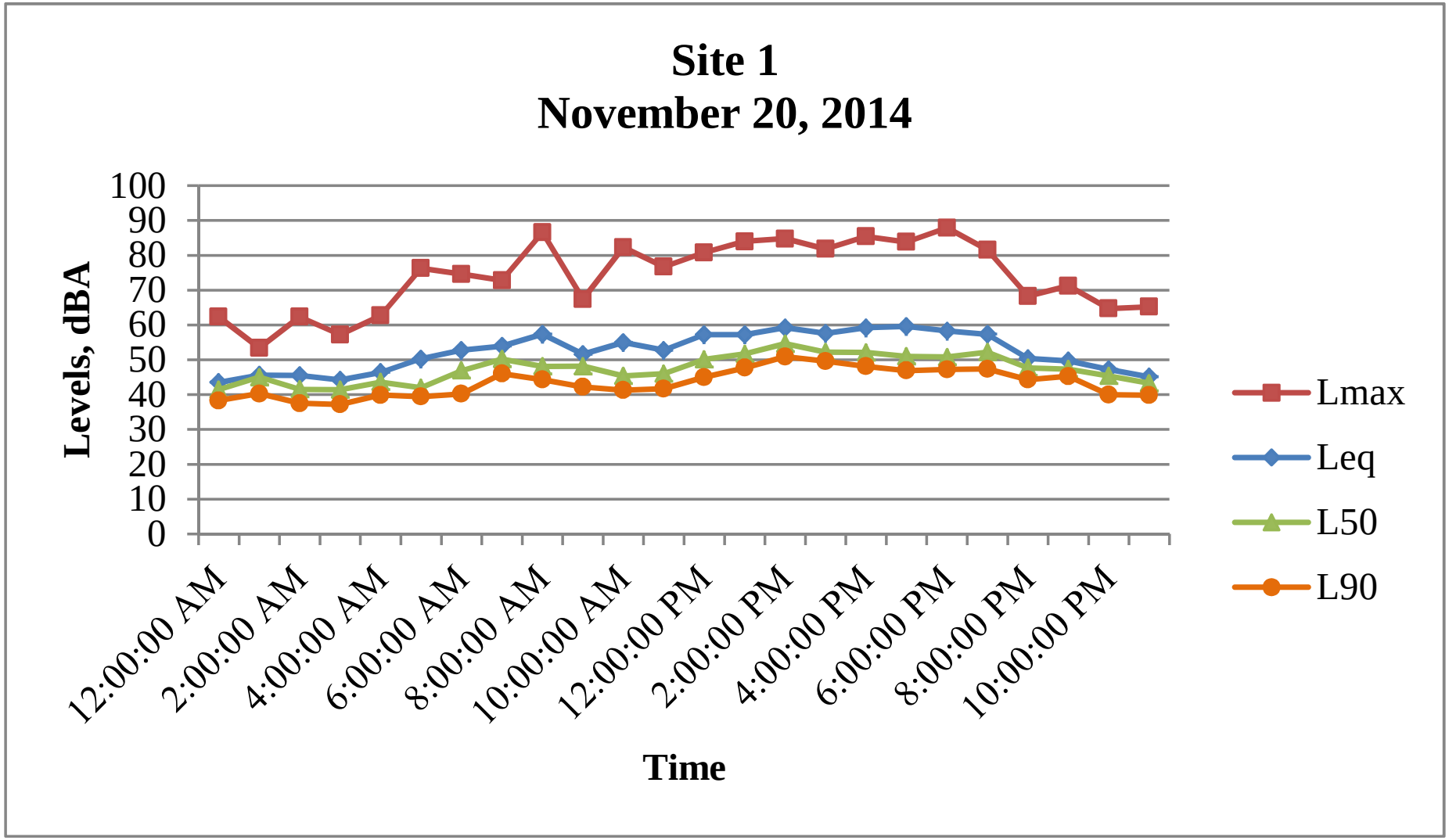
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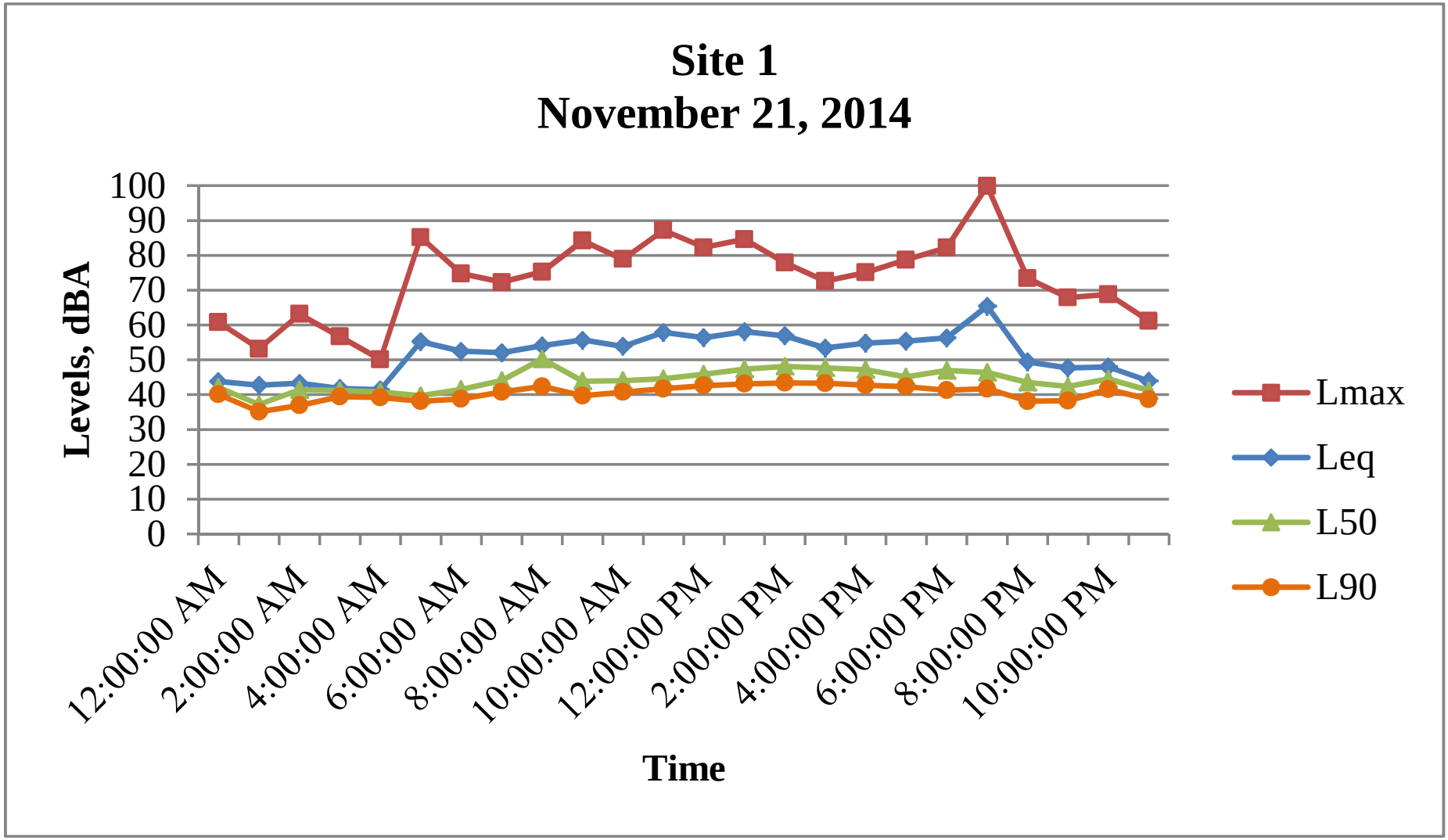
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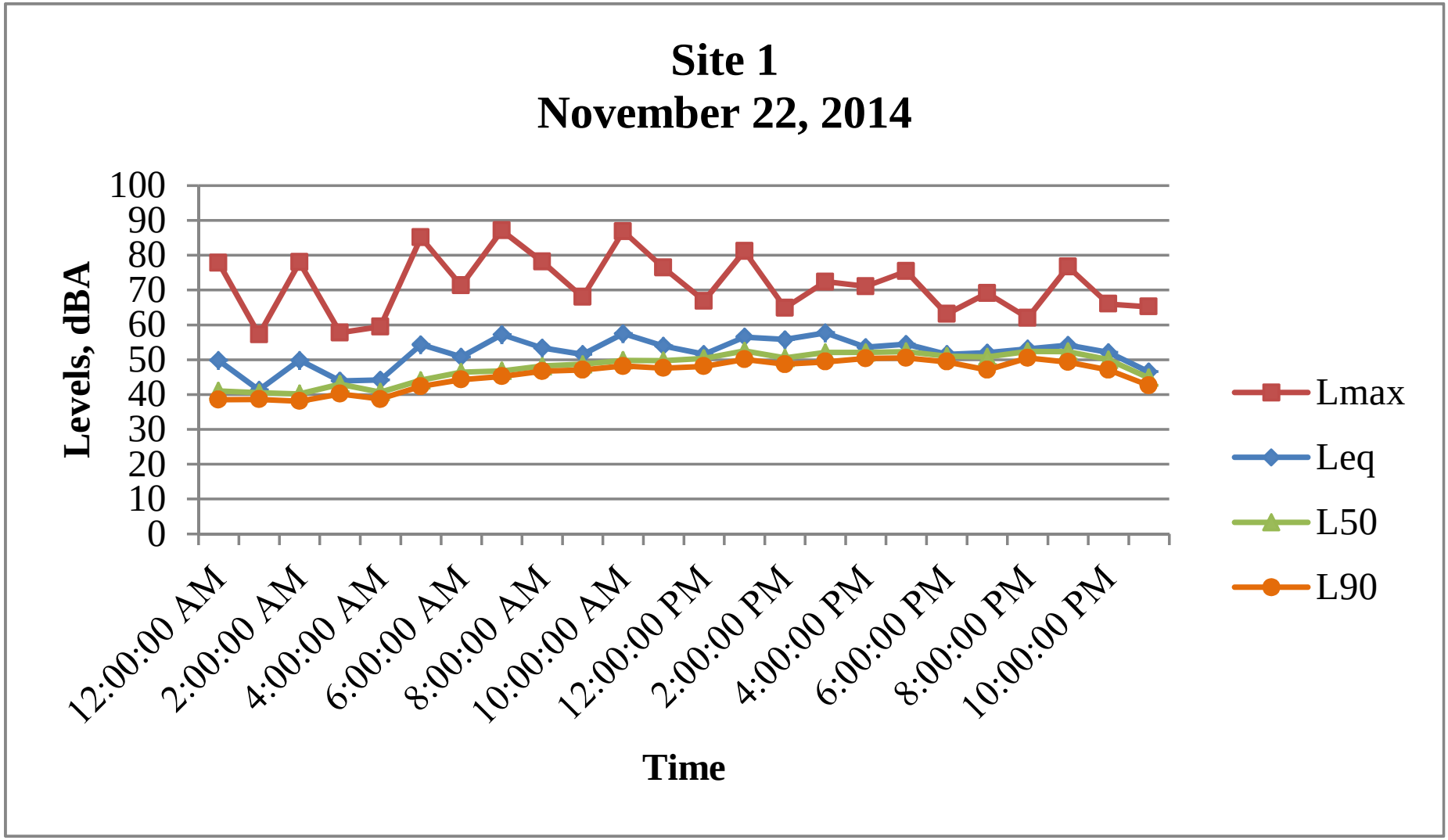
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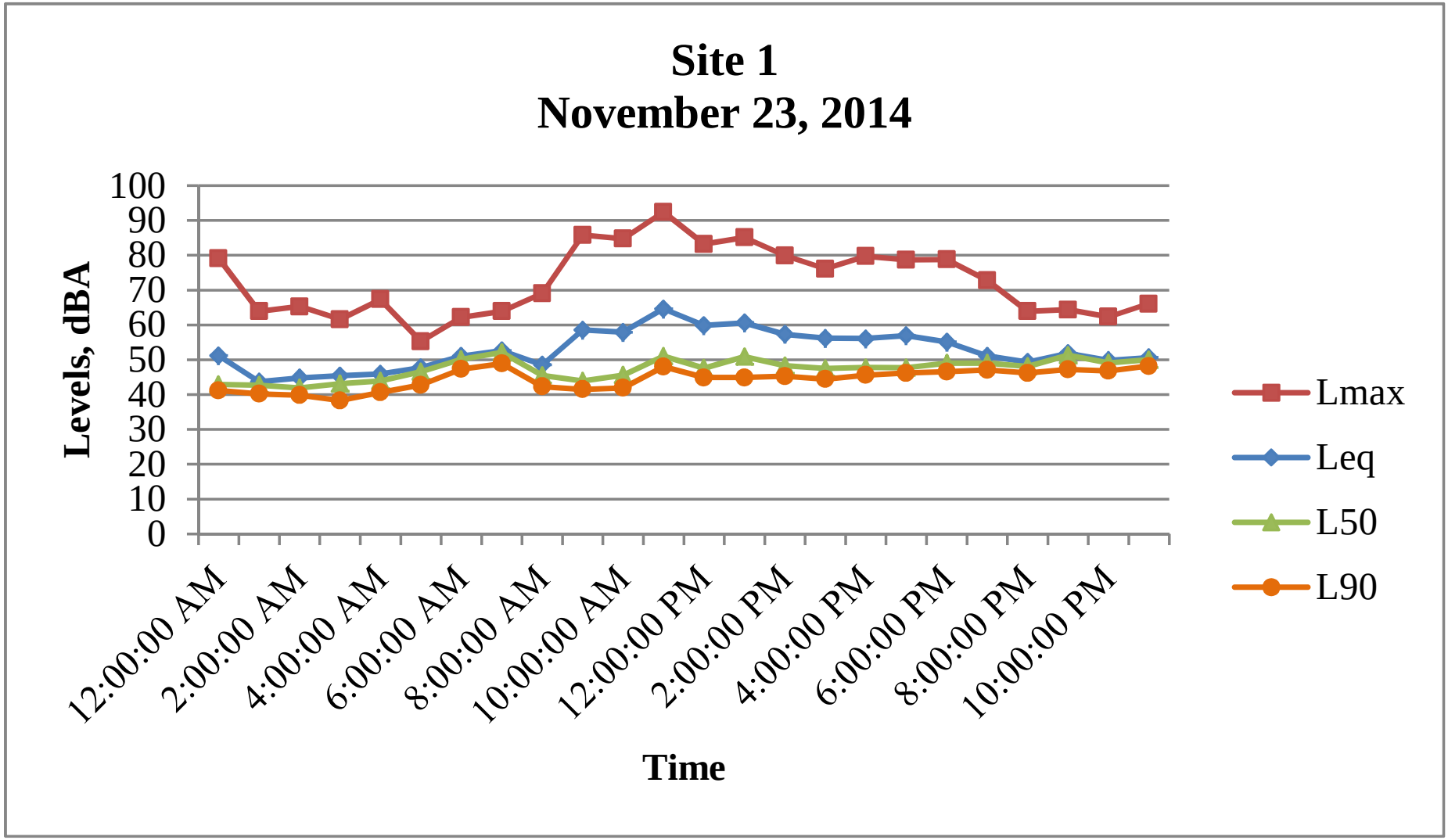
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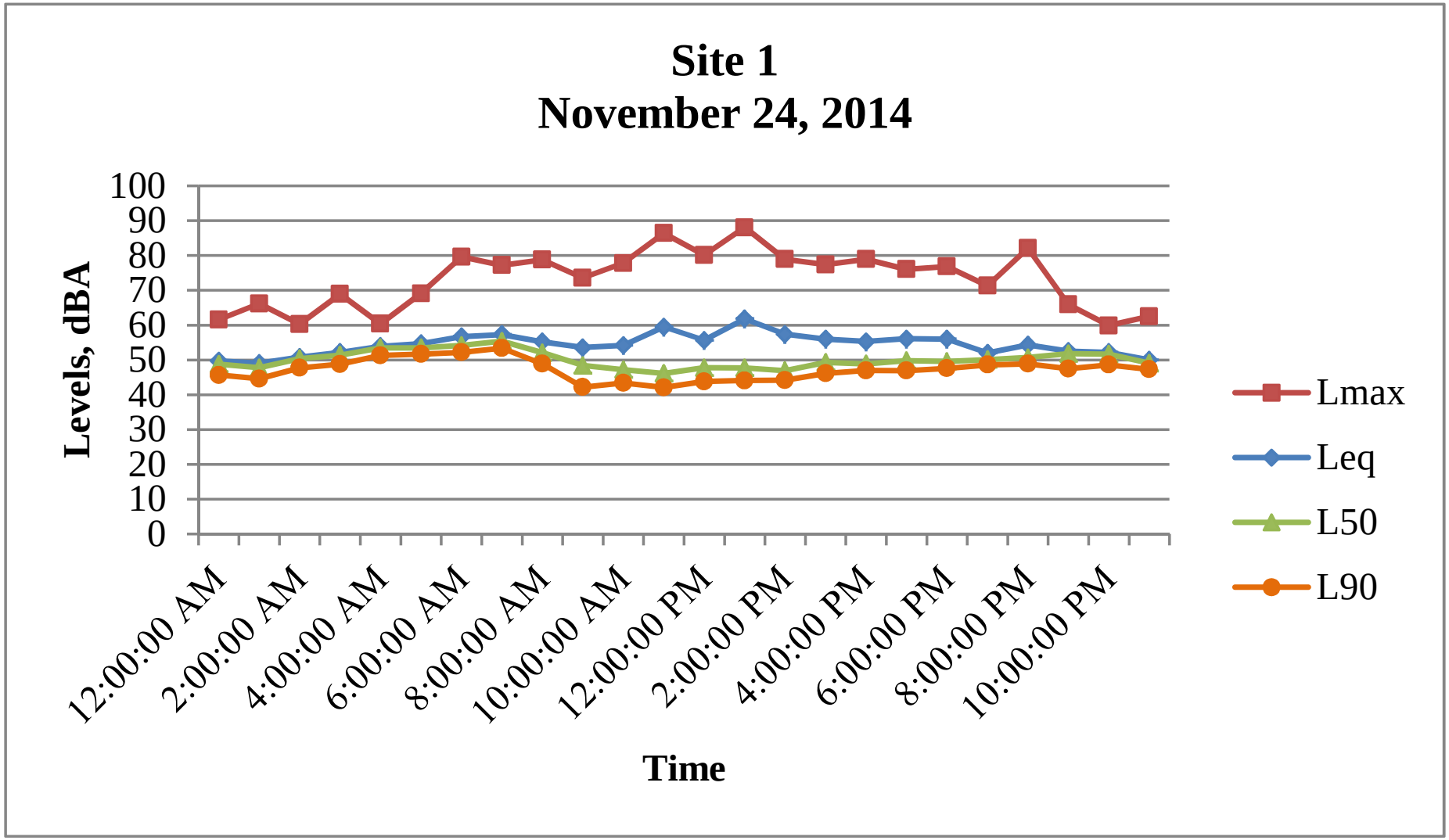
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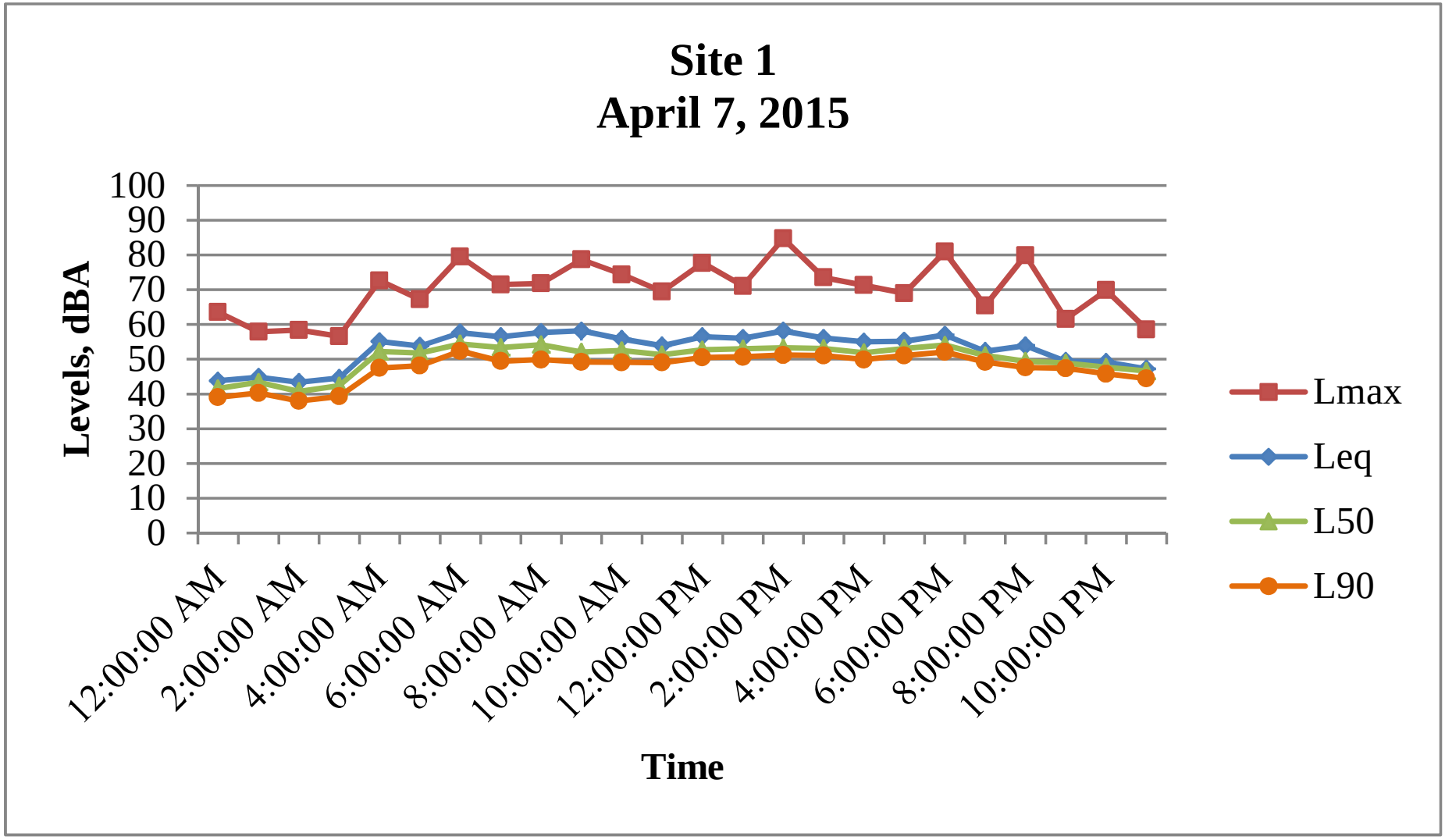
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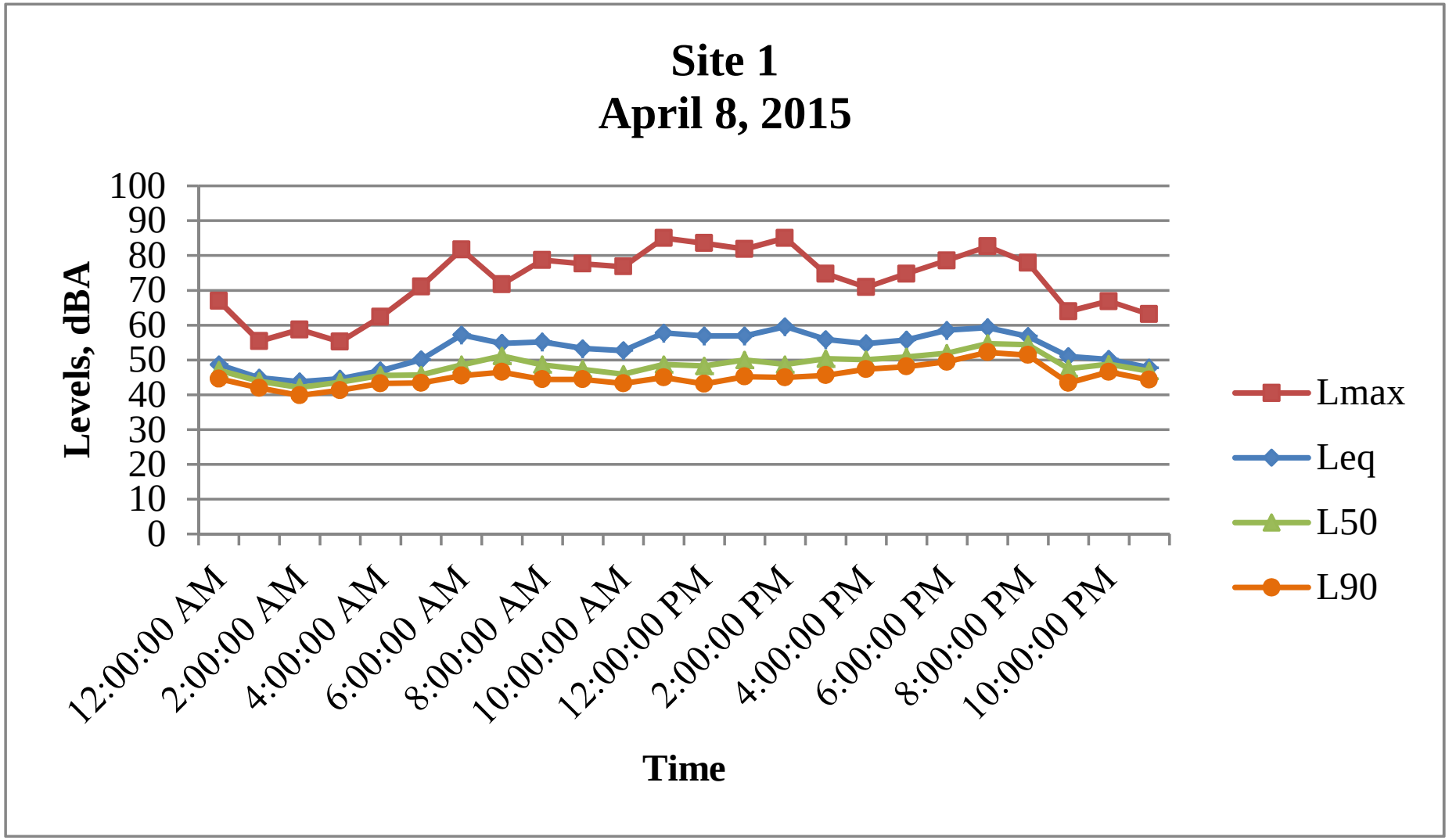
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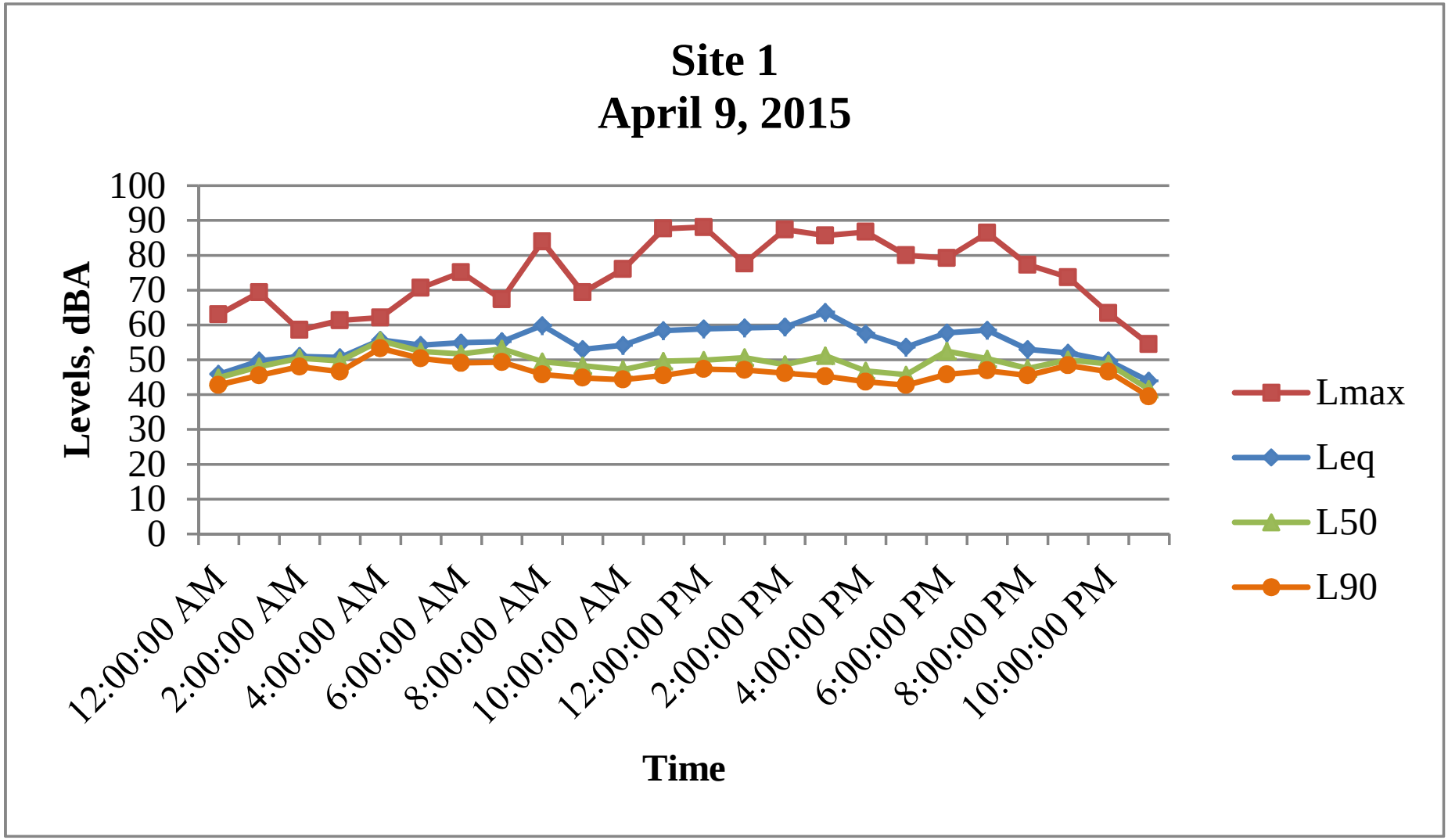
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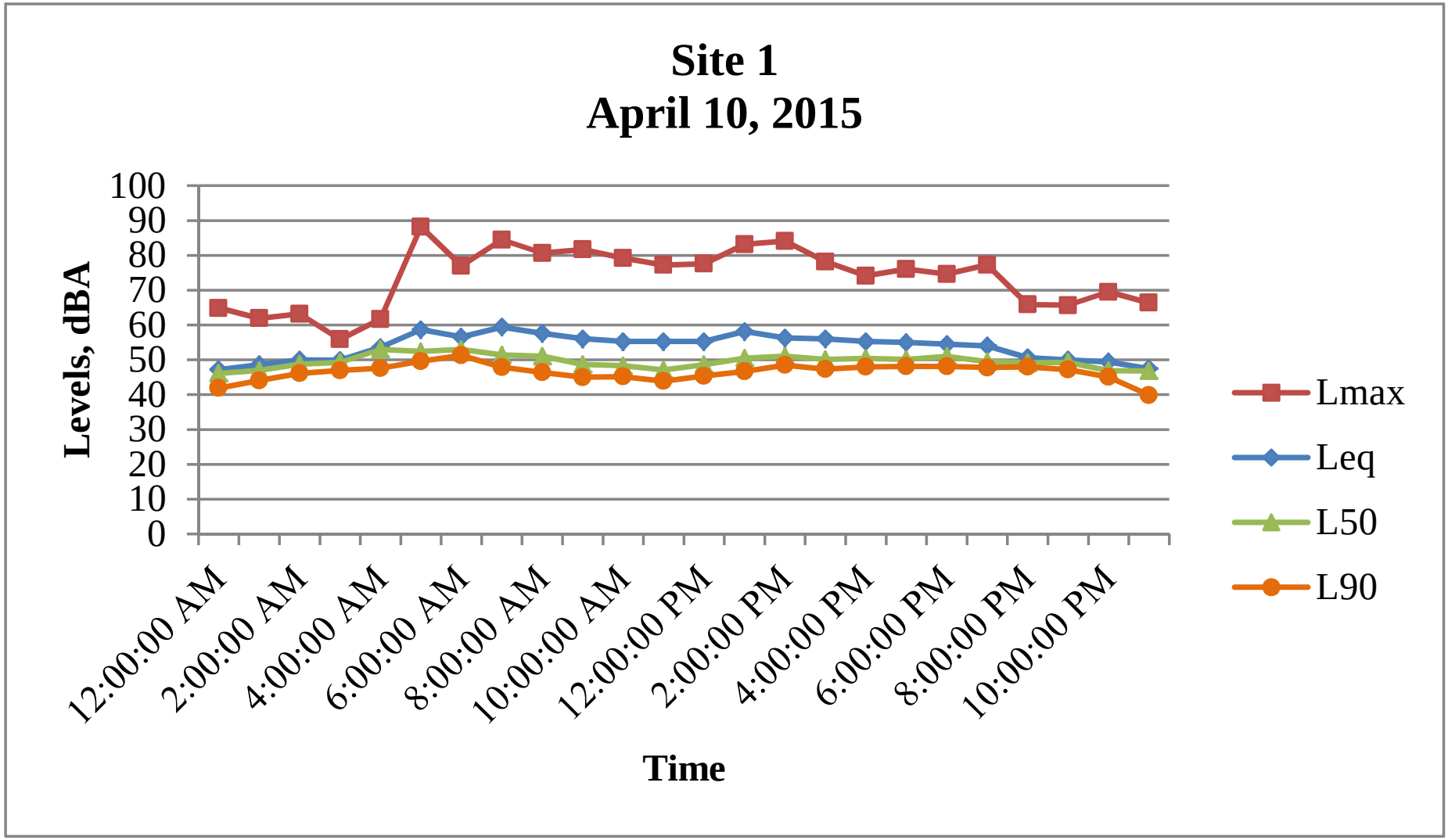
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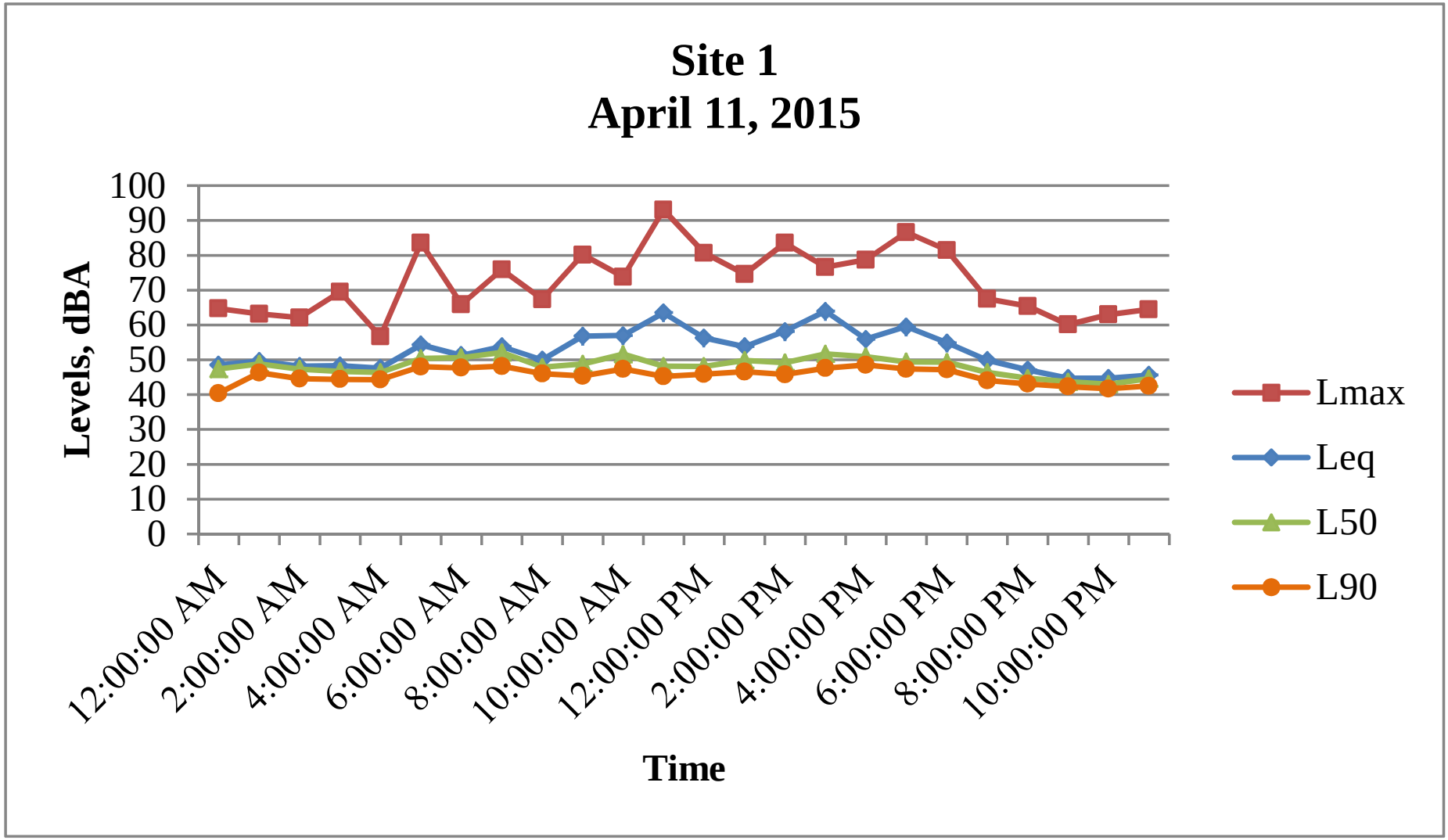
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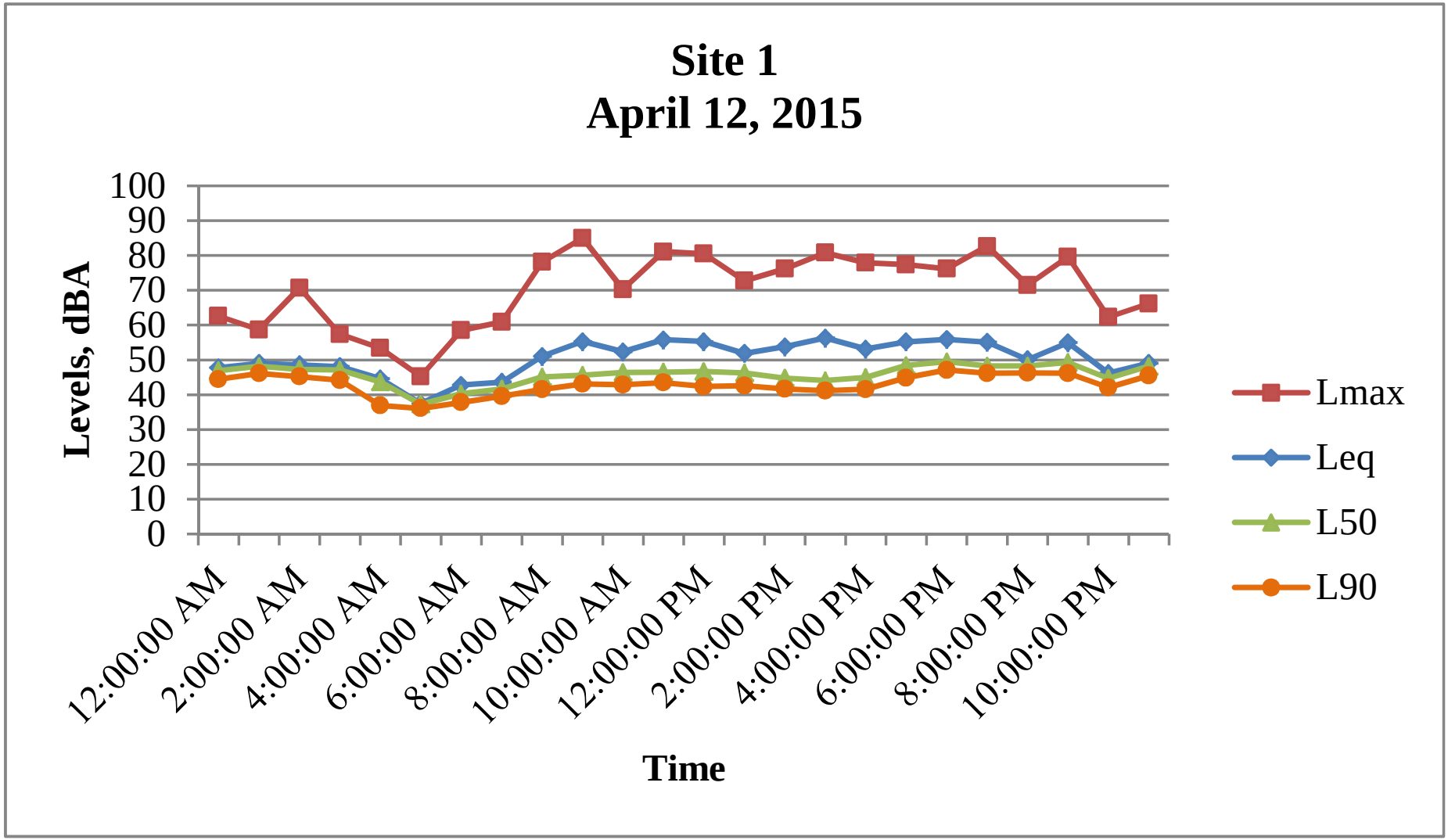
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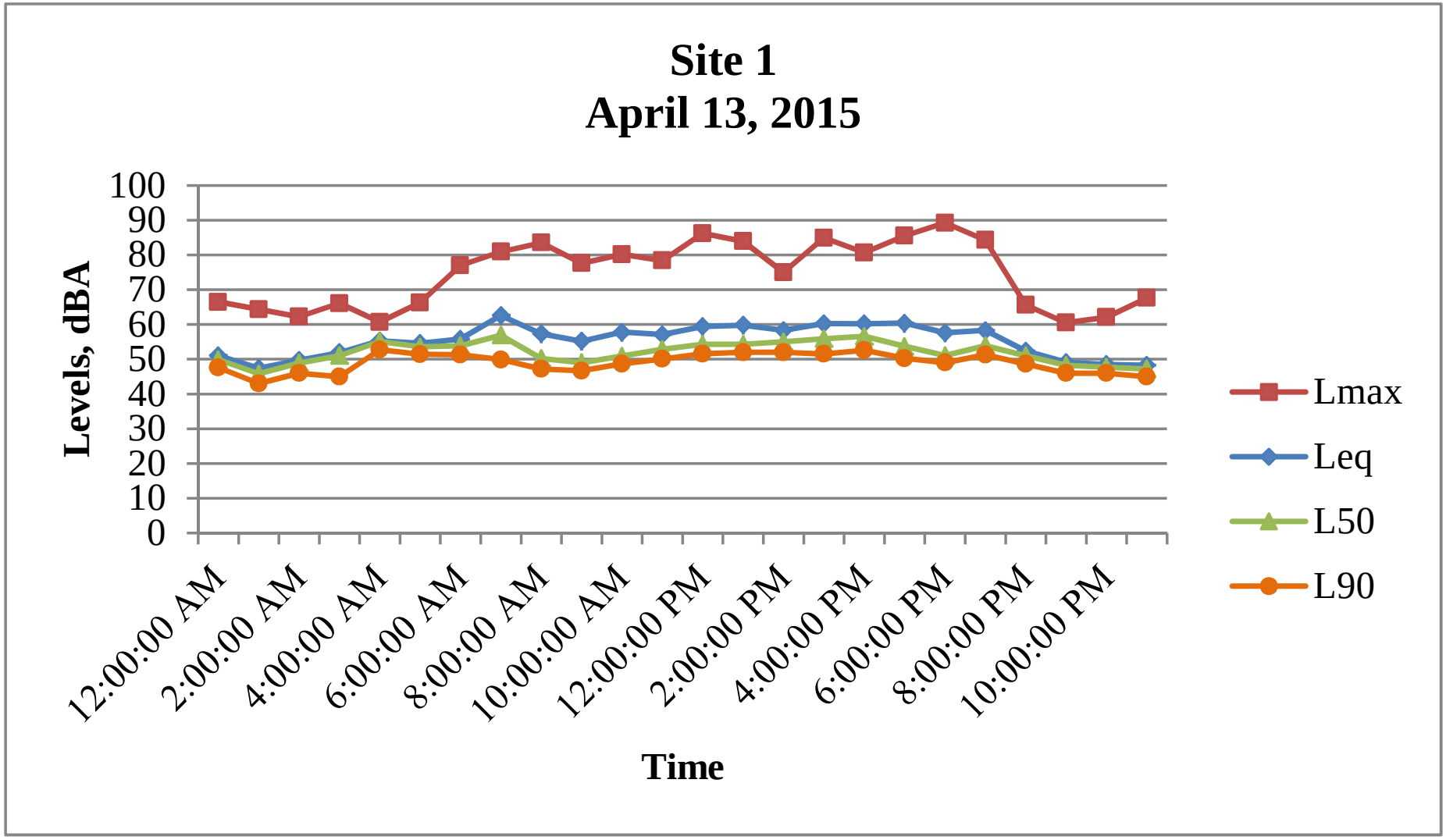
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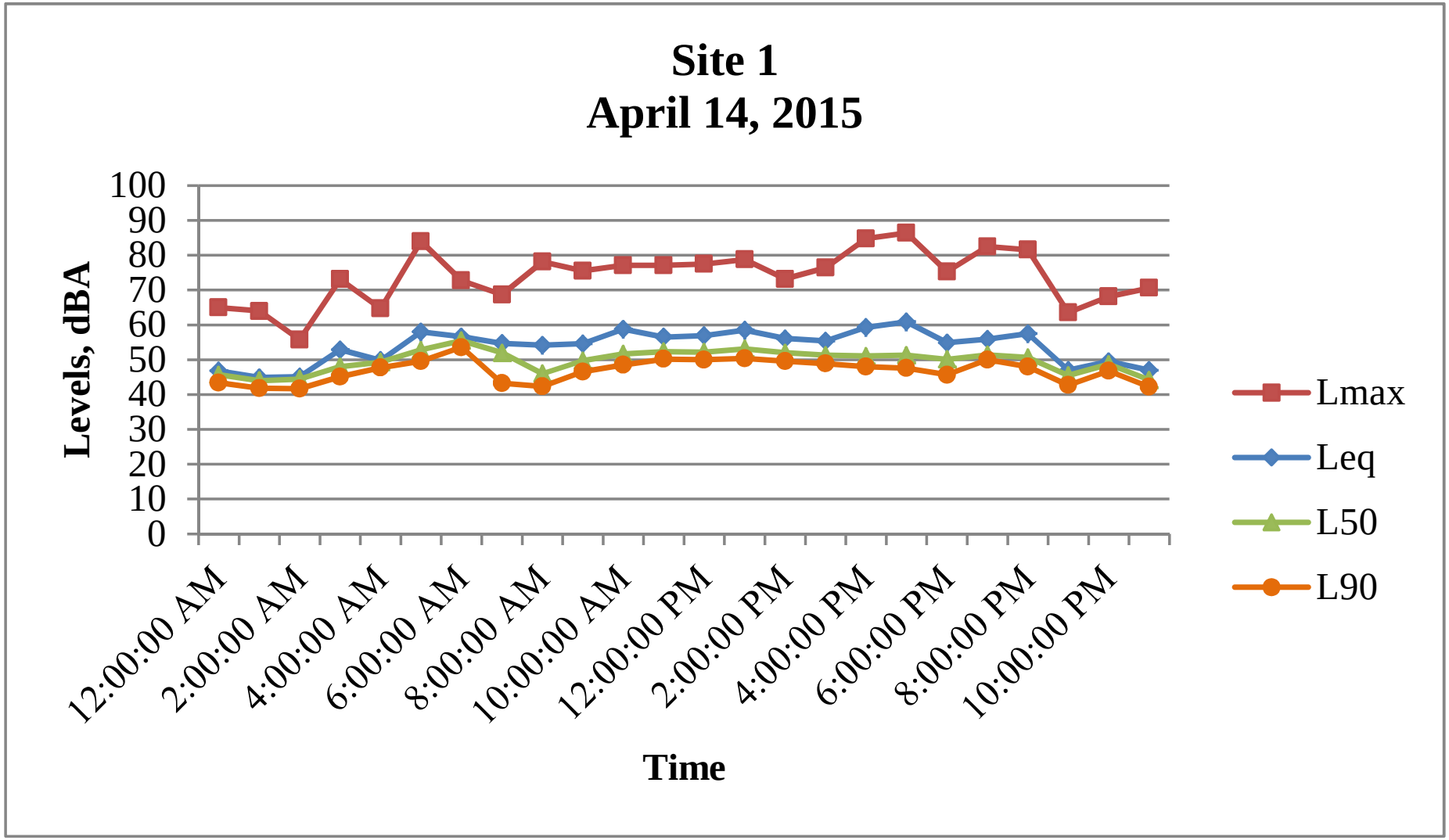
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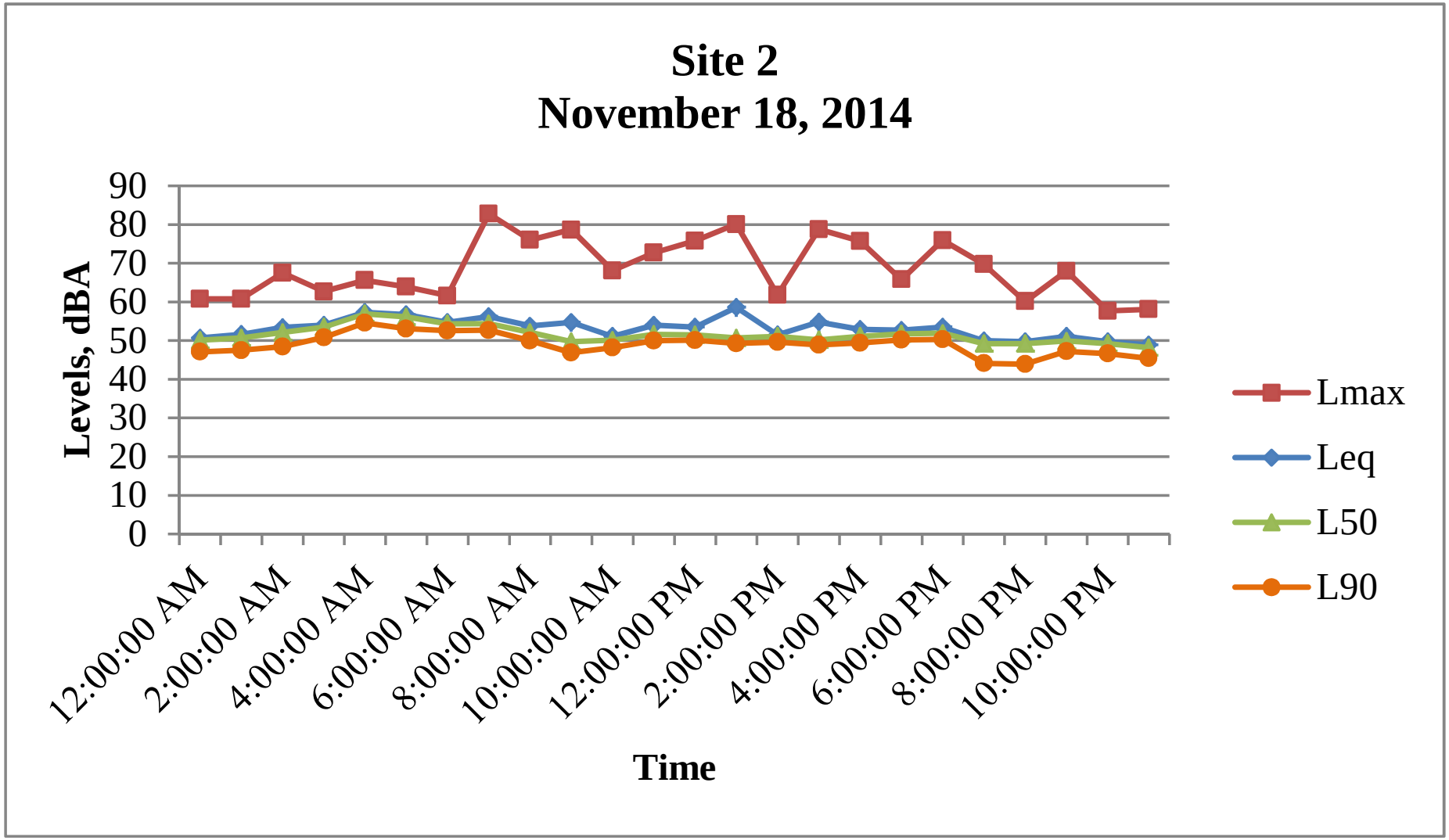
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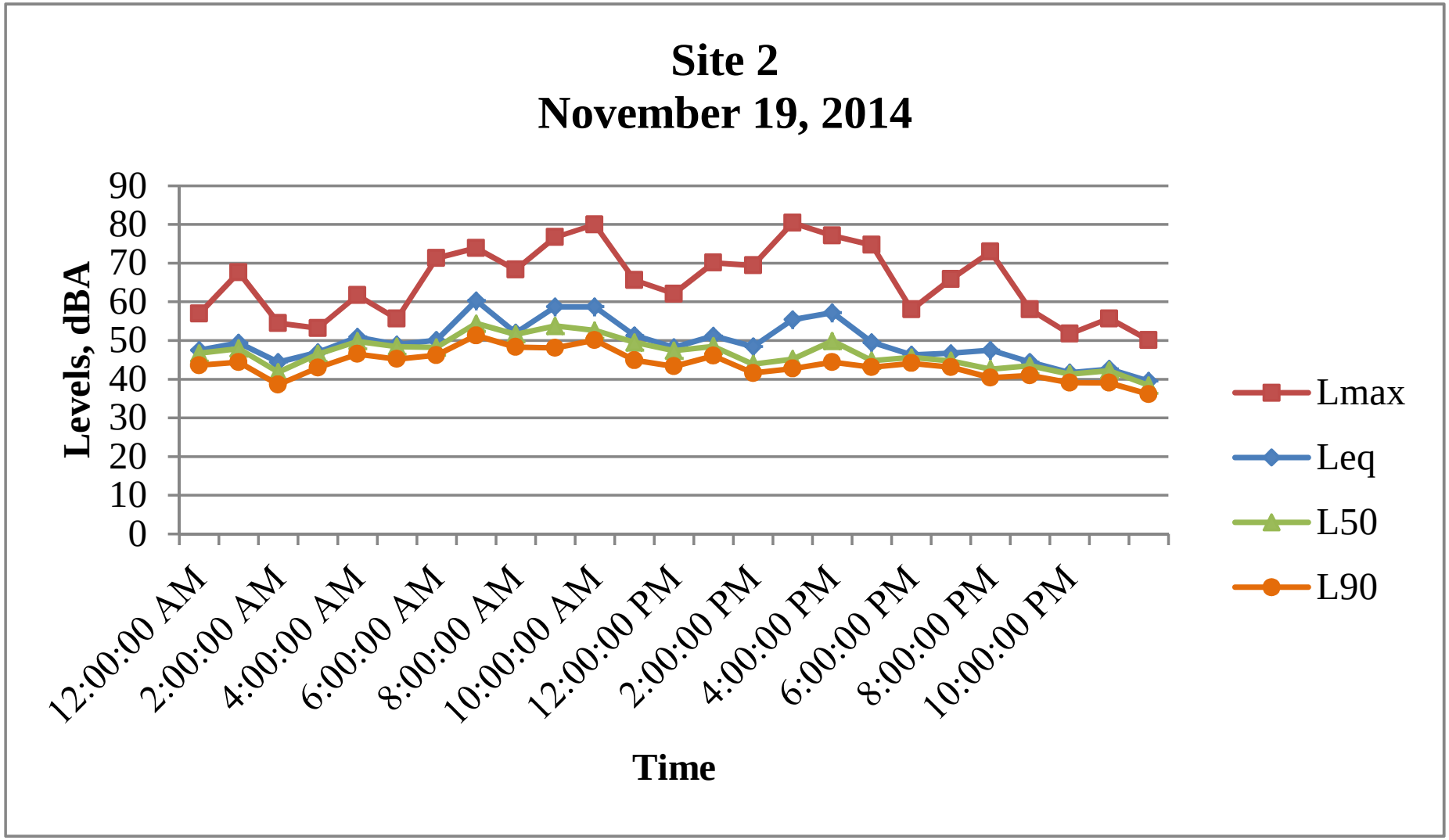
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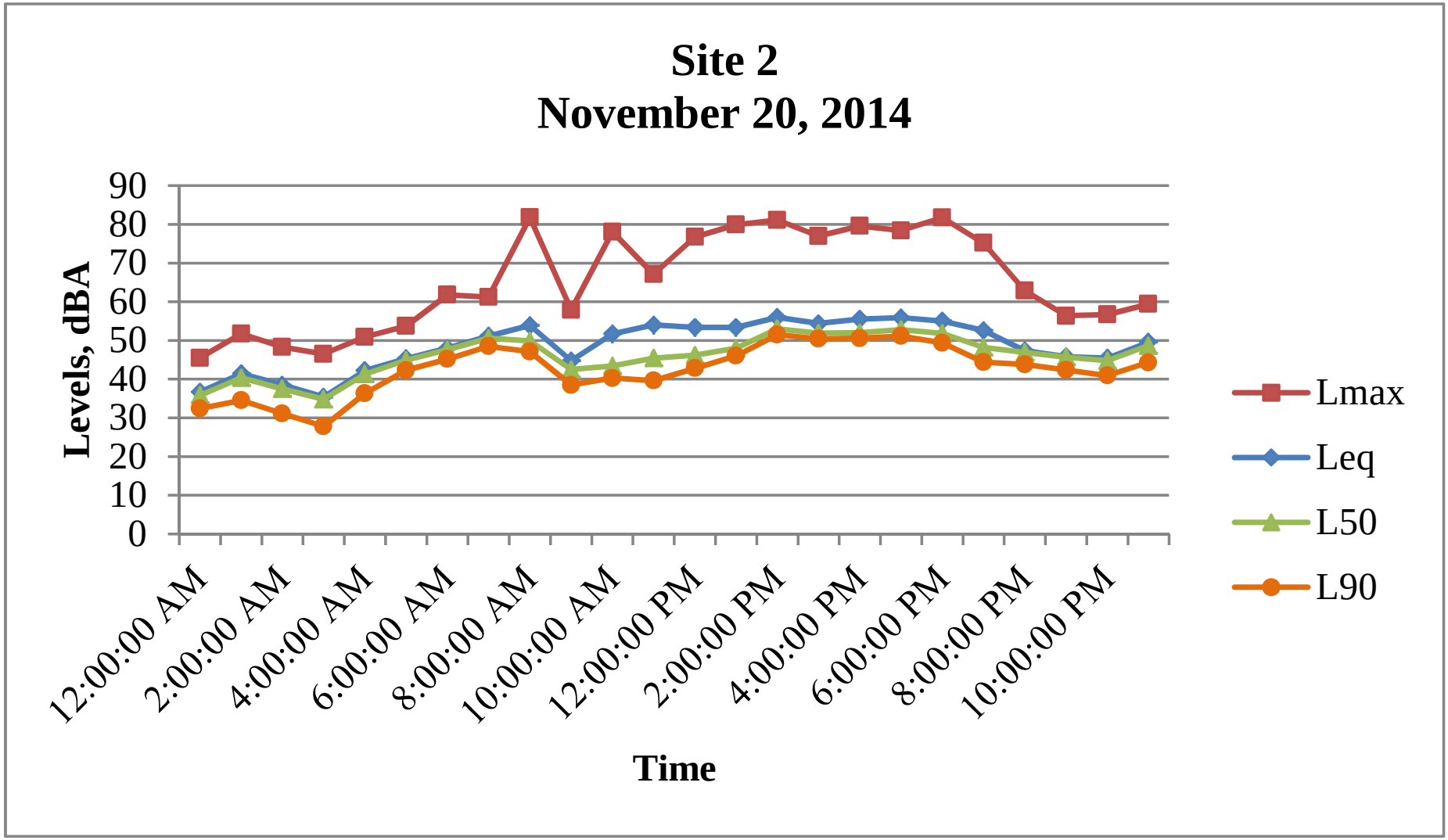
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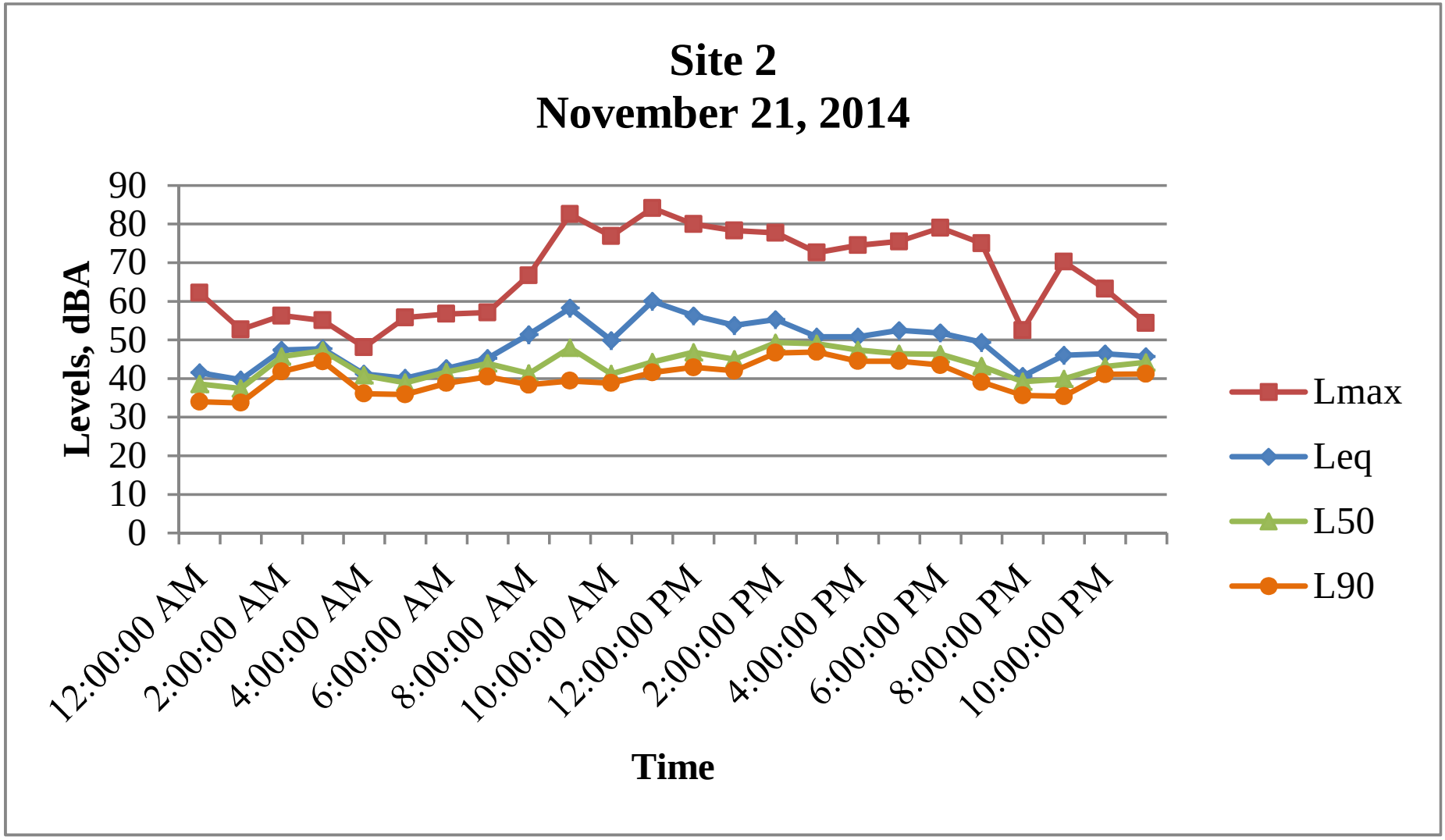
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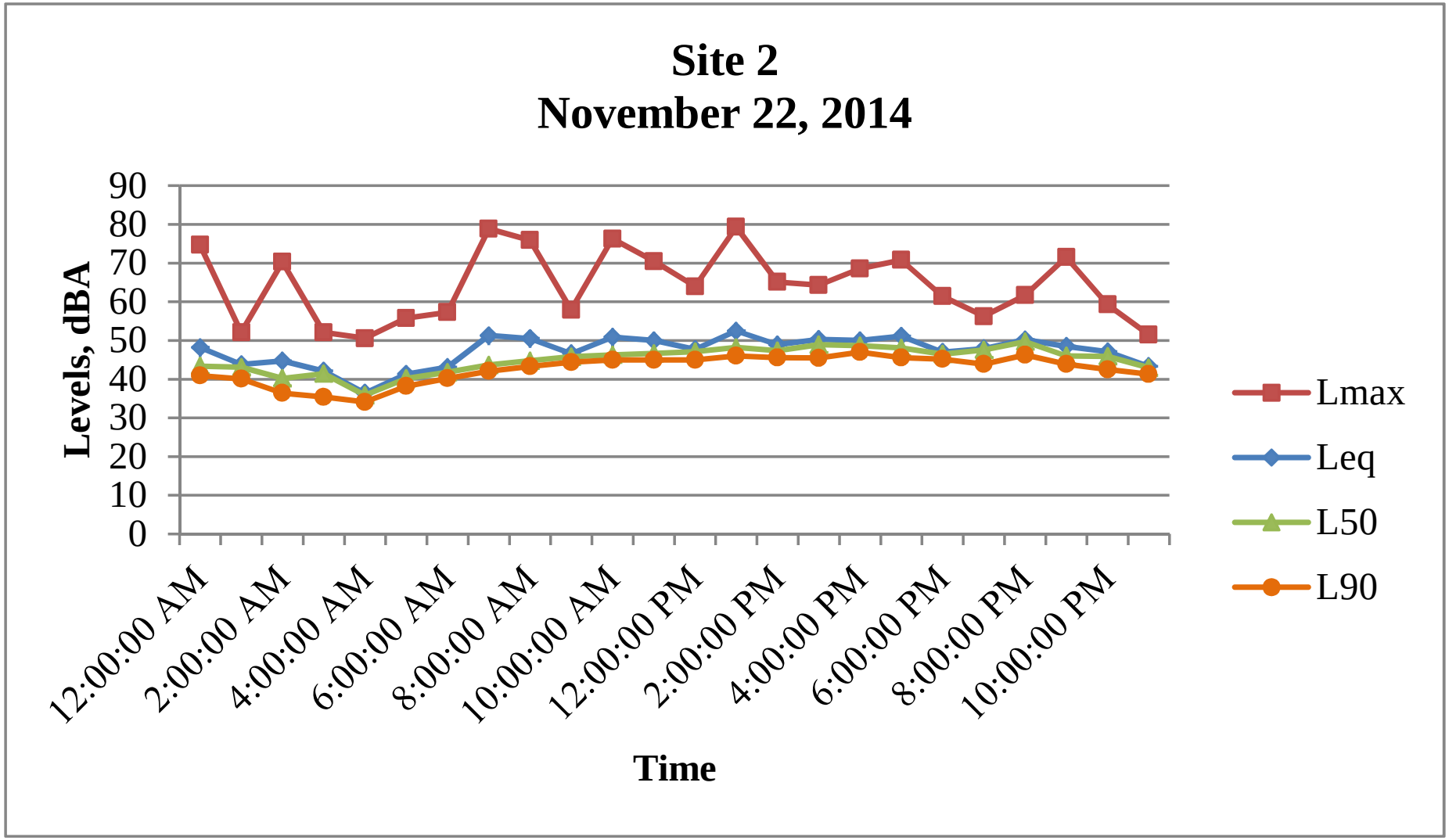
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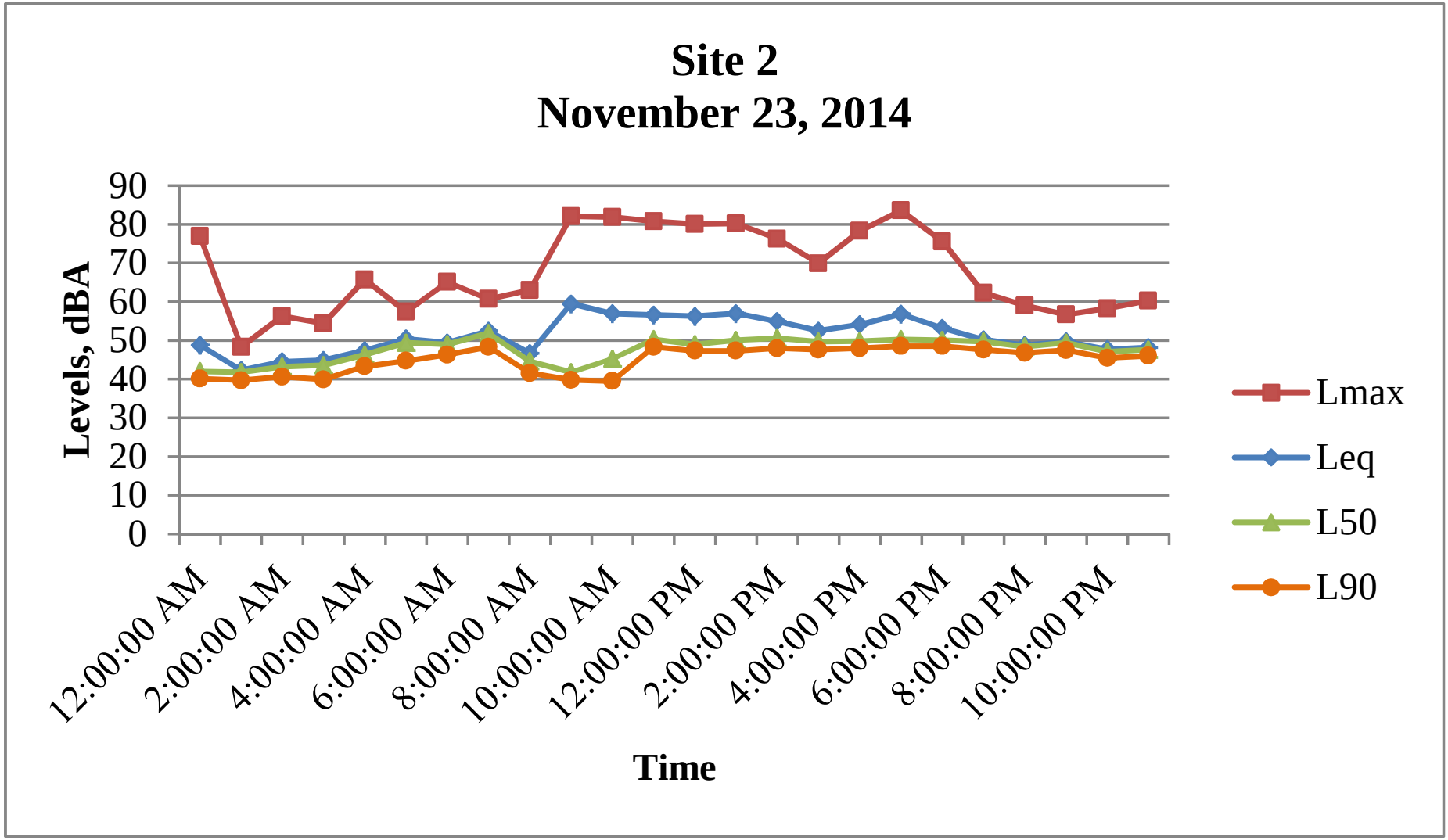
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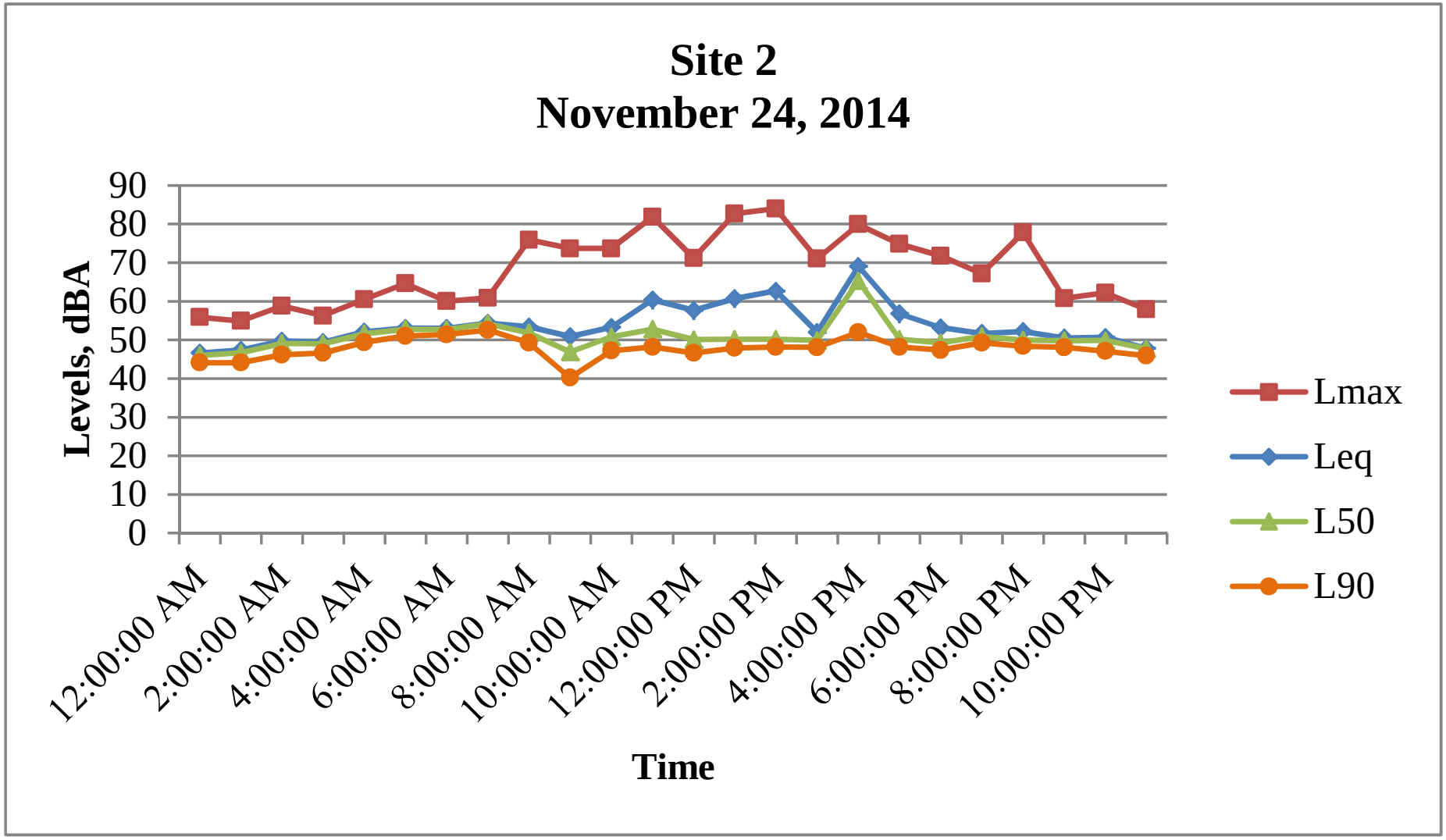
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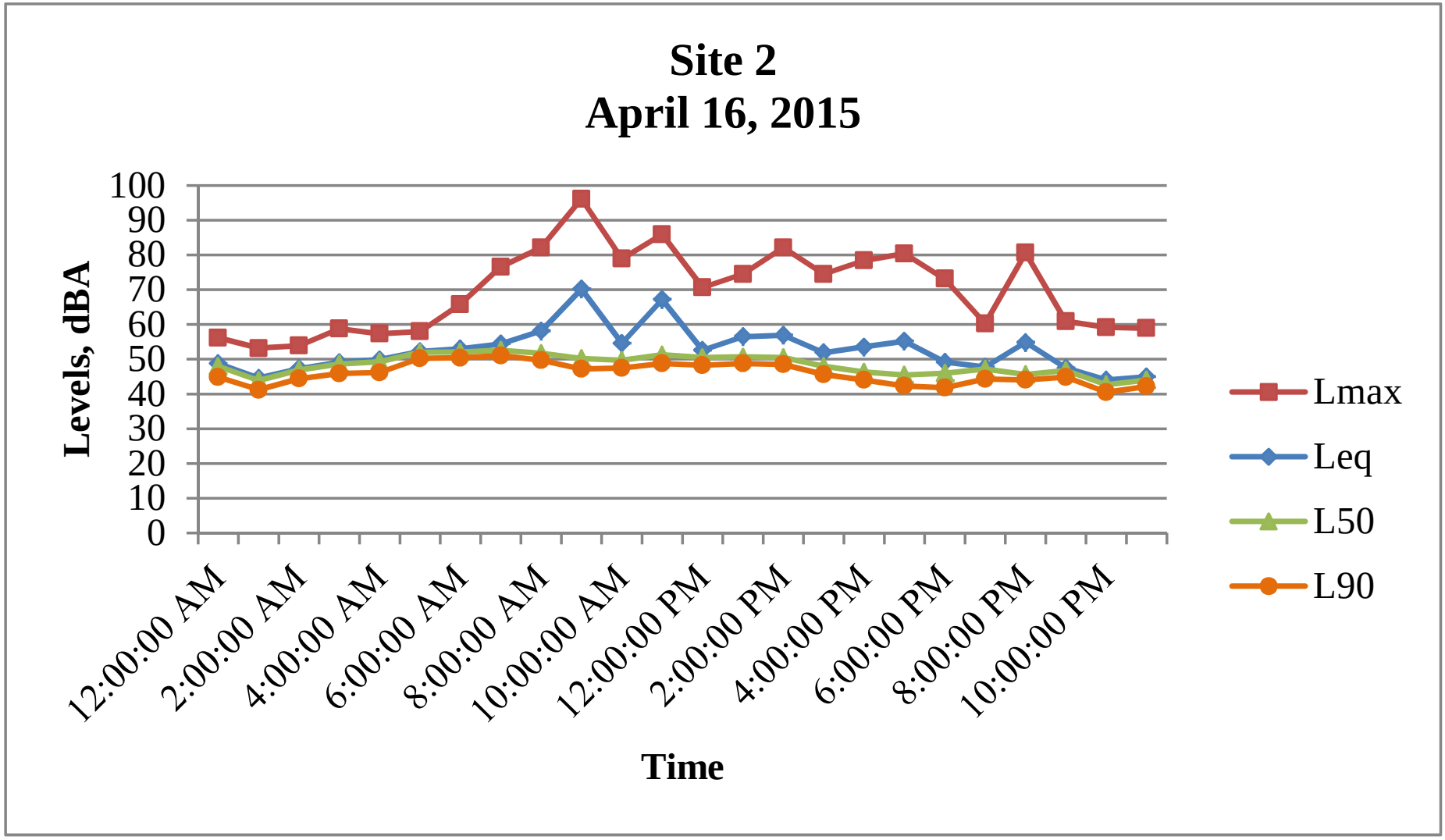
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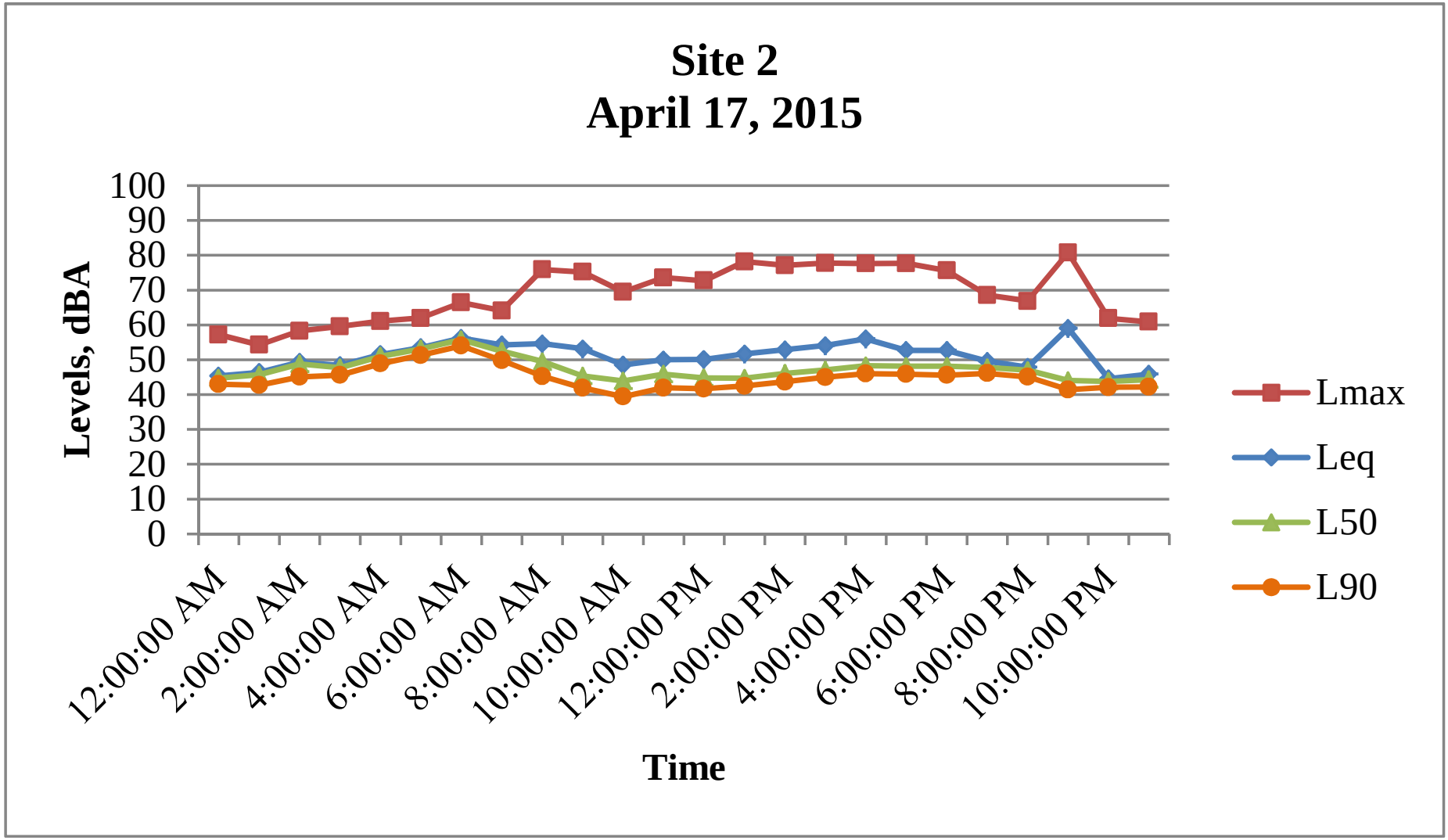
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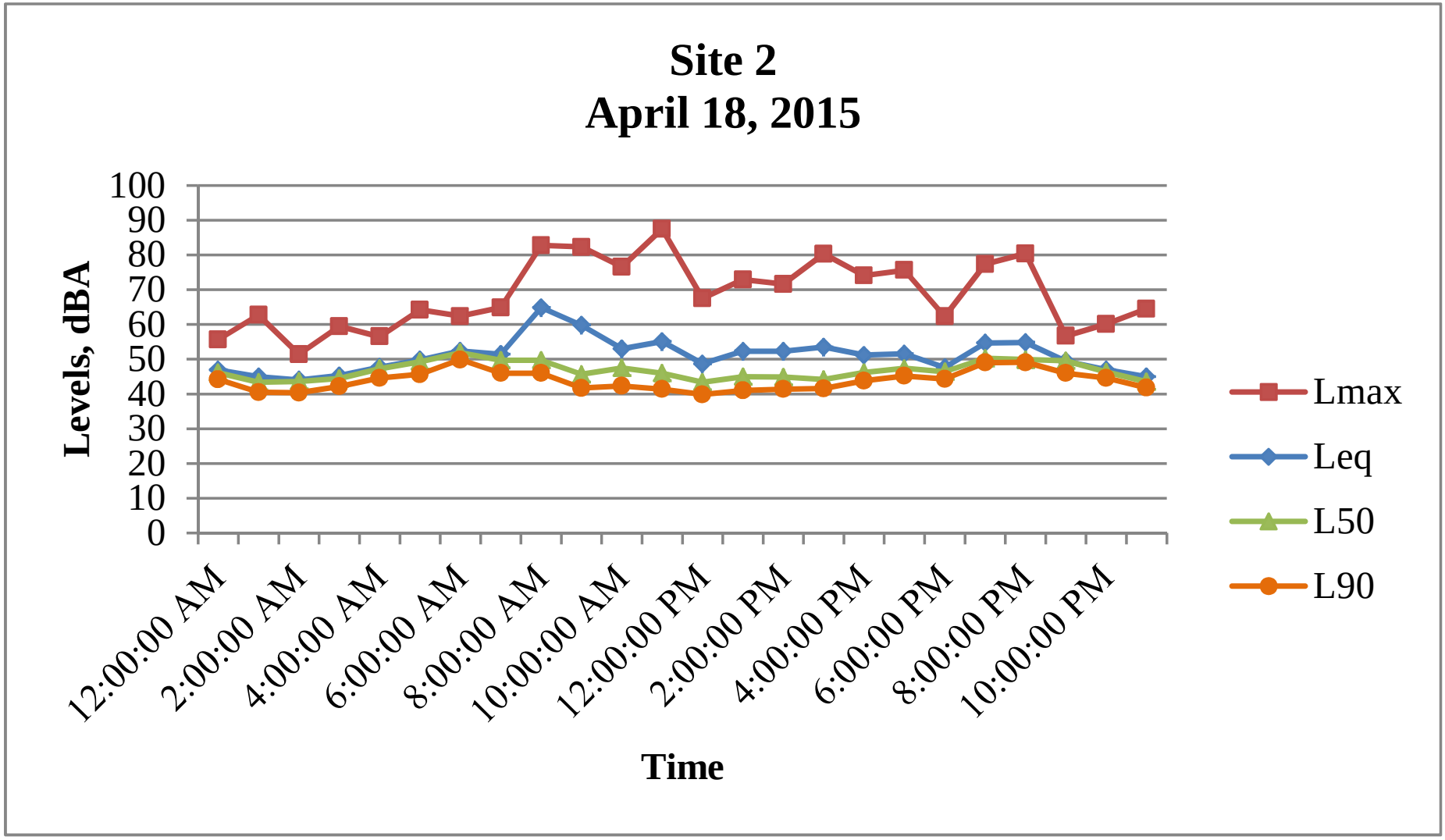
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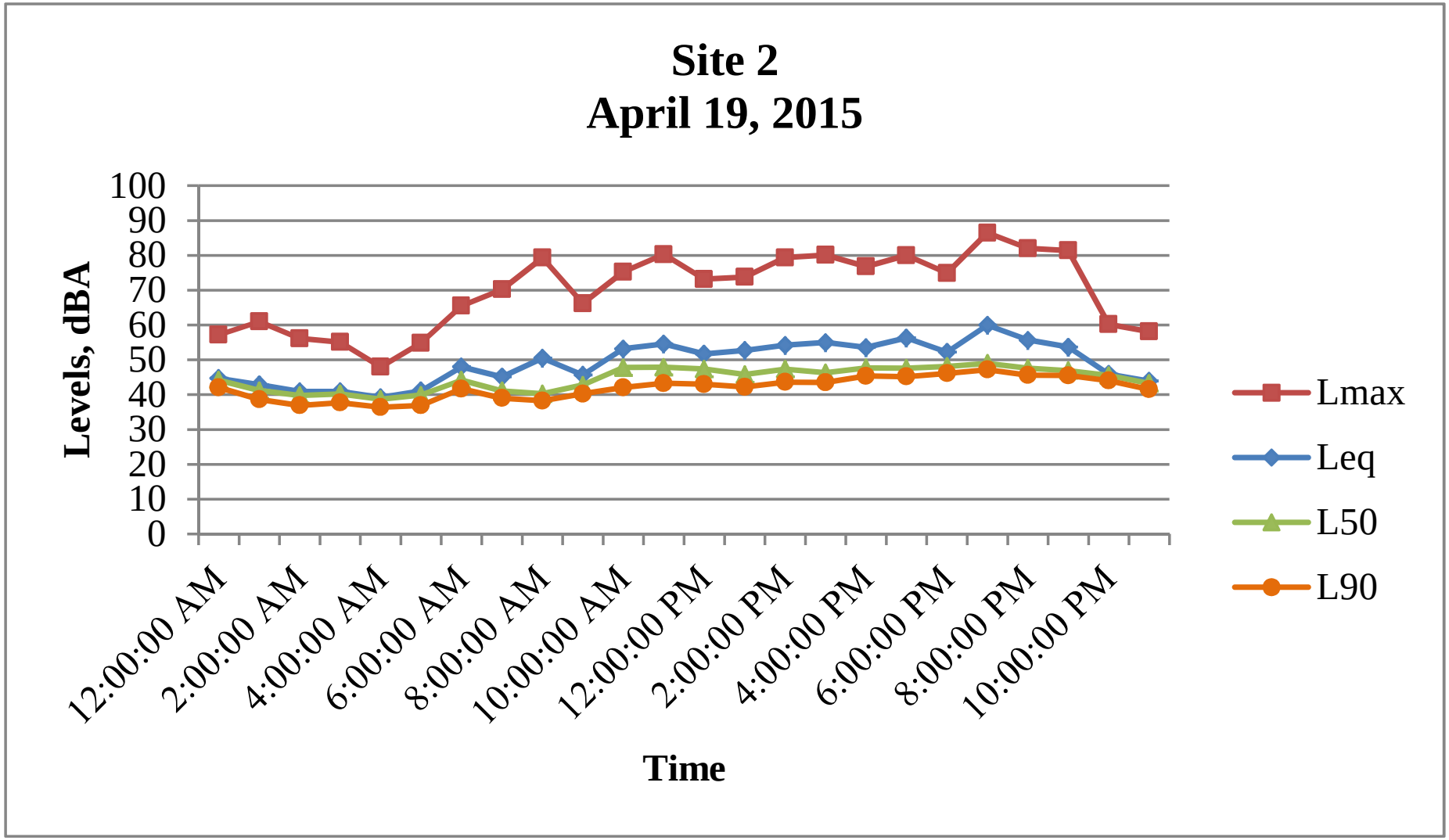
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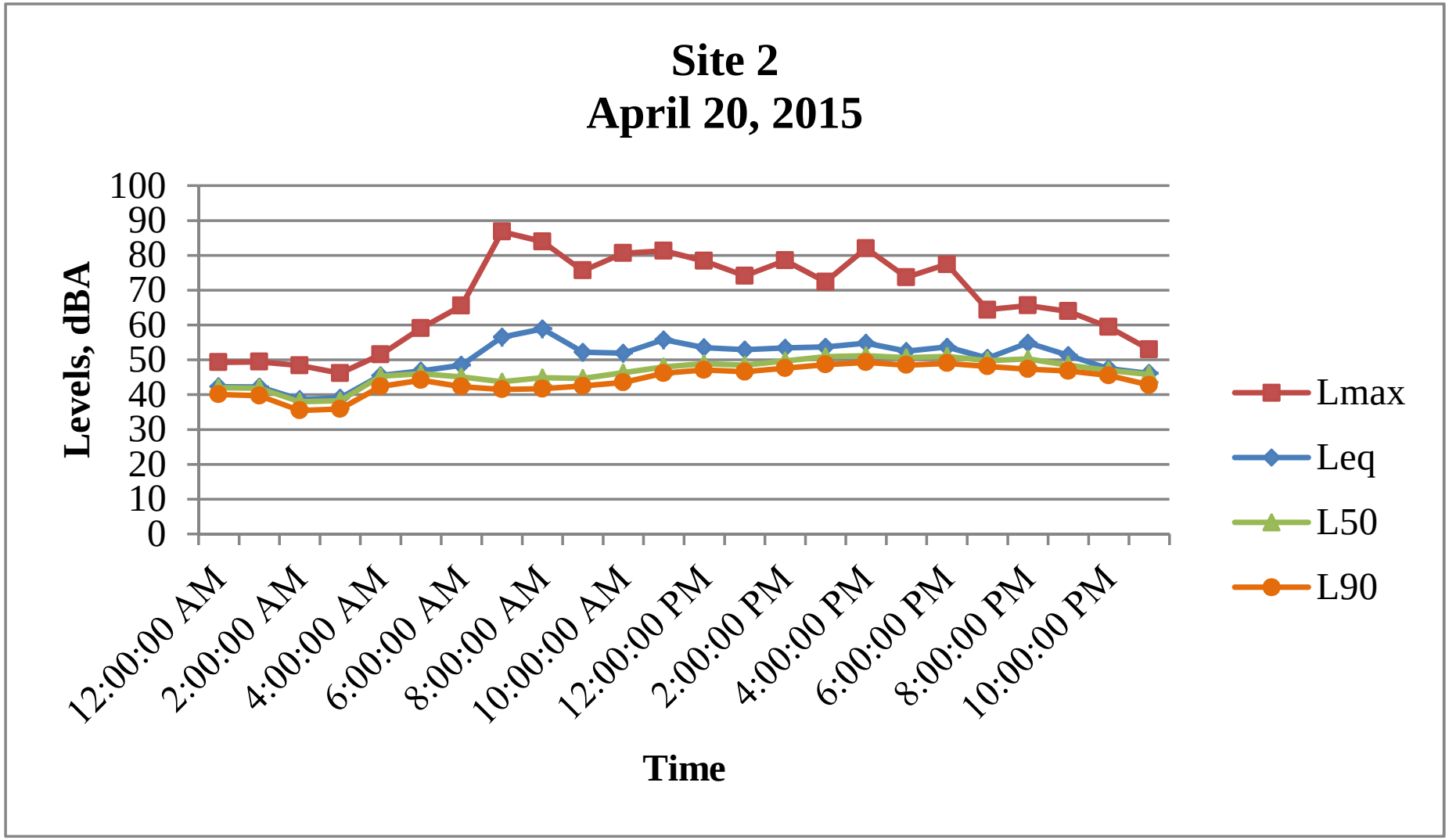
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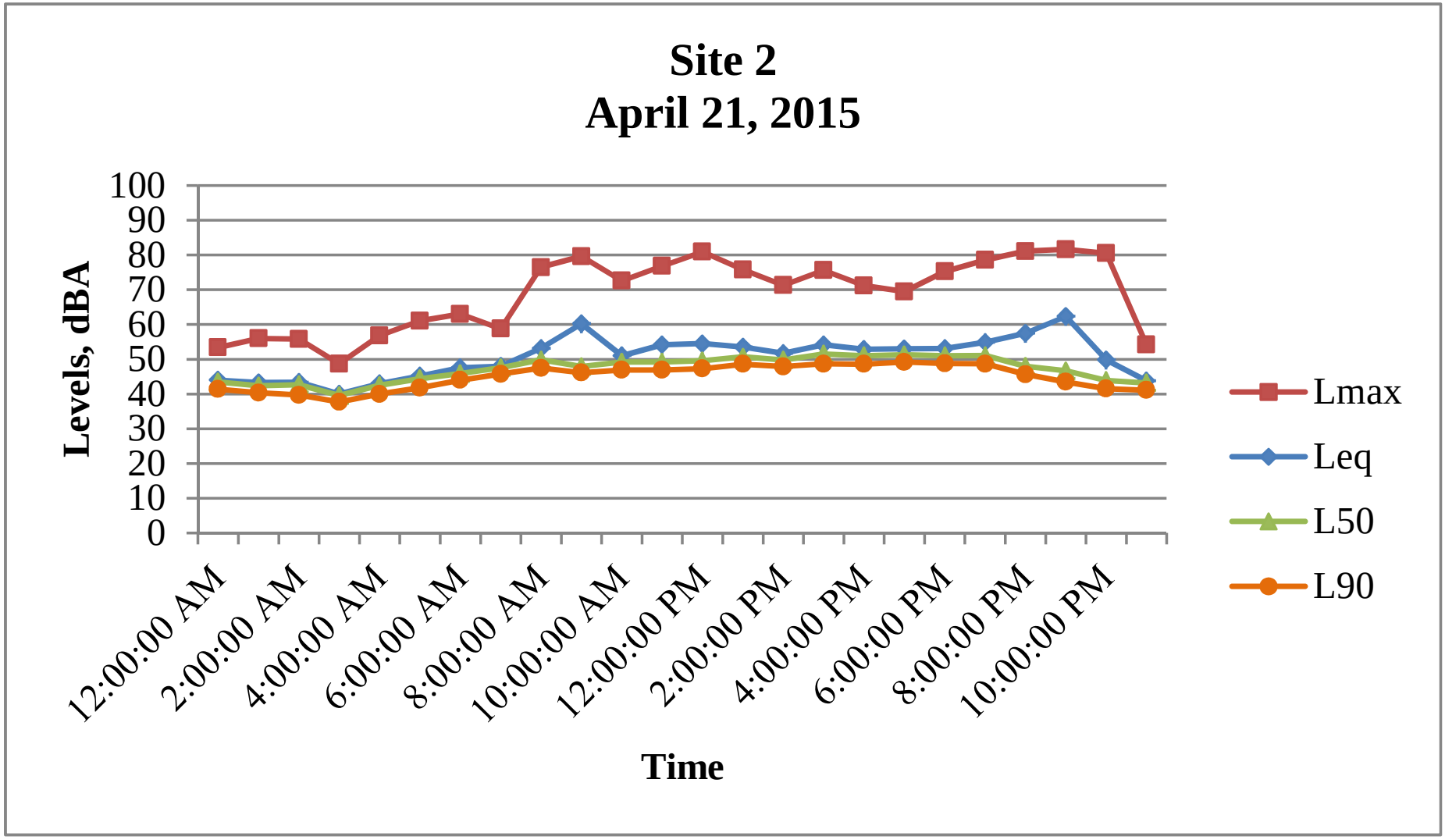
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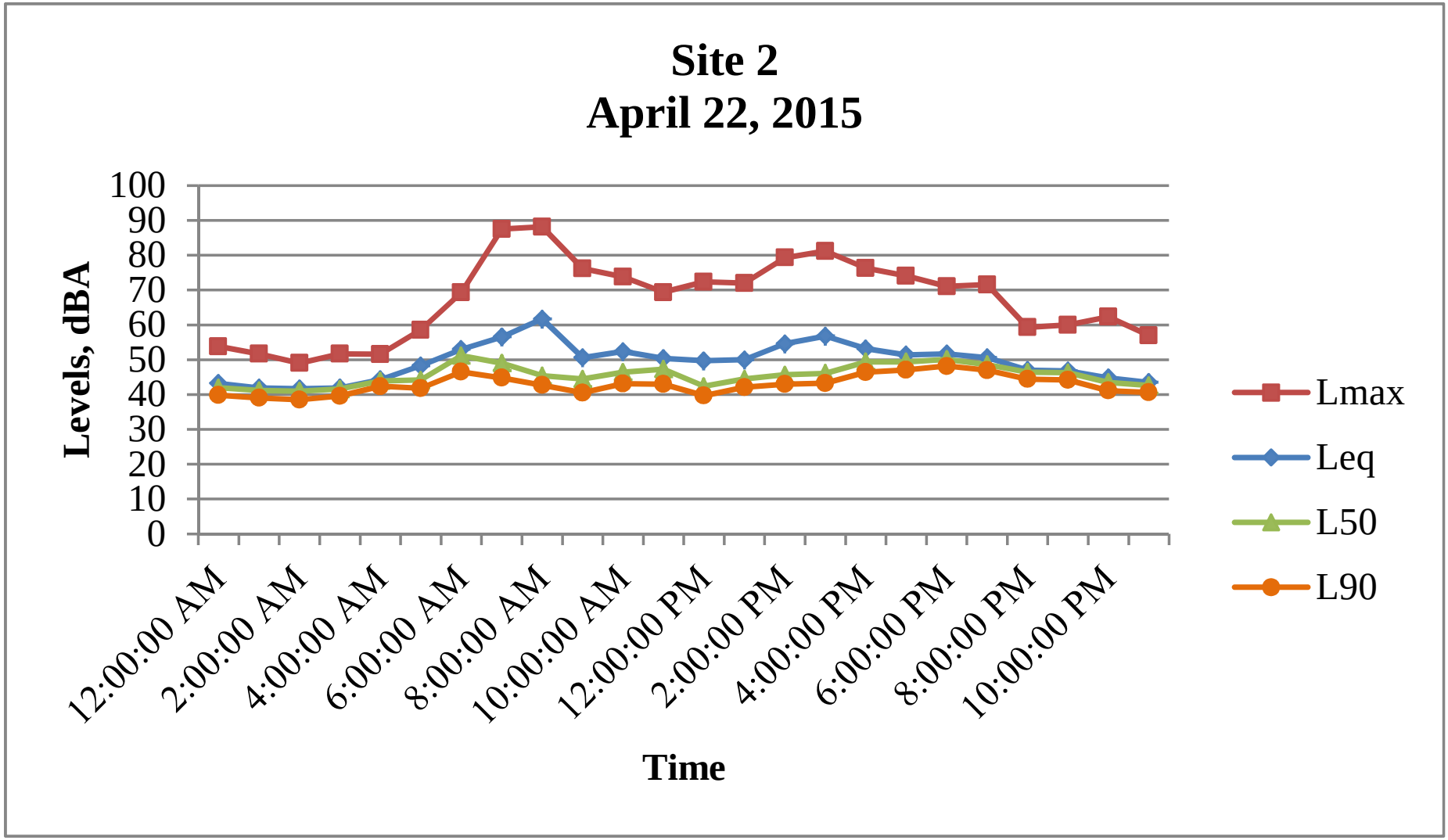
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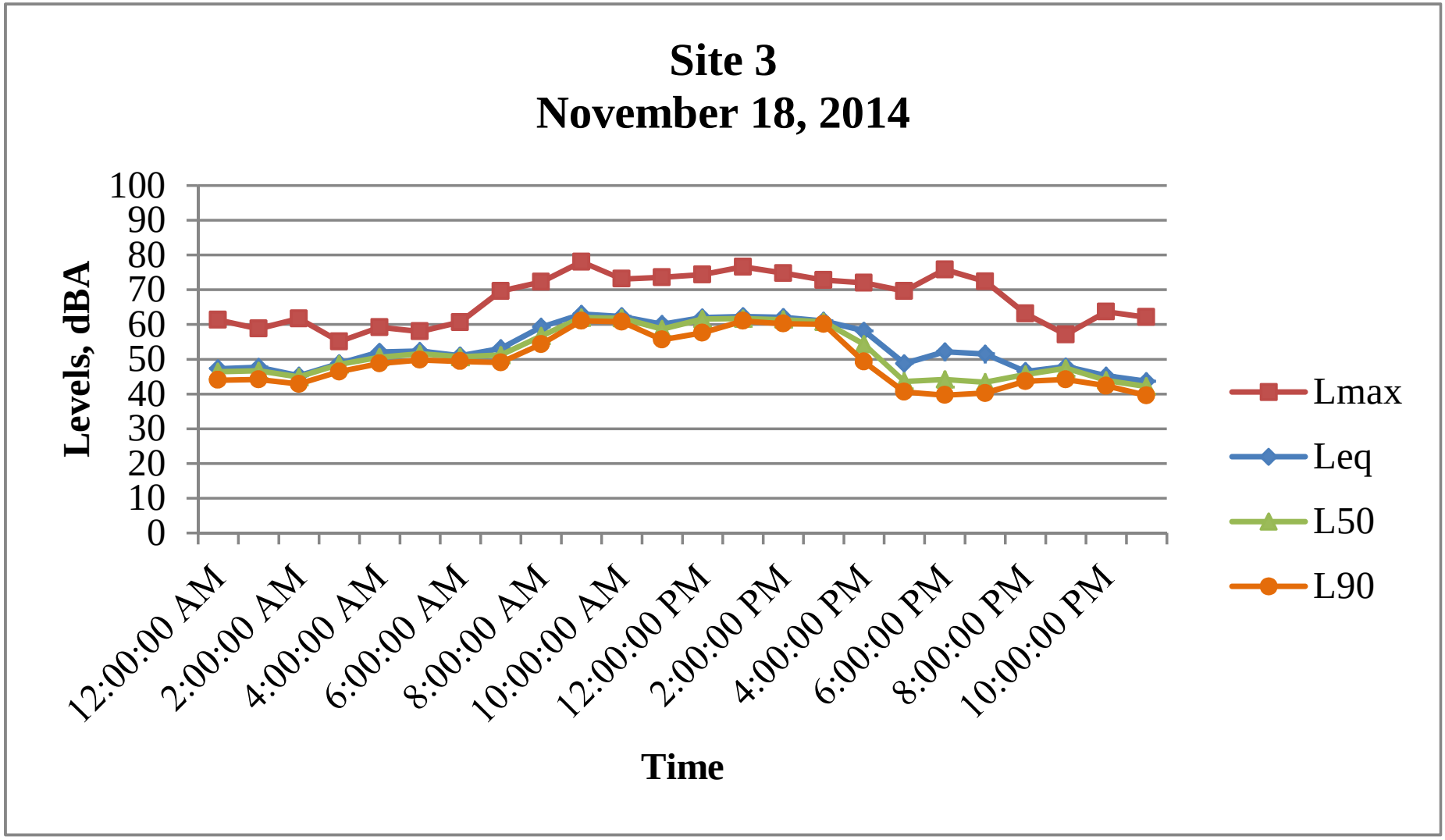
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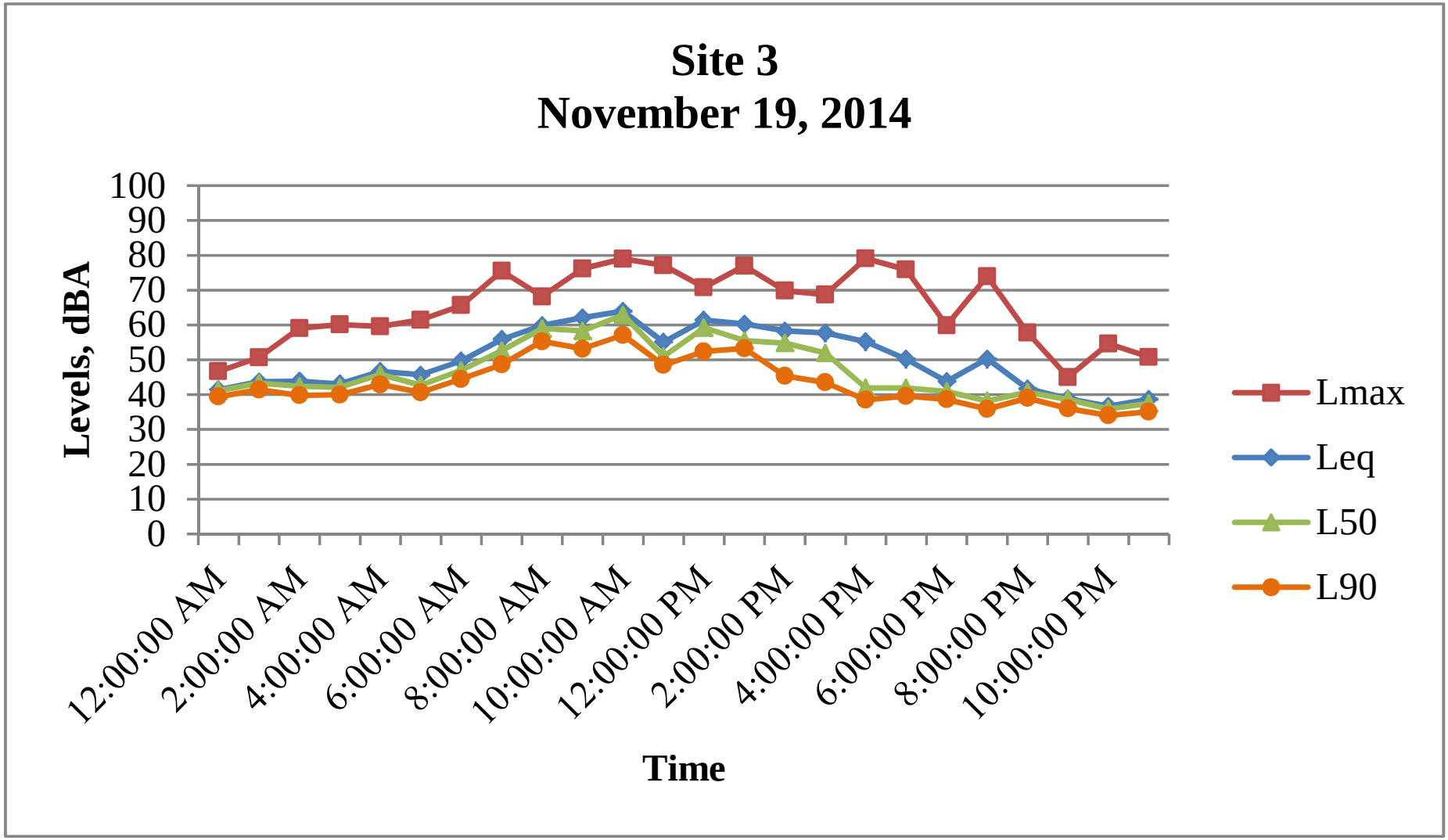
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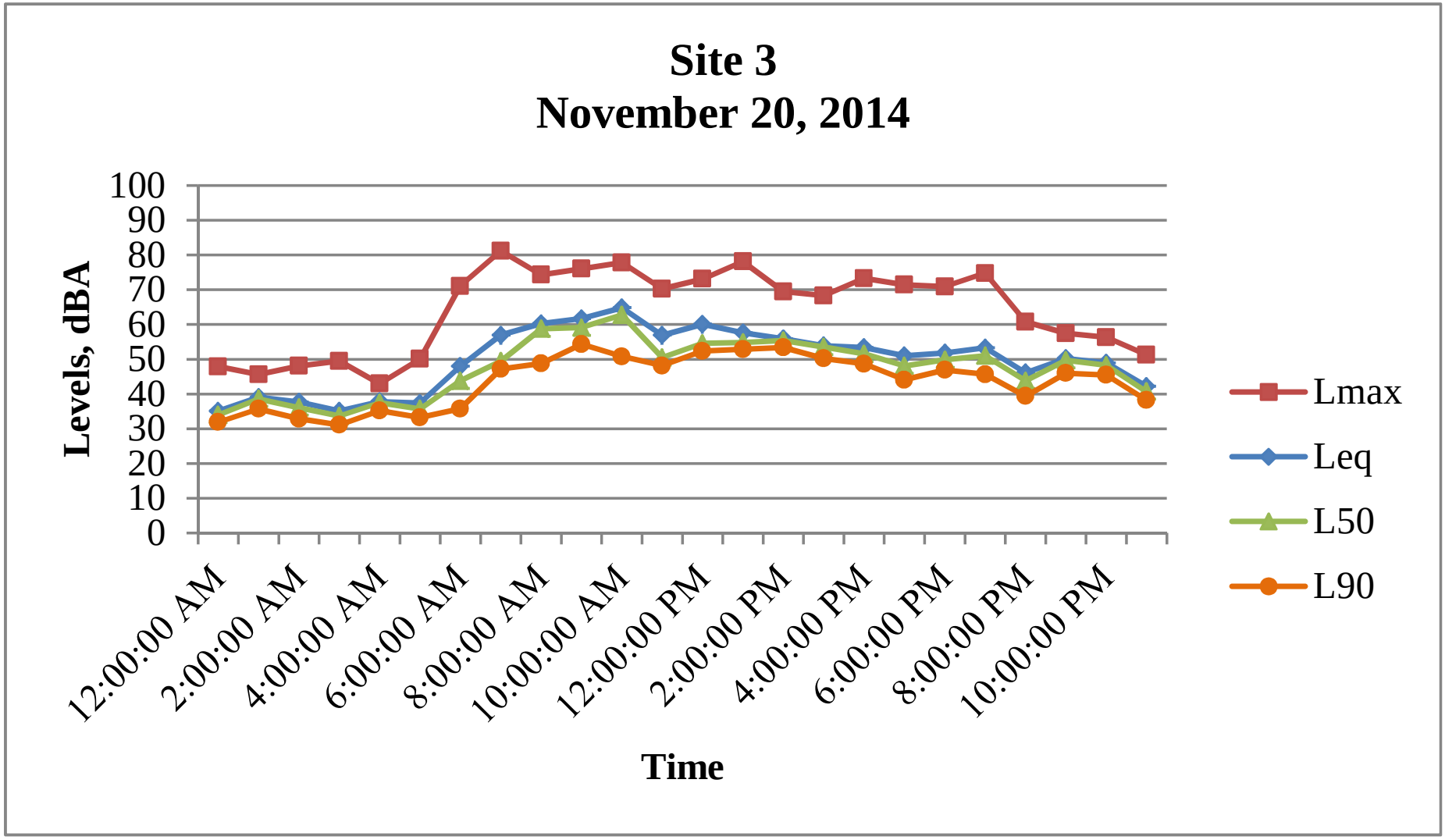
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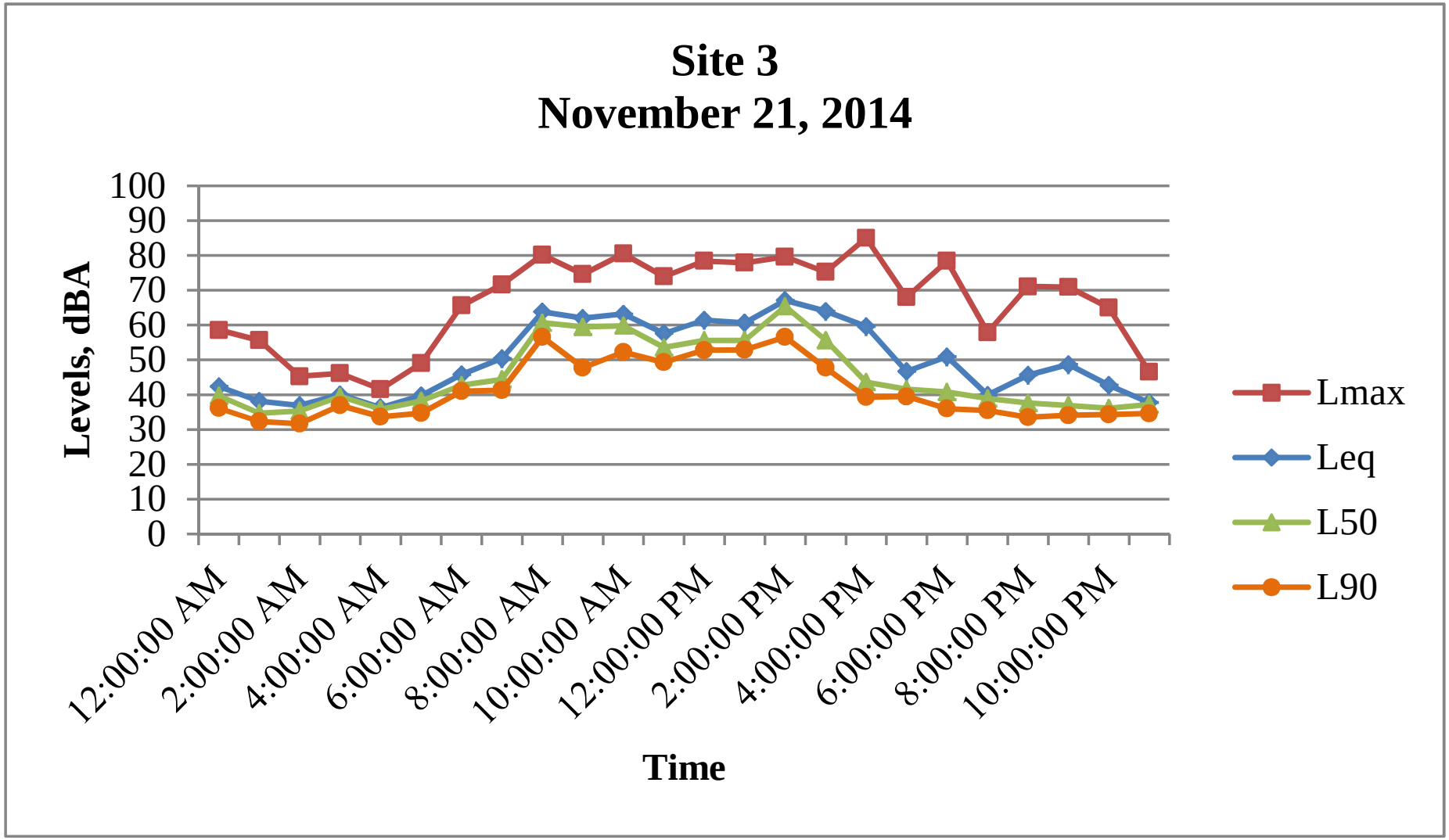
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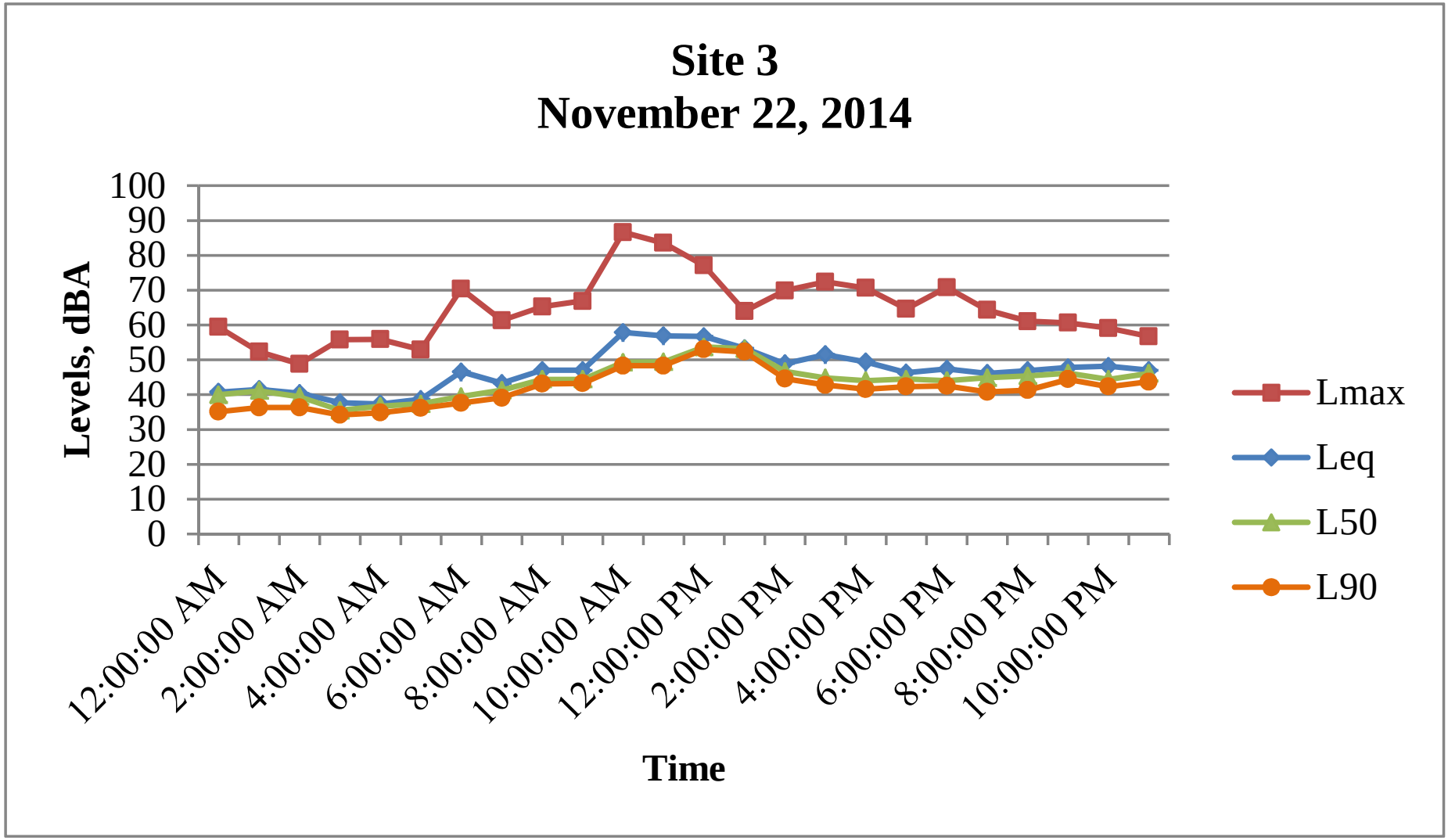
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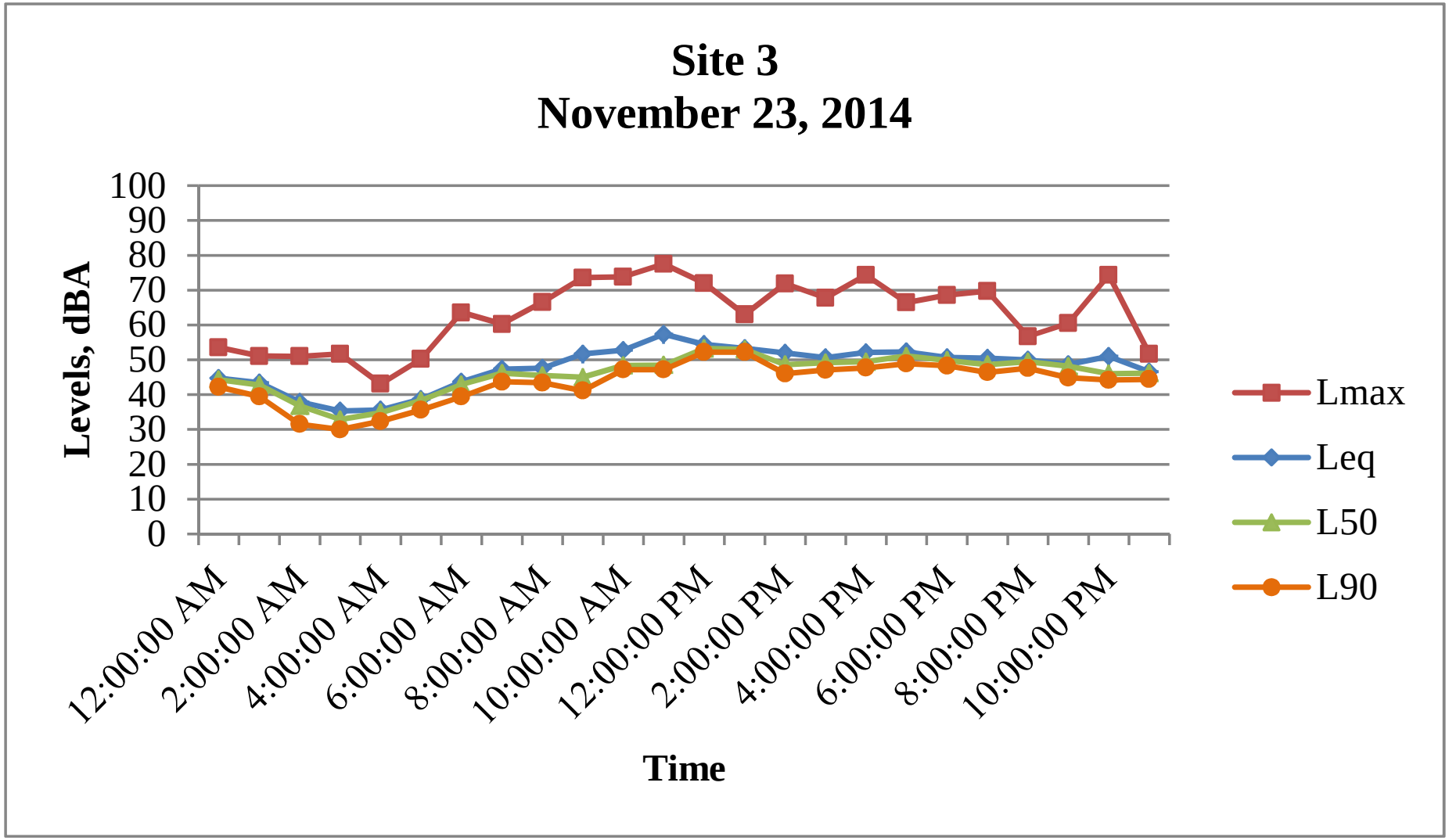
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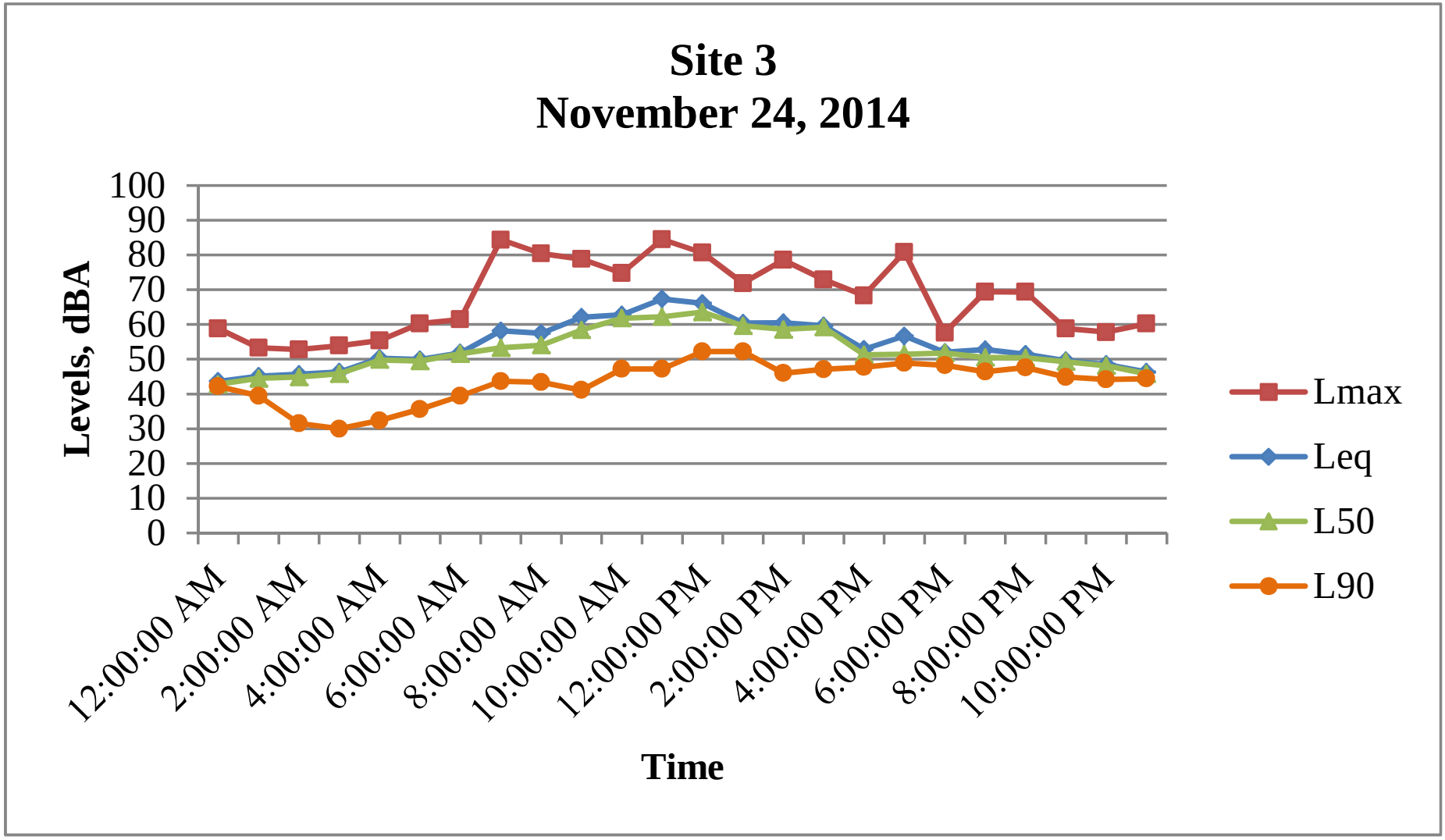
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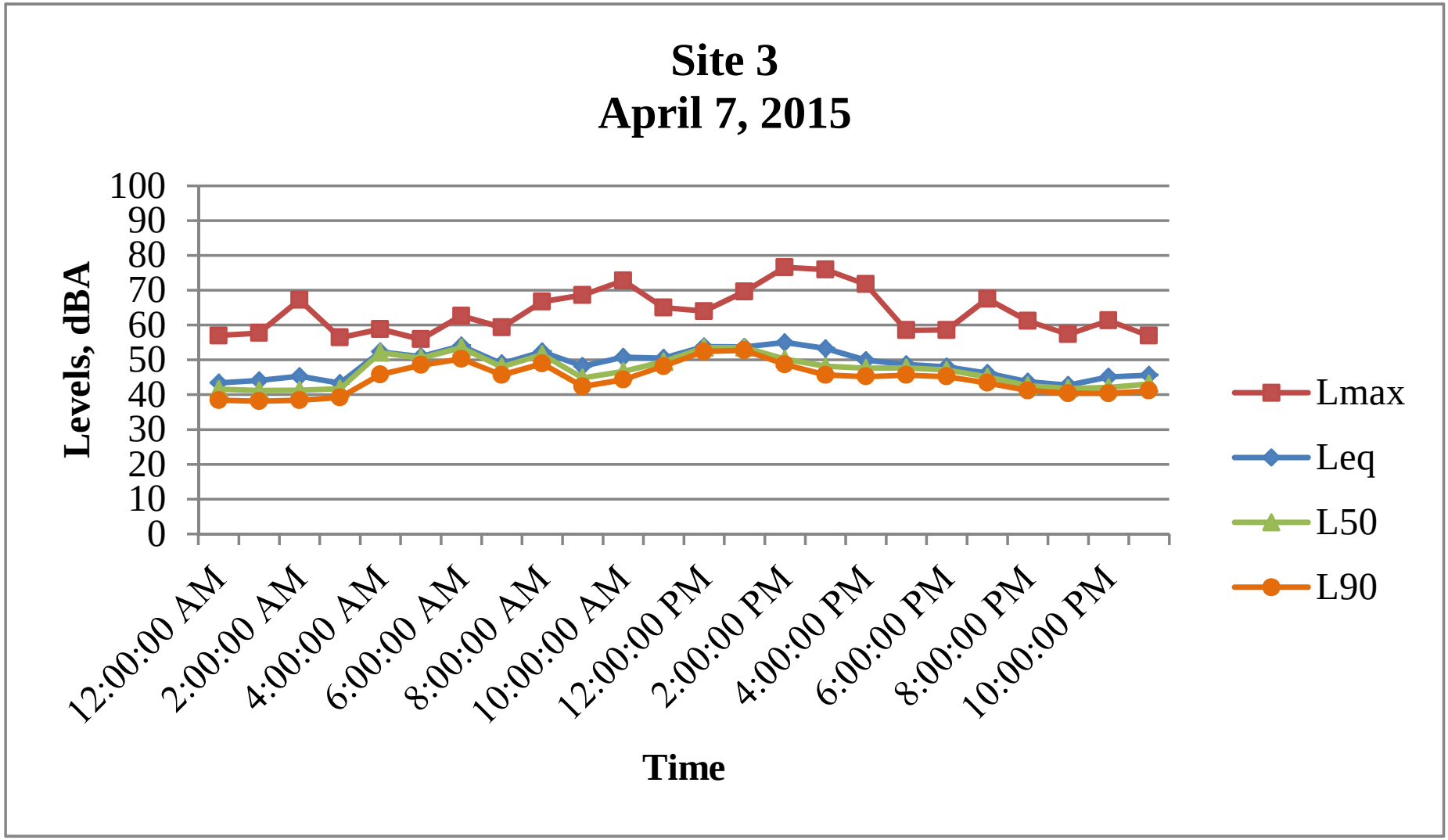
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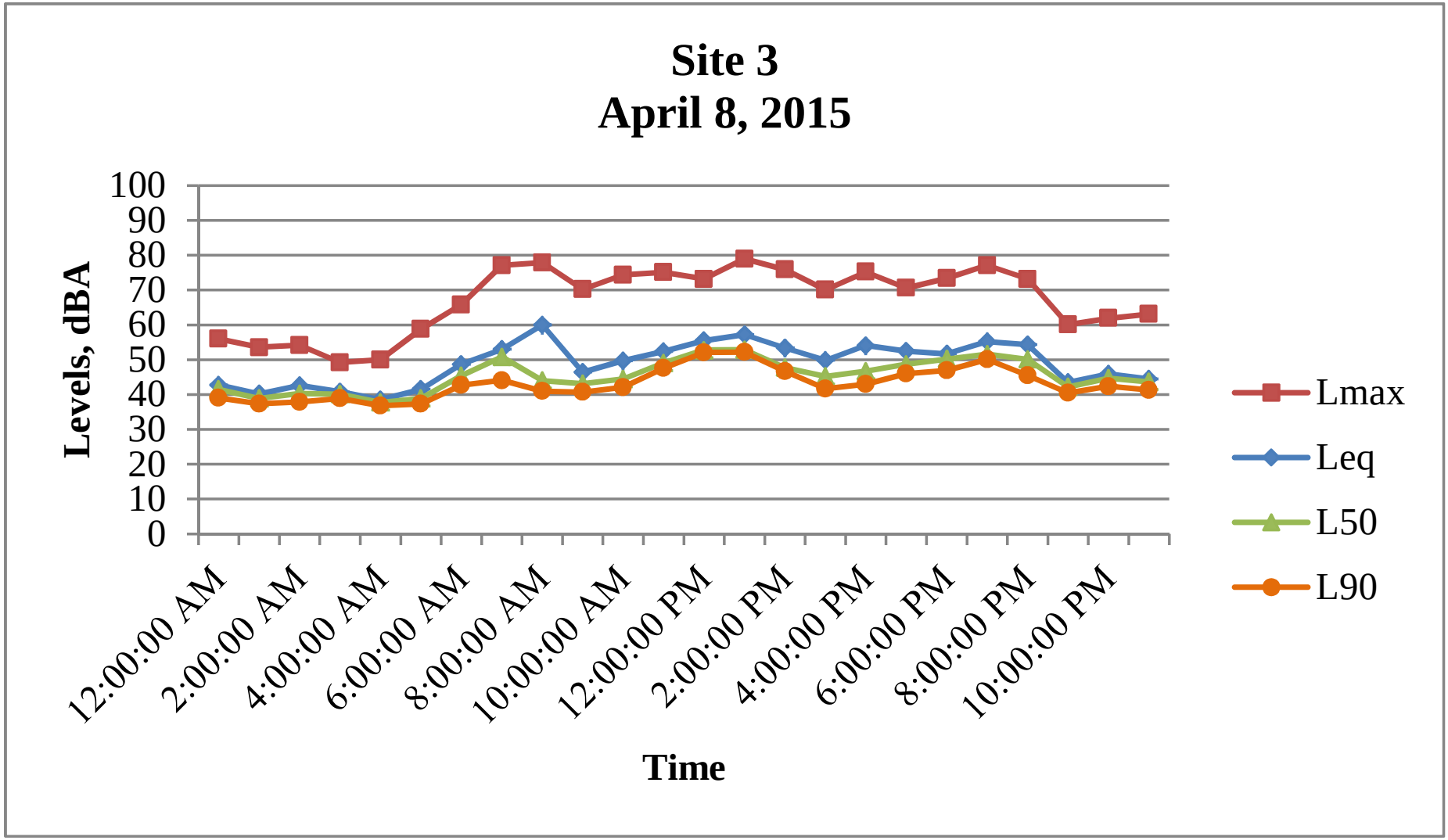
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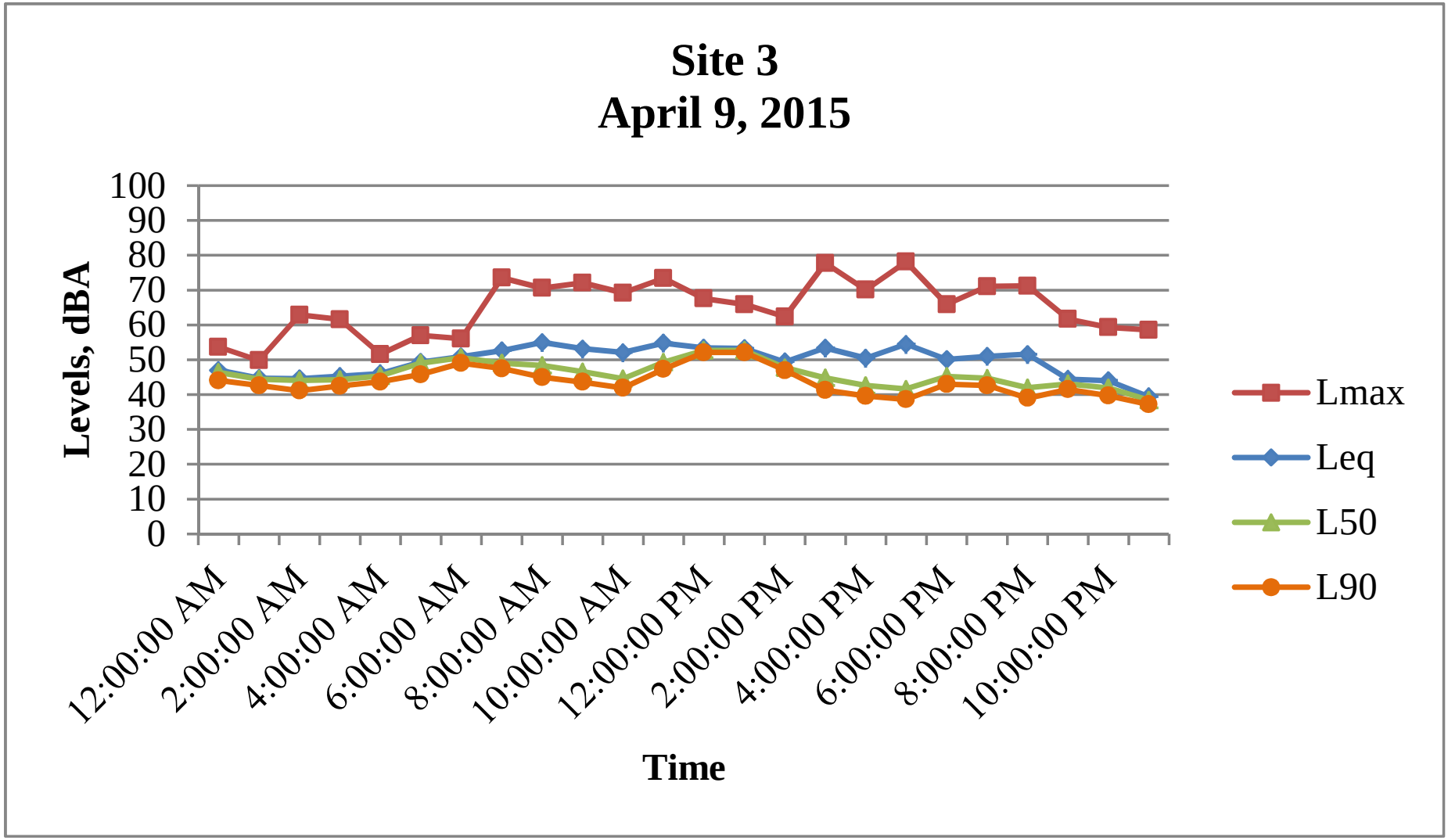
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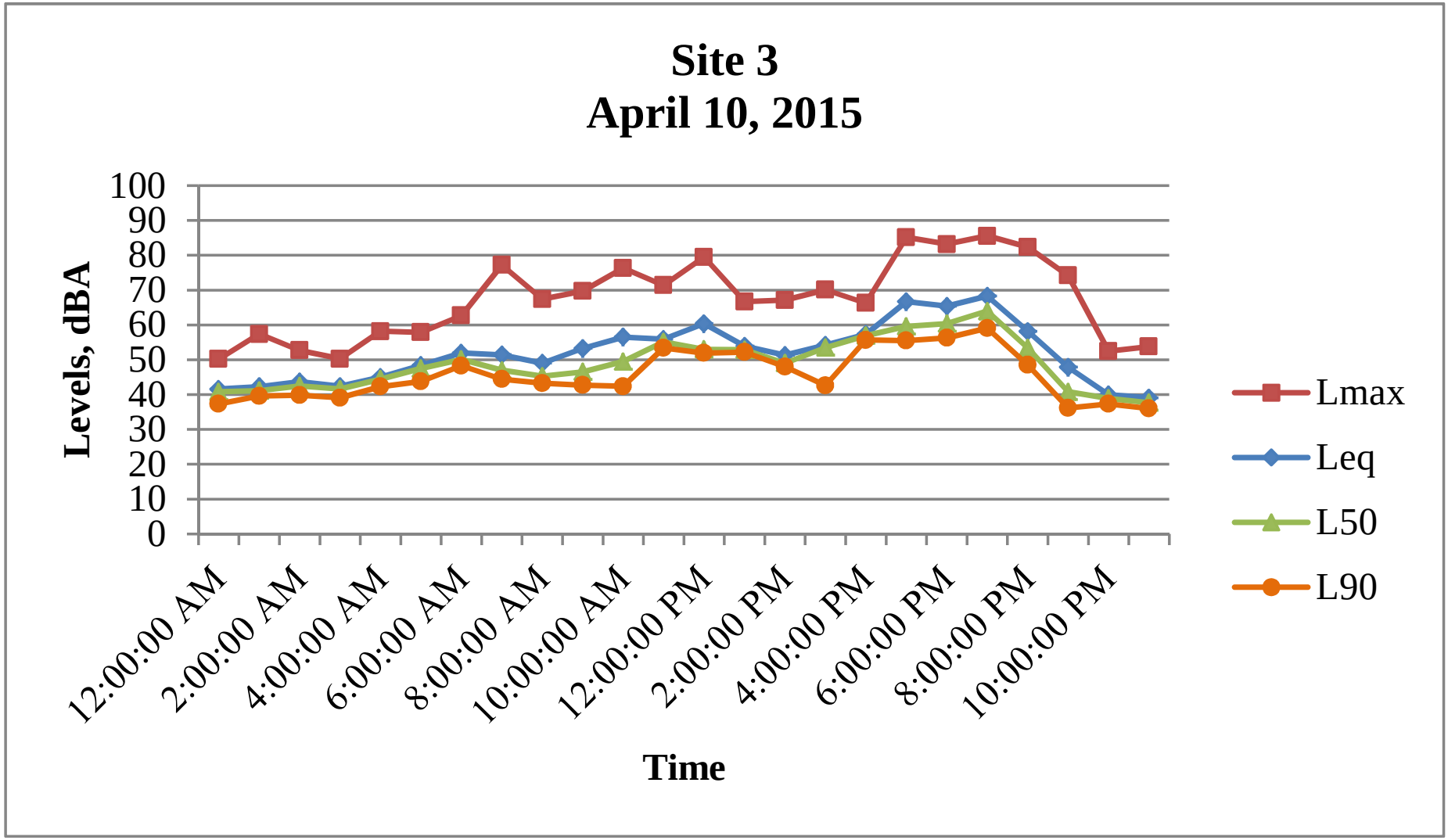
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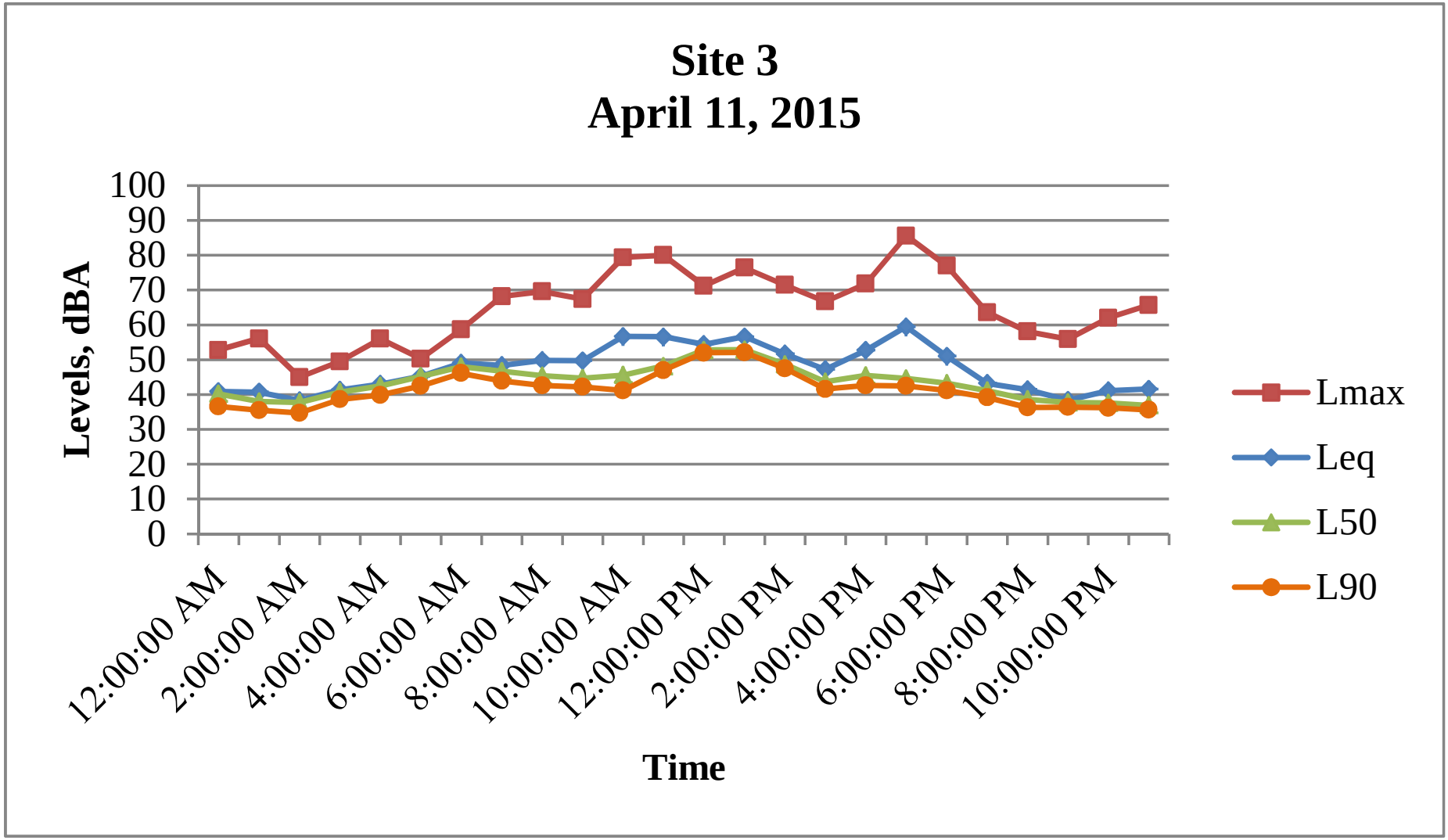
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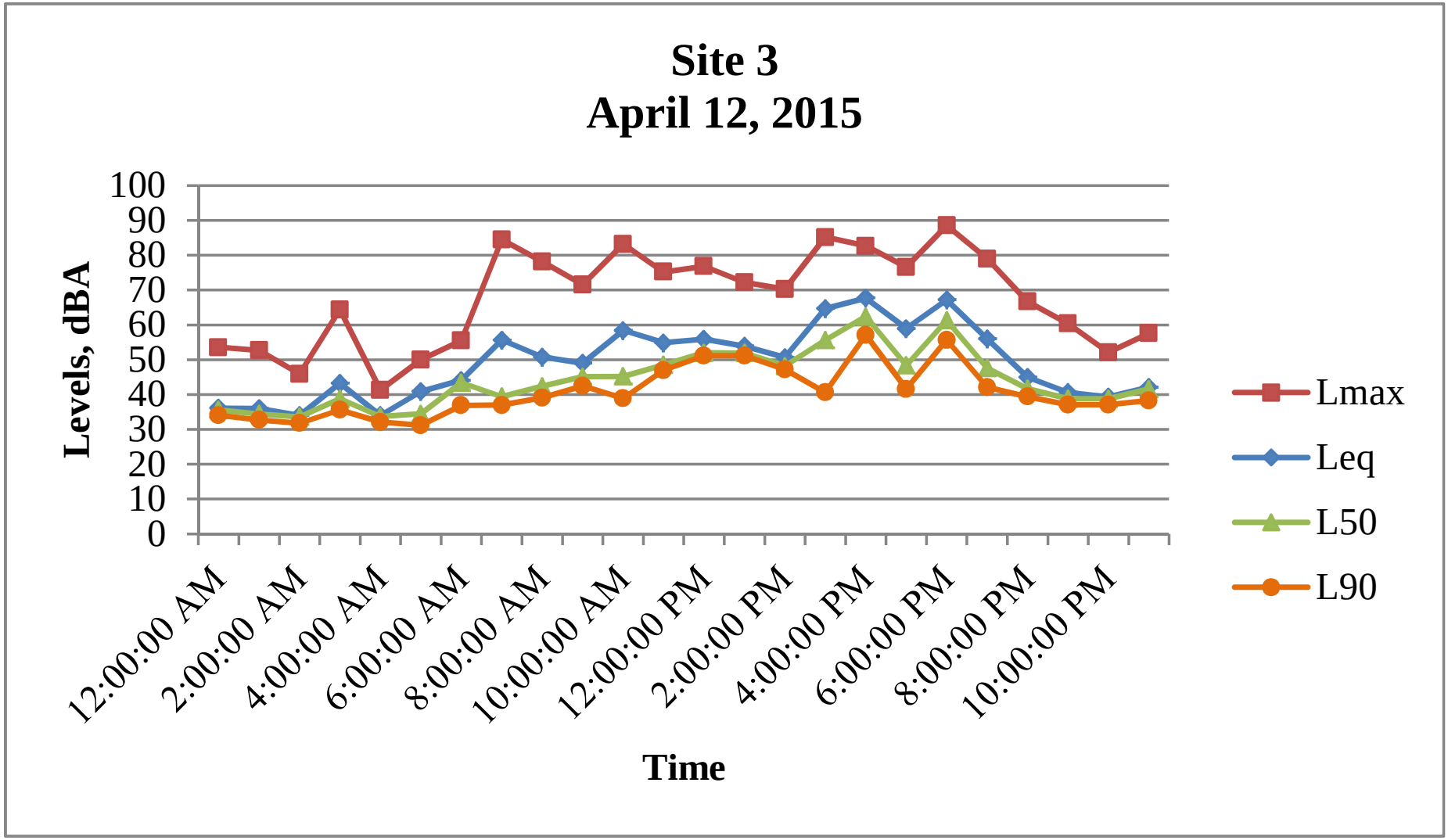
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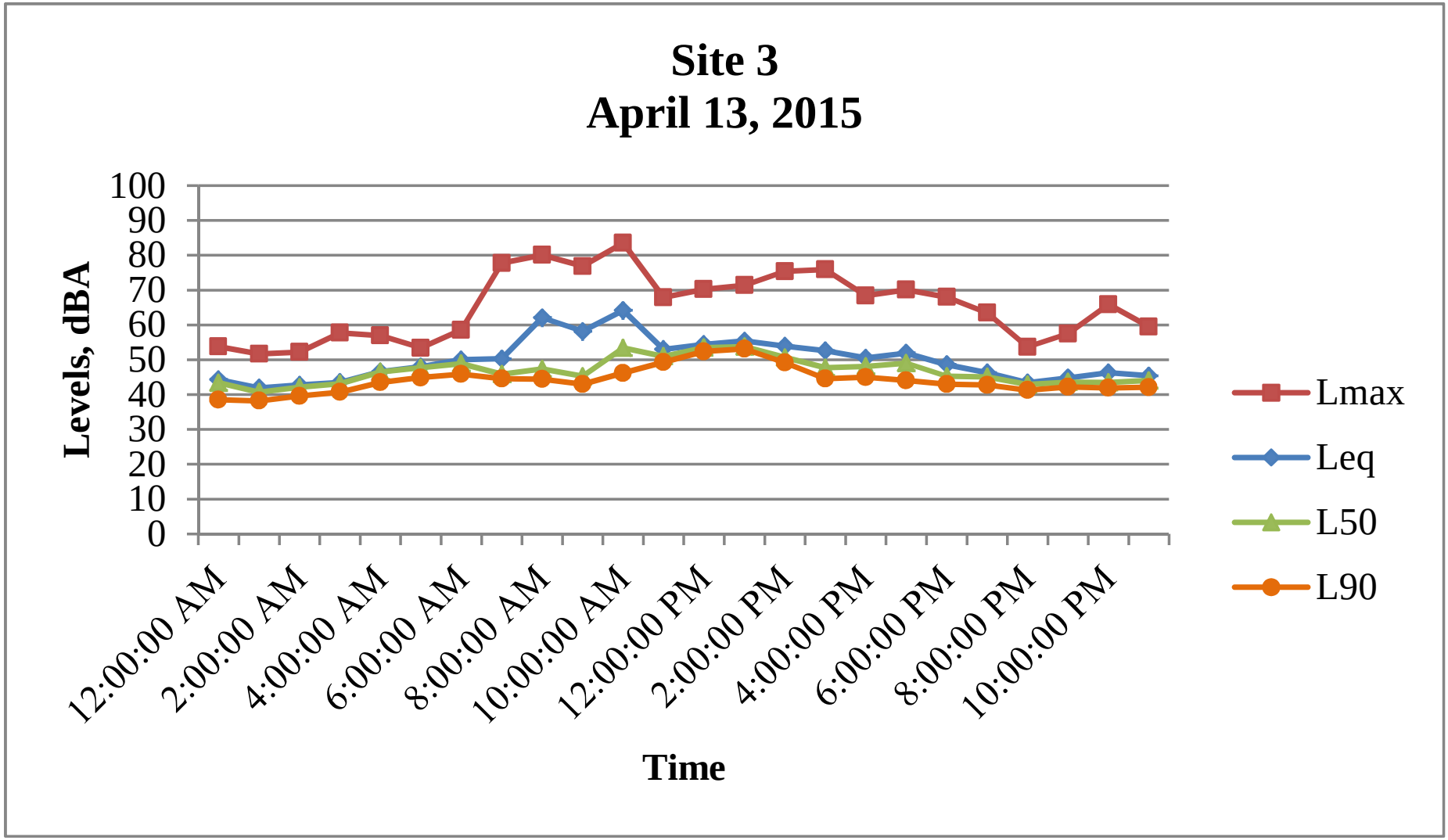
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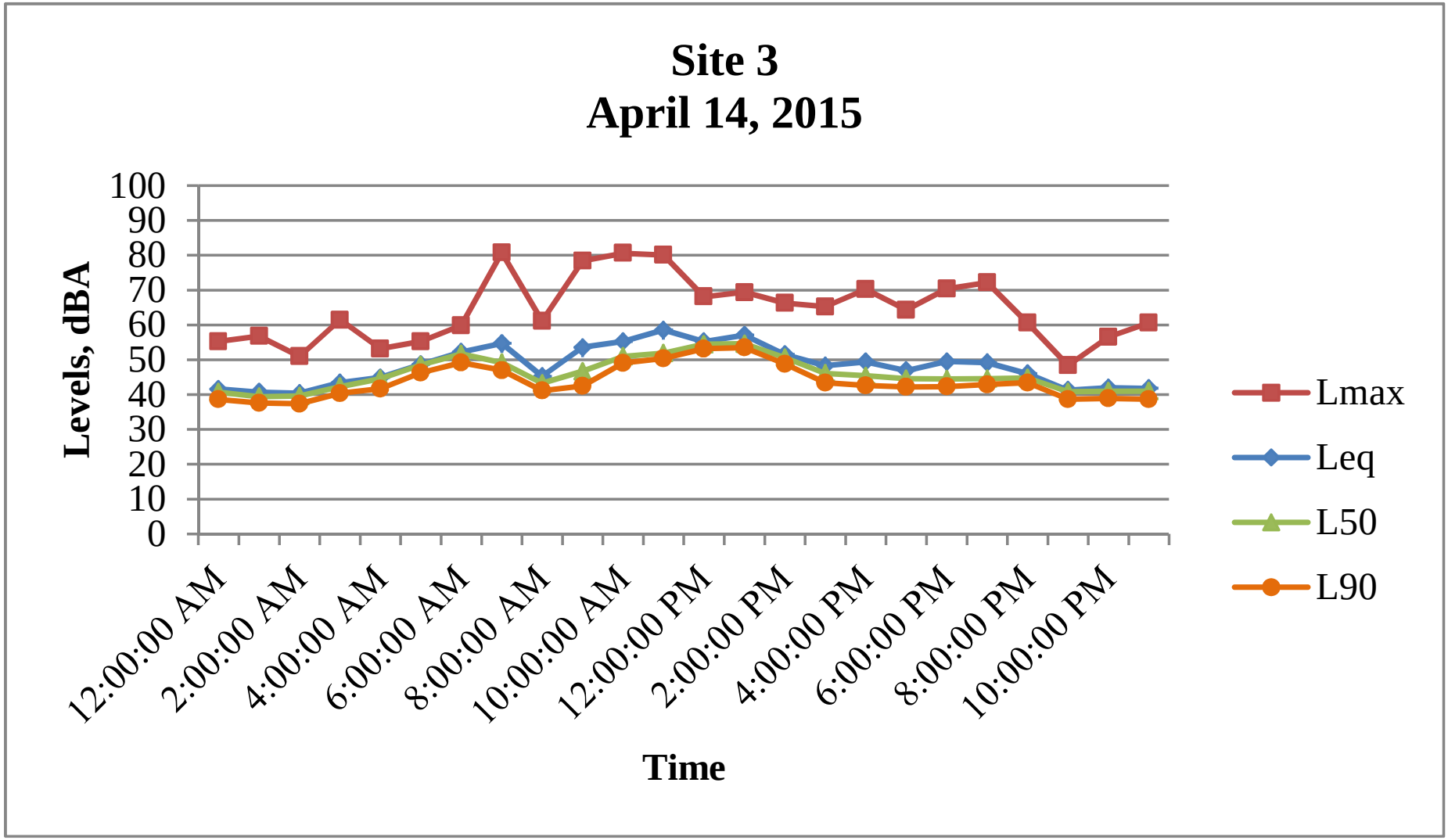
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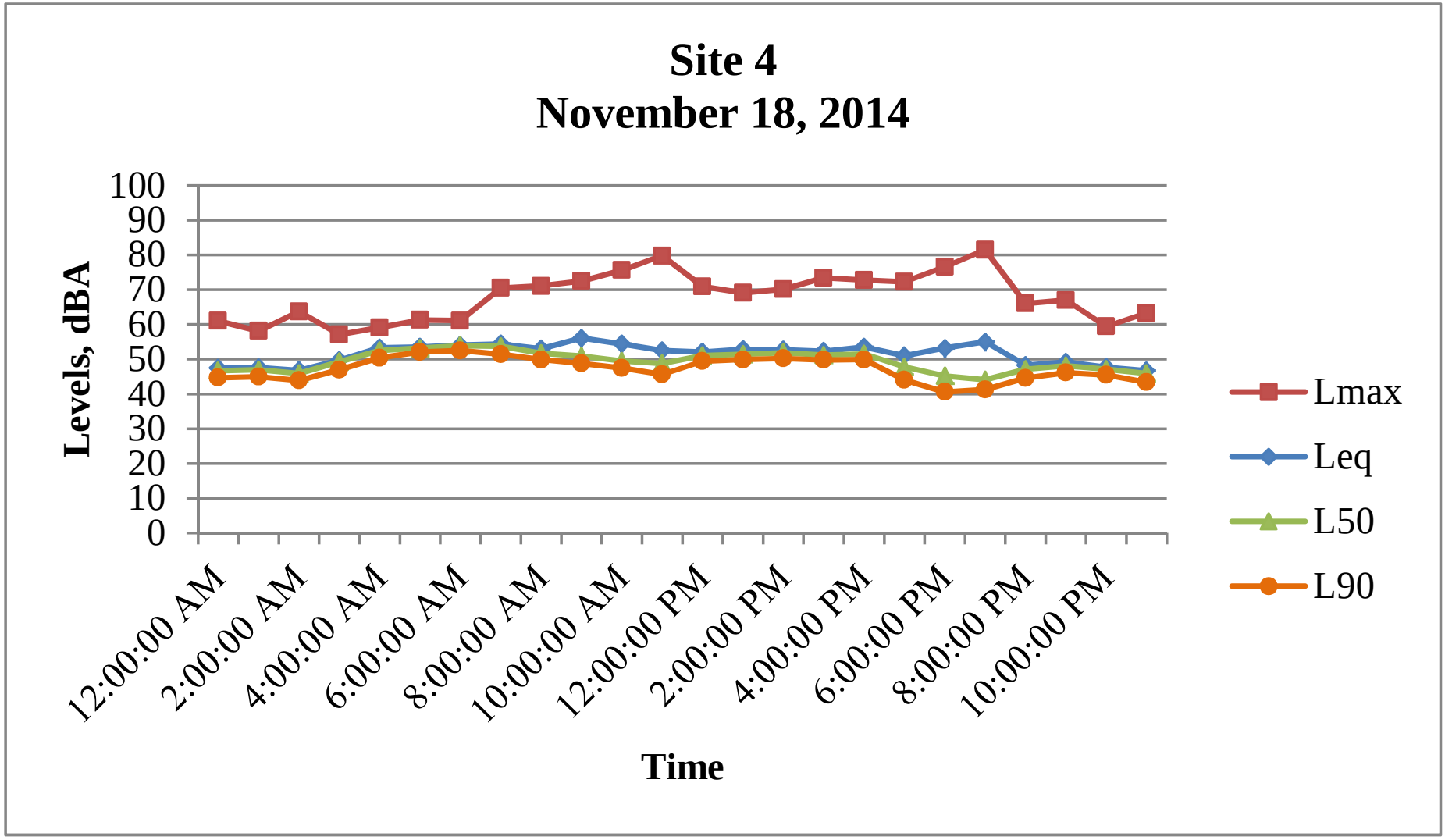
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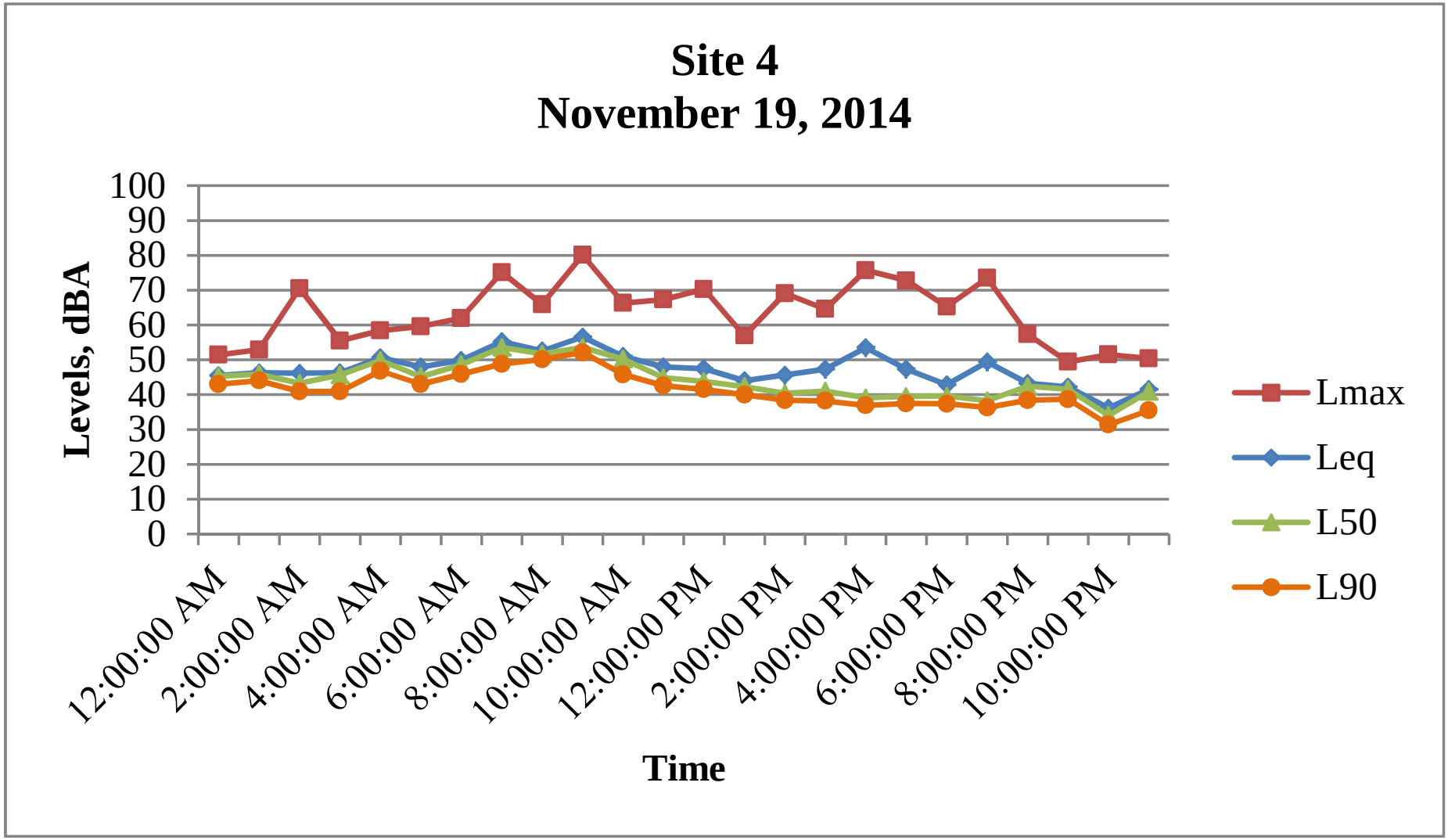
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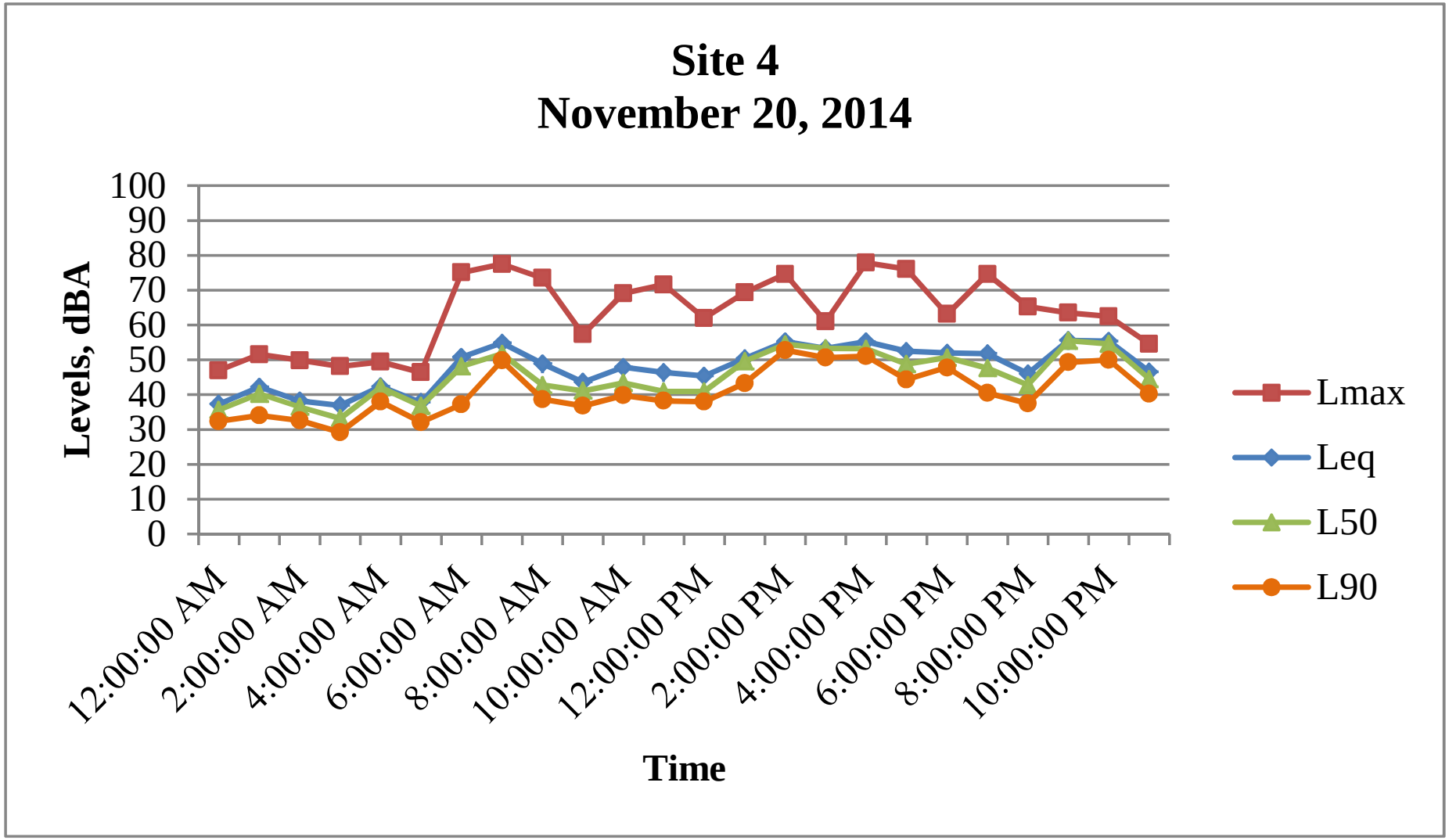
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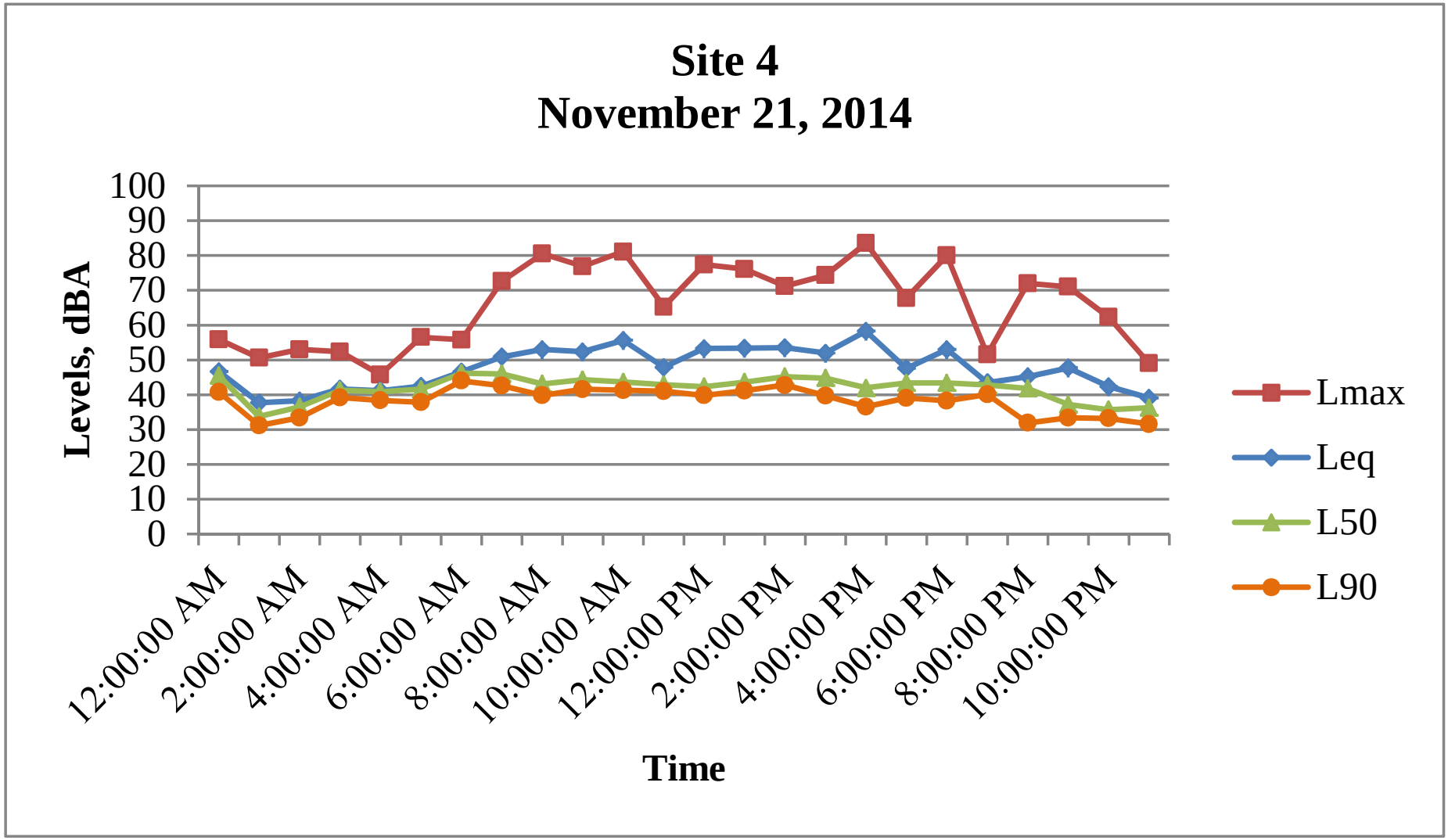
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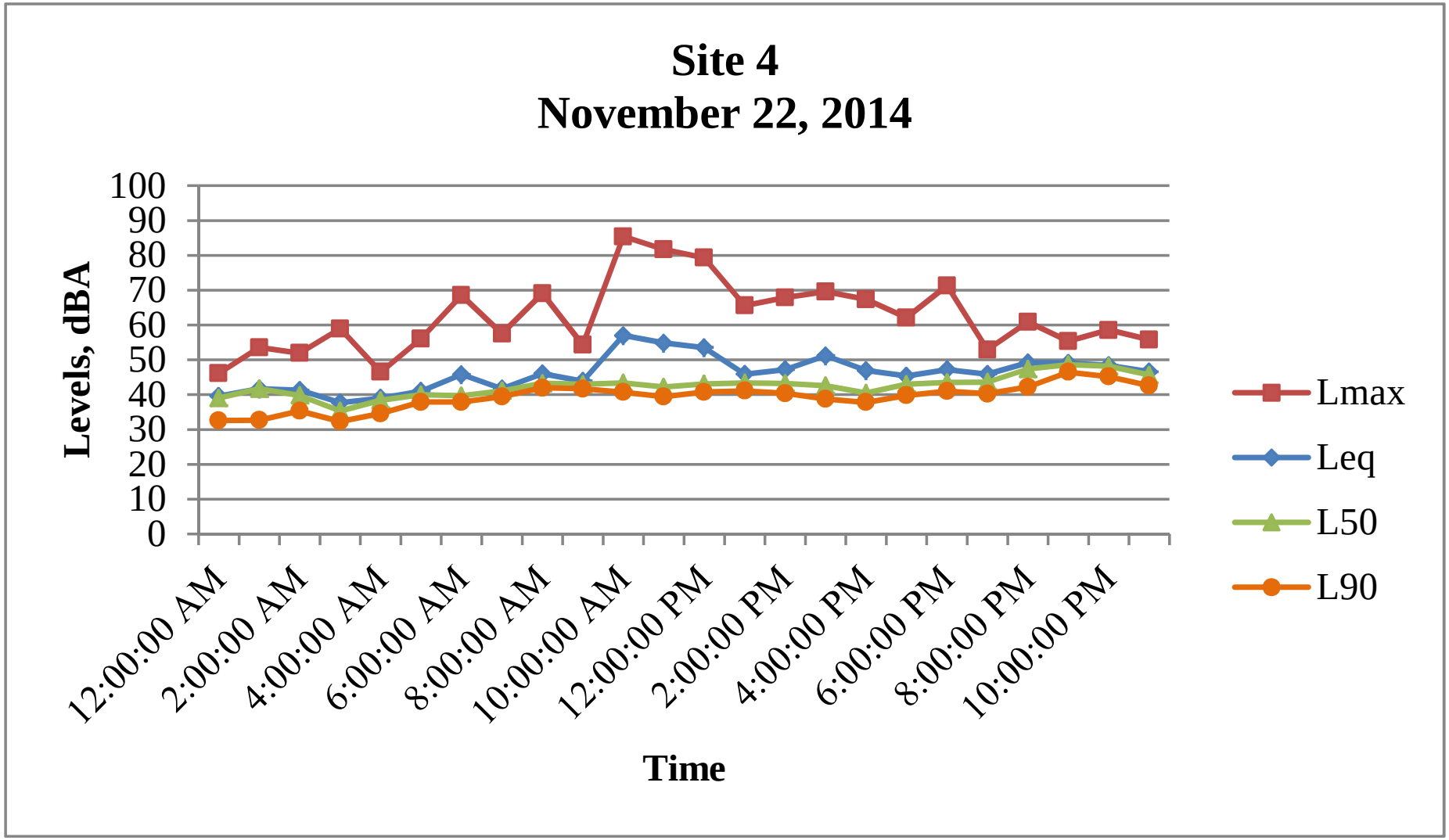
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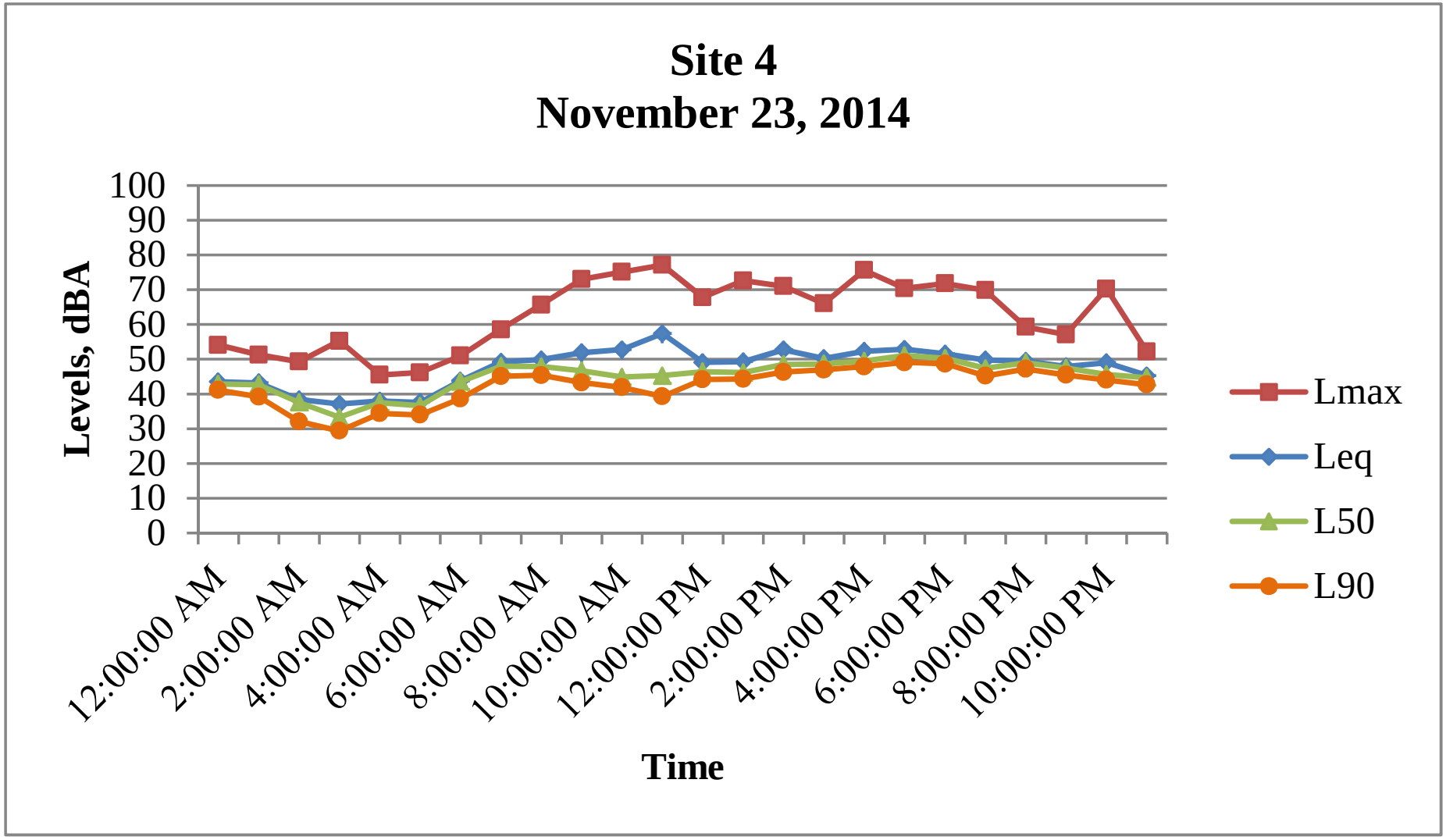
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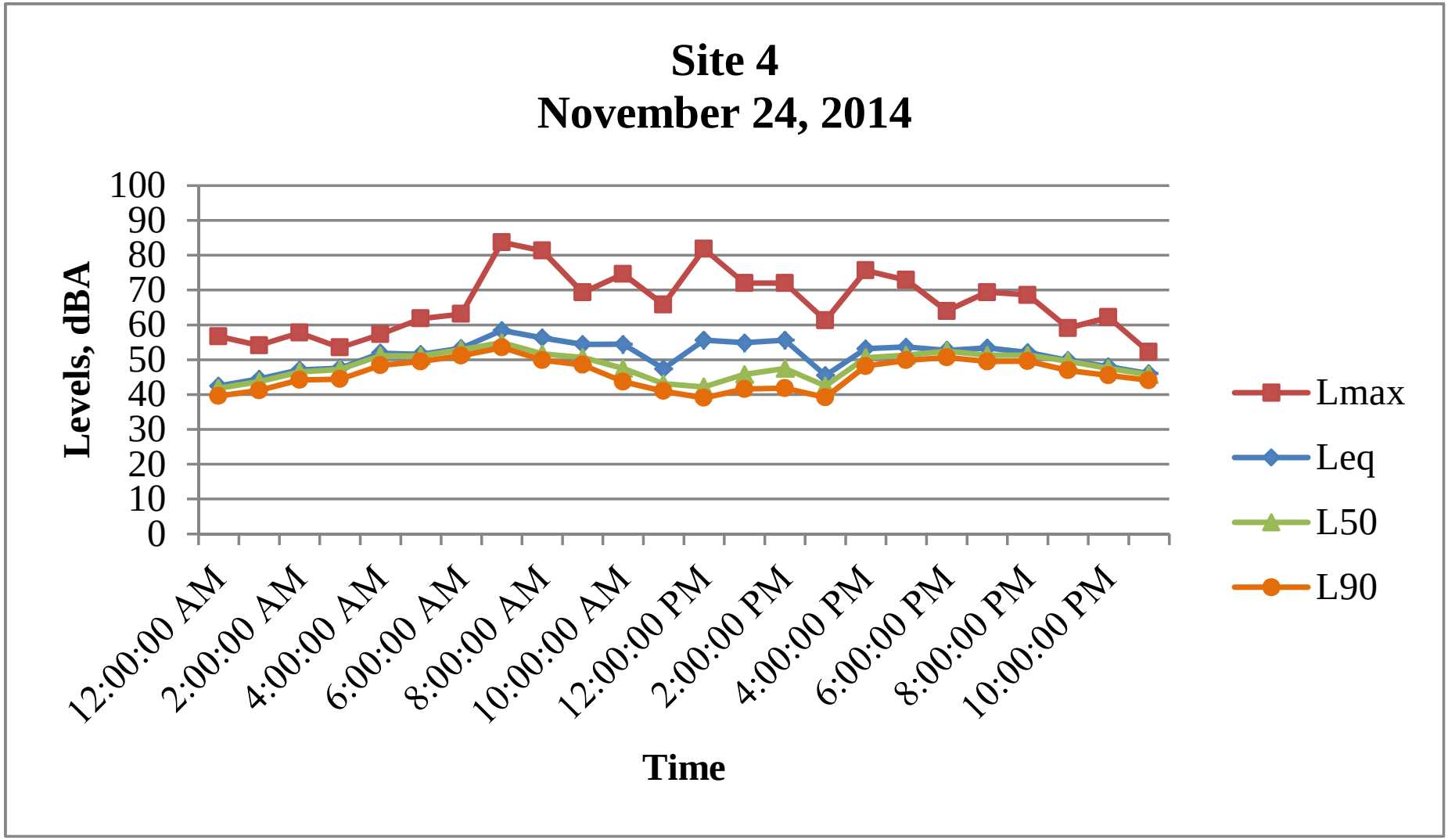
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November 24, 2014
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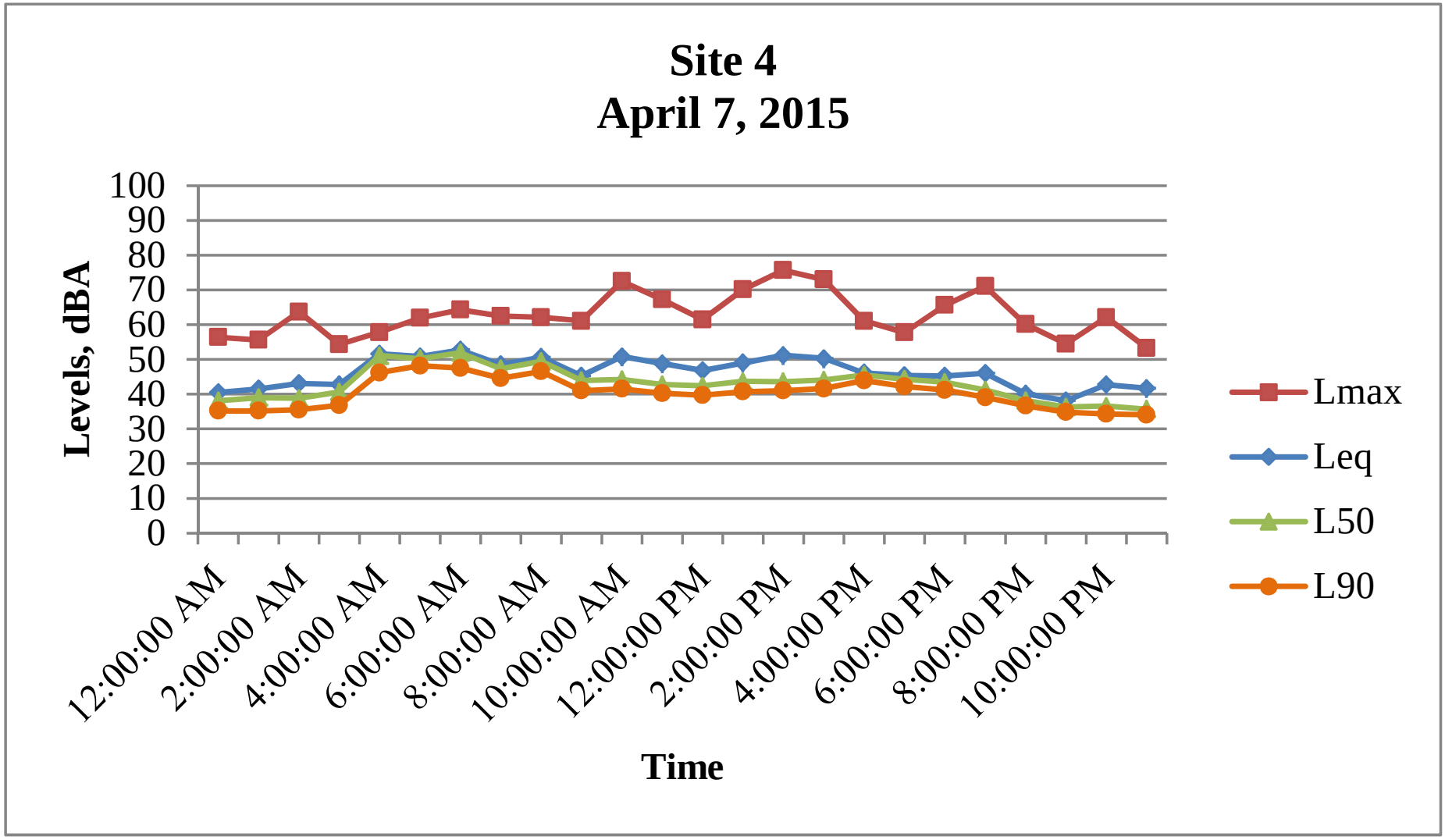
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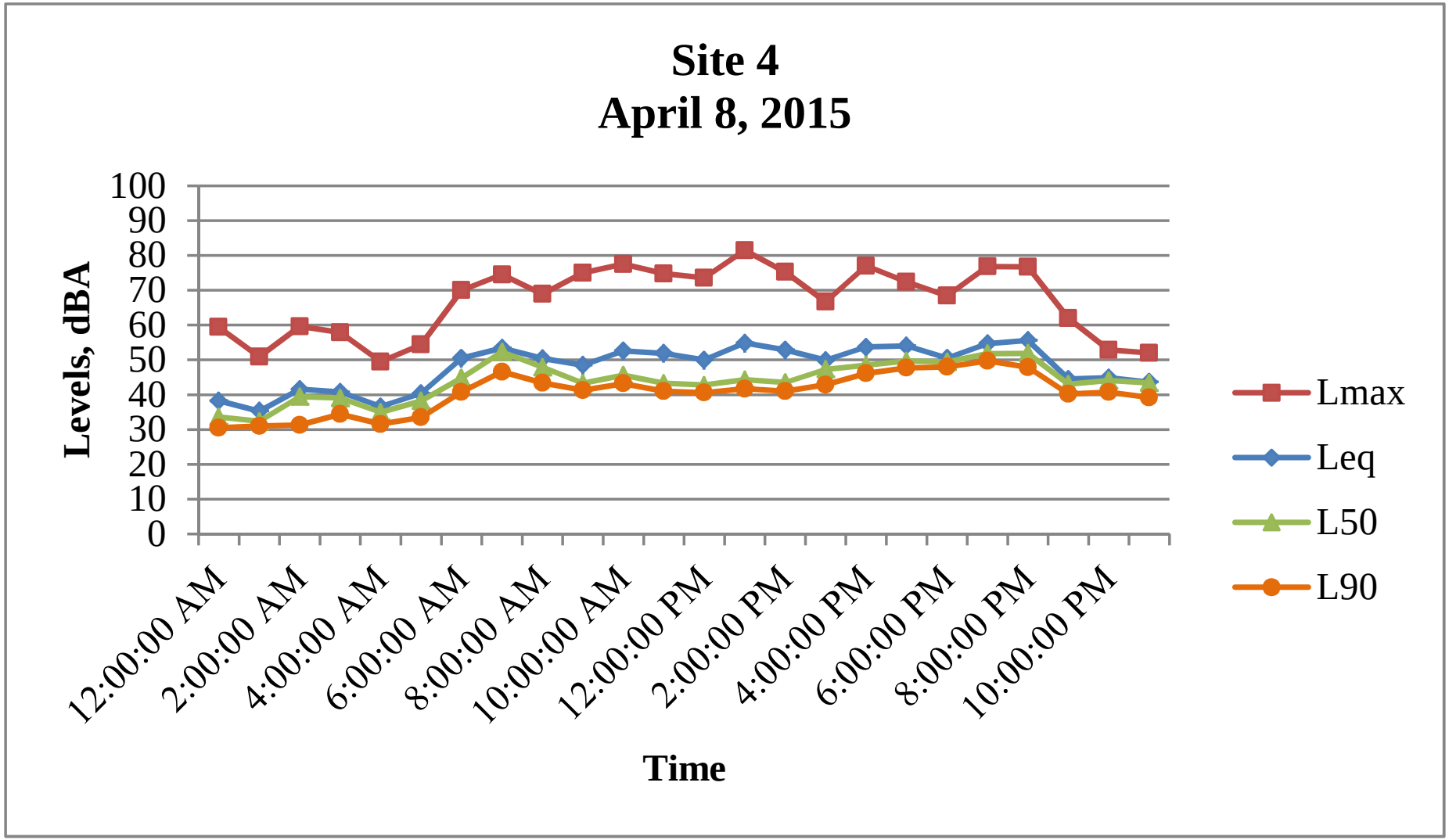
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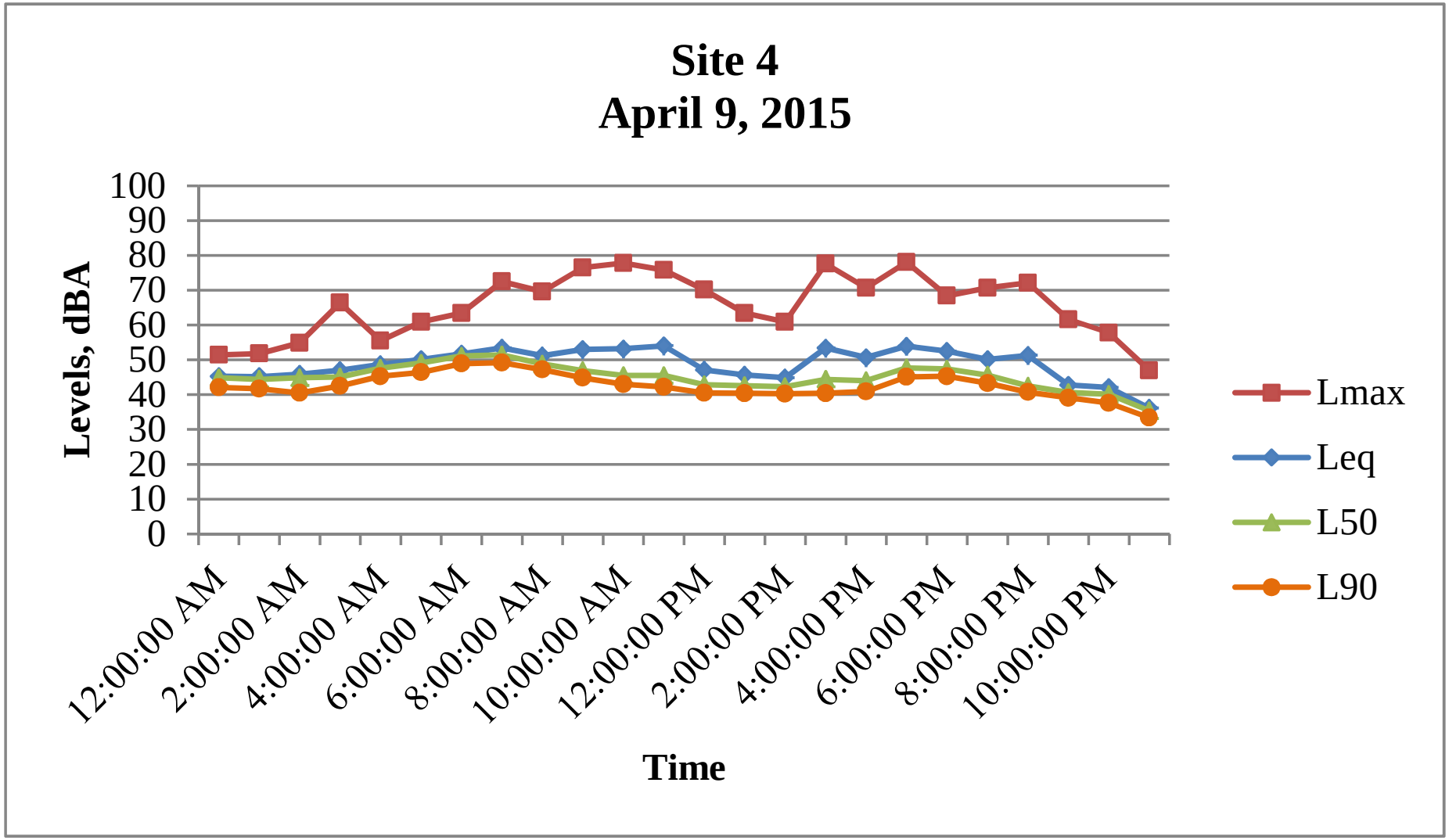
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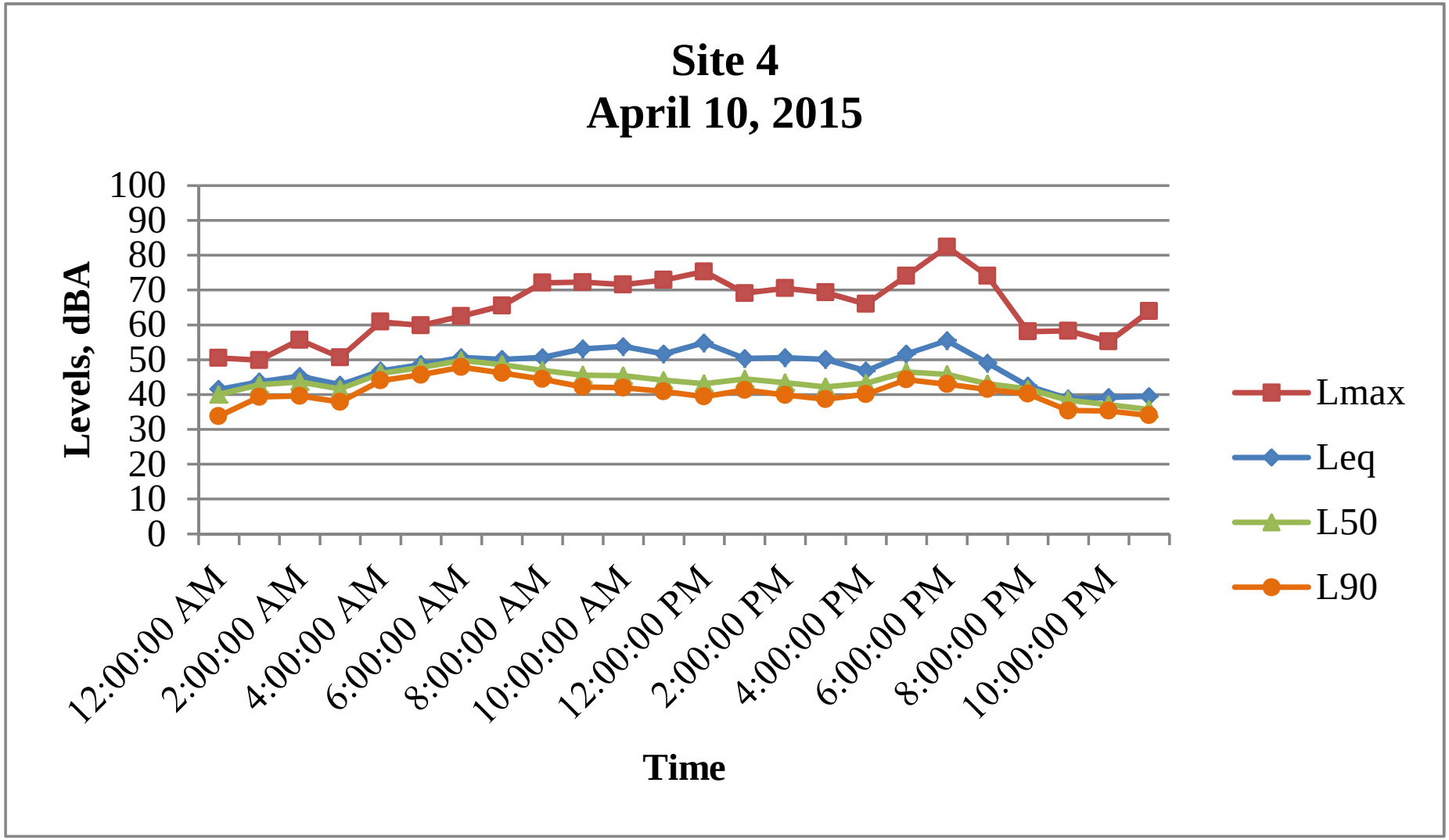
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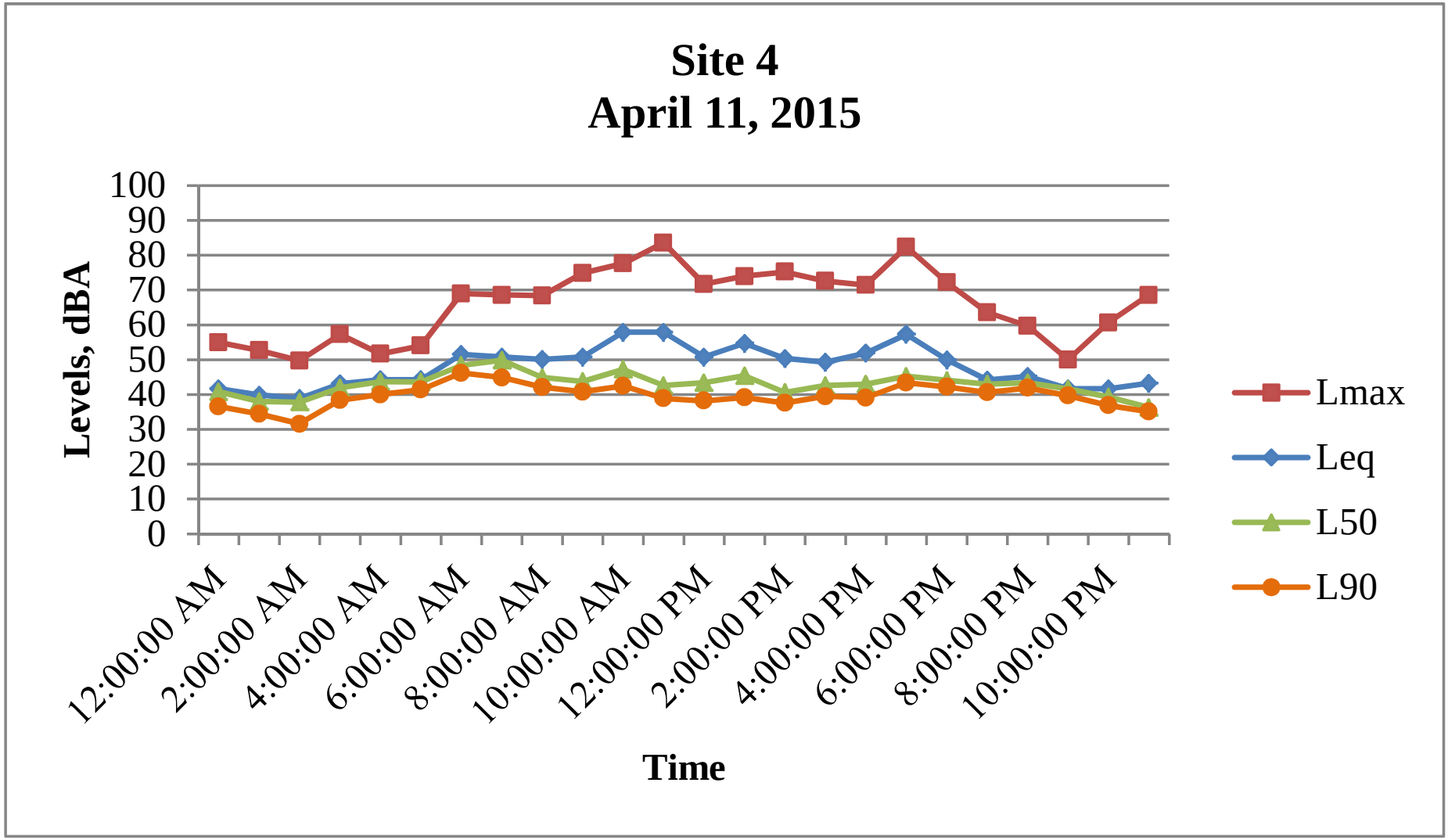
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April 11, 2015
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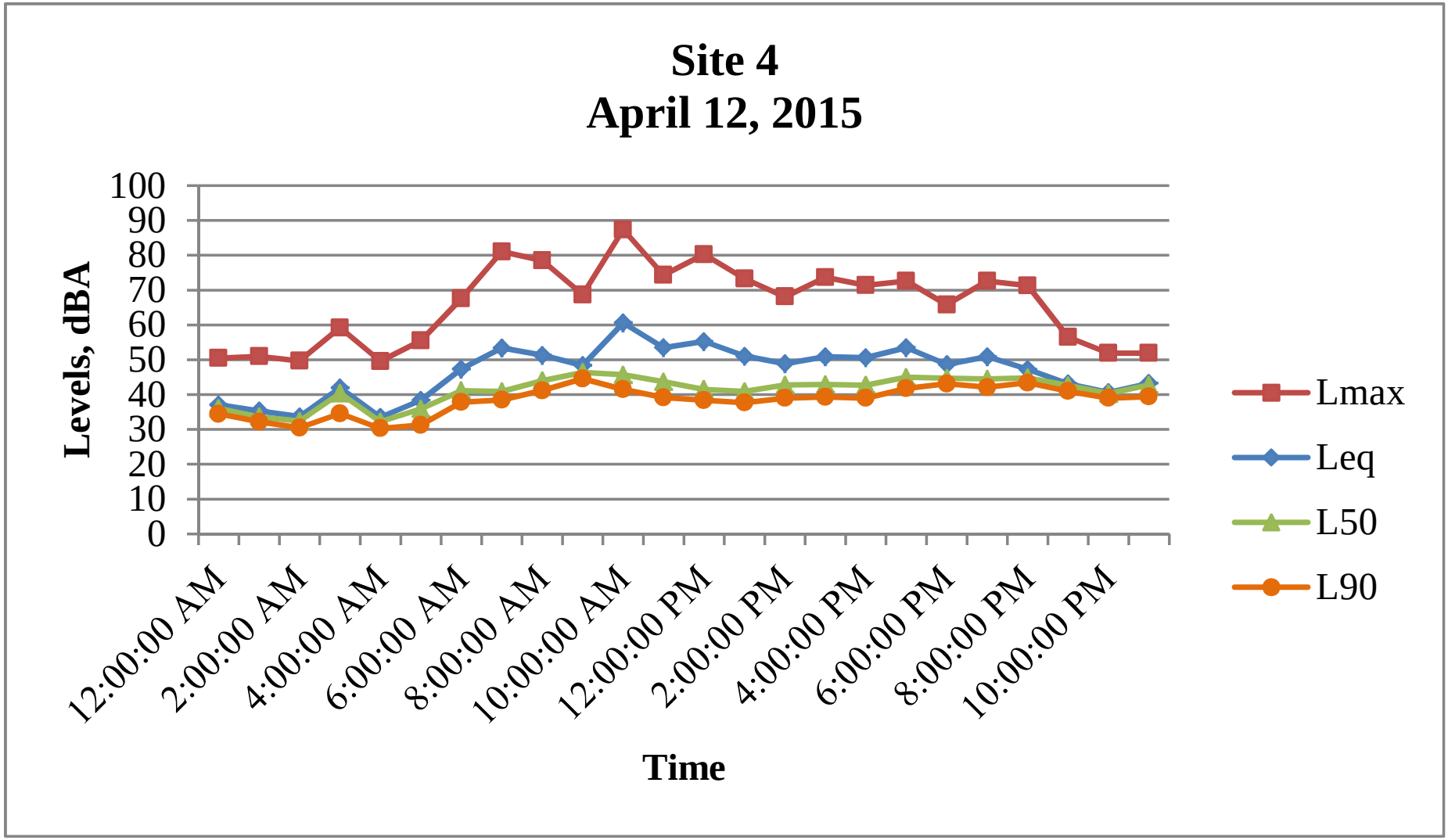
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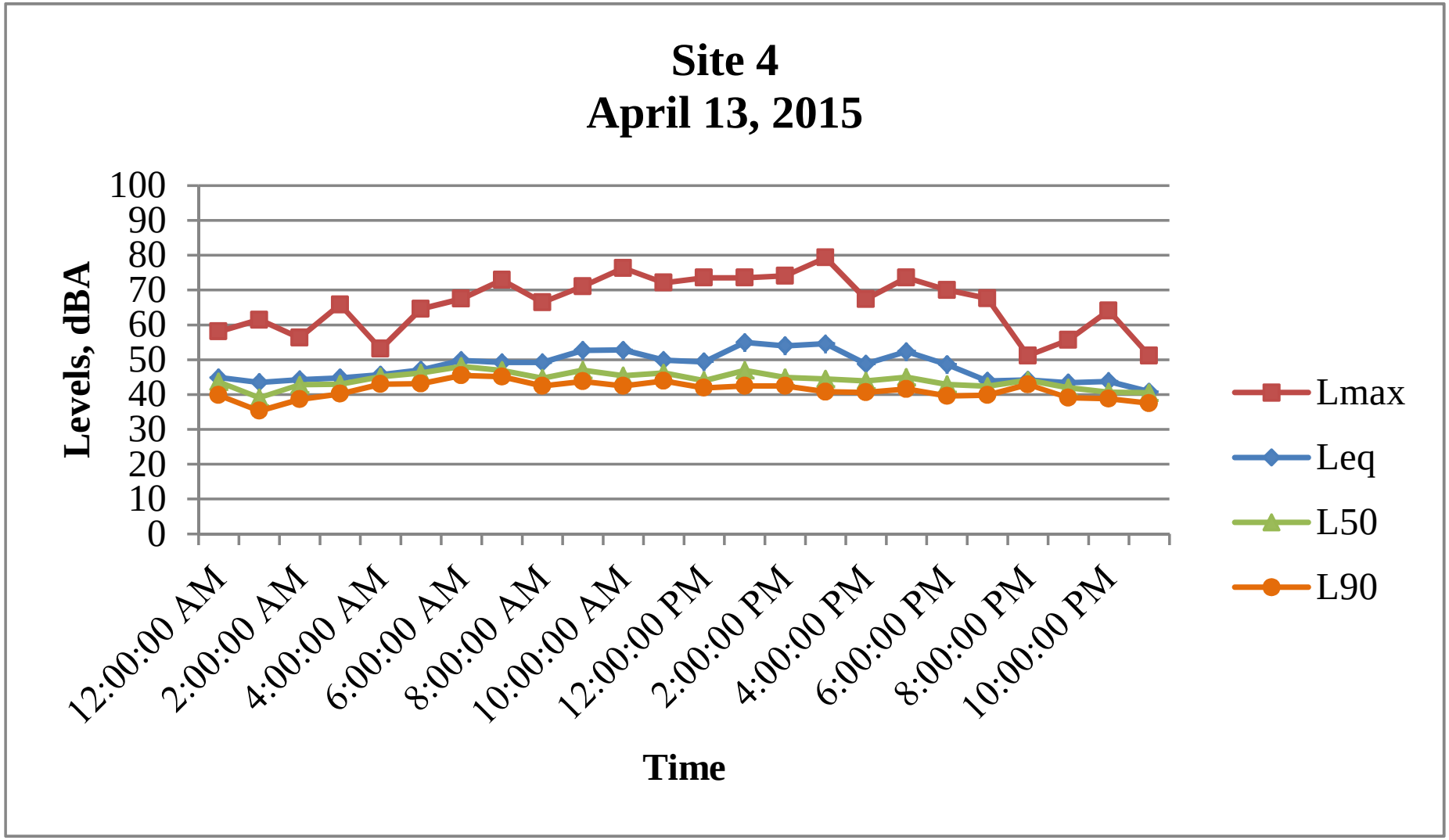
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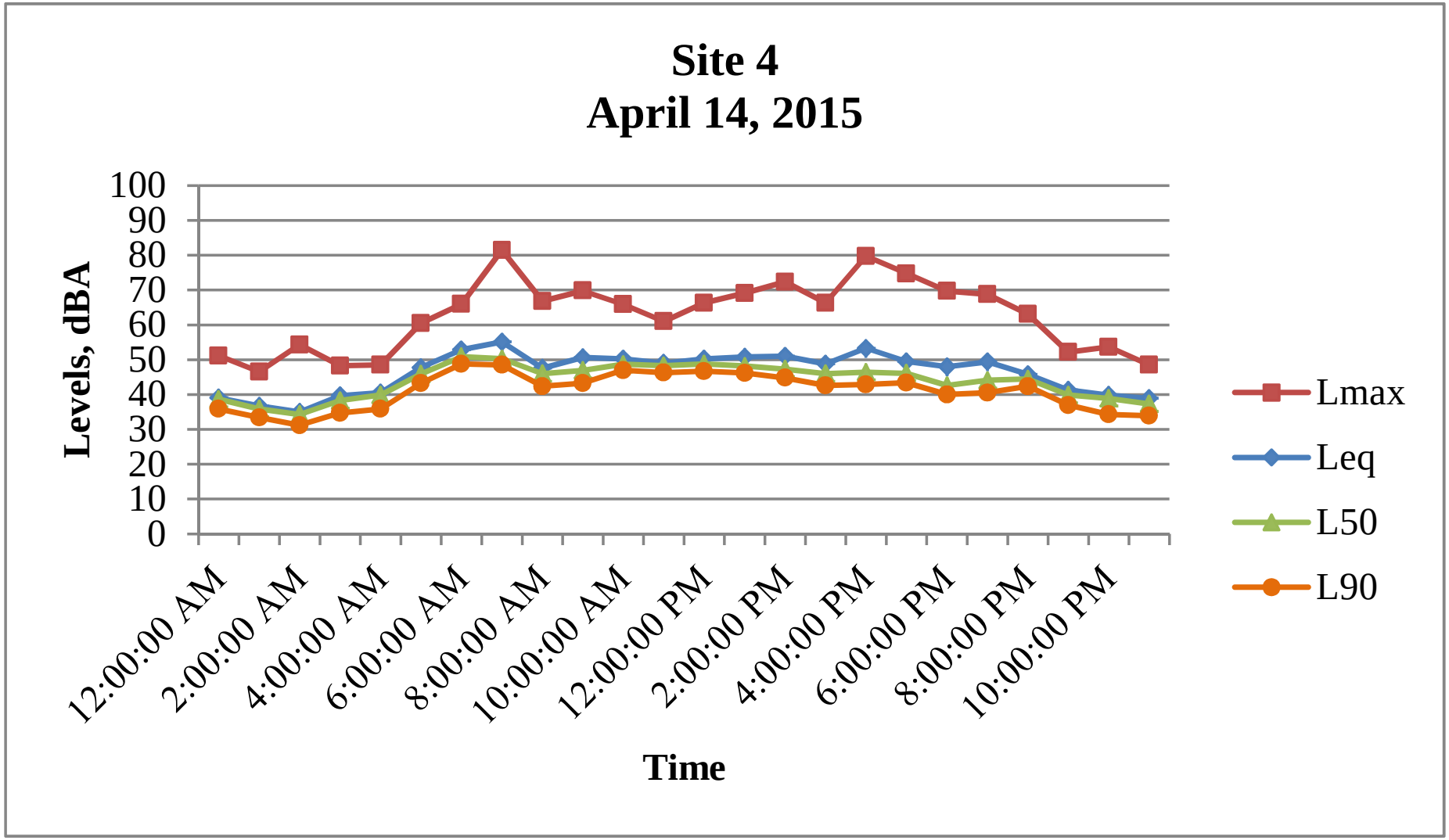
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April 14, 2015
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