AIRCRAFT NOISE MONITORING REPORT
LIVERMORE MUNICIPAL AIRPORT
LIVERMORE, CALIFORNIA

WJVA Report No. 21-23

PREPARED FOR

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INTRODUCTION

This report presents the findings of an aircraft noise monitoring study conducted by WJV Acoustics, Inc. (WJVA) for the Livermore Municipal Airport (LVK) in Livermore, California. Noise monitoring was conducted during two two-week-long periods, one occurring in the spring of 2021 (May) and the other in the fall of 2021 (November). 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 (when applicable).

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 May 11-17, 2021 and May 19-25, 2021 (Spring Noise Survey) and November 4-11, 2021 and November 13-19, 2021 (Fall Noise Survey). Week-long noise measurements were conducted at fourteen (14) locations using automated noise monitoring equipment. The noise monitoring sites were selected by WJVA in conjunction with representatives from the City of Livermore, the City of Dublin and the City of Pleasanton, 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 (when applicable). Short-term measurements of aircraft single event noise levels were also conducted at the sites.

Weather conditions during the spring 2021 noise measurement period consisted of mostly of clear to partly overcast skies, with no precipitation. Temperatures ranged from approximately 50° to 60°F during the early morning hours to approximately 60° to 80°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 50-80%.

During the fall 2021 noise measurement period, weather consisted of overcast skies with moderate rain during the first week of fall measurement 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 40-100%.

Noise Monitoring Locations:

Noise monitoring sites are described below along with their locations relative to sites used during previous noise monitoring studies (when applicable). Livermore site locations are shown in Figure 1. Pleasanton site locations are shown in Figure 2. Dublin site locations are shown in Figure 3.

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, approximately 0.7 nautical miles from the east end of Runway 07L/25R. Aircraft approaching Runways 25L and 25R pass nearly overhead. The site was also used during the fall of 2014 and spring of 2015 aircraft noise monitoring and 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 2 - This site was located in the backyard of a residence at 1613 Placer Circle in Livermore, east of the airport. This home is located between the approach flight paths to Runways 25L and 25R, approximately 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 ¼ mile of sites used for aircraft noise monitoring in the fall of 2014, Spring of 215, 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 was also used during the fall of 2014 and spring of 2015 aircraft noise monitoring and 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 2821 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 two houses south of the residence used for the fall 2014 and spring 2015 aircraft noise monitoring and 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 2014, spring of 2015, fall of 2007 and spring of 2008 noise measurement studies. The event threshold was set to 65 dBA.

Site 6 - This site was located on a building rooftop at Cottonwood Creek K-8 School in Dublin (2400 Central Parkway), northwest of the airport. This site is located approximately 1.4 nautical miles from the west end of Runway 07L/25R. The site is primarily affected by aircraft arriving on Runways 25L and 25R, with a large number of overflights and touch-and-go training operations. The aircraft noise event threshold for this site was set at 58 dBA.

Site 7 - This site was located in the backyard of a residence at 2927 West Castle Pines Terrace in Dublin, northwest of the airport. This site is located approximately 2.5 nautical miles from the west end of Runway 07L/25R. The site is primarily affected by aircraft arriving on Runways 25L and 25R, with a large number of overflights and touch-and-go training operations. The aircraft noise event threshold for this site was set at 57 dBA.

Site 8 - This site was located in the backyard of a residence at 4306 Jordan Ranch Drive in Dublin, northwest of the airport. This site is located approximately 1.7 nautical miles from the west end of Runway 07L/25R. The site is primarily affected by aircraft arriving on Runways 25L and 25R, with a large number of overflights and touch-and-go training operations. The aircraft noise event threshold for this site was set at 57 dBA.

Site 9 - This site was located in an open (south-facing) area at Kolb Elementary School in Dublin (3150 Palermo Way), northwest of the airport. This site is located approximately 2 nautical miles from the west end of Runway 07L/25R. The site is primarily affected by aircraft arriving on Runways 25L and 25R, with a large

number of overflights and touch-and-go training operations. The aircraft noise event threshold for this site was set at 58 dBA.

Site 10 - This site was located in the backyard of a residence at 3014 Staples Ranch Drive 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 aircraft noise event threshold for this site was set at 60 dBA.

Site 11 - This site was located in the backyard of a residence at 3496 Guthrie Street in Pleasanton, west of the airport. This home is located slightly north of the extended centerline of Runway 07L/25R, approximately 1.8 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 aircraft noise event threshold for this site was set at 58 dBA.

Site 12 - This site was located in the backyard of a residence at 3405 Byron Court, in Pleasanton, west of the airport. This home is located due west of the extended centerline of Runway 07L/25R, approximately 2.3 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 aircraft noise event threshold for this site was set at 57 dBA.

Site 13 - This site was located in the backyard of a residence at 3622 Diablo Court, in Pleasanton, west of the airport. This home is located slightly south of the extended centerline of Runway 07L/25R, approximately 2.0 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 aircraft noise event threshold for this site was set at 57 dBA.

Site 14 - This site was located in an open area at Mohr Elementary School in Pleasanton (3300 Dennis Drive), northwest of the airport. This site is located beneath the extended centerline of Runway 07L/25R, approximately 1.7 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 aircraft noise event threshold for this site was set at 60 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 57-65 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 1-14 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 spring 2021 and fall 2021 noise monitoring periods. Seven full days of noise monitoring data were collected at all of the sites during both the spring 2021 and fall 2021 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 WJVA 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.

Appendix C contains bar charts summarizing *aircraft* and *community* (non-aircraft) CNEL values for each measurement day at each of 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	May 11-17, 2021	53.7-57.3	54.5
		November 4-10, 2021	50.5-55.8	53.4
2	1613 Placer Circle, Livermore	May 12-17, 2021	50.8-54.8	52.1
		November 4-10, 2021	47.5-54.5	50.4
3	3318 Vermont Street, Pleasanton	May 11-17, 2021	45.8-51.5	49.1
		November 4-10, 2021	45.9-53.6	49.6
4	2821 Chocolate Street, Pleasanton	May 11-17, 2021	51.0-55.6	52.4
		November 12-18, 2021	44.3-50.5	48.3
5	Next to airport taxiway north of Runway 07L/25R	May 11-25, 2021	61.0-64.2	62.2
		November 4-18, 2021	56.8-63.6	60.3
6	2400 Central Parkway, Dublin (Cottonwood Creek -8 School)	May 11-17, 2021	40.7-52.1	43.6
		November 4-14, 2021	41.7-52.6	47.6
7	2927 West Castle Pines Terrace, Dublin	May 11-17, 2021	37.8-46.8	41.4
		November 13-19, 2021	33.5-43.0	37.9
8	4306 Jordan Ranch Drive, Dublin	May 19-25, 2021	38.7-46.5	43.4
		November 13-19, 2021	40.2-44.9	41.9
9	3150 Palermo Way, Dublin (Kolb Elementary School)	May 11-17, 2021	39.8-45.2	42.9
		November 4-14, 2021	37.2-48.2	44.1
10	3014 Staples Ranch Drive, Pleasanton	May 19-25, 2021	49.8-53.1	51.0
		November 4-10, 2021	57.0-56.1	52.1
11	3496 Guthrie Street, Pleasanton	May 11-17, 2021	42.4-50.0	45.9
		November 12-18, 2021	32.4-45.4	40.2
12	3405 Byron Court, Pleasanton	May 19-25, 2021	43.1-46.7	45.1
		November 12-18, 2021	40.6-47.8	44.0
13	3622 Diablo Court, Pleasanton	May 19-25, 2021	36.6-54.4	42.9
		November 12-18, 2021	36.1-42.0	39.4
14	3300 Dennis Drive, Pleasanton (Mohr Elementary School)	May 11-17, 2021	43.5-50.0	46.0
		November 4-11, 2021	41.9-49.5	46.0

[1]Shown are the range of daily CNEL values and mean (average) CNEL for the entire measurement period.
Source: WJV Acoustics, Inc.

Single Event Noise Level Measurements:

Detailed single event measurements were conducted in the vicinity of each of the long-term aircraft noise measurement sites described above. Due to their close proximity to each other, single event monitoring at Site 3 and Site 10 were conducted at one common location, and single event monitoring at Site 4 and Site 14 were conducted at one common location. 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 four (4) hours to record the type of aircraft, type of operation (arrival or departure), runway used (if discernible), 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 90° means that the aircraft passed directly over the microphone. It should be noted, a determination of the aircraft operation type (arrival or departure) was not made for sites located in the Dublin area, as a large majority of the aircraft flyovers in the Dublin area consist of touch-and-go training operations or it is not immediately discernable as to whether the aircraft is arriving or departing.

Tables II summarize the results of detailed single event noise level measurements at the monitoring sites, for the combined spring 2021 and fall 2021 monitoring periods. 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 therefore 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
2021

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Site 1 - Arrivals on Runway 25L/25R (5/13/21 and 11/4/21)				
Bizjet	2	90.1 (89.6-90.5)	85.5 (84.9-86.12)	90°
Single Engine Prop.	31	84.6 (63.0-98.4)	65.4 (54.3-83.9)	60°S-60°N
Twin Engine Prop.	2	86.3 (79.3-88.8)	77.4 (70.9-83.9)	75°N-90°
Site 1 - Departures on Runway 07L/07R (11/5/21 and 11/8/21)				
Bizjet	1	89.2	82.2	90°
Helicopter	1	81.2	72.4	75°W
Single Engine Prop.	22	83.8 (67.5-94.1)	70.5 (48.6-88.8)	45°S-60°N
Site 2 - Arrivals on Runway 25L/25R (11/5/21)				
Single Engine Prop.	25	77.6 (62.1-88.9)	64.9	45°S
Twin Engine Prop.	1	73.1	77.4 (70.9-83.9)	75°N-90°
Site 2 – Departures on Runway 07L/07R (11/8/21)				
Single Engine Prop.	15	77.6 (64.5-83.2)	65.6 (57.7-73.0)	45°S-45°N
Site 3 / Site 10 - Arrivals on Runway 07L/07R (5/20/21 and 11/16/21)				
Single Engine Prop.	8	73.8 (62.2-79.1)	60.8 (54.0-69.3)	45°E-45°W
Site 3 / Site 10 – Departures on Runway 25L/25R (5/13/21, 11/4/21 and 11/10/21)				
Bizjet	8	83.5 (61.0-88.8)	70.6 (53.3-79.6)	75°N-90°
Helicopter	1	72.7	65.3	15°E
Single Engine Prop.	49	76.9 (57.8-85.5)	63.4 (50.5-77.1)	30°E-60°N
Twin Engine Prop.	1	85.5	77.7	75°N-90°
Site 4 / Site 14 – Arrivals on Runway 07L/07R (11/11/21 and 11/17/21)				
Bizjet	2	80.0 (76.1-82.0)	69.7 (65.2-74.2)	45°N-90°
Single Engine Prop.	35	73.2 (57.0-82.0)	59.6 (45.8-73.8)	45°S-45°S
Twin Engine Prop.	1	82.5	75.2	45°N
Site 4 – Departures on Runway 25L/25R (5/11/21, 5/25/21, 11/4/21 and 11/10/21)				
Bizjet	4	87.8 (79.9-90.3)	78.3 (70.5-82.1)	30°N-90°
Single Engine Prop.	82	76.7 (59.5-88.2)	63.1 (49.8-80.1)	45°N-60°S
Twin Engine Prop.	31	77.1 (65.8-80.2)	66.5 58.3-71.4)	45°N-75°N

Source: WJV Acoustics, Inc.

TABLE II
(CONTINUED)

SUMMARY OF AIRCRAFT SINGLE EVENT NOISE LEVEL MEASUREMENTS
LIVERMORE MUNICIPAL AIRPORT
2021

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Site 6 – LVK Operations (Arrivals/Departures/Overflights) (5/13/21 and 11/9/21)				
Bizjet	4	71.1 (62.6-76.5)	56.6 (52.8-64.9)	45°S
Helicopter	1	76.9	67.9	45°S
Single Engine Prop.	42	77.4 (61.3-90.7)	63.5 (54.8-81.5)	45°S-45°N
Twin Engine Prop.	1	74.4	65.7	90°
Site 7 – LVK Operations (Arrivals/Departures/Overflights) (5/25/21 and 11/18/21)				
Bizjet	1	82.3	71.0	90°
Single Engine Prop.	10	74.1 (56.3-83.5)	56.3 (48.0-15.0)	45°S-60°N
Site 8 – LVK Operations (Arrivals/Departures/Overflights) (5/25/21 and 11/18/21)				
Bizjet	2	65.1 (64.5-65.7)	55.2 (54.5-55.9)	45°S-60°N
Single Engine Prop.	58	70.0 (58.1-80.0)	58.2 (50.6-69.7)	45°S-45°N
Site 9 – LVK Operations (Arrivals/Departures/Overflights) (5/11/21 and 11/8/21)				
Bizjet	1	76.8	64.6	90°
Helicopter	2	74.3 (66.2-77.0)	62.9 (59.6-66.2)	90°
Single Engine Prop.	29	70.8 (61.0-80.0)	58.7 (50.8-68.4)	45°S-90°
Twin Engine Prop.	2	74.7 (73.5-75.7)	64.8 (63.0-66.5)	45°S-75°E
Site 11 – Arrivals on Runway 07L/07R (11/16/21 and 11/17/21)				
Single Engine Prop.	6	72.1 (56.7-78.5)	58.2 (50.0-70.9)	45°S-45°N
Site 11 - Departures on Runway 25L/25R (5/17/21, 11/15/21 and 11/16/21)				
Bizjet	2	80.3 (74.2-82.7)	69.0 (64.6-73.4)	60°N-90°
Single Engine Prop.	19	74.4 (61.6-83.8)	61.0 (54.4-75.2)	45°N-60°S
Twin Engine Prop.	2	81.2 (76.8-83.4)	70.6 (67.2-74.0)	60°N-90°
Site 12 - Departures on Runway 25L/25R (5/18/21, 11/15/21 and 11/19/21)				
Bizjet	3	84.1 (77.9-86.5)	73.8 (70.4-75.8)	60°N-90°
Single Engine Prop.	7	74.5 (56.5-80.5)	61.9 (50.2-68.9)	45°N-90°
Site 13 - Arrivals on Runway 07L/07R (11/11/21)				
Single Engine Prop.	2	65.1 (63.3-66.4)	56.2 (55.5-56.8)	30°N

Source: WJV Acoustics, Inc.

TABLE II
(CONCLUDED)

SUMMARY OF AIRCRAFT SINGLE EVENT NOISE LEVEL MEASUREMENTS
LIVERMORE MUNICIPAL AIRPORT
2021

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Site 13 - Departures on Runway 25L/25R (5/20/21 and 11/15/21)				
Bizjet	2	74.9 (71.6-76.7)	66.3 (65.5-67.1)	45°N-60°N
Single Engine Prop.	9	73.3 (60.6-80.4)	60.3 (54.2-72.2)	45°N-90°
Twin Engine Prop.	1	75.6	67.5	60°N

Source: WJV Acoustics, Inc., Inc.

COMPARISON OF PRESENT AND PREVIOUS AIRCRAFT NOISE STUDIES

Table III compares measured aircraft CNEL values from the spring 2021 and fall 2021 noise monitoring periods to those obtained during previous noise monitoring studies conducted by WJVA during fall 2007, spring 2008, fall 2014 and spring 2015, monitoring events. Although Sites 1-4 were not in the exact locations used for all of the previous measurements, they are generally within approximately one-half block of the previously utilized noise monitoring sites. An exception to this occurred at Site 2 which ended up being located approximately ¼ mile northwest of the site utilized during the previous noise measurements.

Table III shows that the aircraft noise levels measured during the spring 2021 and fall 2021 noise monitoring periods were within range of noise levels measured during the previous four monitoring periods (fall 2007, spring 2008, fall 2014 and spring 2015). An exception to this occurred at Site 4, at which noise levels measured during the Spring 2021 monitoring period were approximately 2 dB higher than noise levels measured during previous monitoring periods (as well as the Fall 2021 monitoring period) at the site.

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 III

COMPARISON OF MEASURED AIRCRAFT CNEL VALUES
LIVERMORE MUNICIPAL AIRPORT

Site	Measured Aircraft CNEL, dB					
	Measured Fall 2007 Mean (Range)	Measured Spring 2008 Mean (Range)	Measured Fall 2014 Mean (Range)	Measured Spring 2015 Mean (Range)	Measured Spring 2021 Mean (Range)	Measured Fall 2021 Mean (Range)
1	53.8 (53.1-54.9)	57.3 (53.6-62.4)	53.0 (50.8-54.6)	53.6 (50.7-55.7)	54.5 (53.7-57.3)	53.4 (50.5-55.8)
2	52.3 (47.7-58.0)	55.1 (52.7-57.4)	47.8 (45.7-50.7)	51.0 (47.1-58.2)	52.1 (50.8-54.8)	50.4 (47.5-54.5)
3	49.0(44.9-51.9)	52.0 (48.4-57.8)	49.7 (46.1-55.3)	48.9 (41.1-54.6)	49.1 (45.8-51.5)	49.6 (45.9-53.6)
4	50.3 (46.3-49.8)	50.5 (47.3-54.2)	47.4 (44.7-49.7)	46.5 (40.5-49.9)	52.4 (51.0-55.6)	48.3 (44.3-50.5)

Source: WJV Acoustics, 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: LIVERMORE NOISE MONITORING SITES

FIGURE 2: PLEASANTON NOISE MONITORING SITES

FIGURE 3: DUBLIN NOISE MONITORING SITES

APPENDIX A

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.

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

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).

DNL/L_{dn}: Day/Night Average Sound 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.

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 and DNL represent daily levels of noise exposure averaged on an annual basis, while 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.

ACOUSTICAL TERMINOLOGY

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

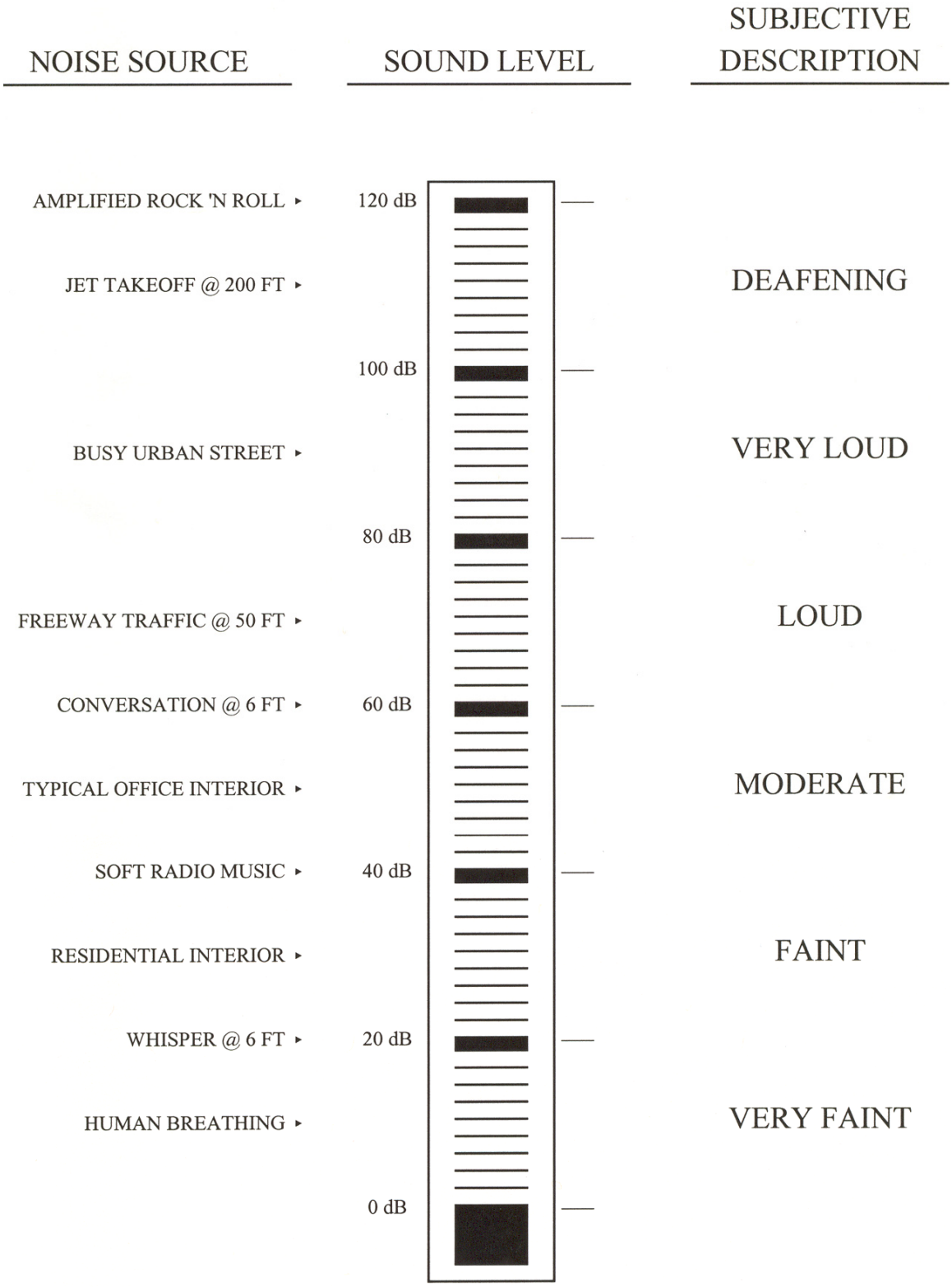
NOISE LEVEL REDUCTION (NLR): The noise reduction between indoor and outdoor environments or between two rooms that is the numerical difference, in decibels, of the average sound pressure levels in those areas or rooms. A measurement of "noise level reduction" combines the effect of the transmission loss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

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 overflight, 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.

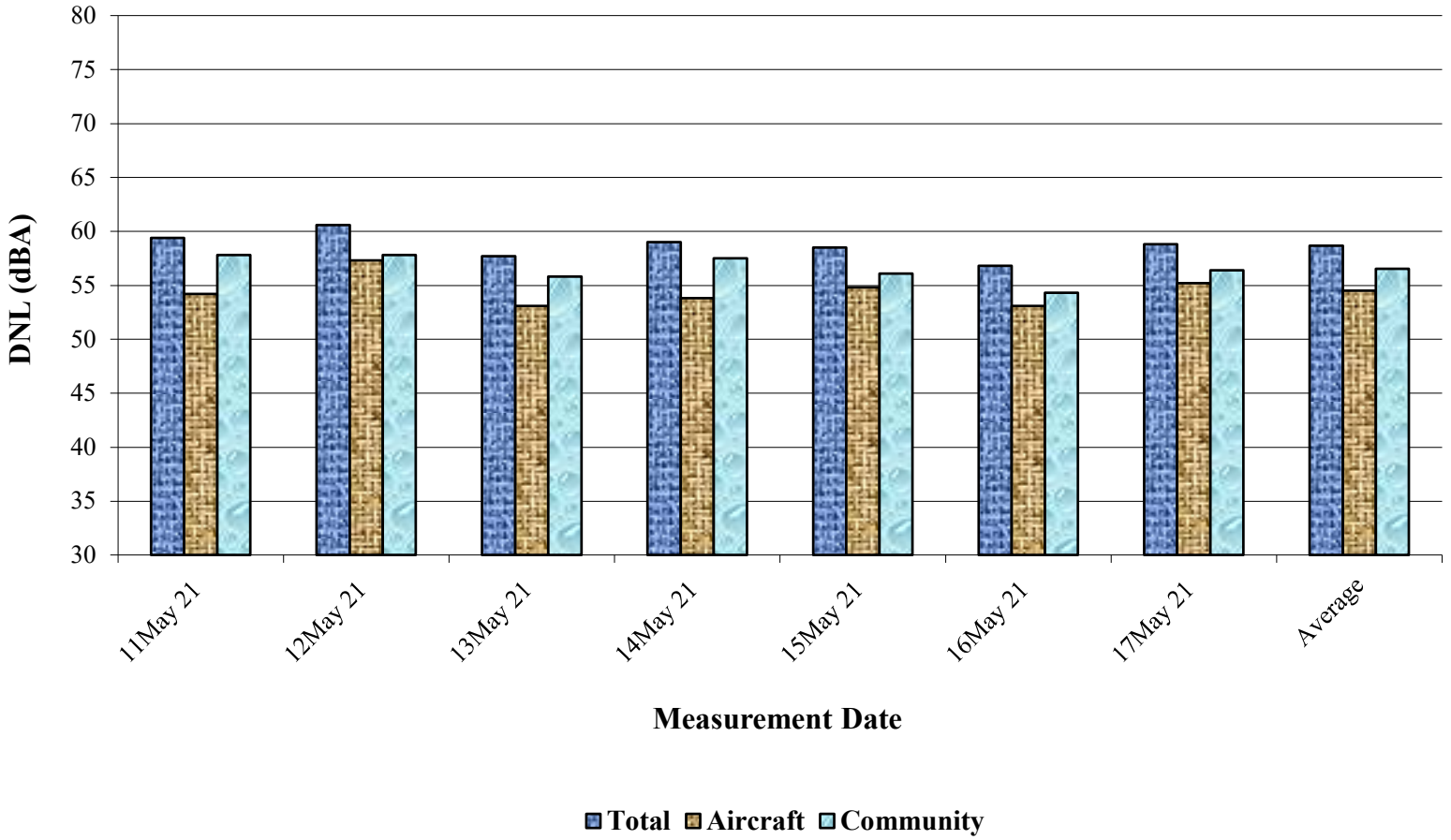
APPENDIX B
EXAMPLES OF SOUND LEVELS



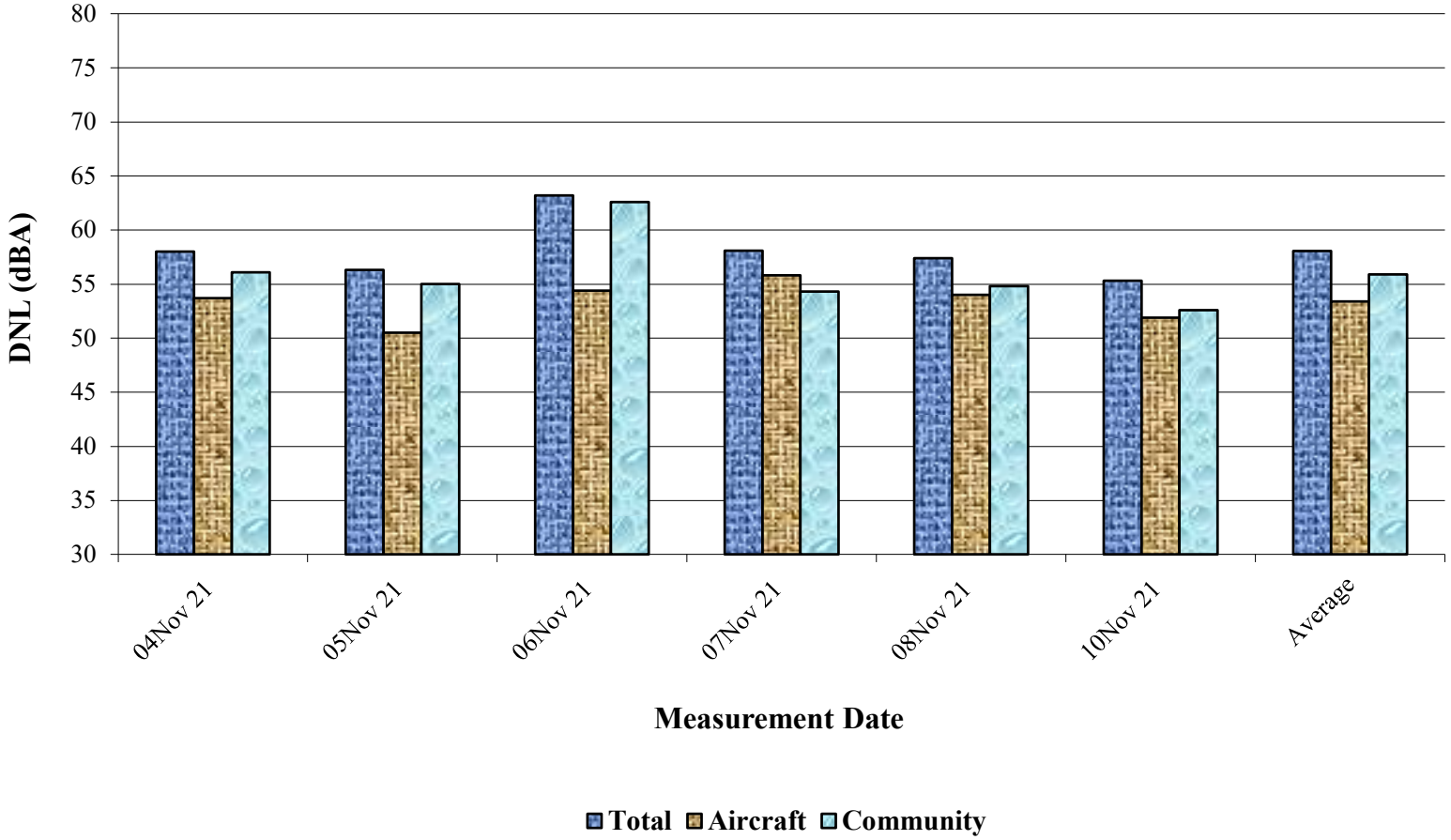
APPENDIX C

DAILY MEASURED CNEL VALUES
LIVERMORE MUNICIPAL AIRPORT
SPRING 2021 AND FALL 2021

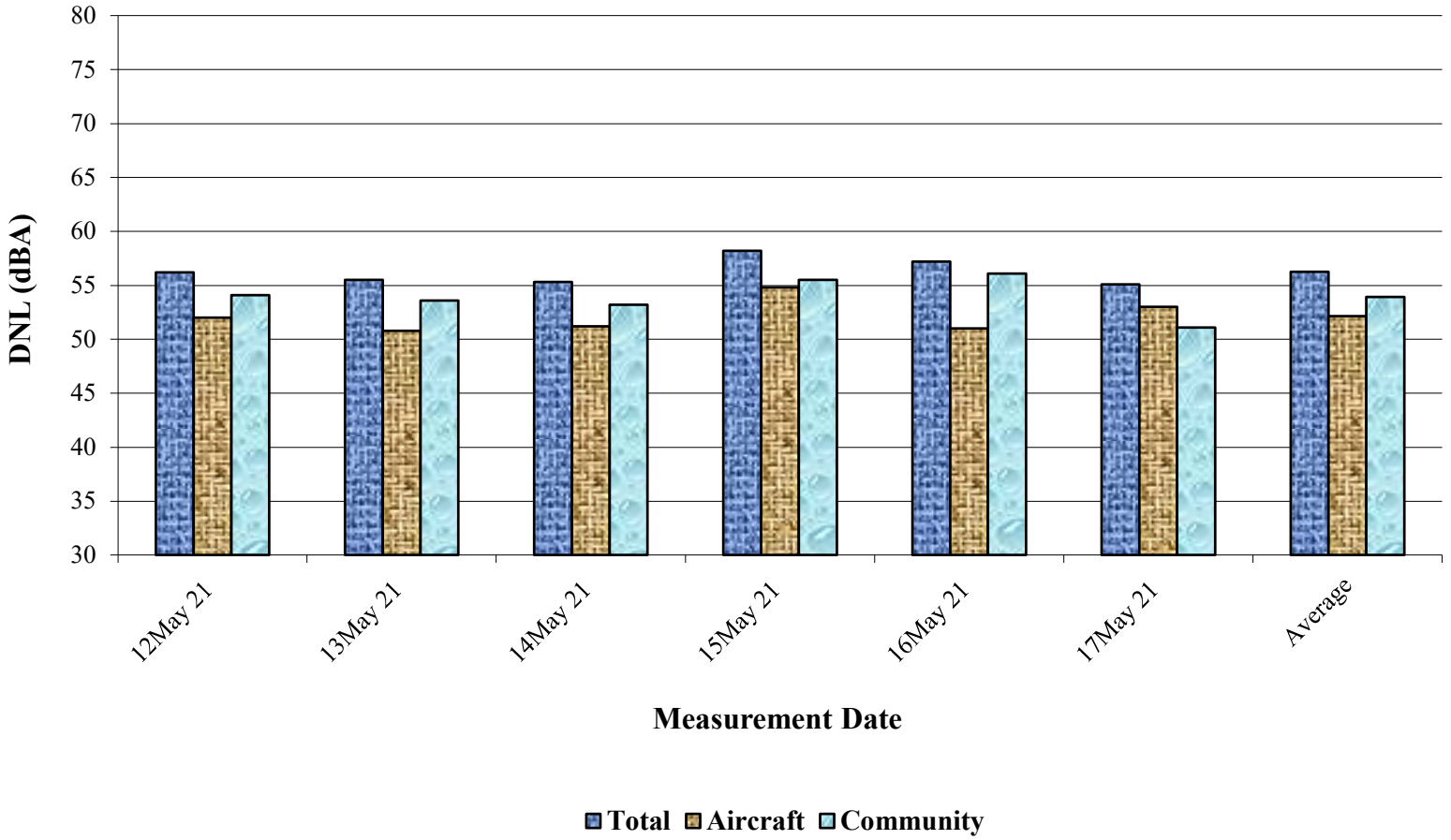
C-1
Daily Measured CNEL Values
Livermore Municipal Airport
1386 Arlington Road.: Spring 2021
Site 1



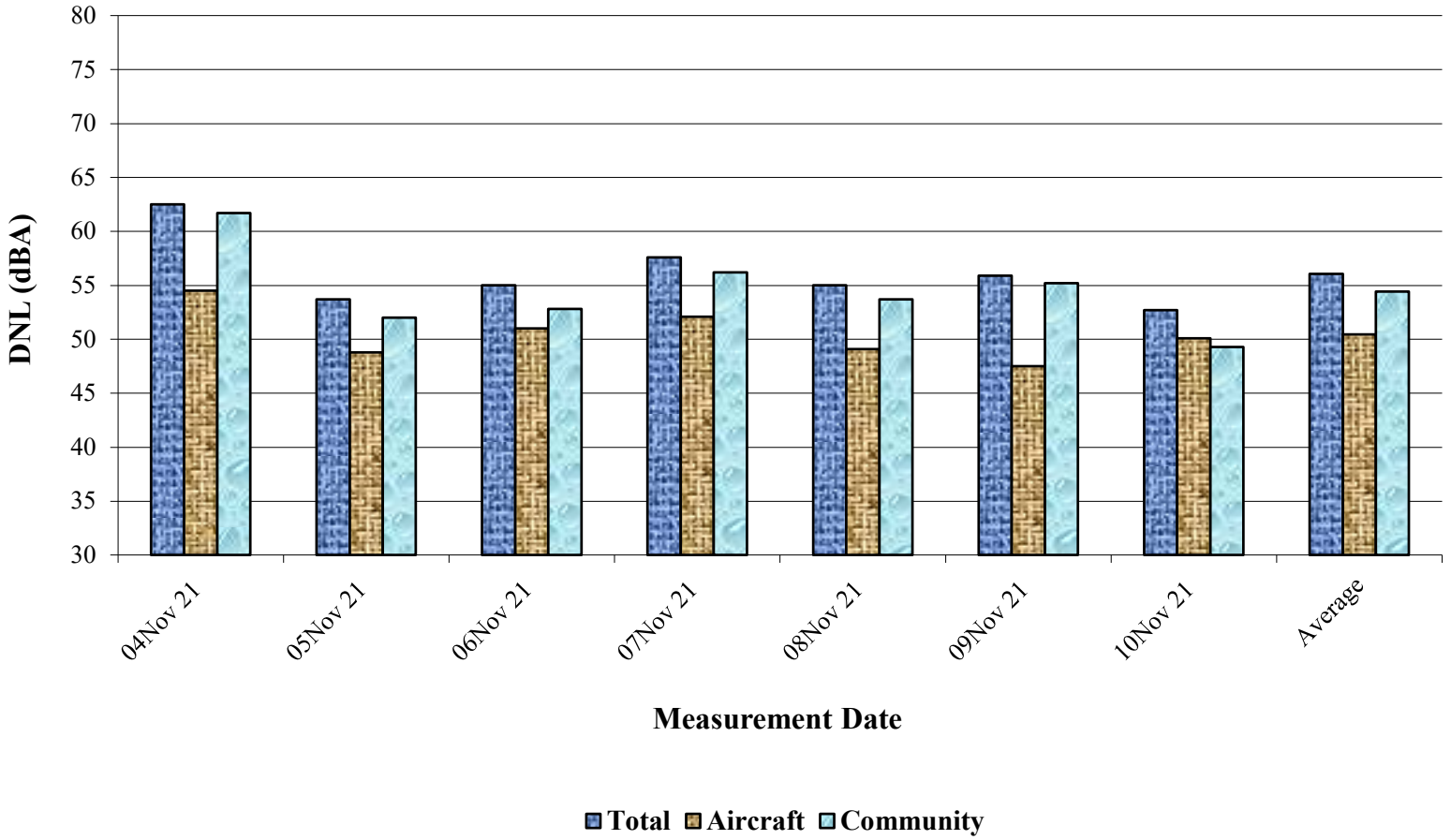
C-2
Daily Measured CNEL Values
Livermore Municipal Airport
1386 Arlington Road, Livermore: Fall 2021
Site 1



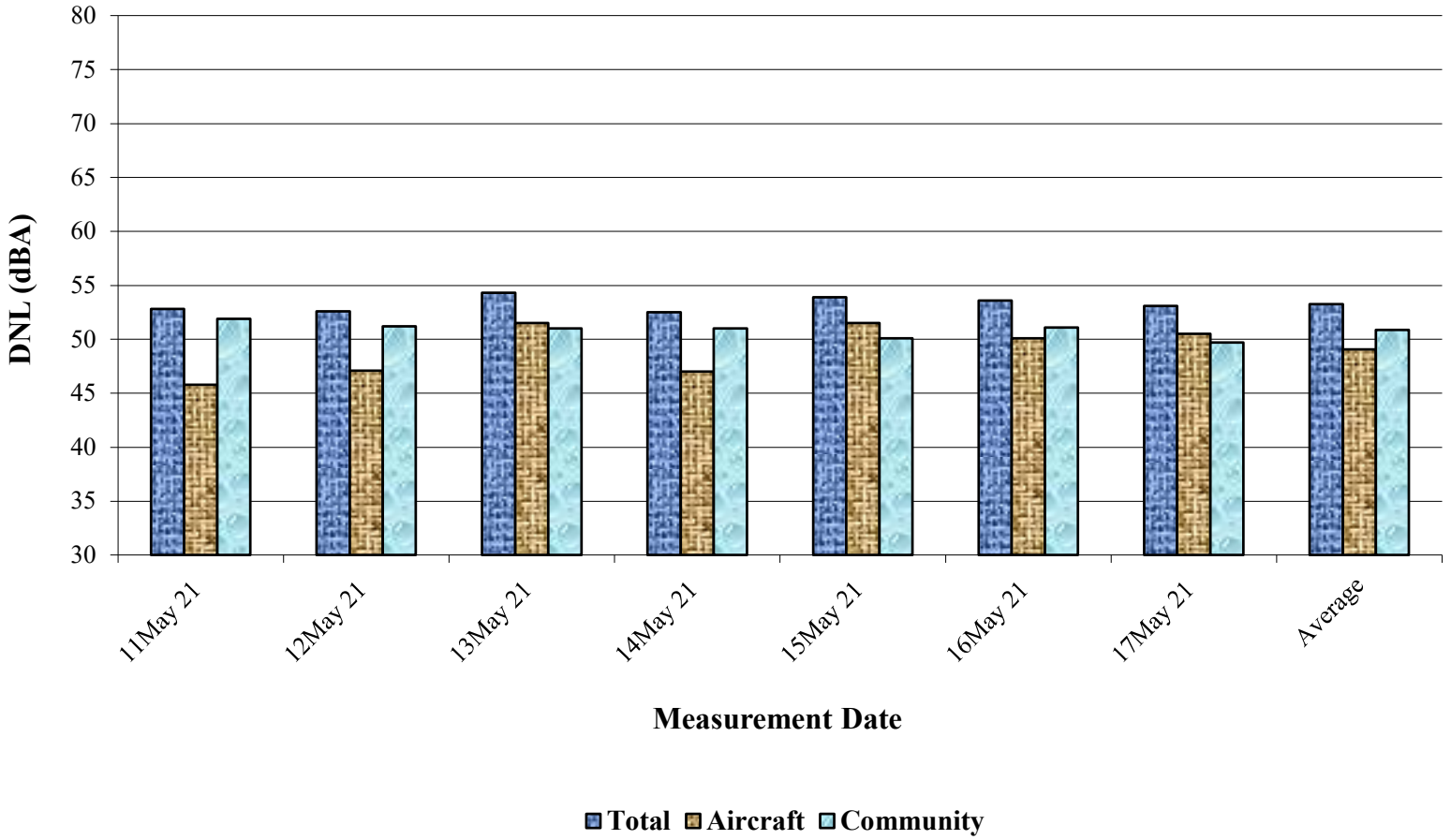
C-3
Daily Measured CNEL Values
Livermore Municipal Airport
1613 Placer Circle.: Spring 2021
Site 2



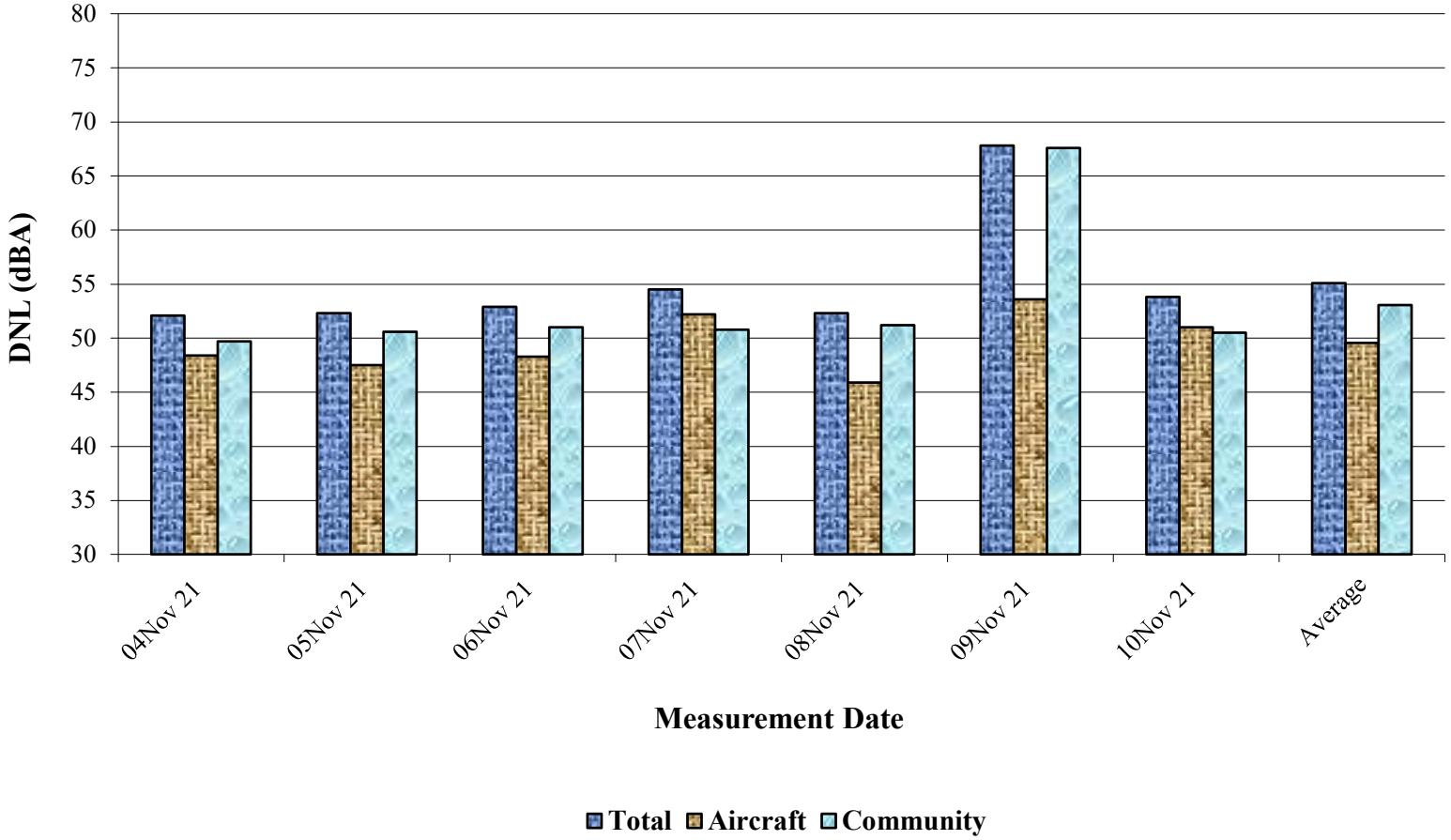
C-4
Daily Measured CNEL Values
Livermore Municipal Airport
1613 Placer Circle, Livermore: Fall 2021
Site 2



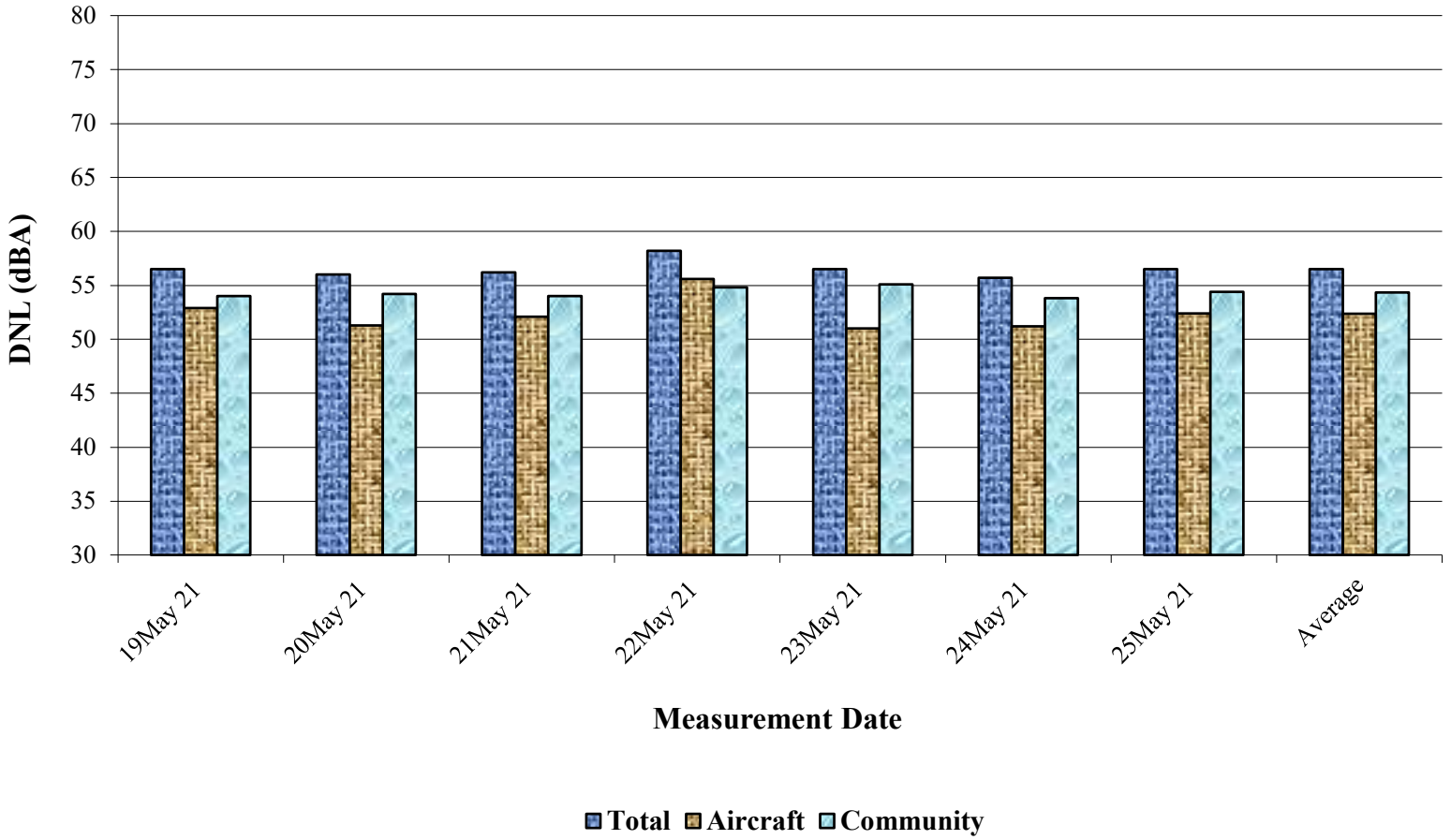
C-5
Daily Measured CNEL Values
Livermore Municipal Airport
3318 Vermont Place.: Spring 2021
Site 3



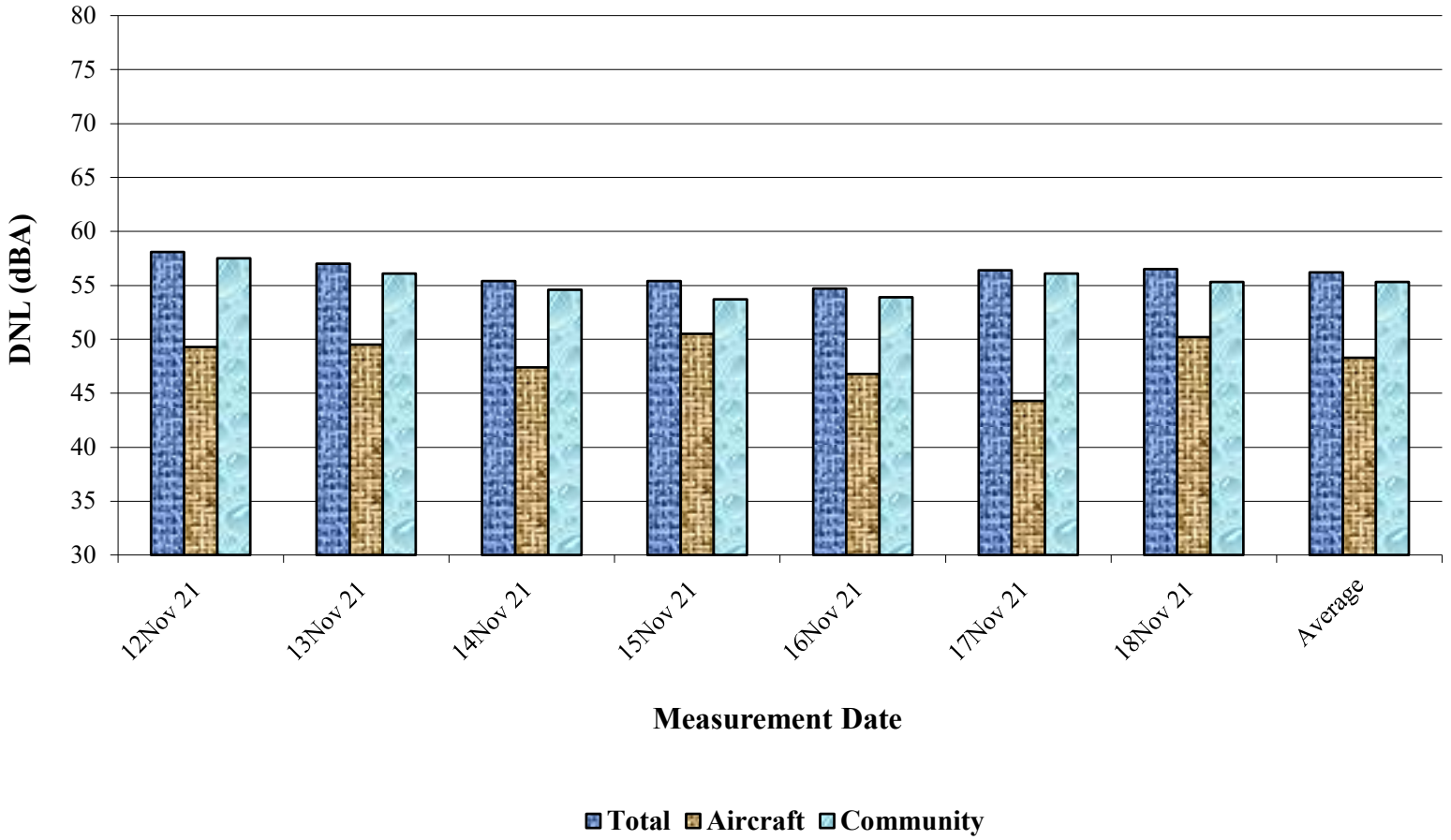
C-6
Daily Measured CNEL Values
Livermore Municipal Airport
3318 Vermont Place, Pleasanton: Fall 2021
Site 3



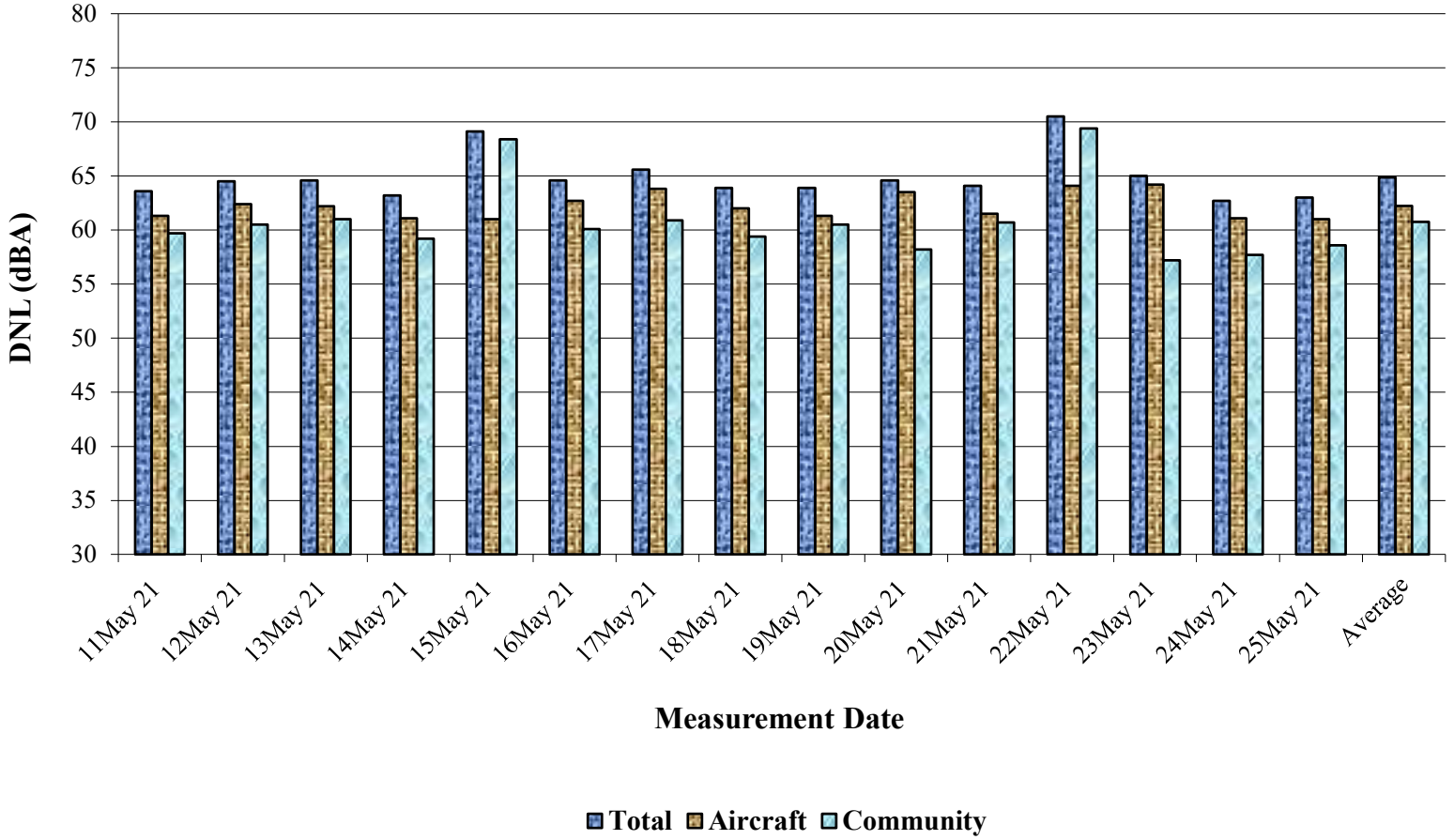
C-7
Daily Measured CNEL Values
Livermore Municipal Airport
2821 Chocolate Street.: Spring 2021
Site 4



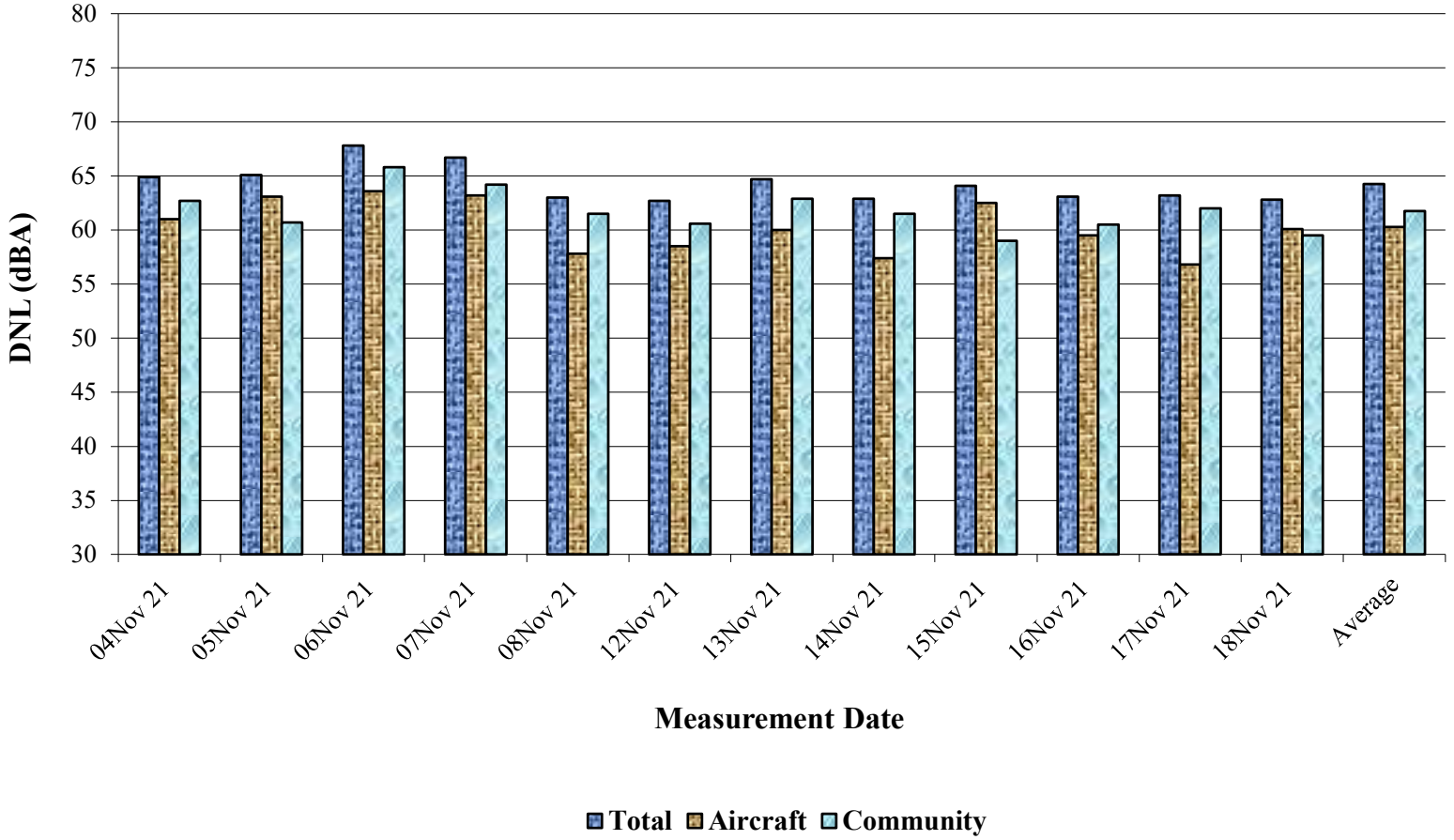
C-8
Daily Measured CNEL Values
Livermore Municipal Airport
2821 Chocolate Street, Pleasanton: Fall 2021
Site 4



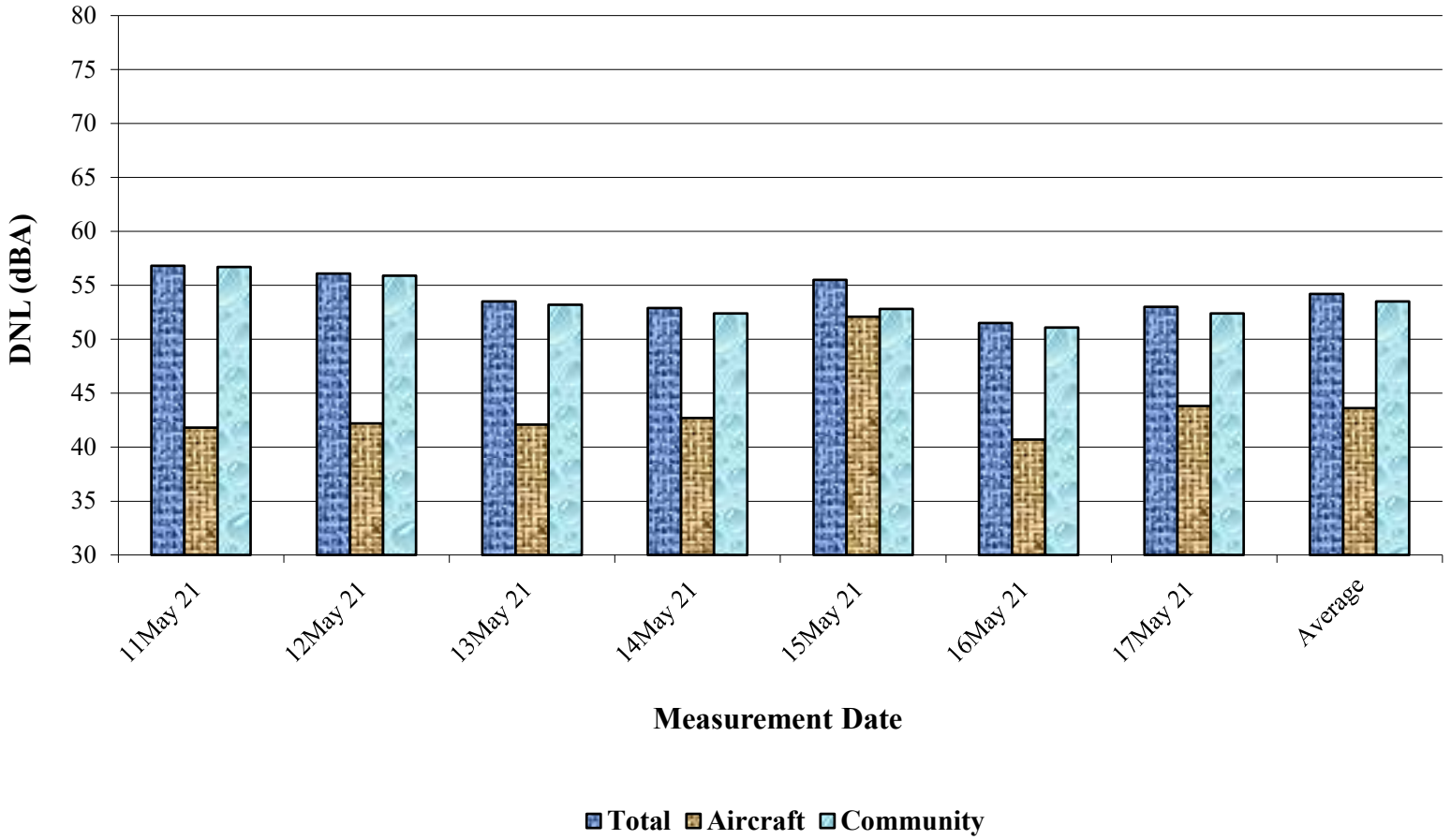
C-9
Daily Measured DNL Values
Livermore Municipal Airport
LVK: Spring 2021
Site 5



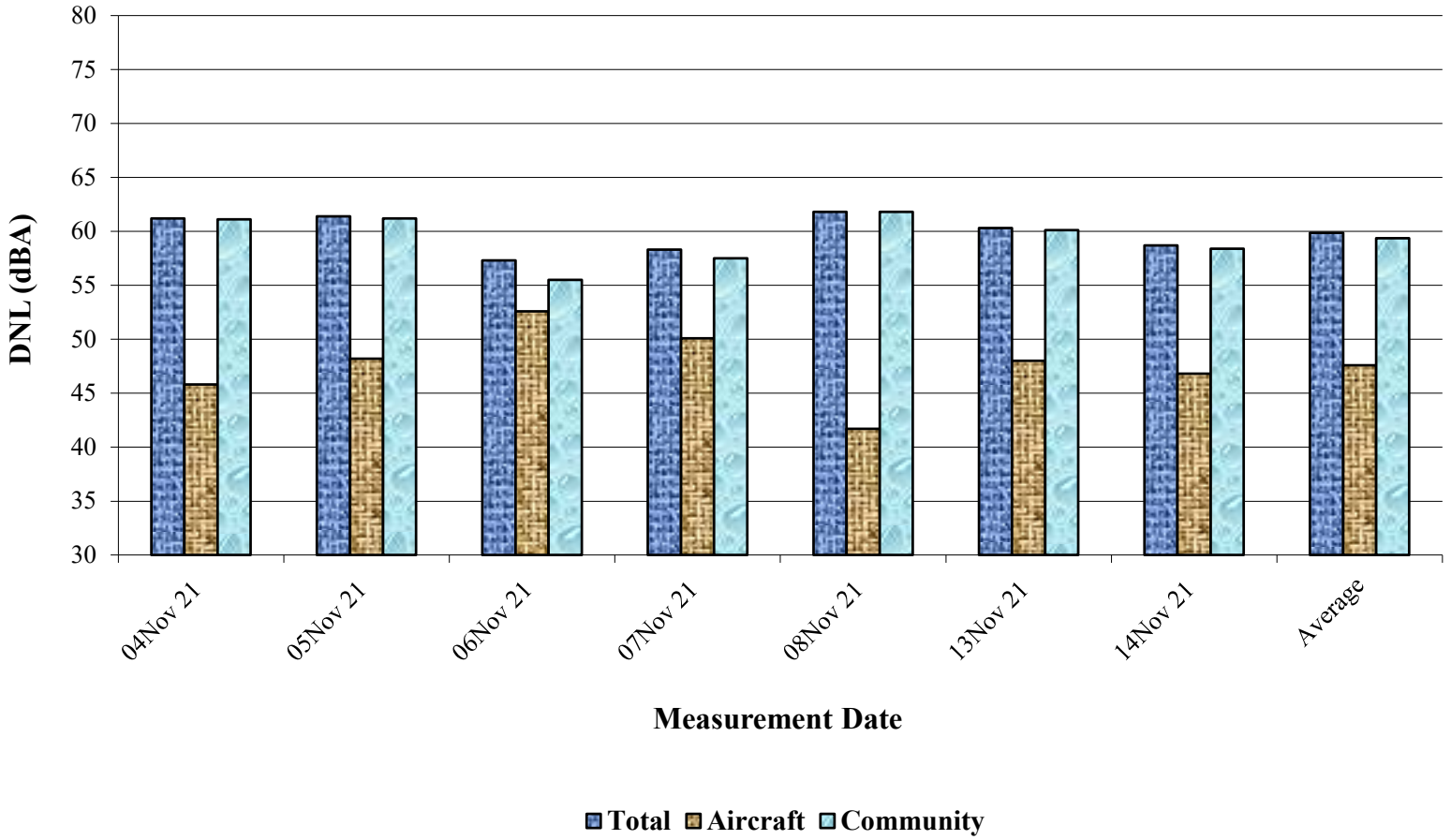
C-10
Daily Measured DNL Values
Livermore Municipal Airport
LVK: Fall 2021
Site 5



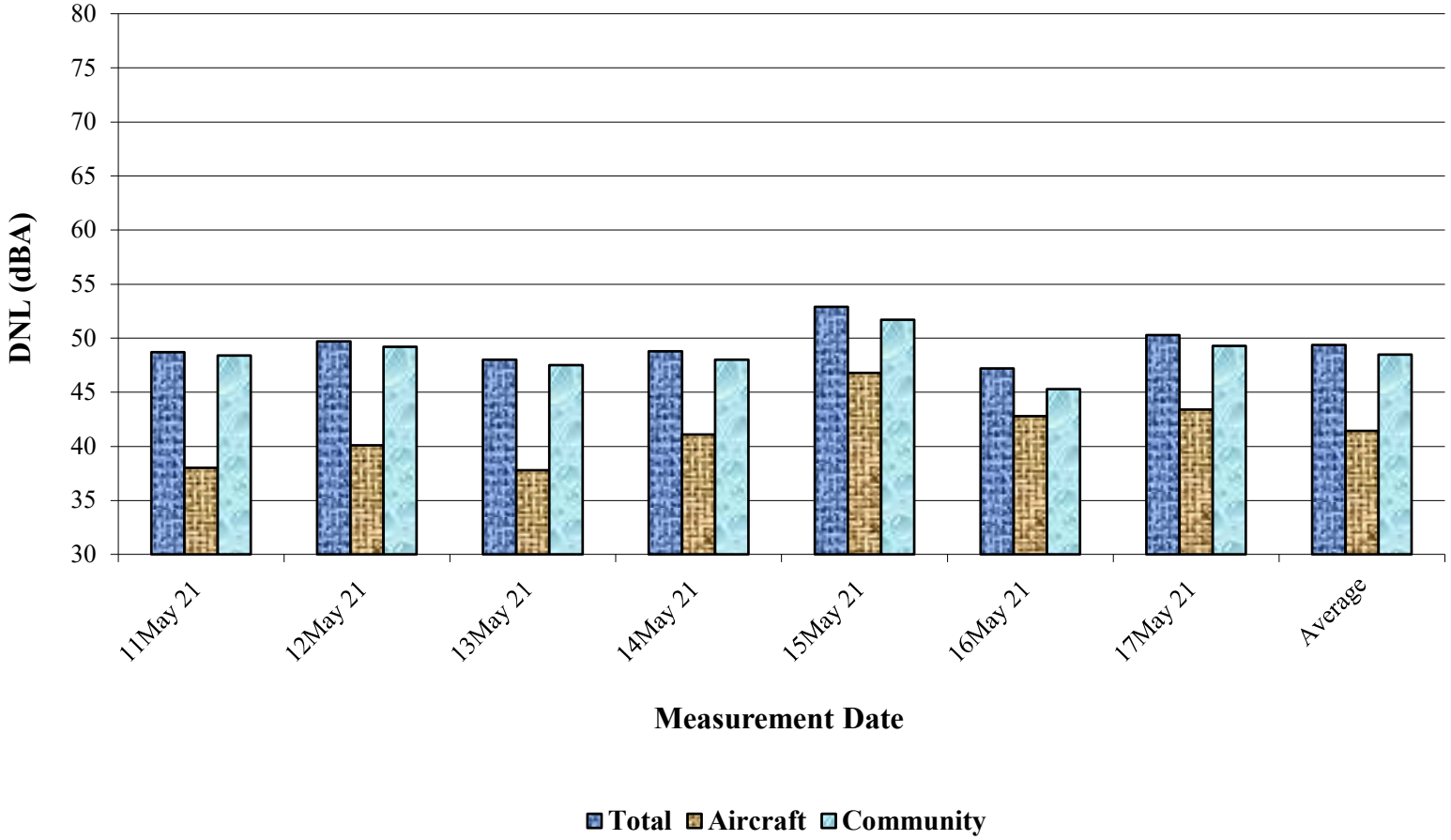
C-11
Daily Measured CNEL Values
Livermore Municipal Airport
2400 Central Parkway, Dublin (Cottnwood Creek Elementary): Spring 2021
Site 6



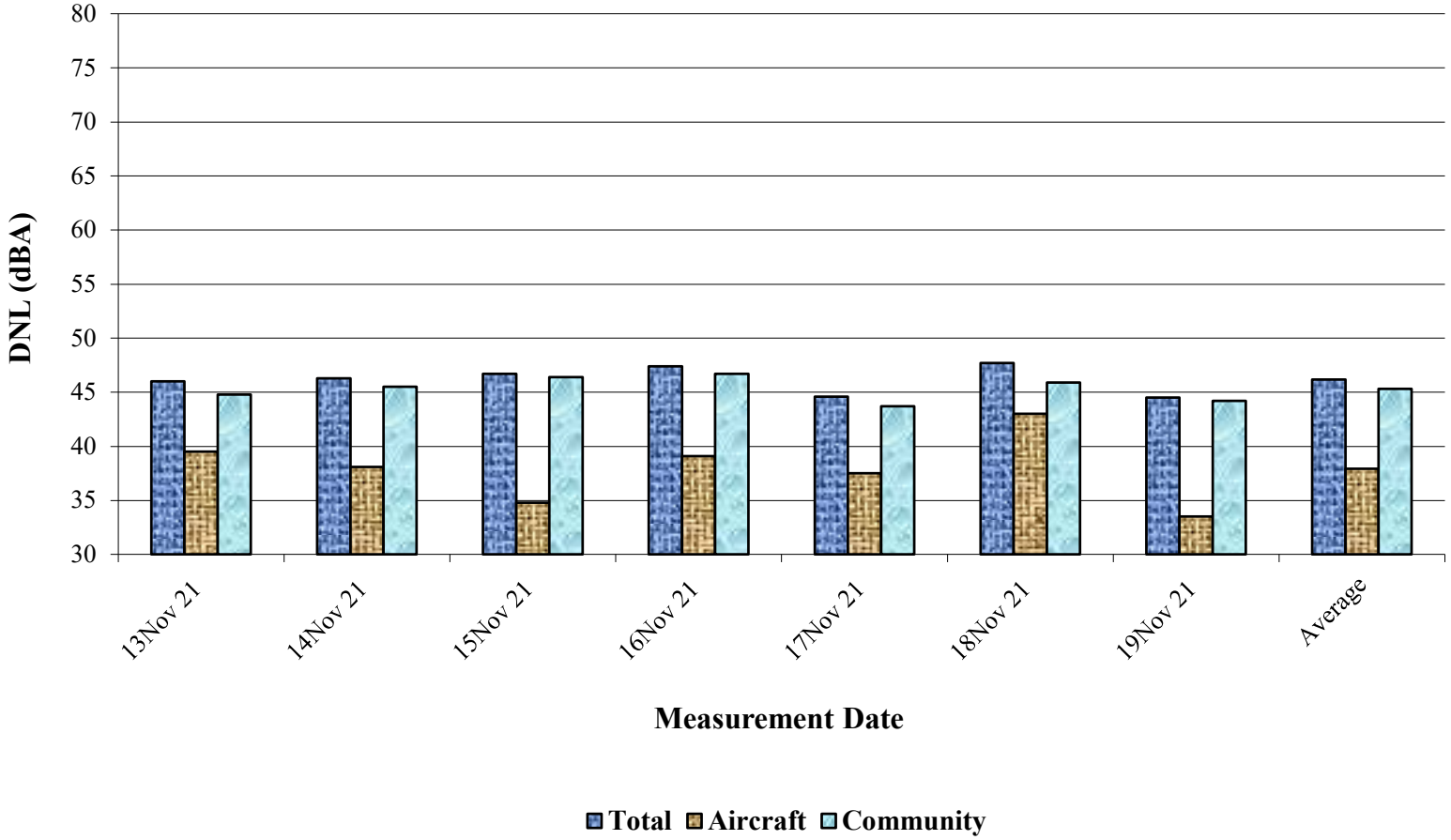
C-12
Daily Measured CNEL Values
Livermore Municipal Airport
2400 Central Parkway, Dublin (Cottnwood Creek Elementary): Fall 2021
Site 6



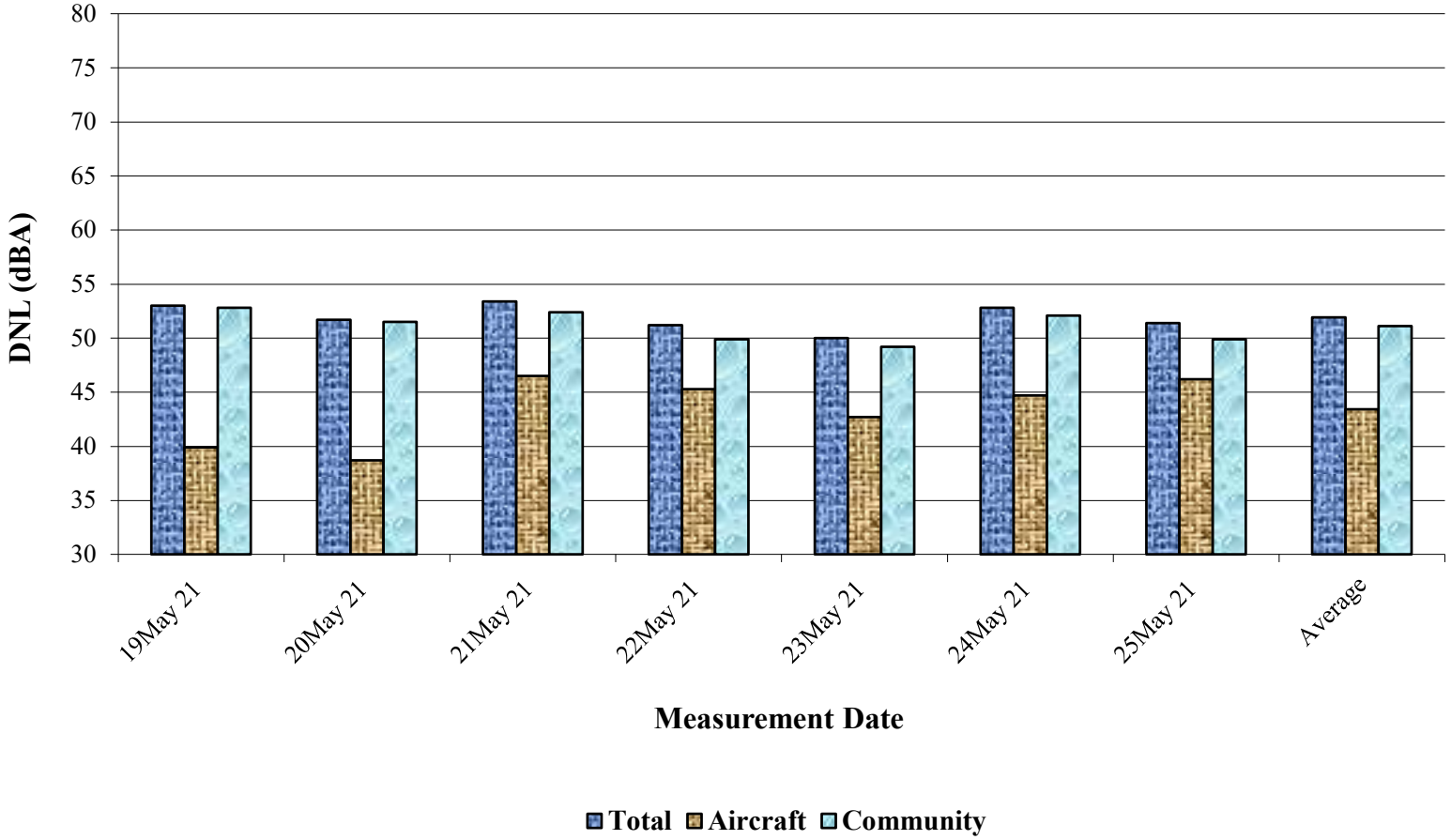
C-13
Daily Measured CNEL Values
Livermore Municipal Airport
2927 W. Castle Pines, Dublin: Spring 2021
Site 7



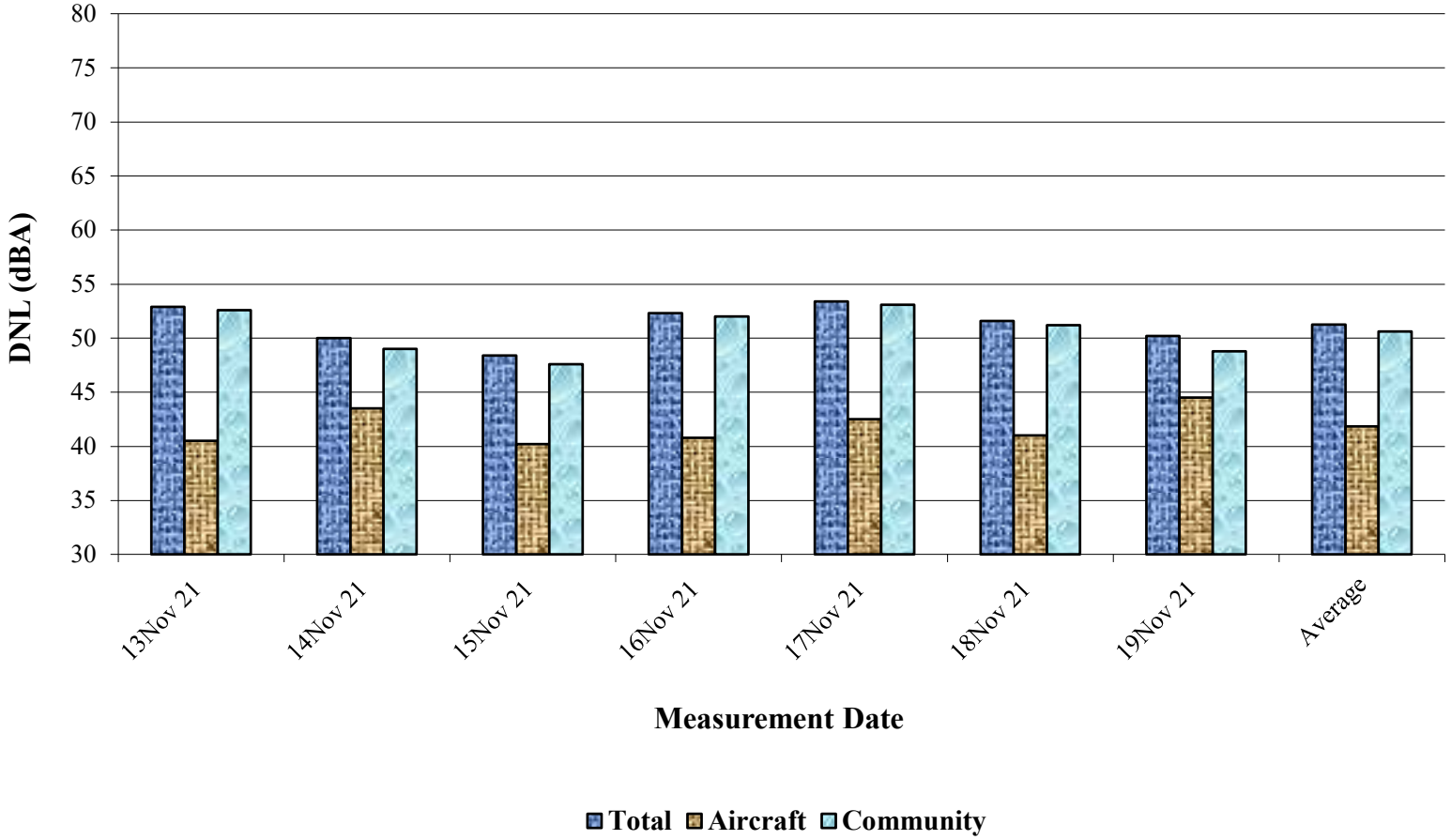
C-14
Daily Measured CNEL Values
Livermore Municipal Airport
2927 W. Castle Pines, Dublin: Fall 2021
Site 7



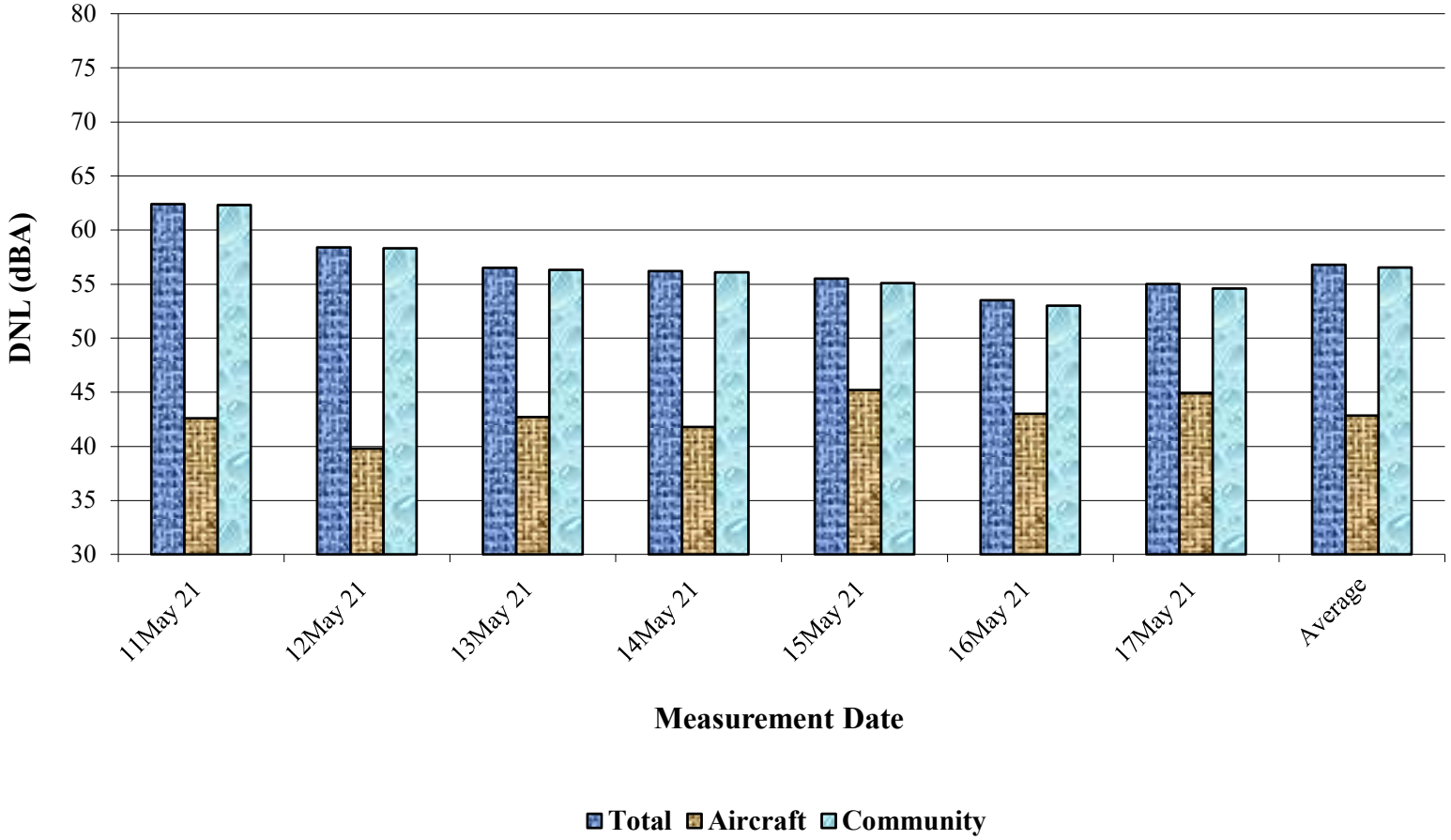
C-15
Daily Measured CNEL Values
Livermore Municipal Airport
4306 Jordan Ranch Dr. Dublin: Spring 2021
Site 8



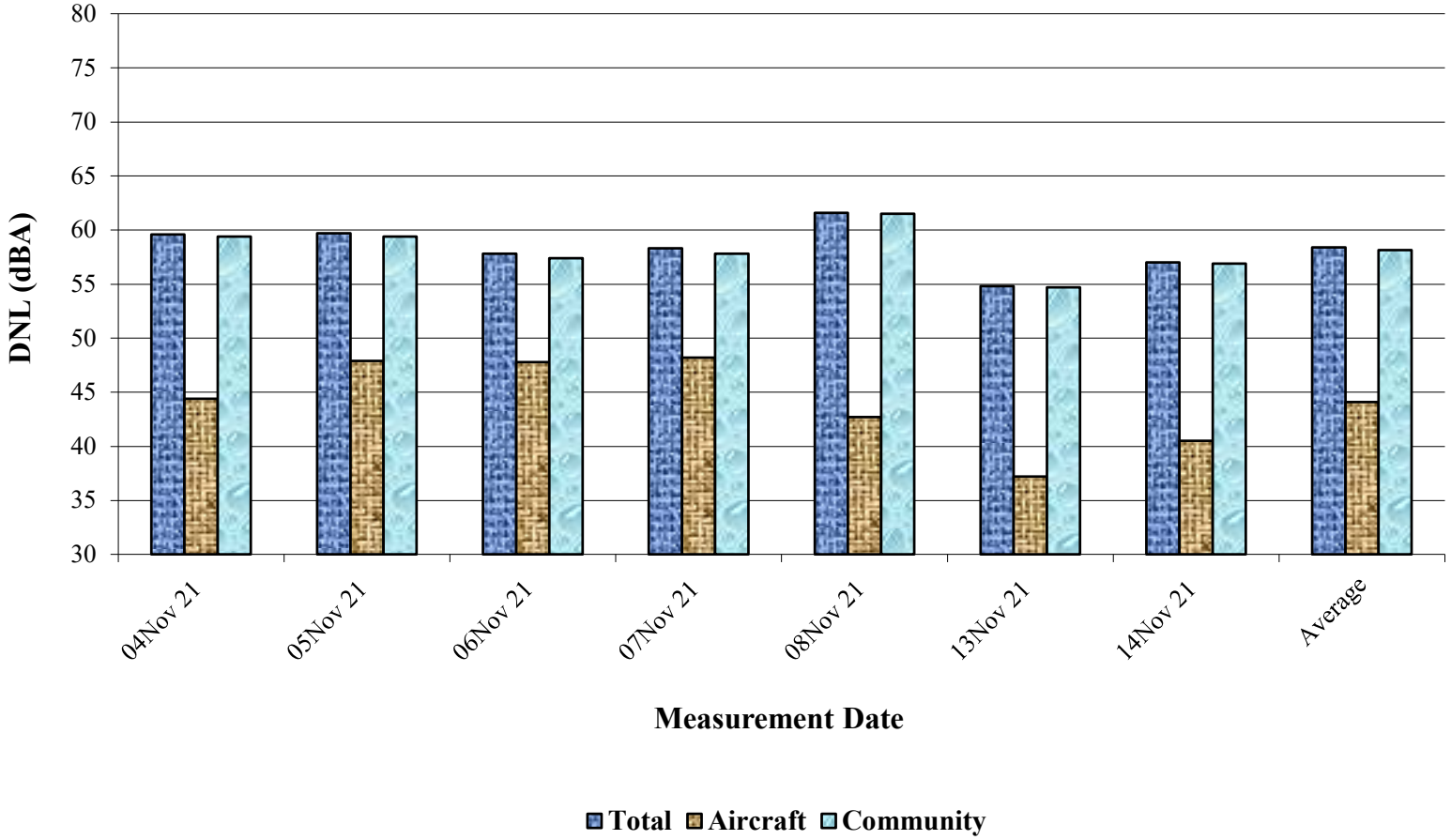
C-16
Daily Measured CNEL Values
Livermore Municipal Airport
4306 Jordan Ranch Dr. Dublin: Fall 2021
Site 8



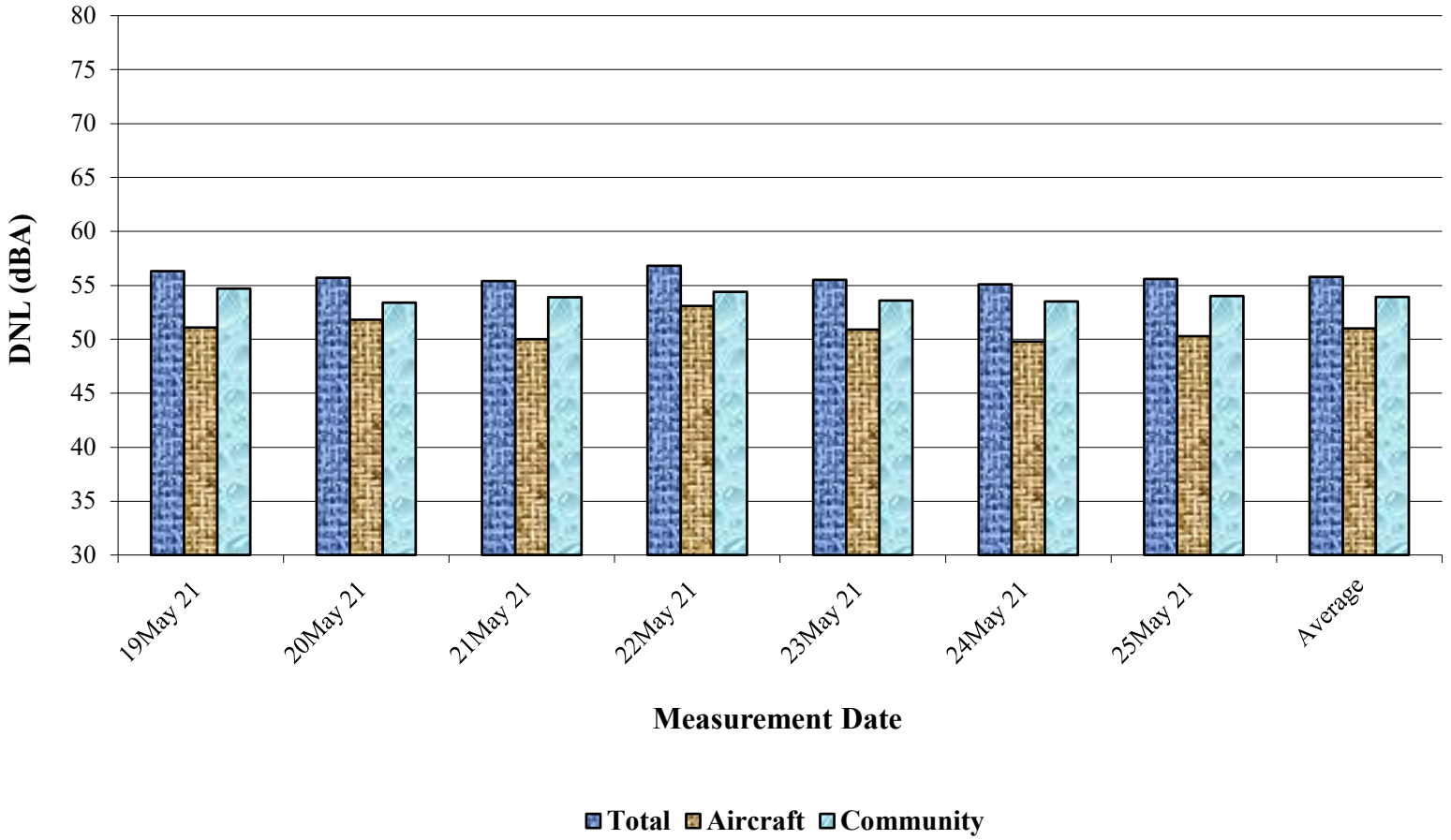
C-17
Daily Measured CNEL Values
Livermore Municipal Airport
3150 Palermo Way, (Kolb Elementary) Dublin: Spring 2021
Site 9



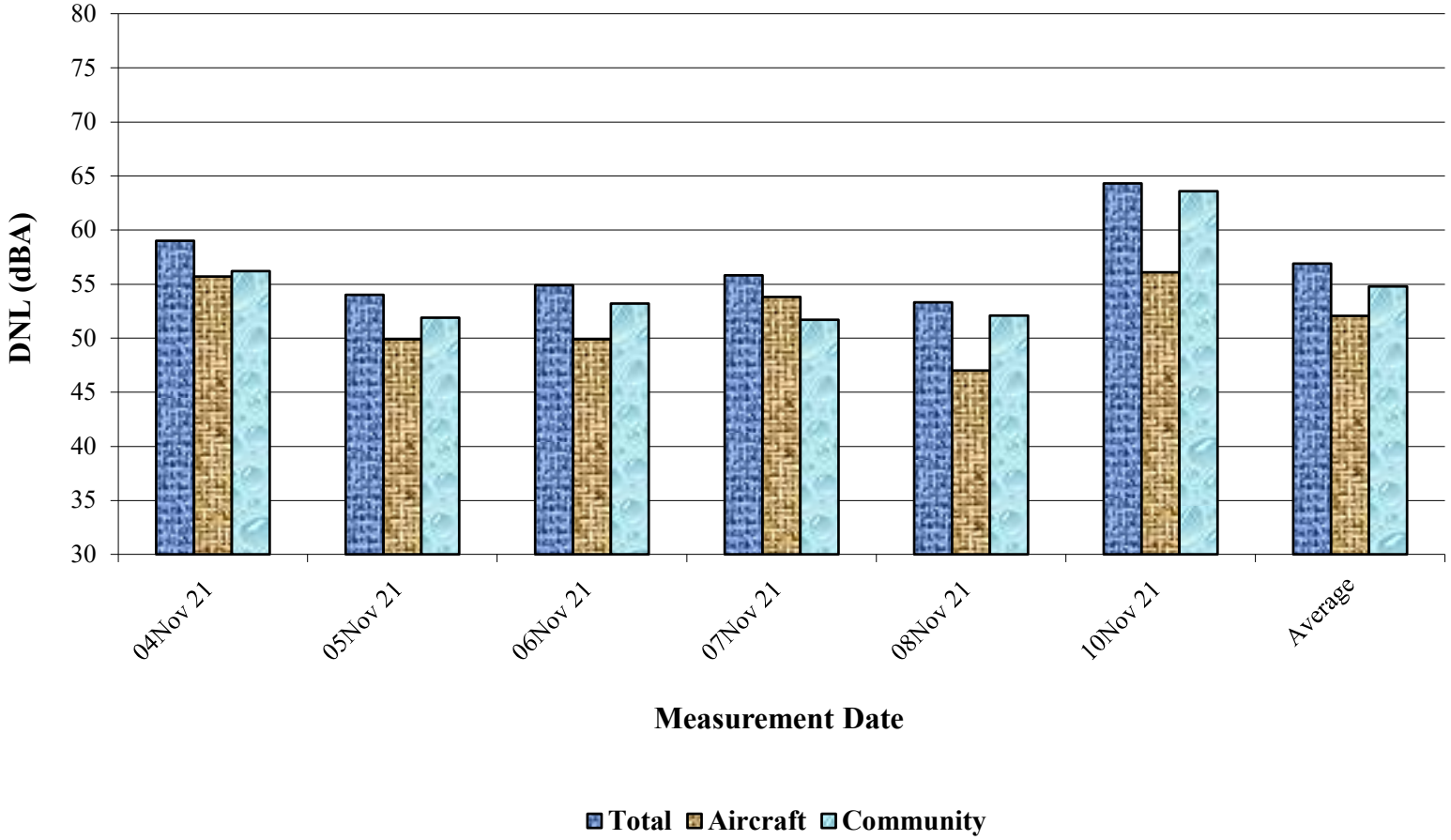
C-18
Daily Measured CNEL Values
Livermore Municipal Airport
3150 Palermo Way, (Kolb Elementary) Dublin: Fall 2021
Site 9



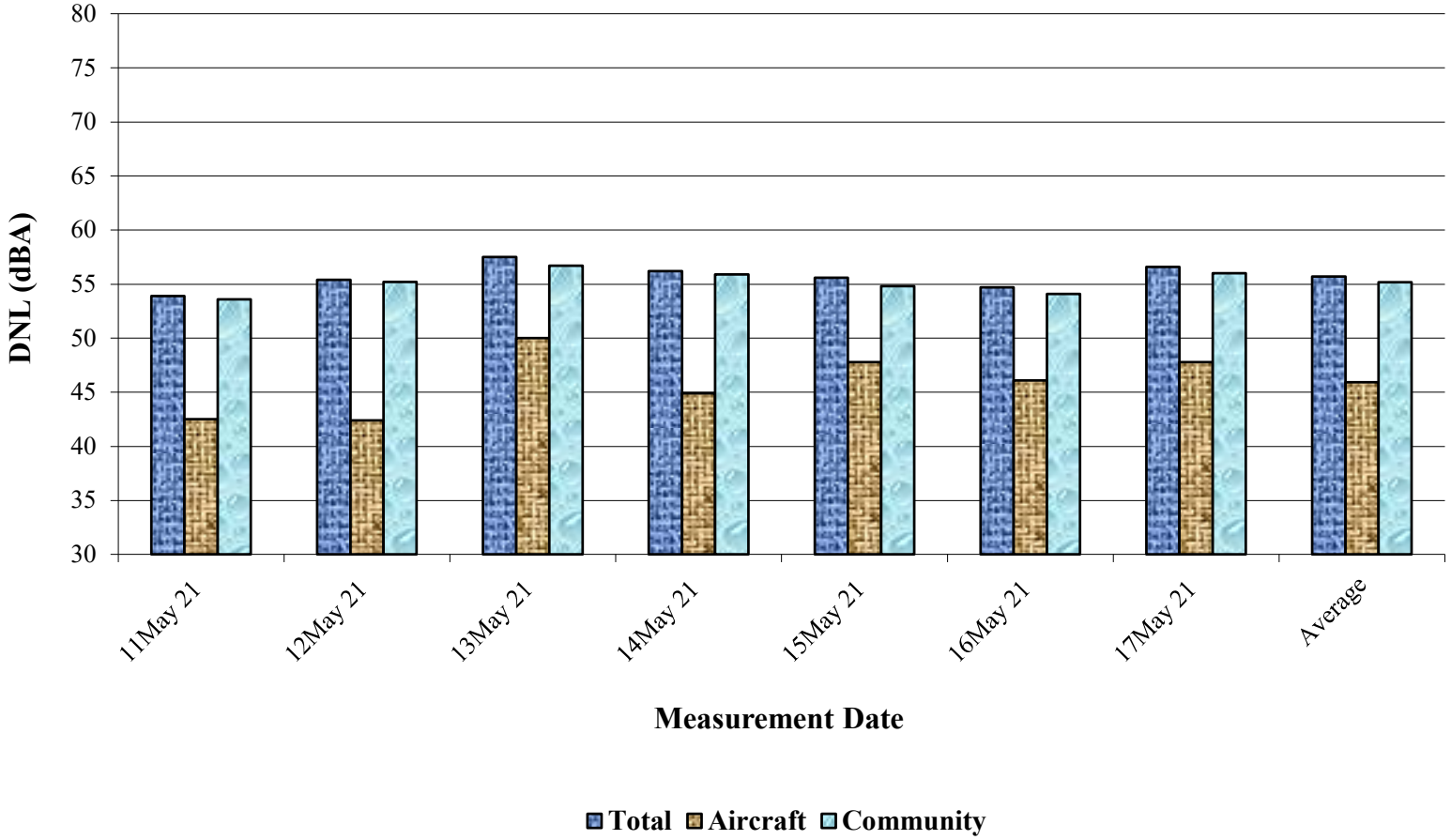
C-19
Daily Measured CNEL Values
Livermore Municipal Airport
3014 Staples Ranch Drive, Pleasanton.: Spring 2021
Site 10



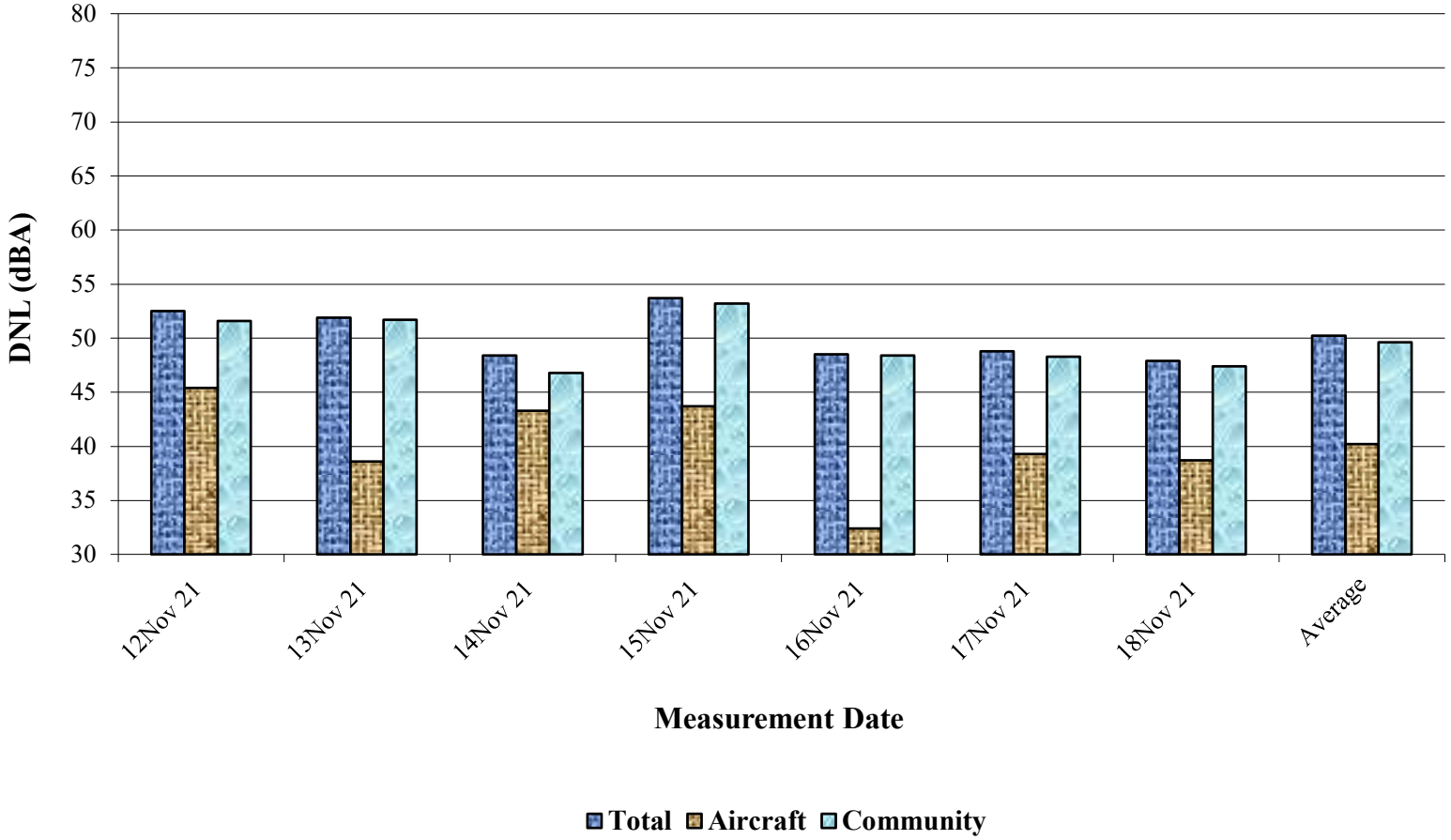
C-20
Daily Measured CNEL Values
Livermore Municipal Airport
3014 Staples Ranch Drive, Pleasanton: Fall 2021
Site 10



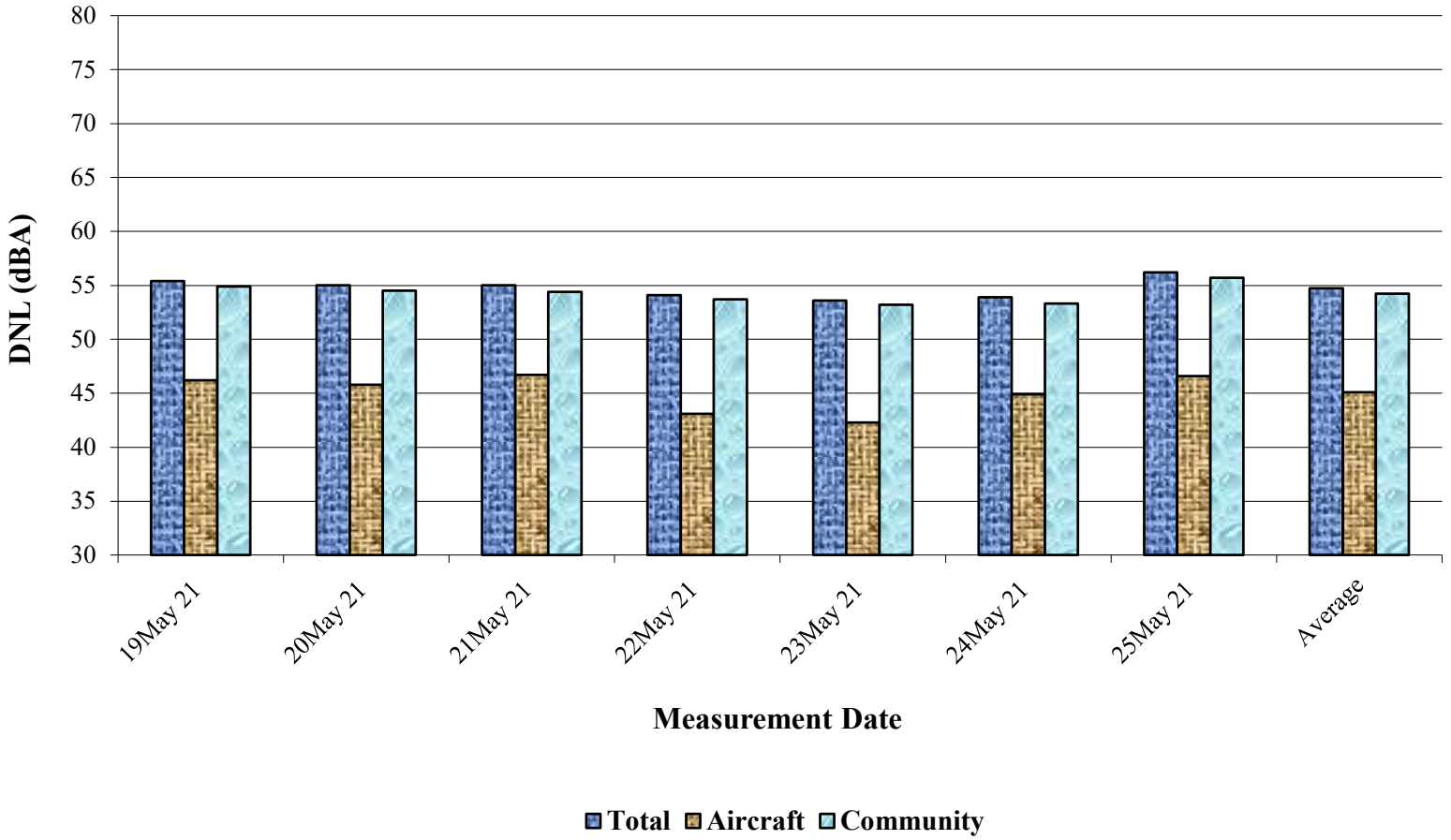
C-21
Daily Measured CNEL Values
Livermore Municipal Airport
3496 Guthrie St, Pleasanton.: Spring 2021
Site 11



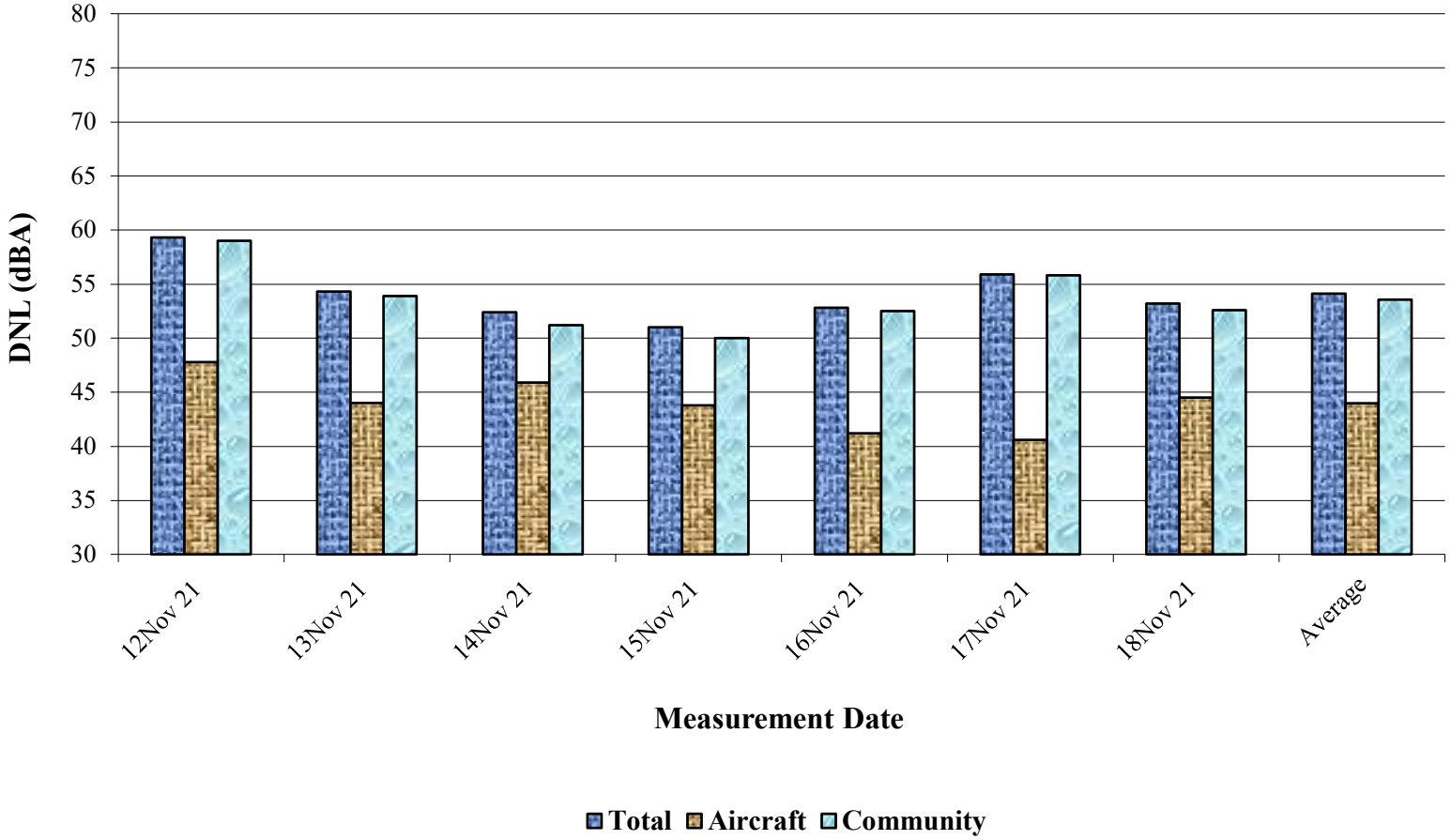
C-22
Daily Measured CNEL Values
Livermore Municipal Airport
3496 Guthrie St, Pleasanton: Fall 2021
Site 11



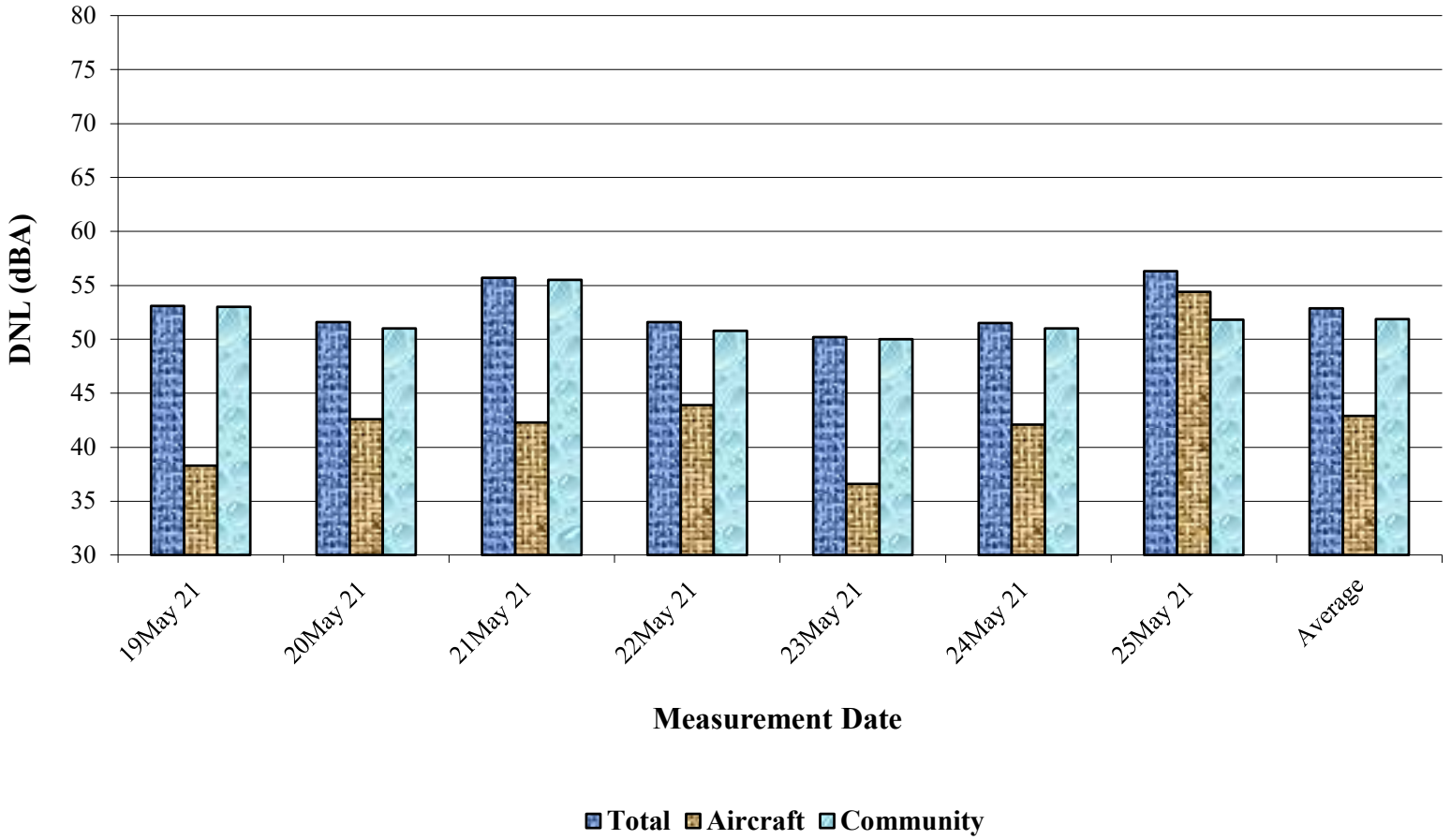
C-23
Daily Measured CNEL Values
Livermore Municipal Airport
3405 Byron Ct., Pleasanton.: Spring 2021
Site 12



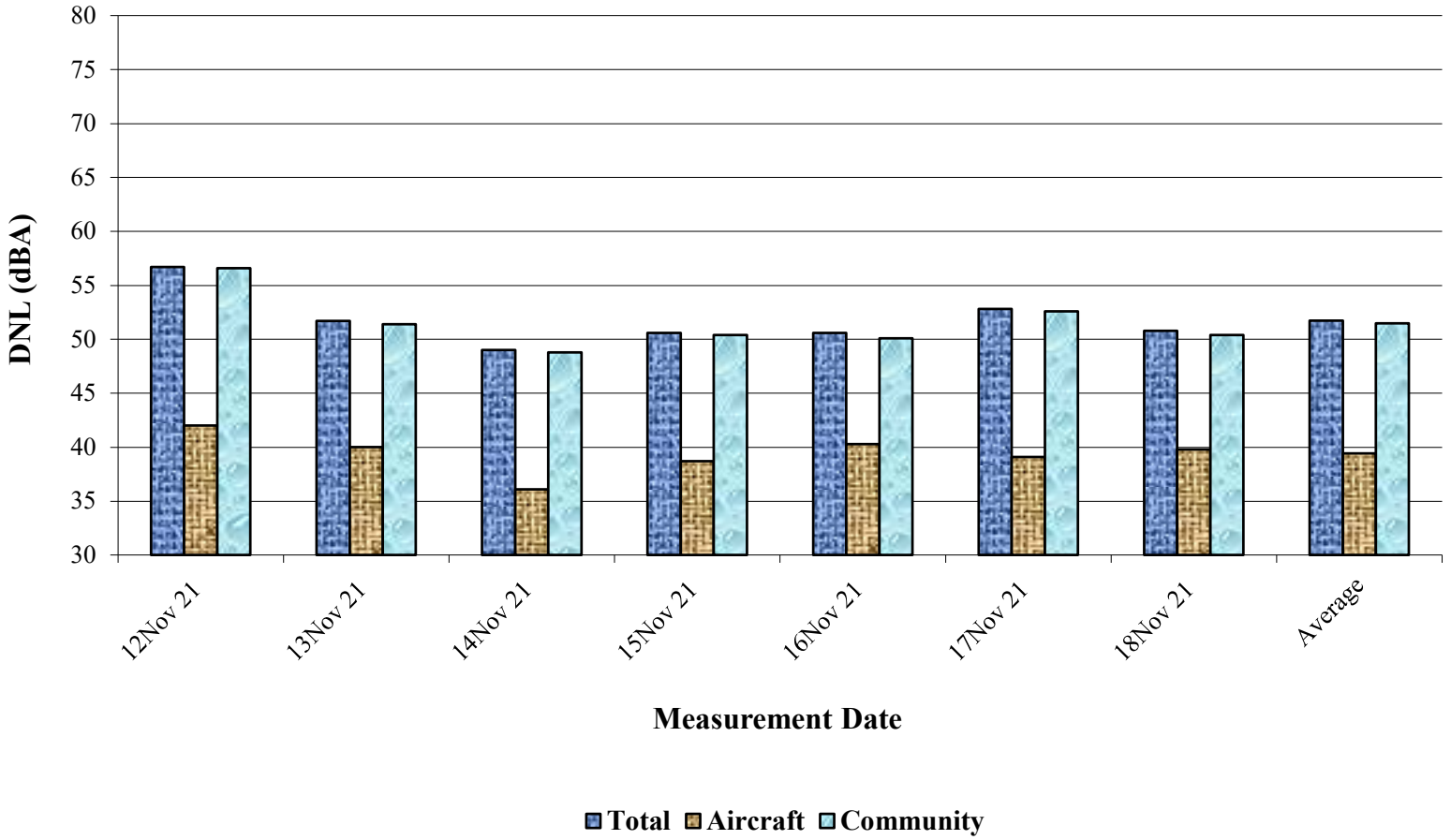
C-24
Daily Measured CNEL Values
Livermore Municipal Airport
3405 Byron Ct., Pleasanton: Fall 2021
Site 12



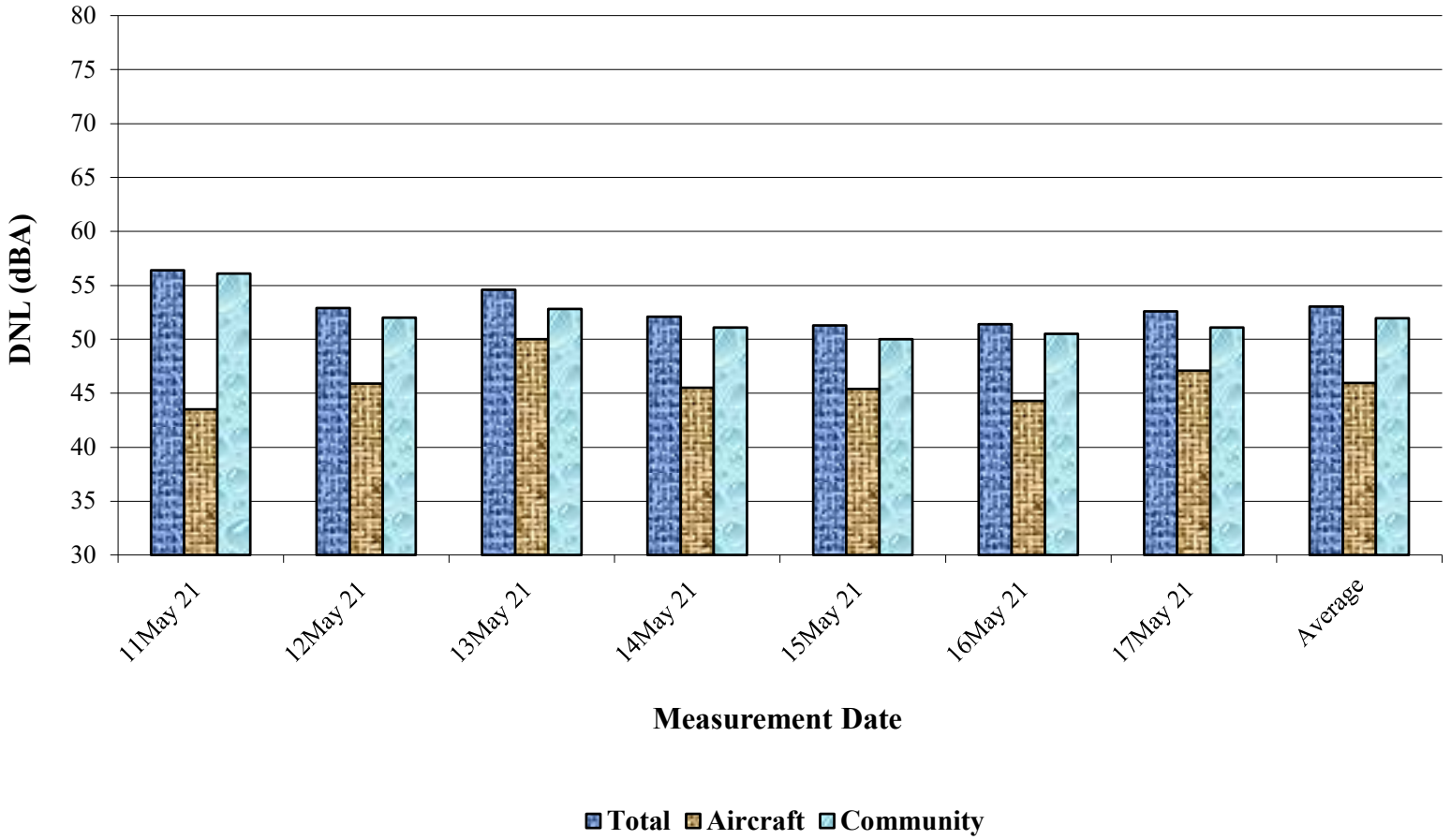
C-25
Daily Measured CNEL Values
Livermore Municipal Airport
3622 Diablo Ct., Pleasanton.: Spring 2021
Site 13



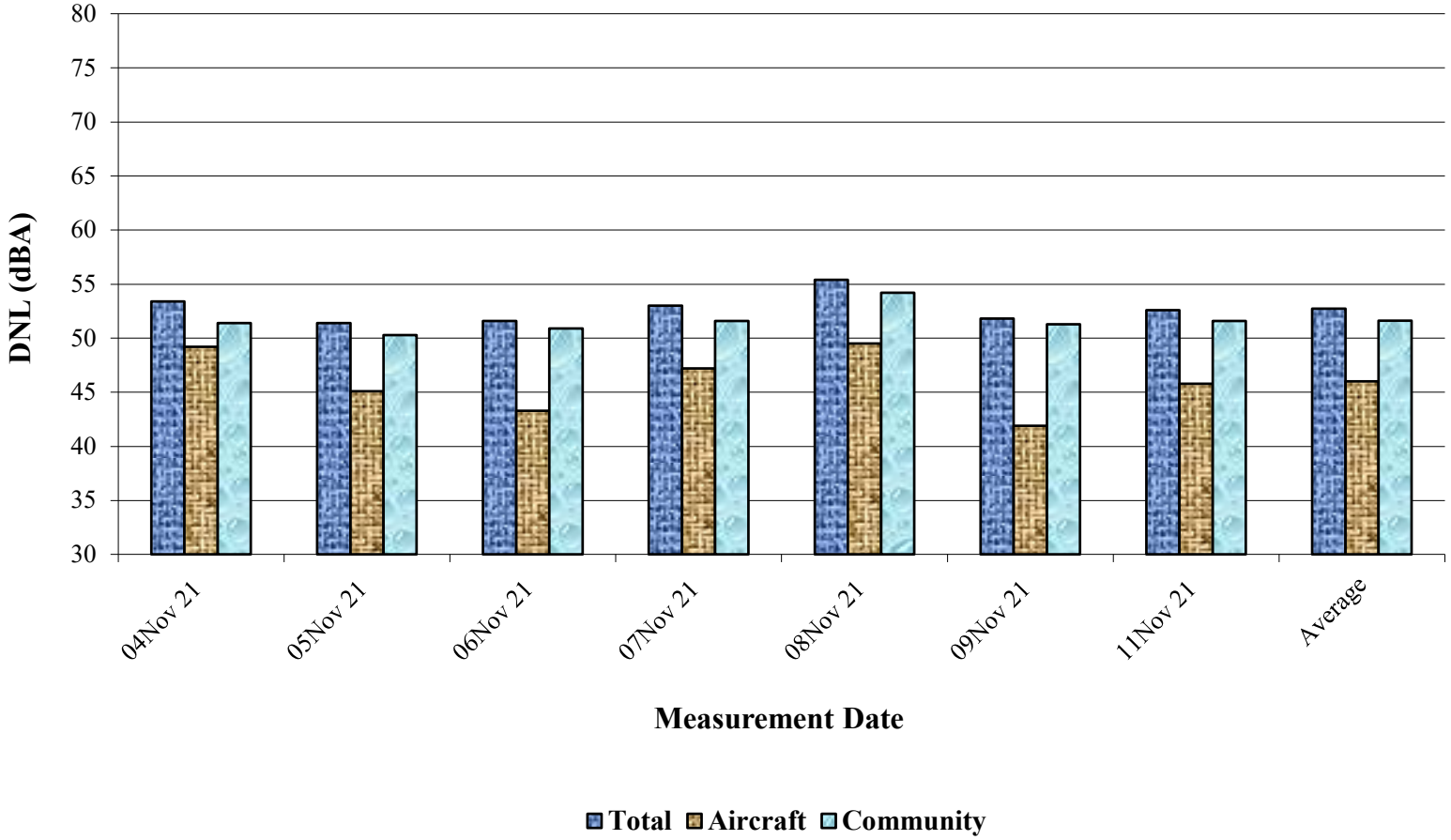
C-26
Daily Measured CNEL Values
Livermore Municipal Airport
3622 Diablo Ct., Pleasanton: Fall 2021
Site 13



C-27
Daily Measured CNEL Values
Livermore Municipal Airport
3300 Dennis Dr., Pleasanton.: Spring 2021
Site 14

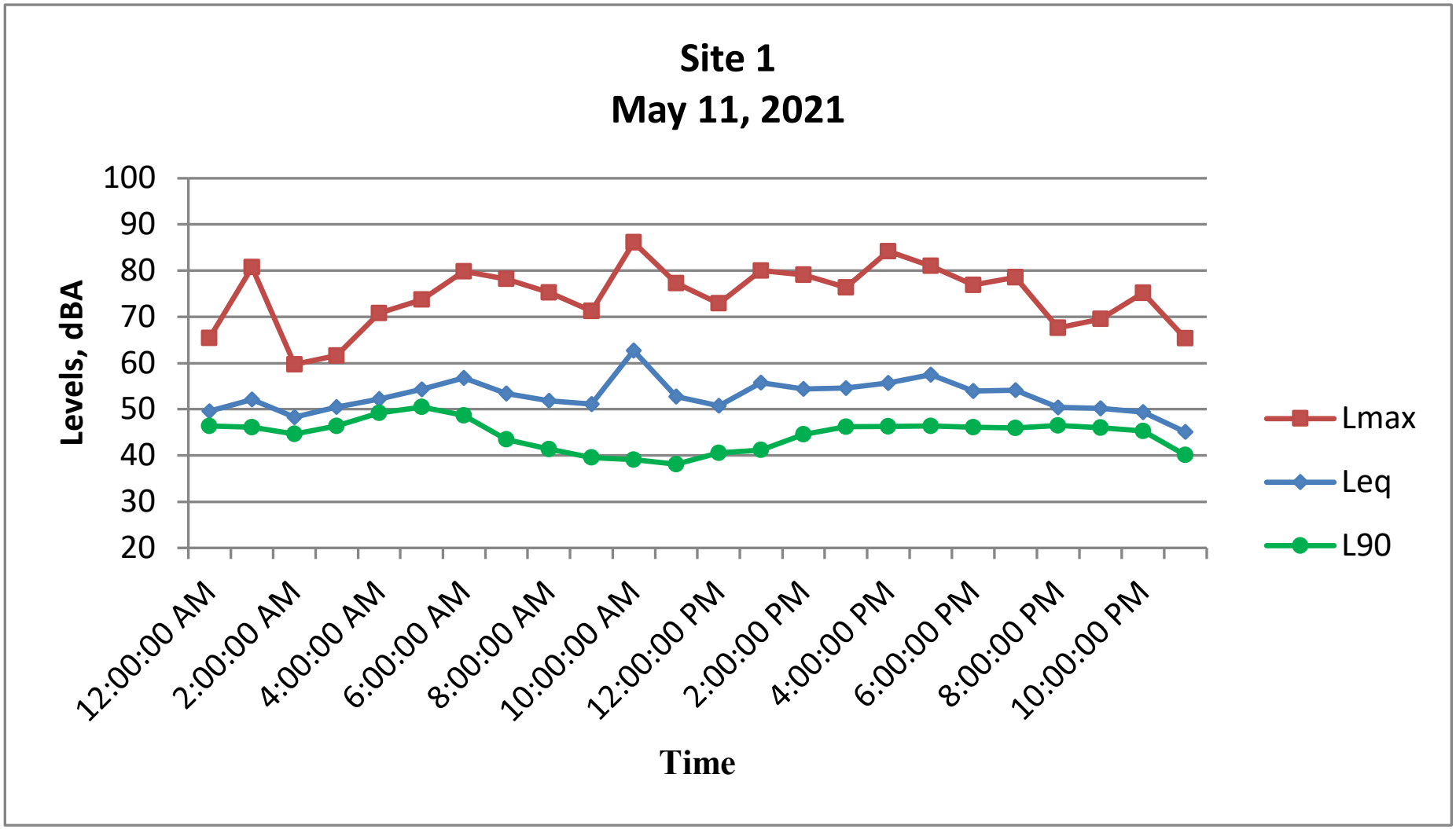


C-28
Daily Measured CNEL Values
Livermore Municipal Airport
3300 Dennis Dr., Pleasanton: Fall 2021
Site 14



APPENDIX D

MEASURED HOURLY NOISE LEVELS
LIVERMORE MUNICIPAL AIRPORT
SPRING 2021 AND FALL 2021


Site 1
May 11, 2021
Levels, dBA
100
90
80
70
60
50
40
30
20
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
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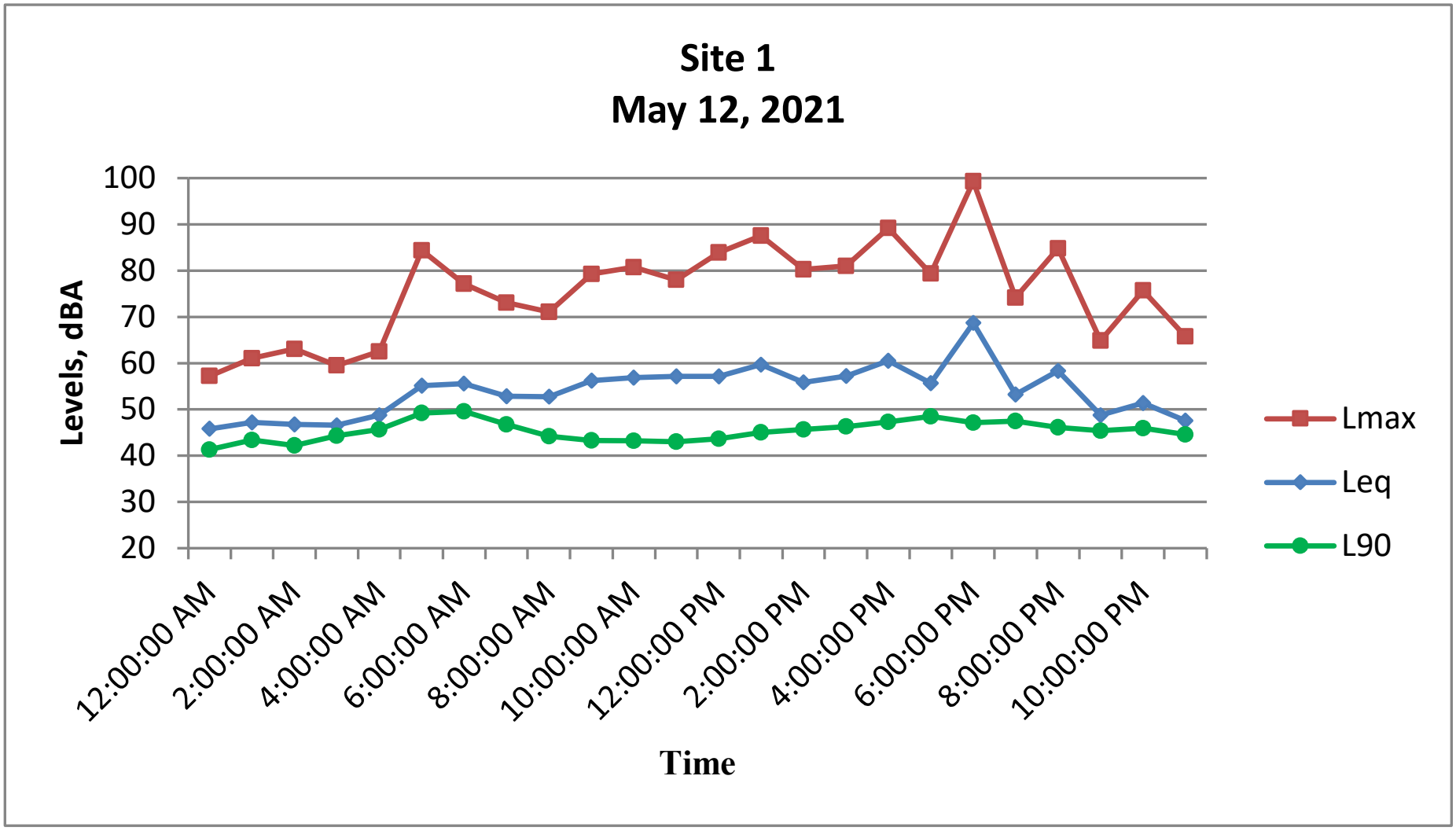
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
May 12, 2021
Levels, dBA
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60
50
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30
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8:00:00 AM
10:00:00 AM
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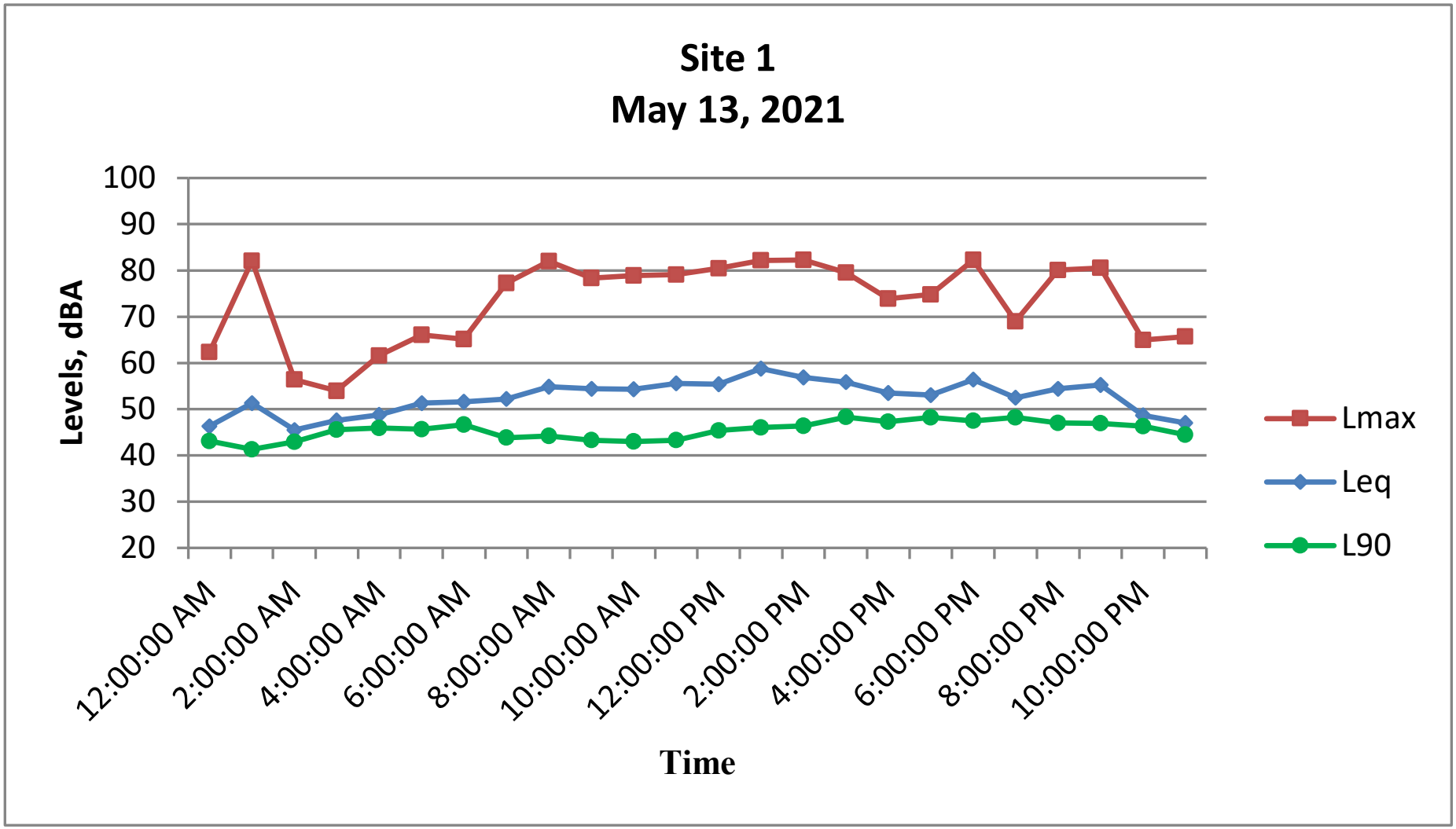
10:00:00 PM
Time
Lmax
Leq
L90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May 13, 2021
Levels, dBA
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60
50
40
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8:00:00 AM
10:00:00 AM
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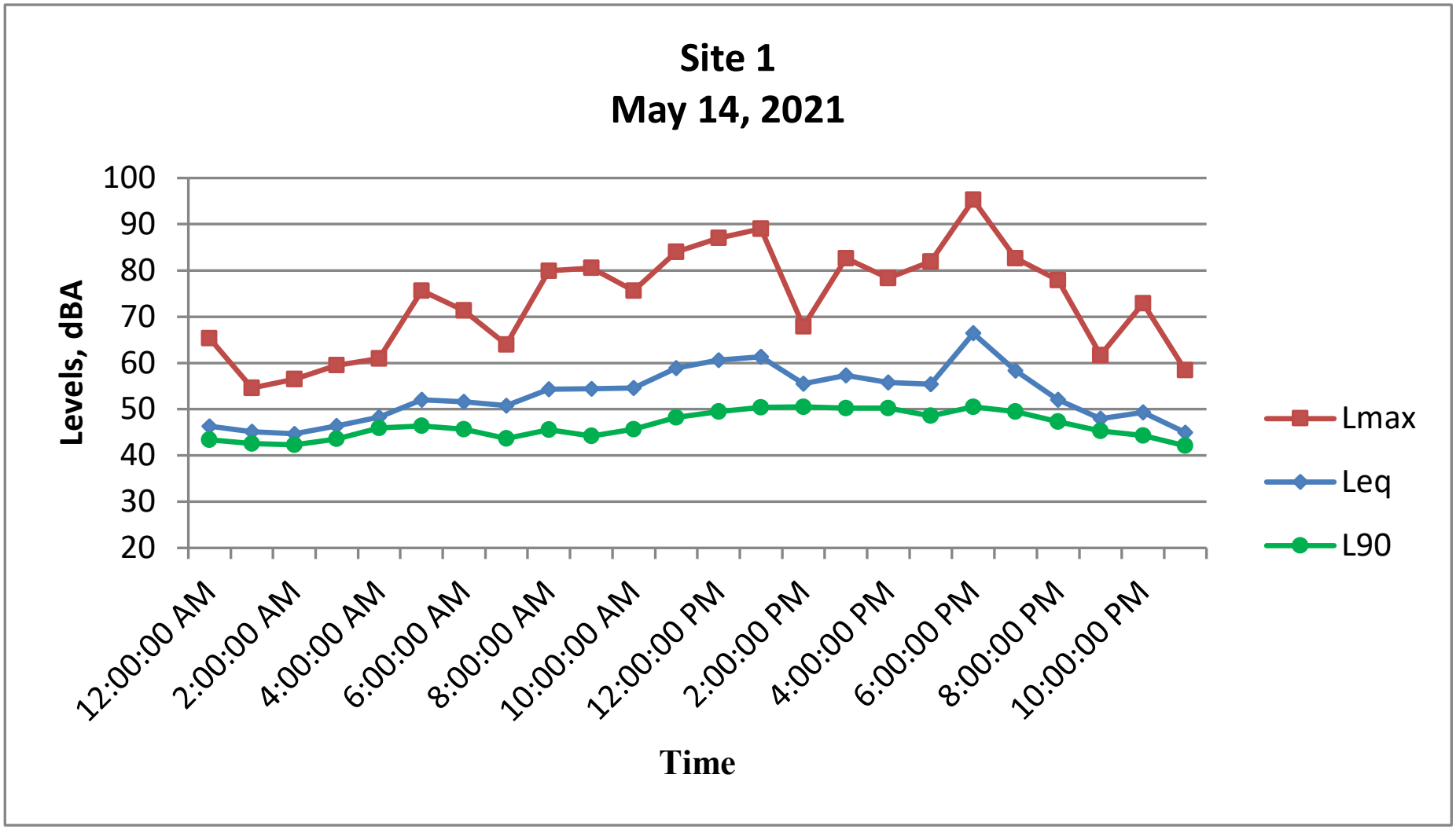
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
May 14, 2021
Levels, dBA
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90
80
70
60
50
40
30
20
12:00:00 AM
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6:00:00 AM
8:00:00 AM
10:00:00 AM
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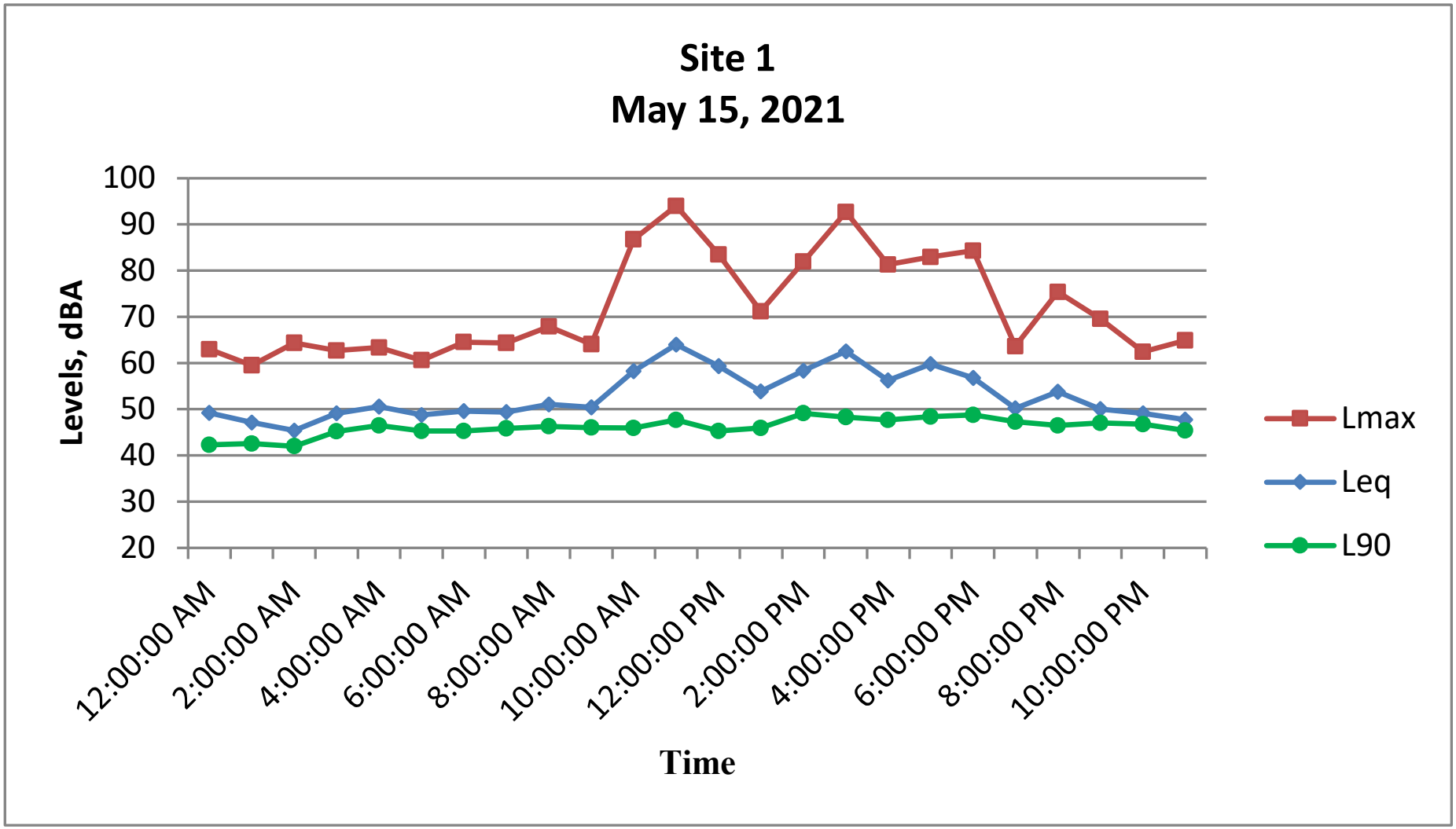
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
May 15, 2021
Levels, dBA
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60
50
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20
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8:00:00 AM
10:00:00 AM
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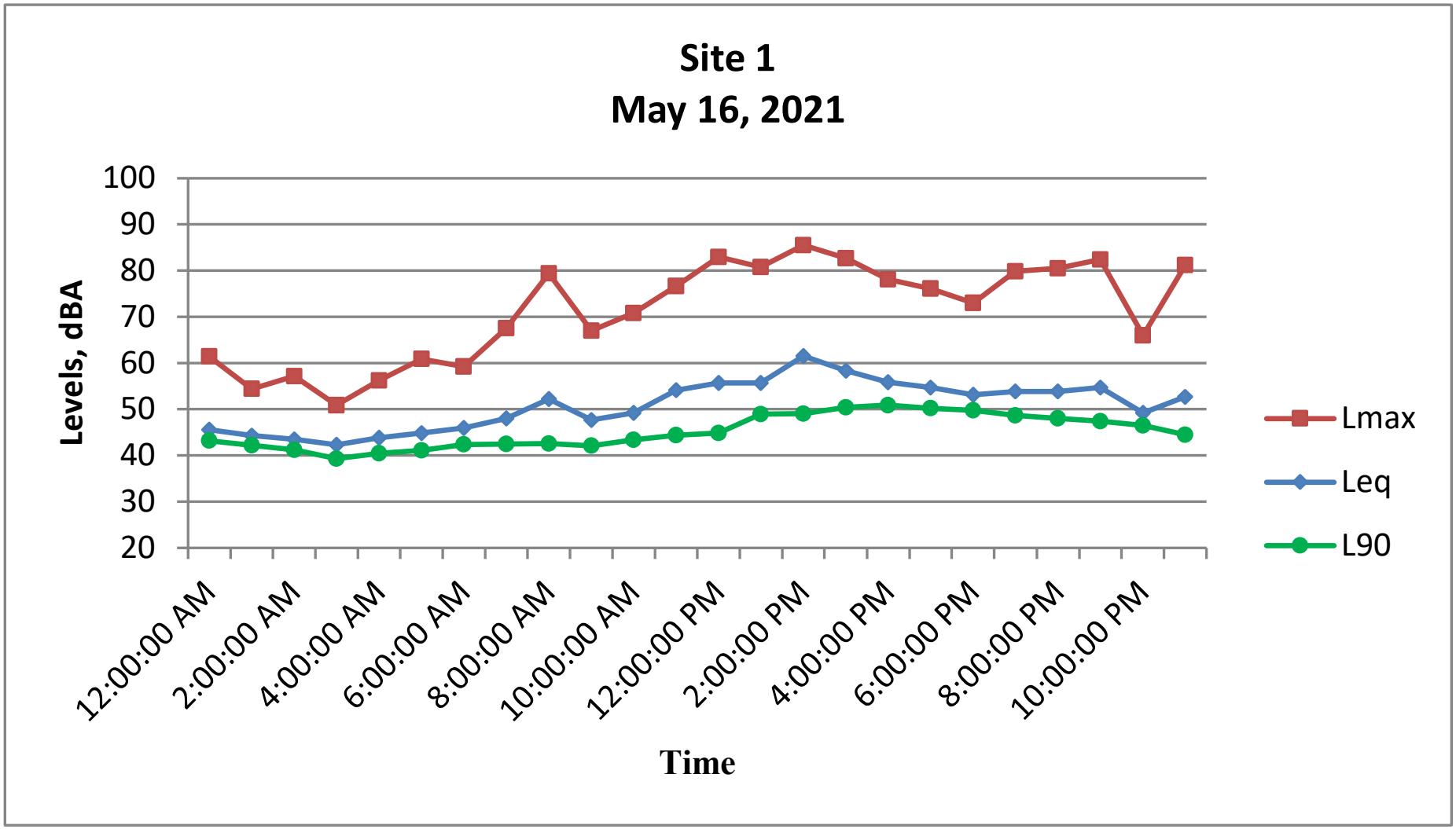
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
May 16, 2021
Levels, dBA
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60
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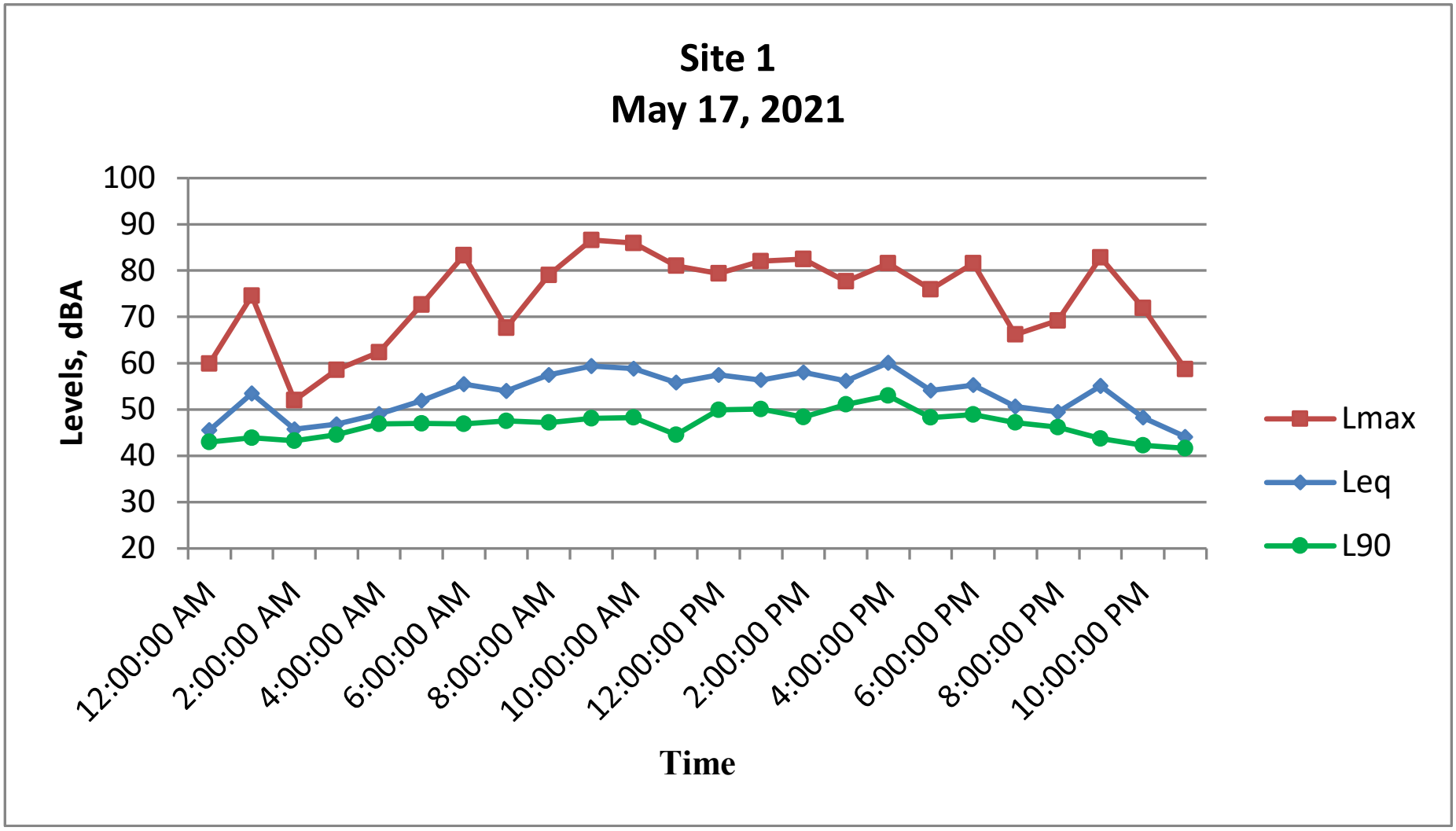
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
May 17, 2021
Levels, dBA
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80
70
60
50
40
30
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12:00:00 AM
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8:00:00 AM
10:00:00 AM
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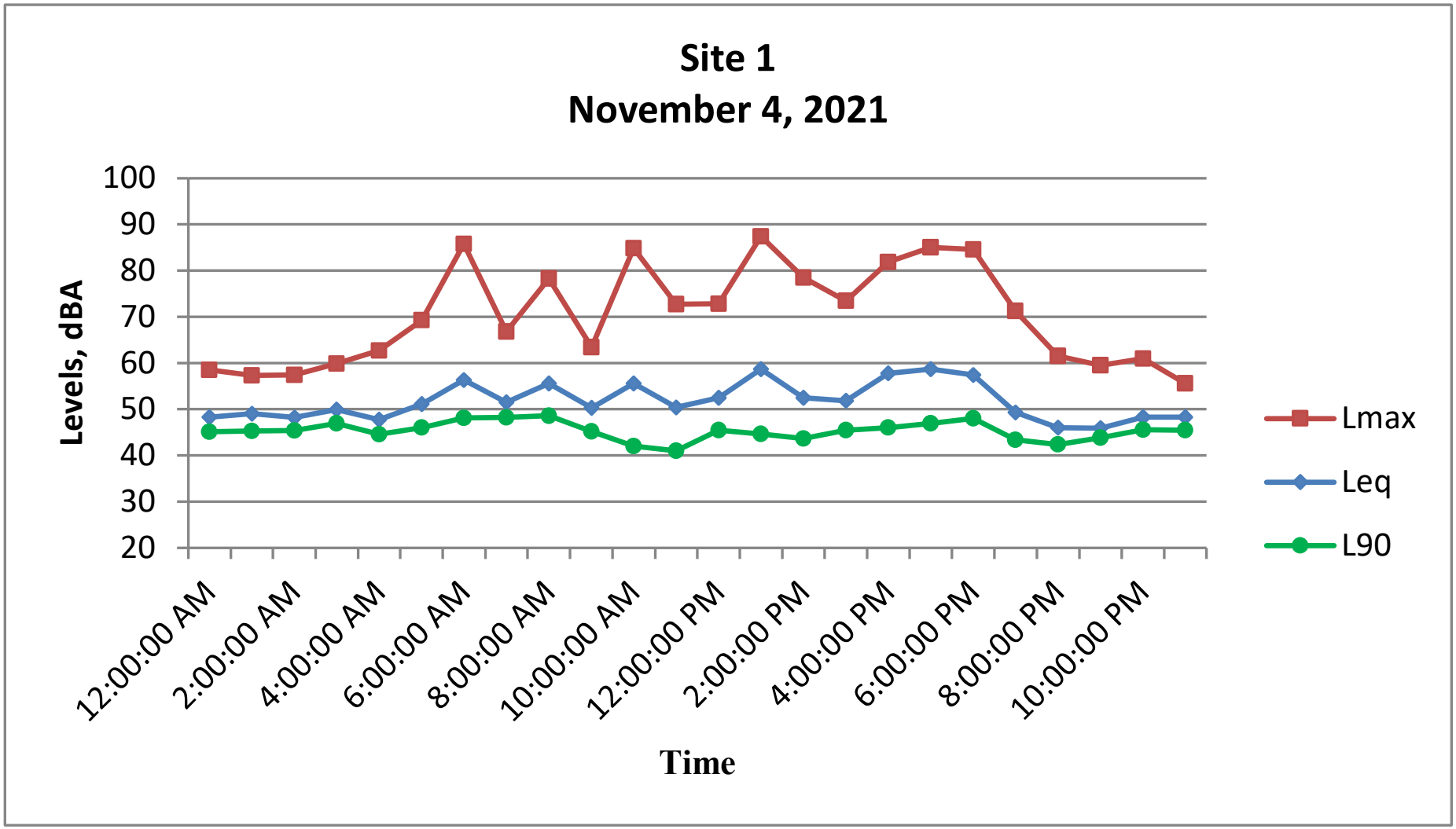
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
November 4, 2021
Levels, dBA
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90
80
70
60
50
40
30
20
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
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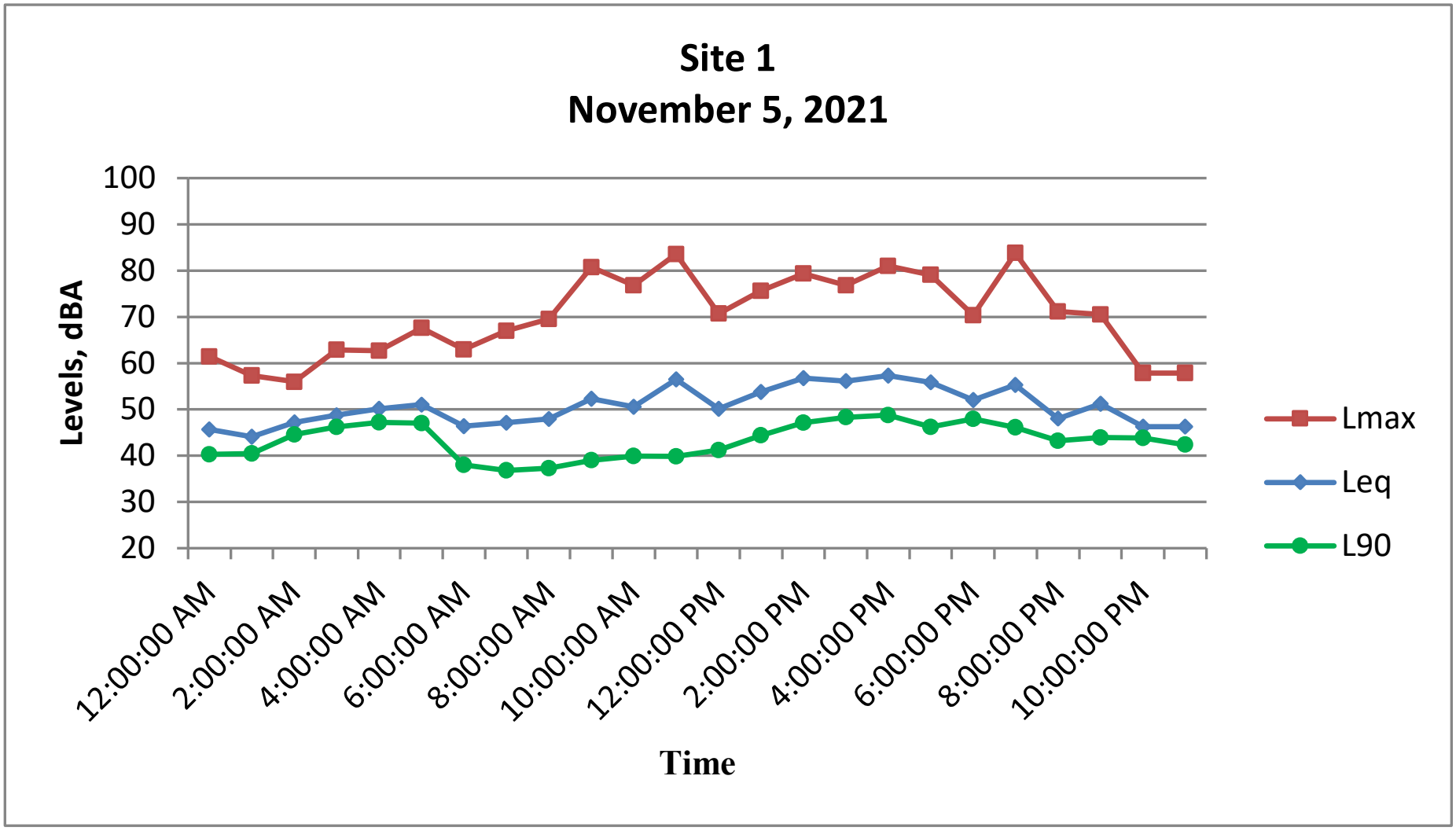
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
November 5, 2021
Levels, dBA
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70
60
50
40
30
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2:00:00 AM
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8:00:00 AM
10:00:00 AM
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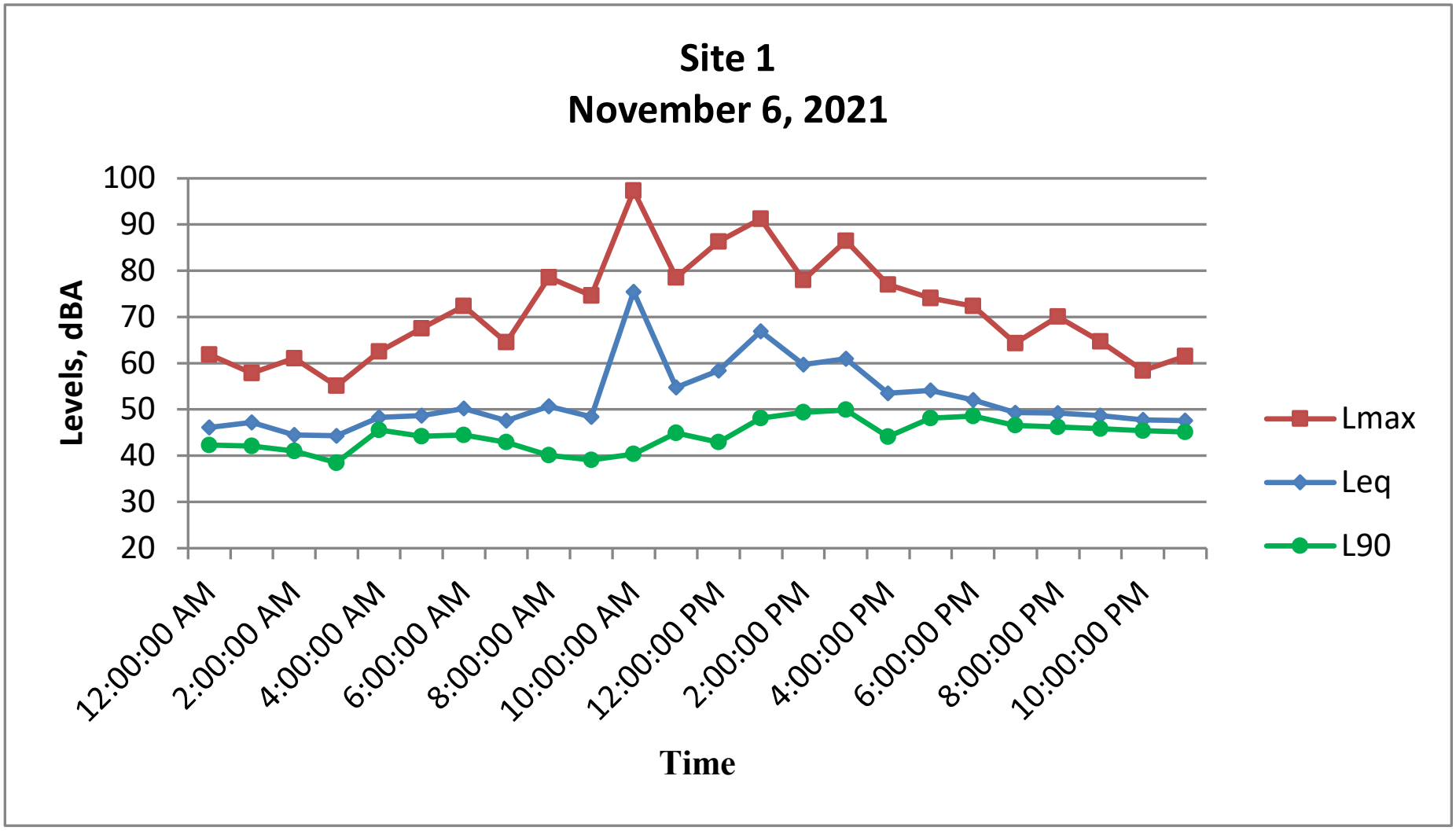
10:00:00 PM
Time
Lmax
Leq
L90


Site 1
November 6, 2021
Levels, dBA
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90
80
70
60
50
40
30
20
12:00:00 AM
2:00:00 AM
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8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
Time
Lmax
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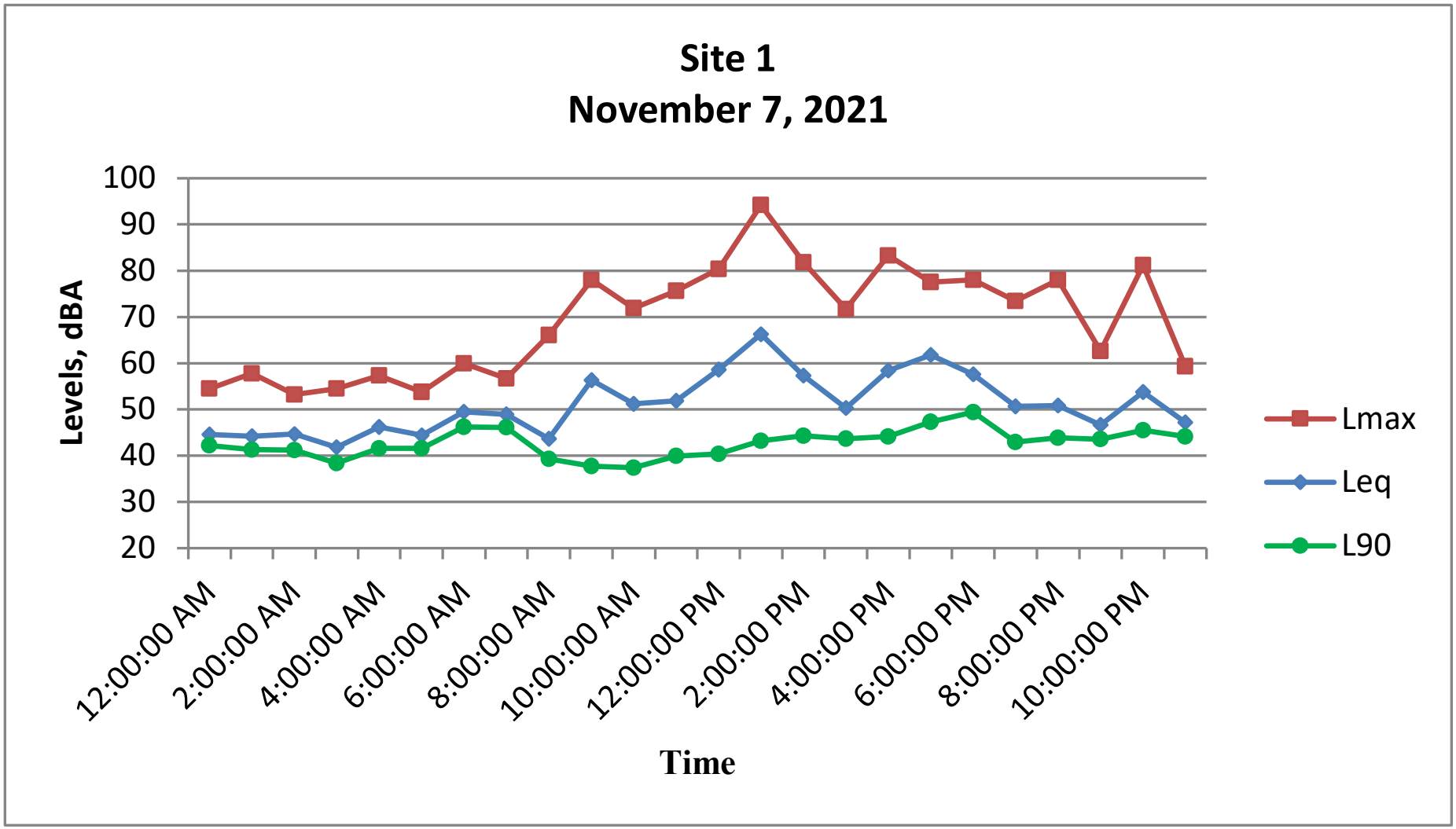
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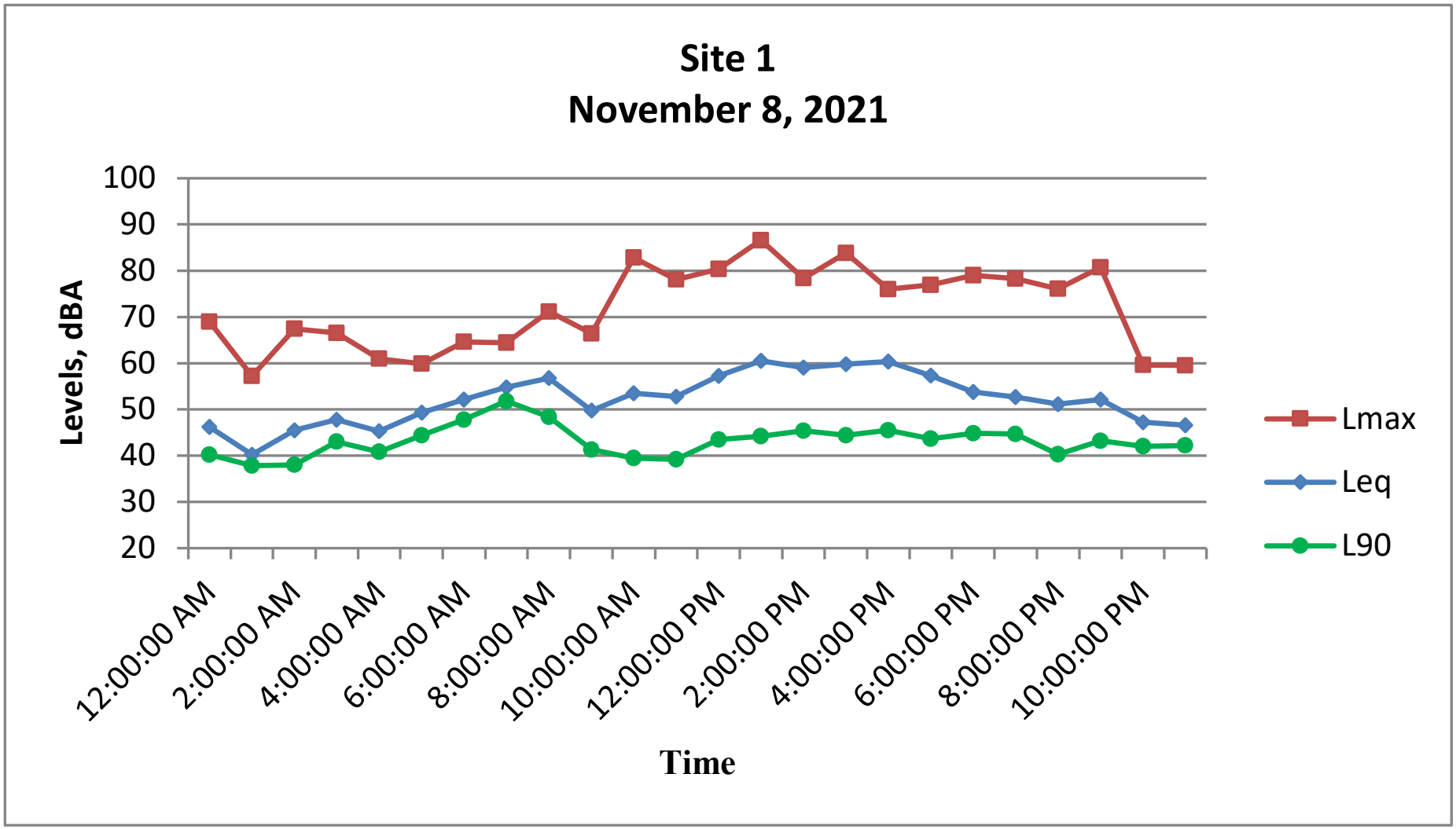
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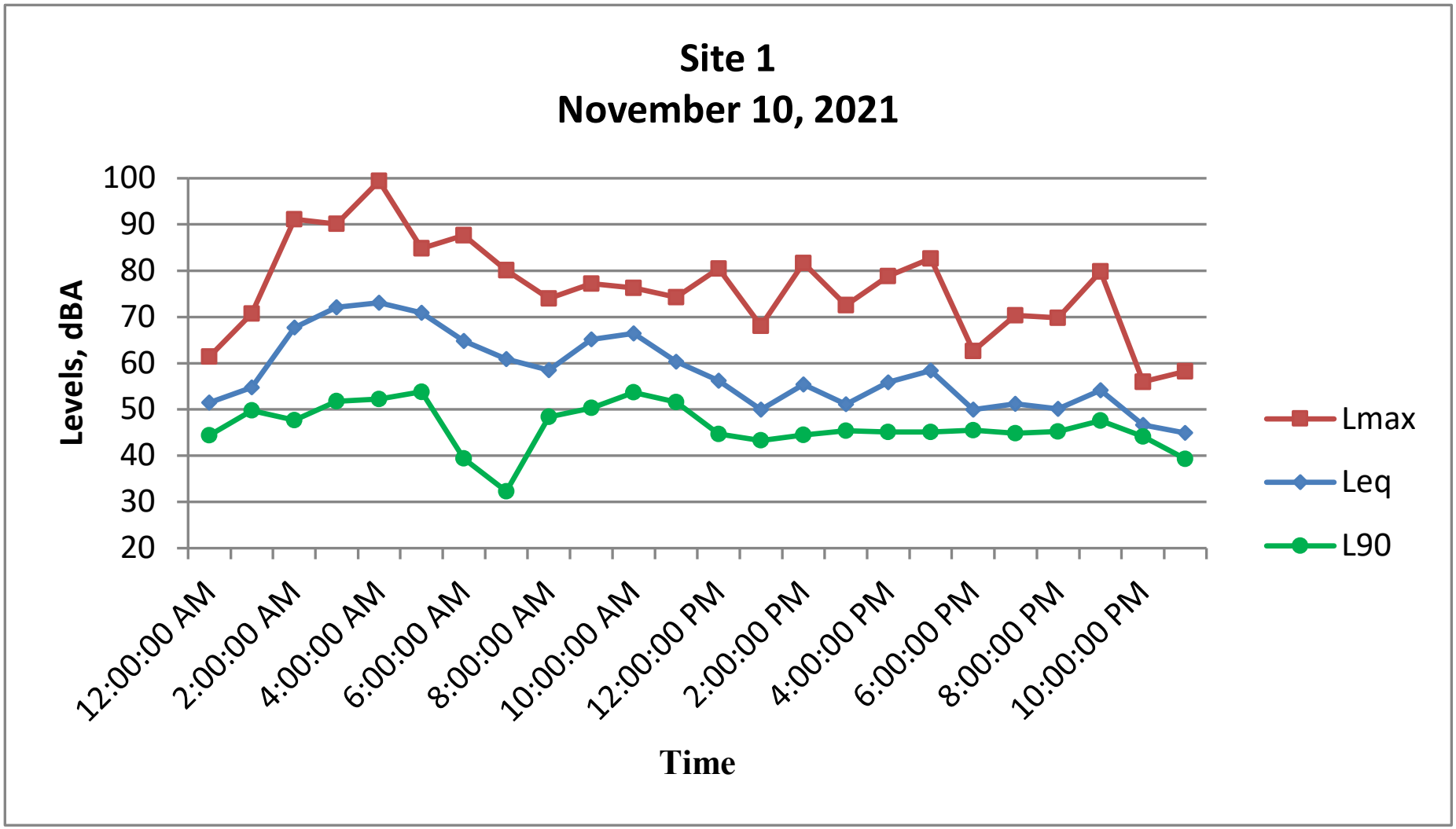
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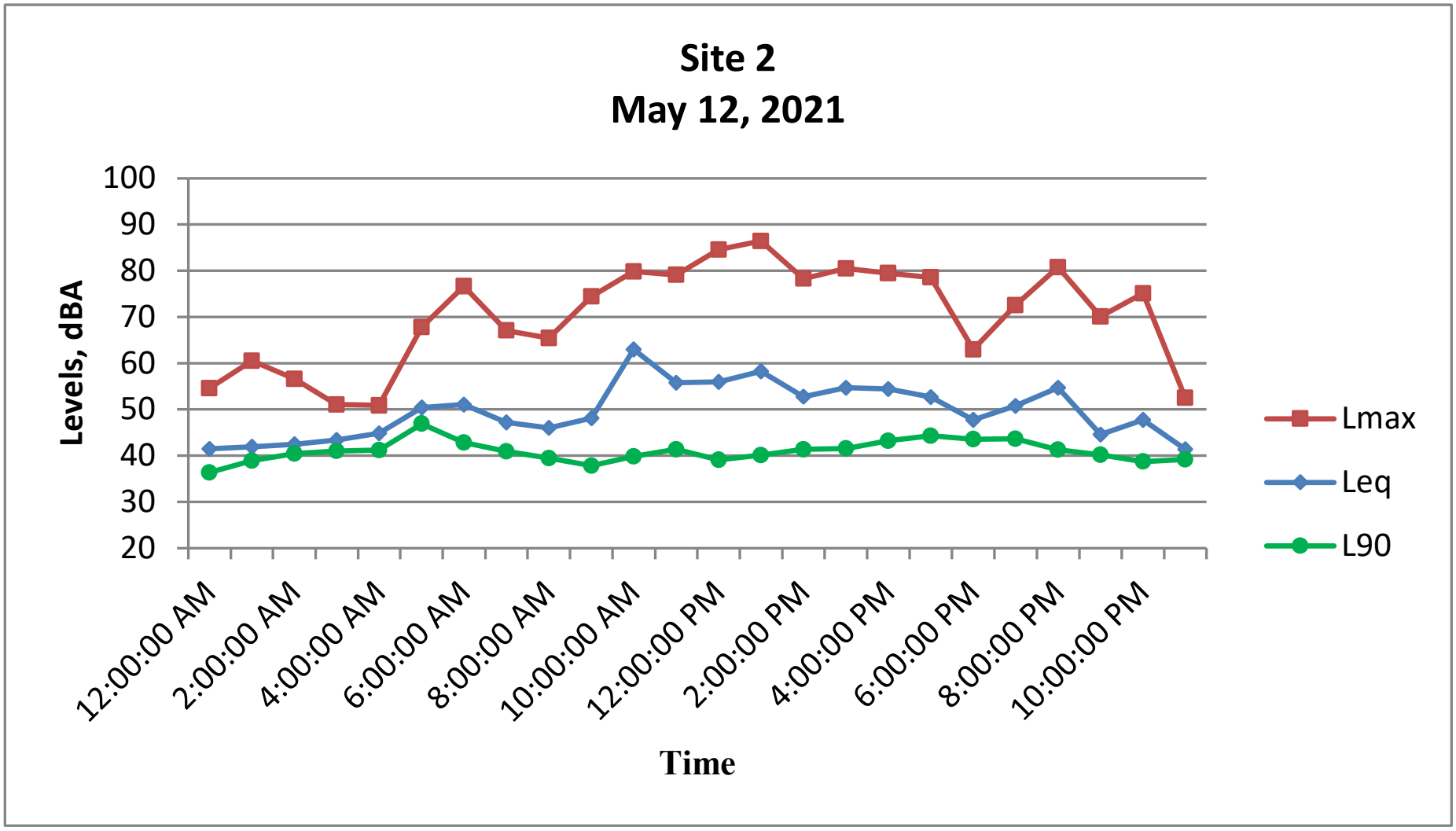
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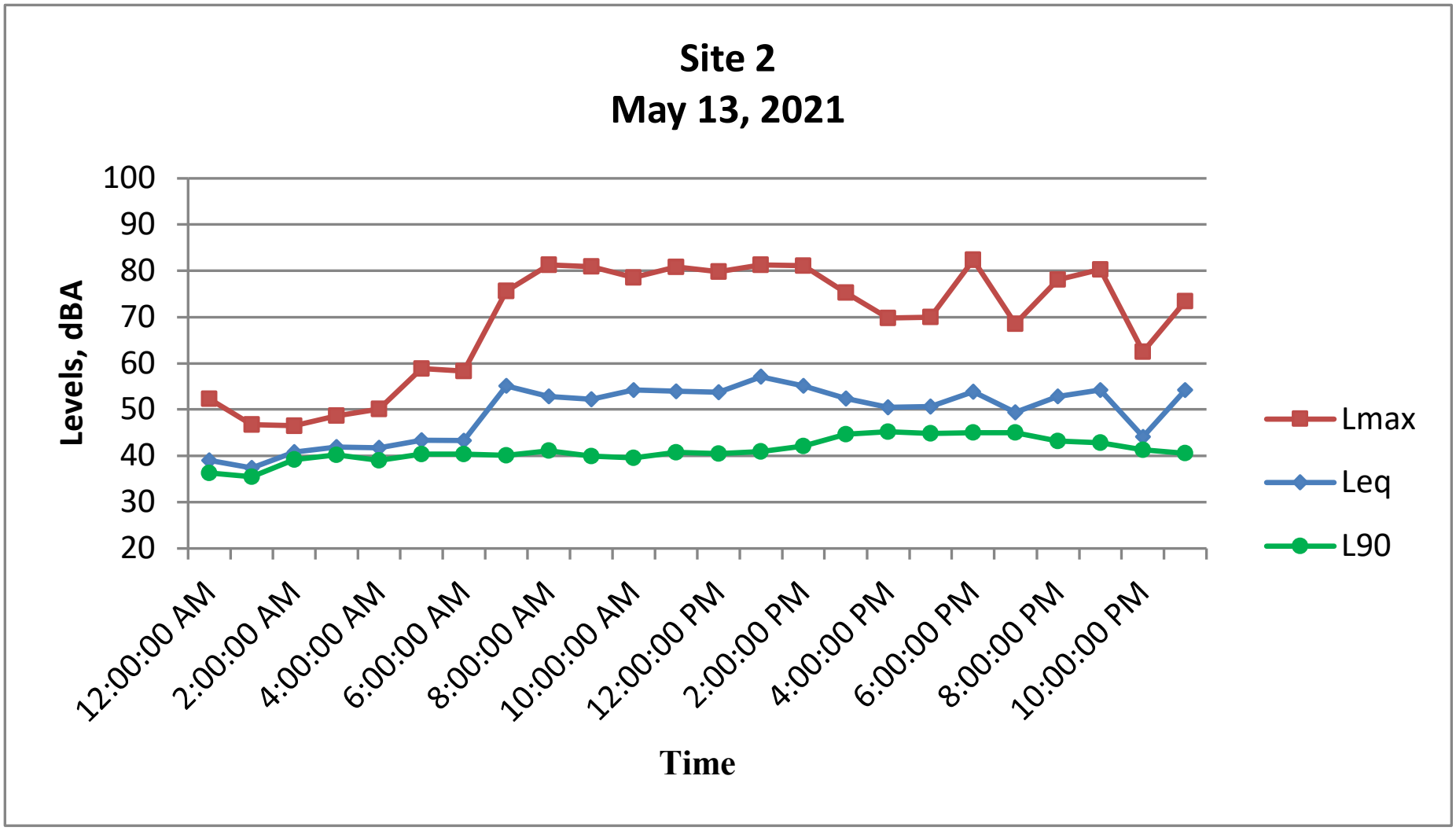
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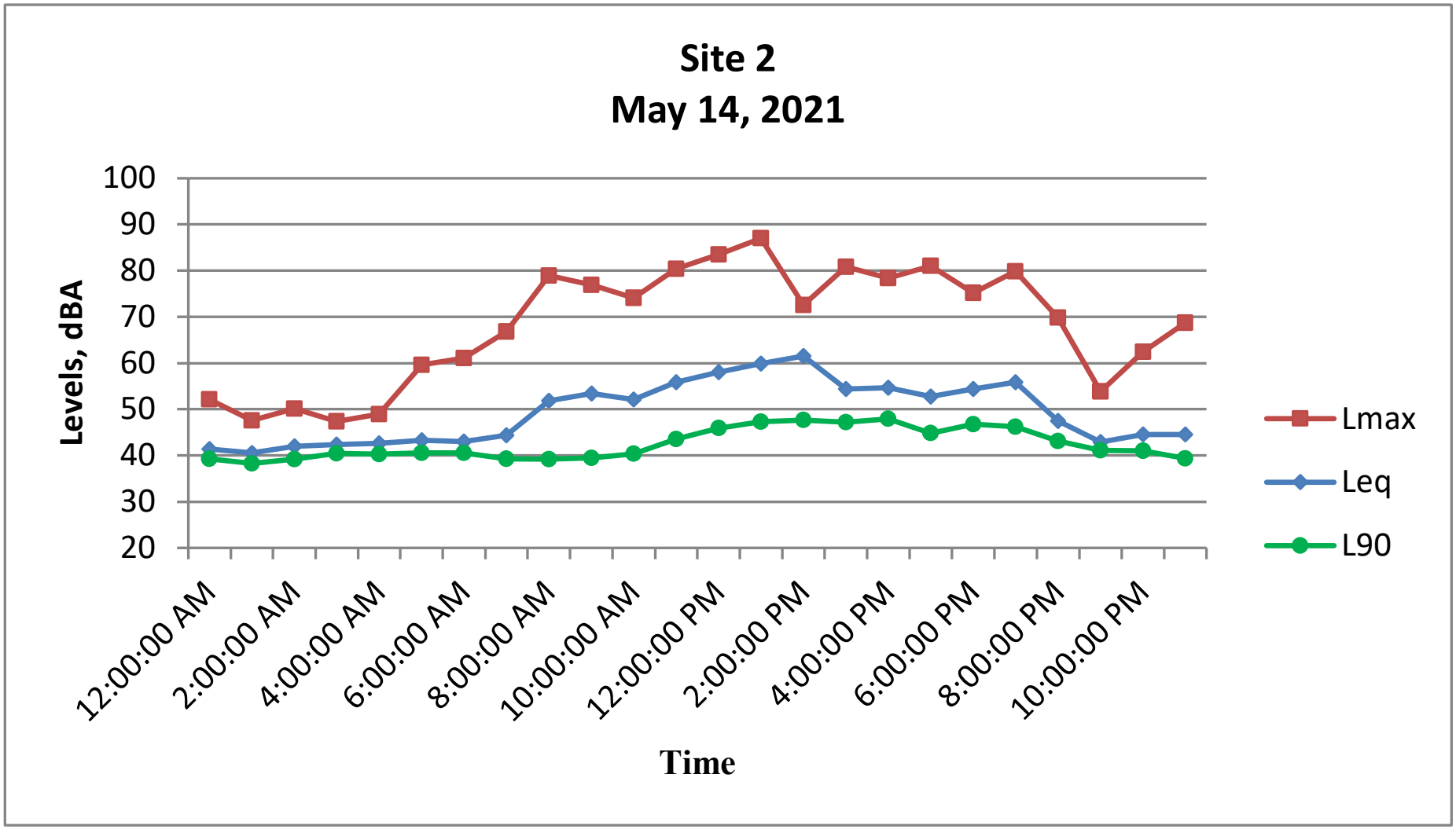
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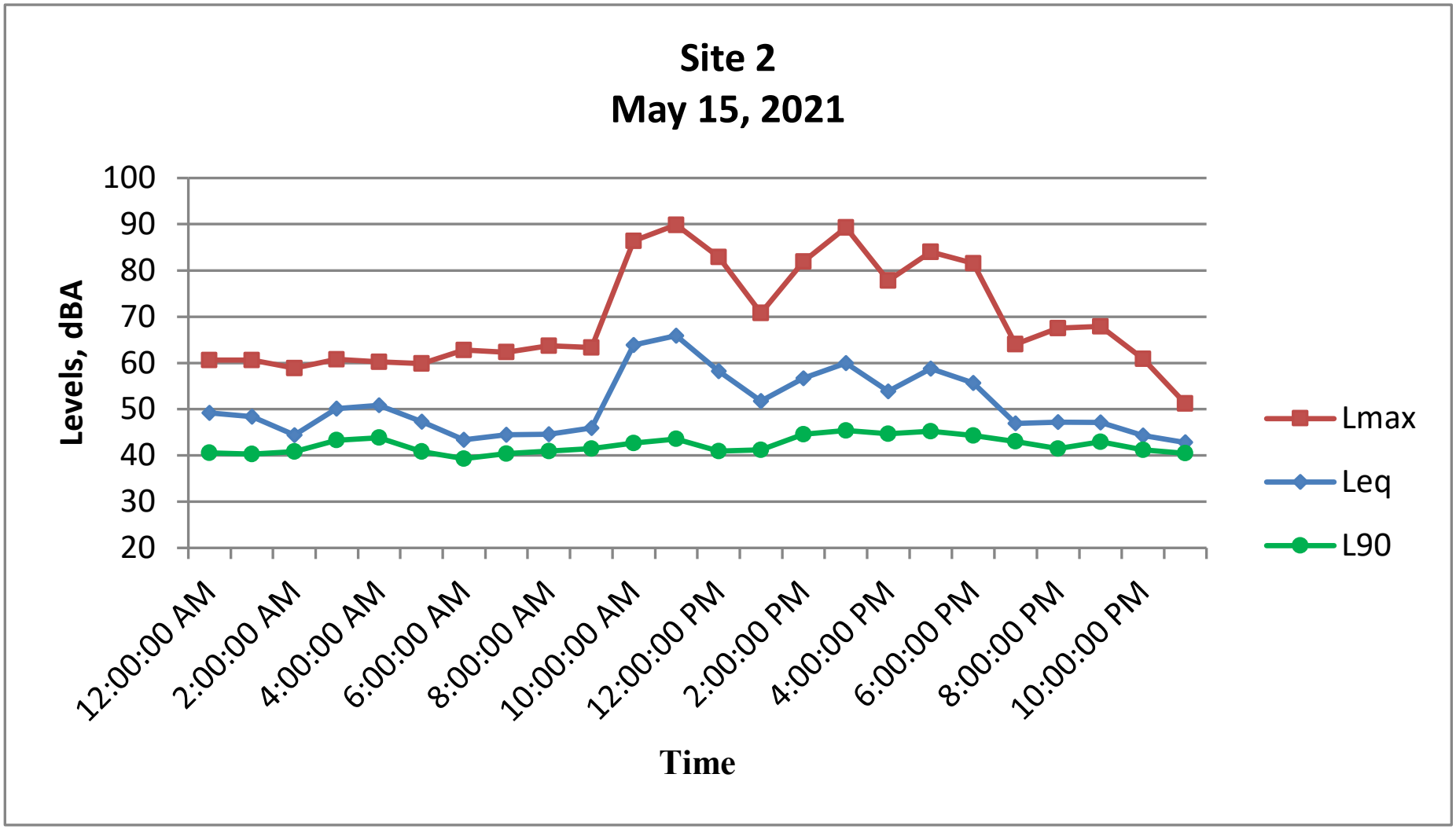
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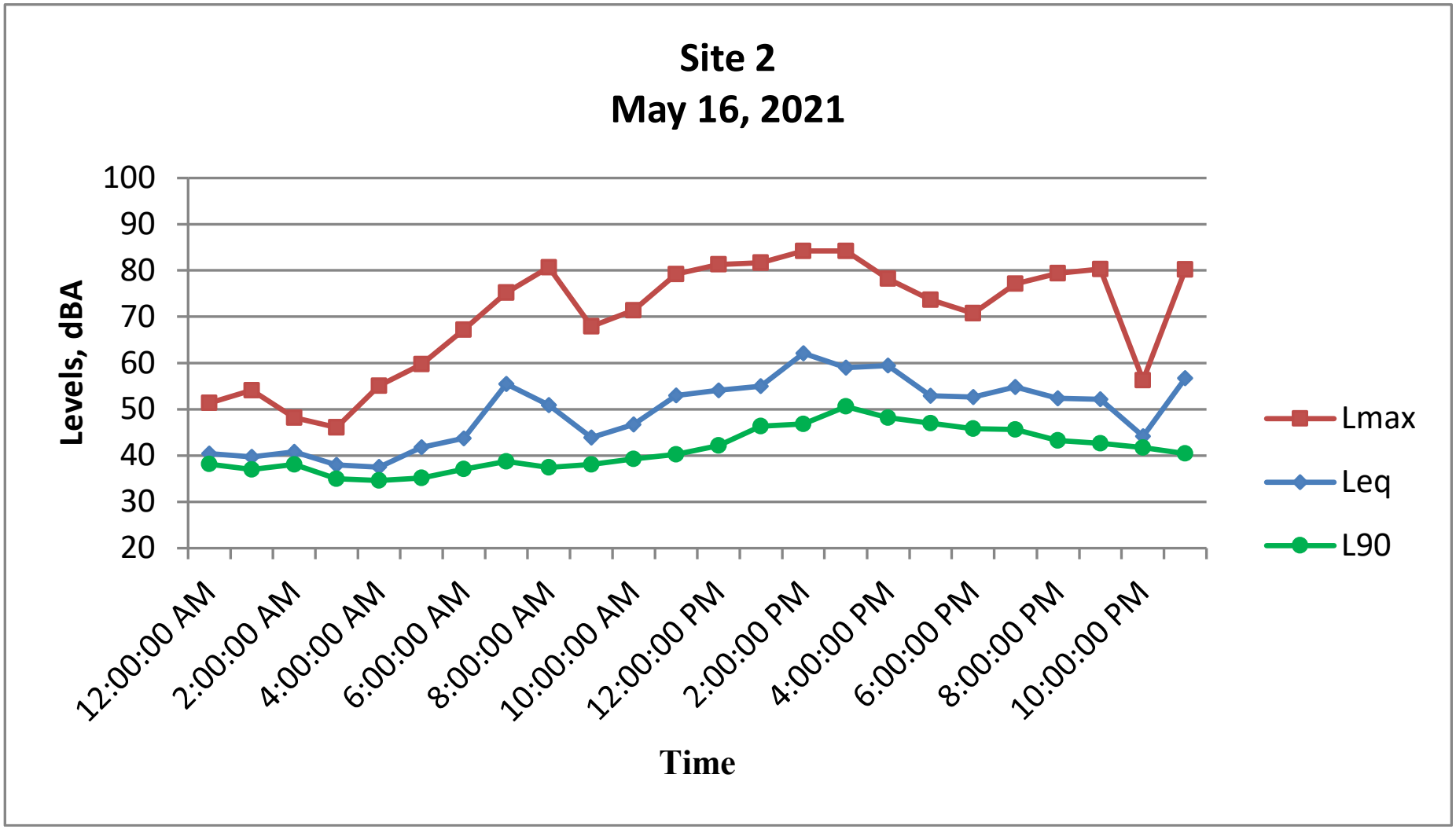
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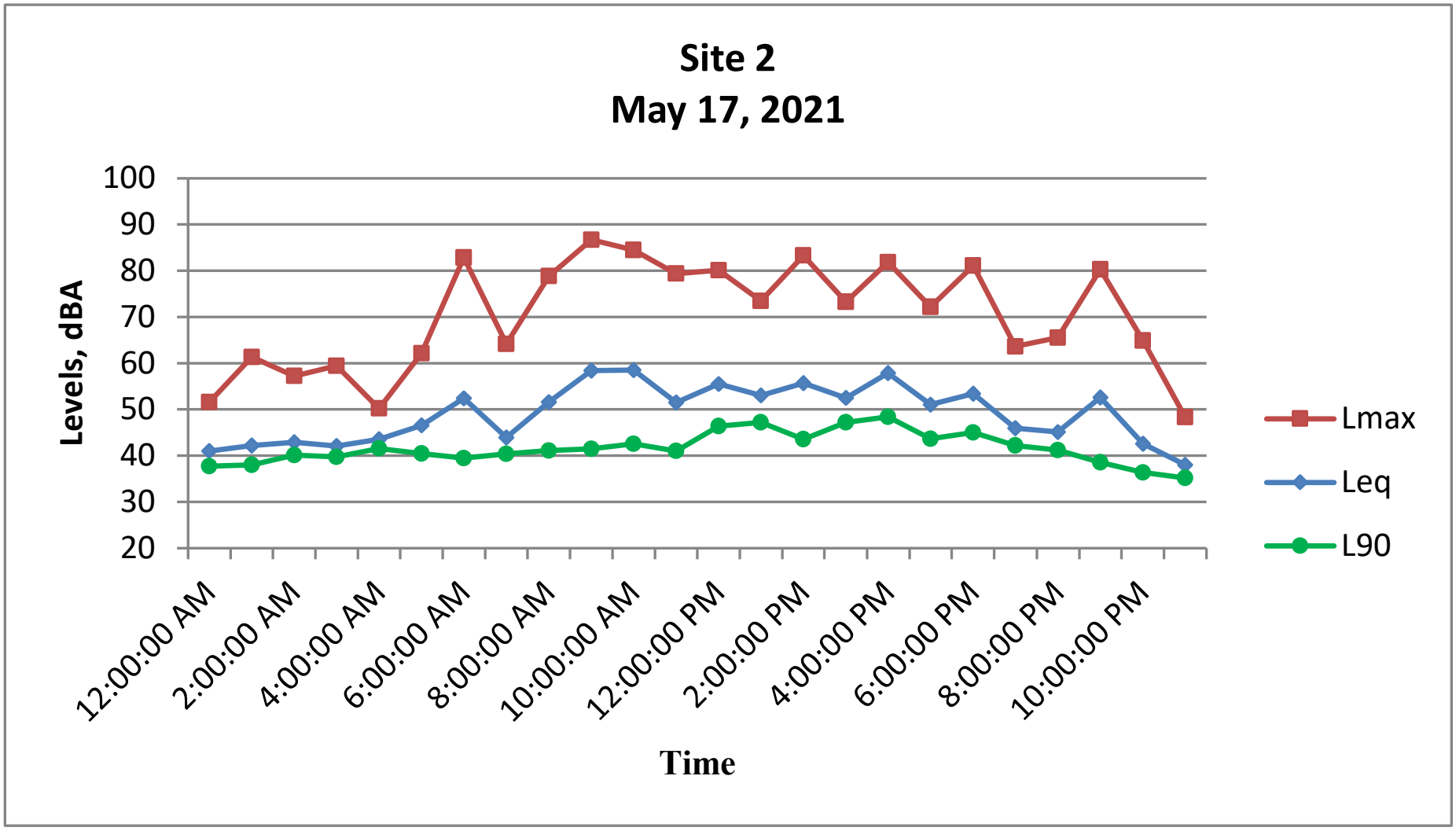
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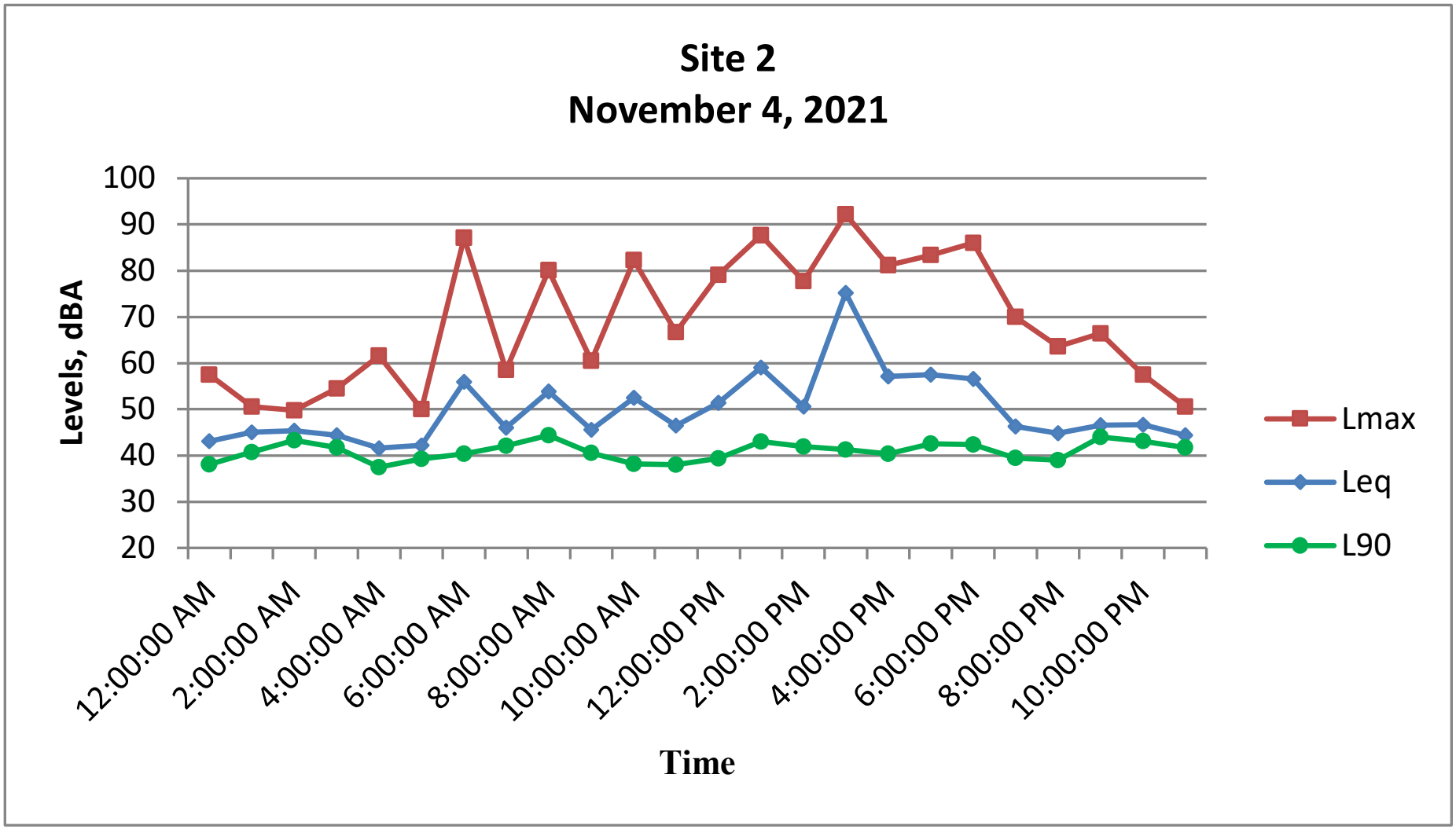
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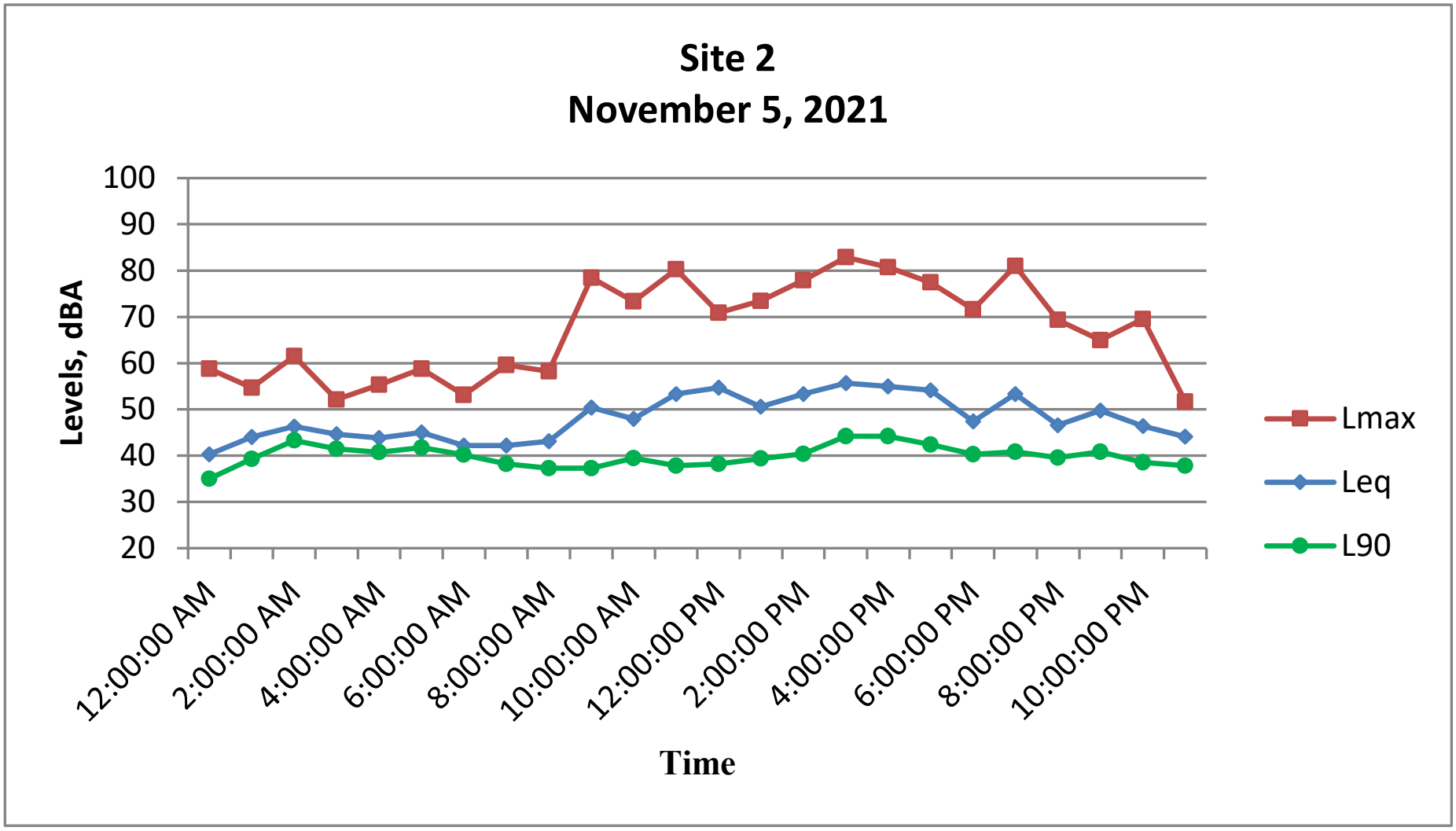
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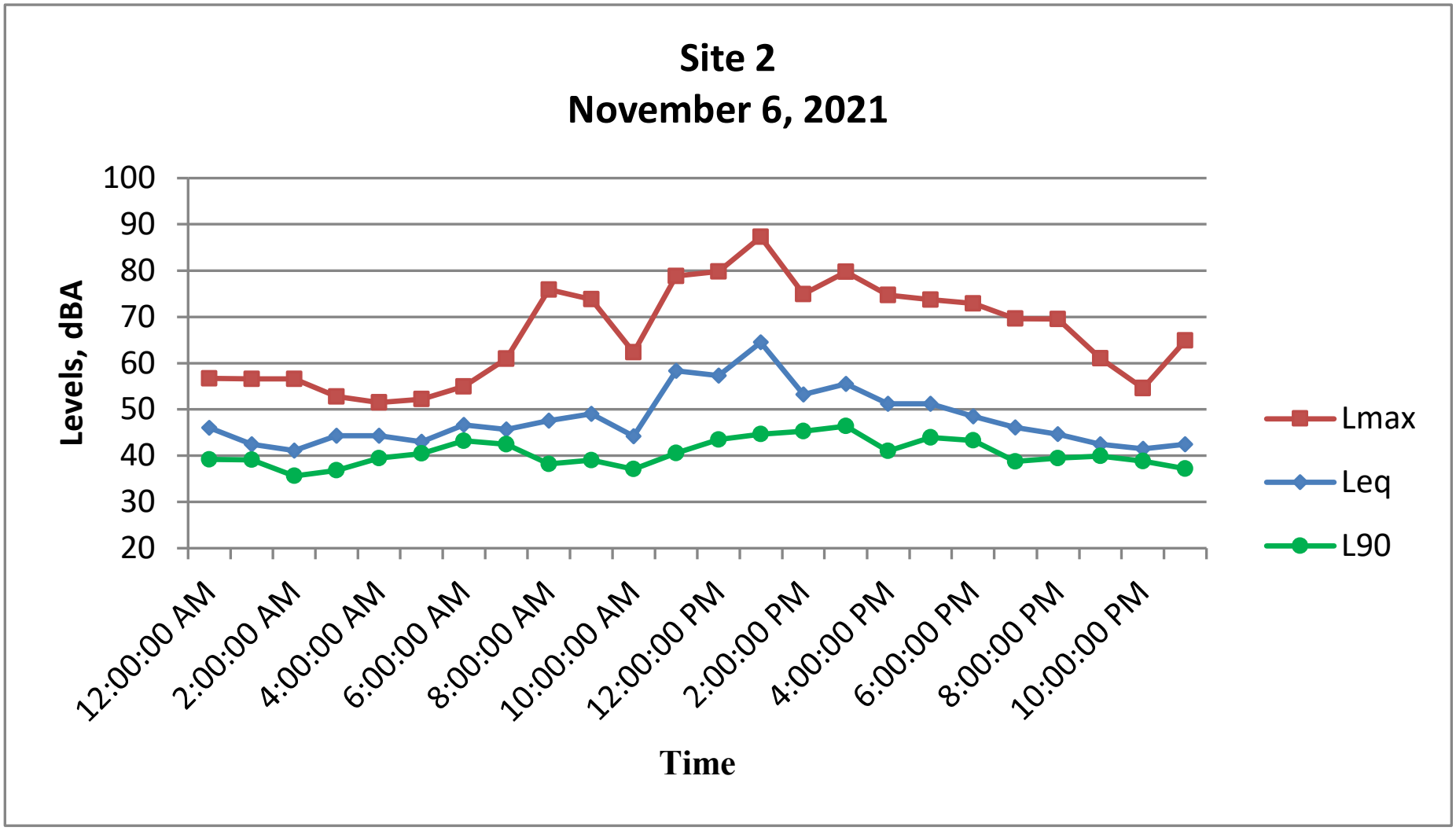
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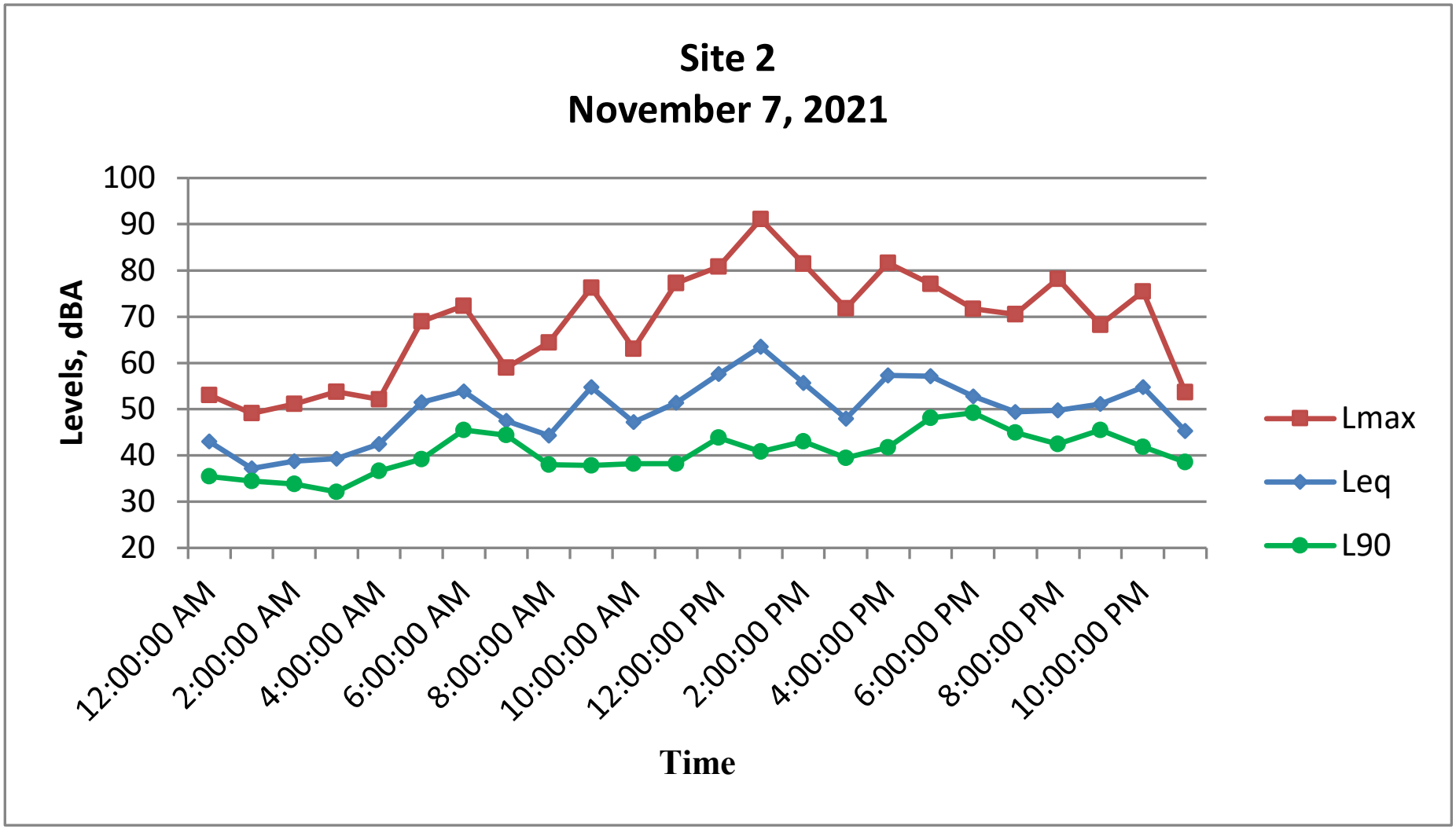
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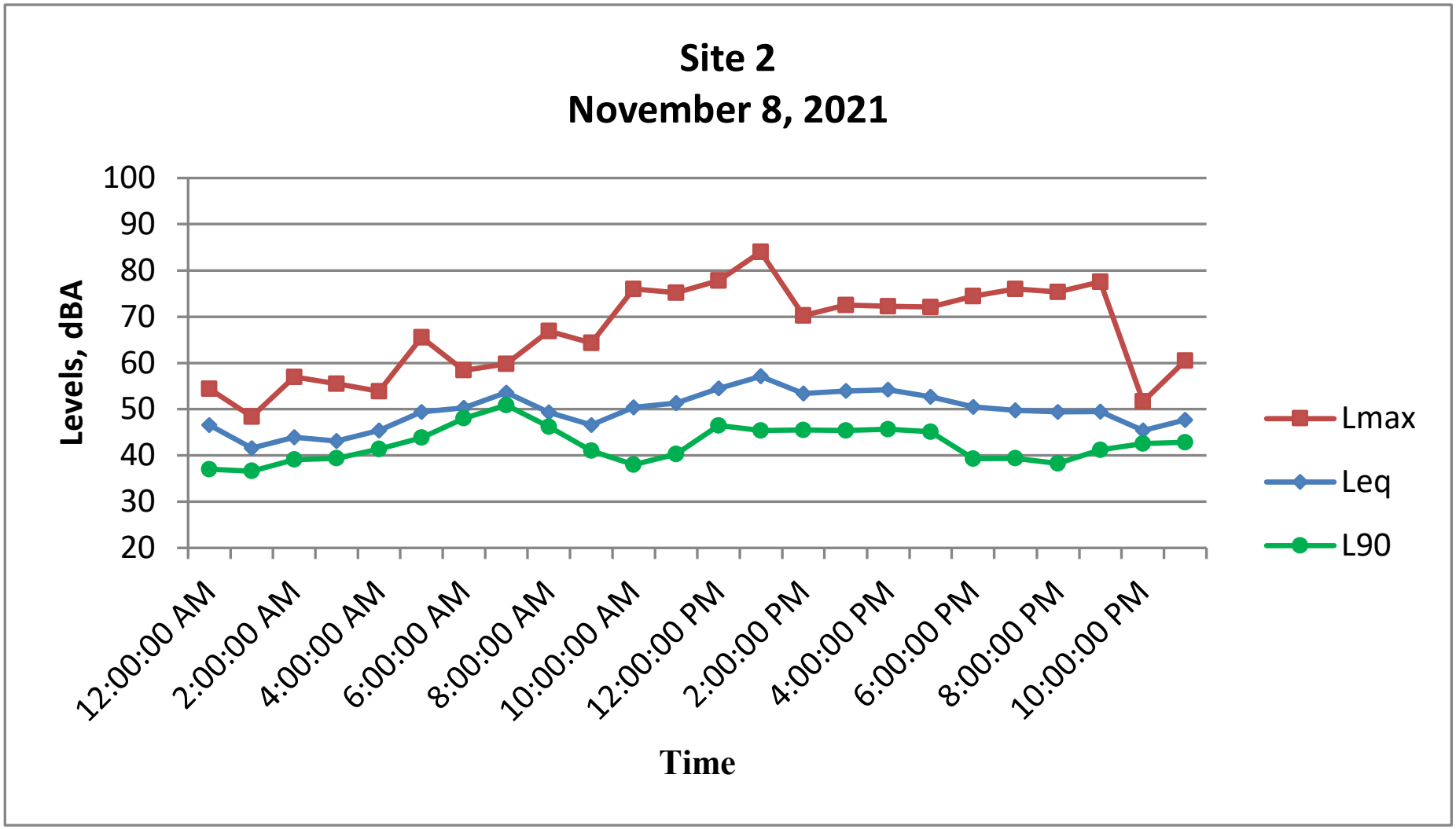
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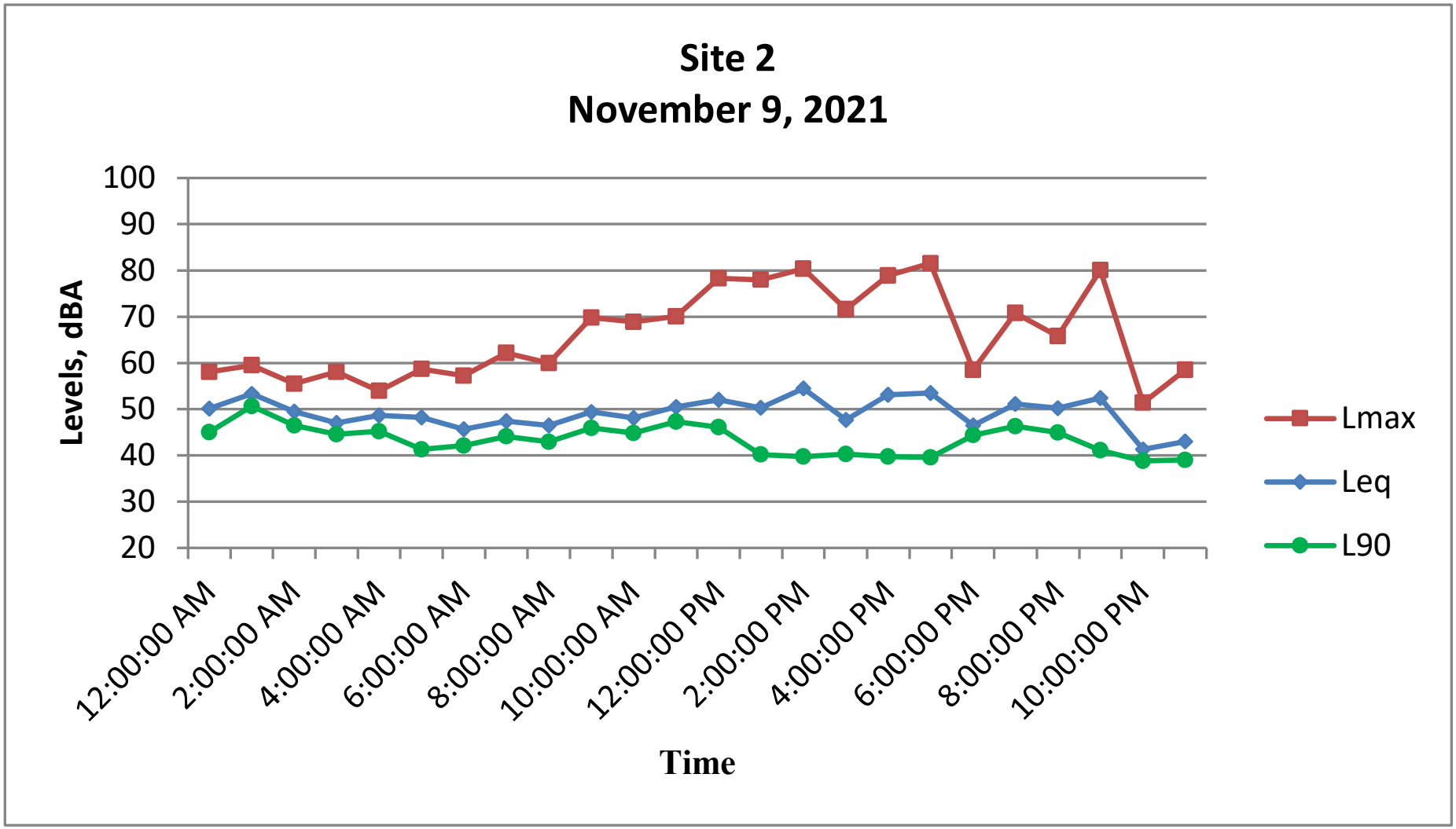
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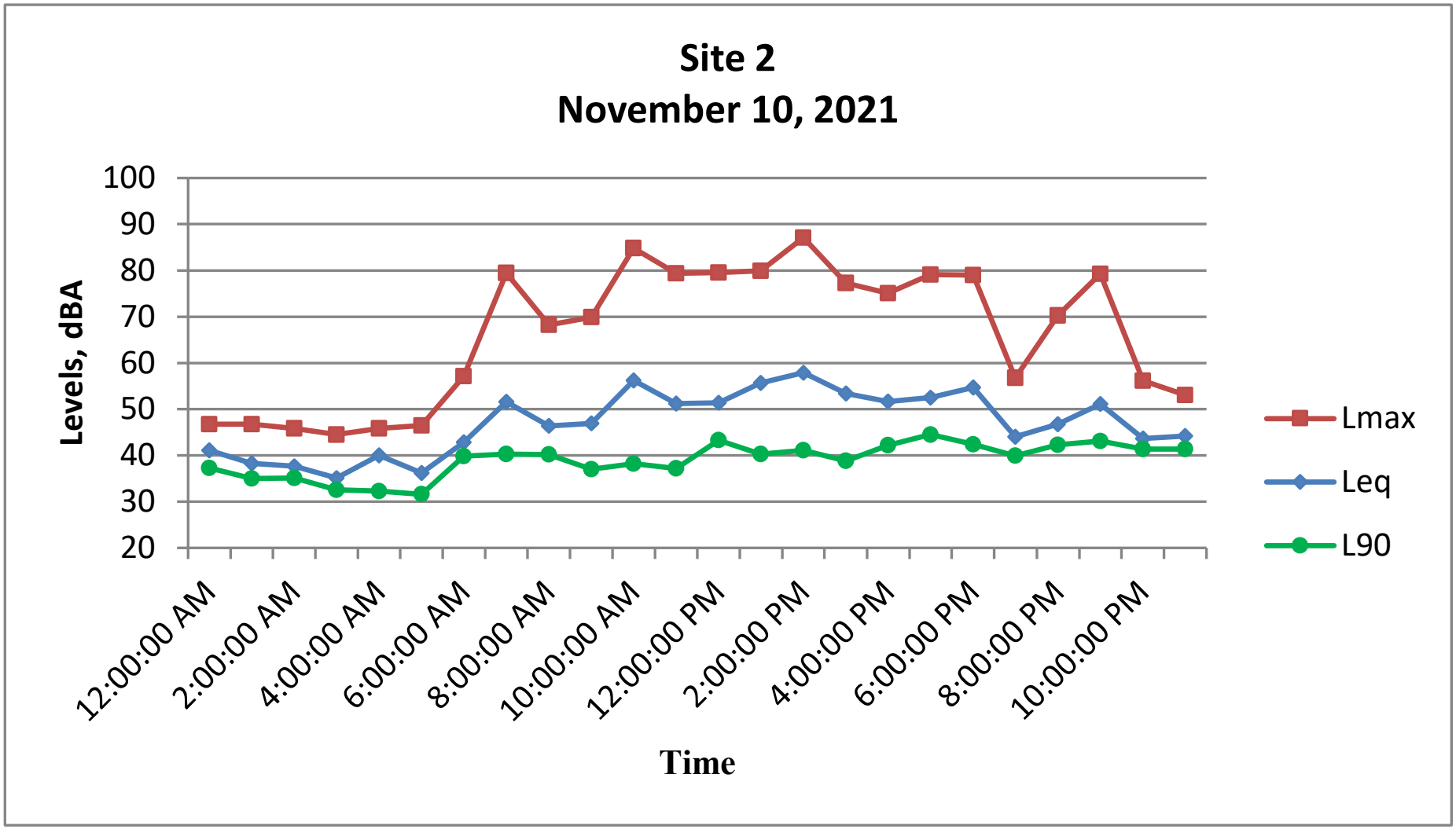
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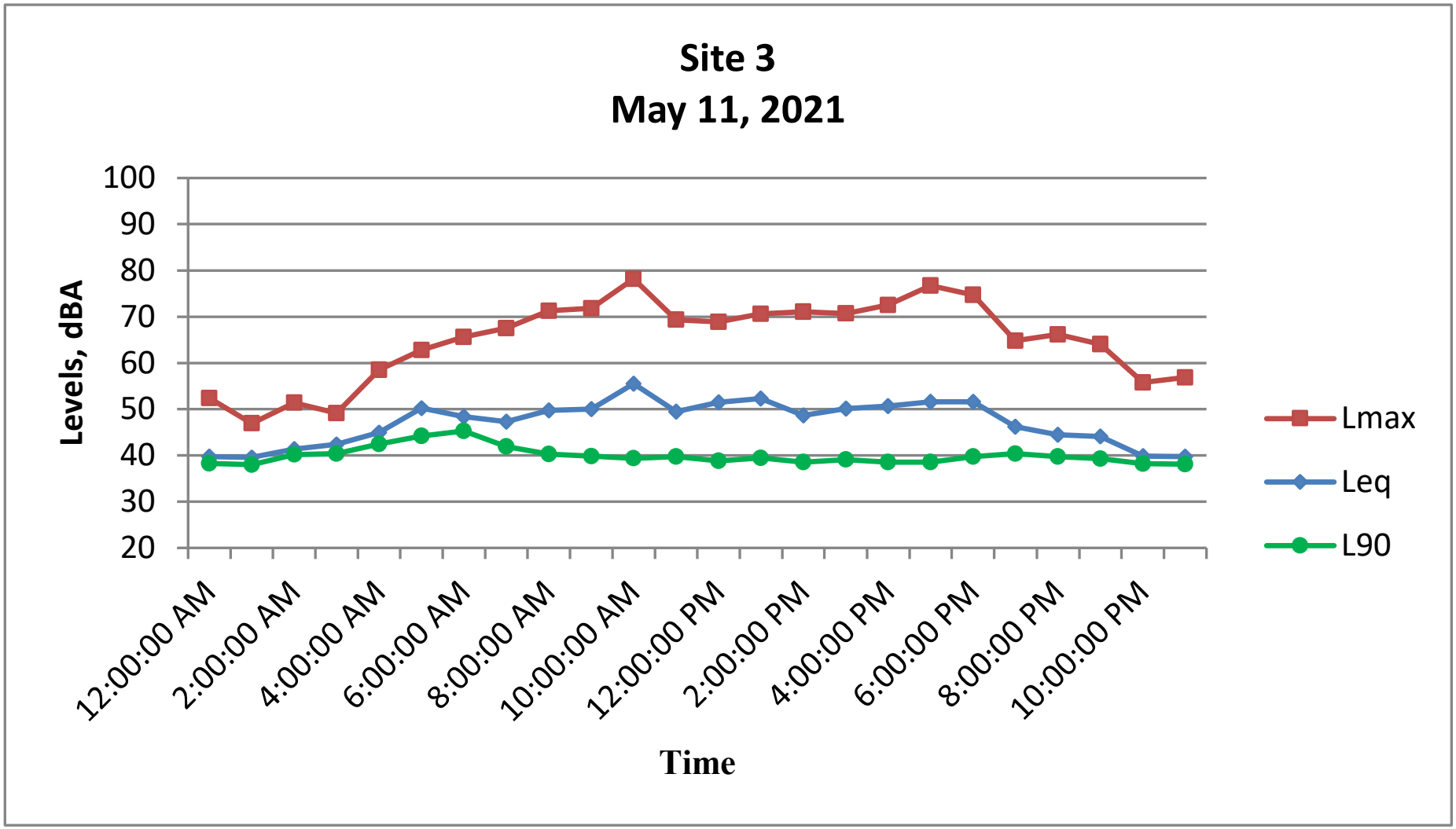
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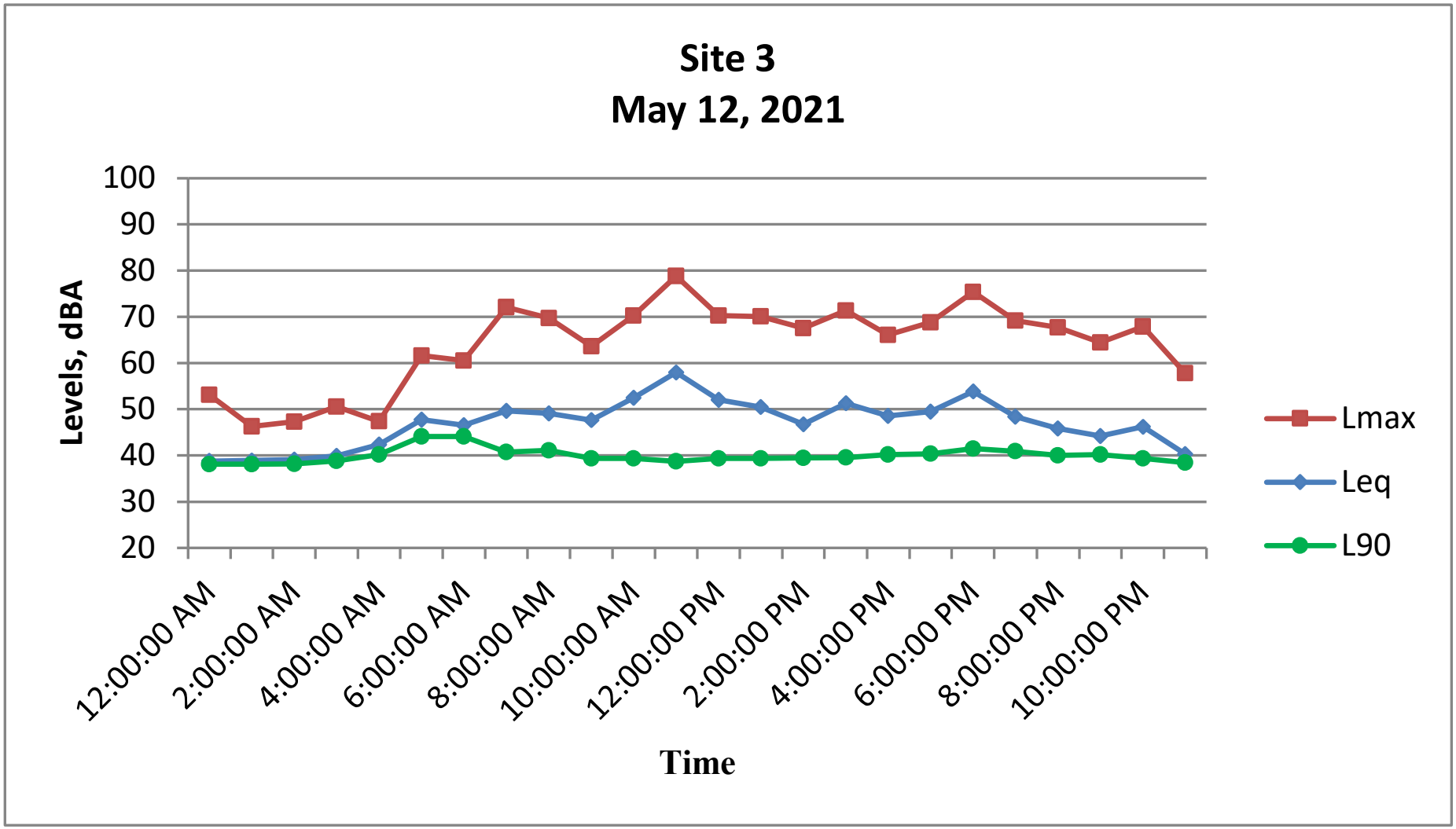
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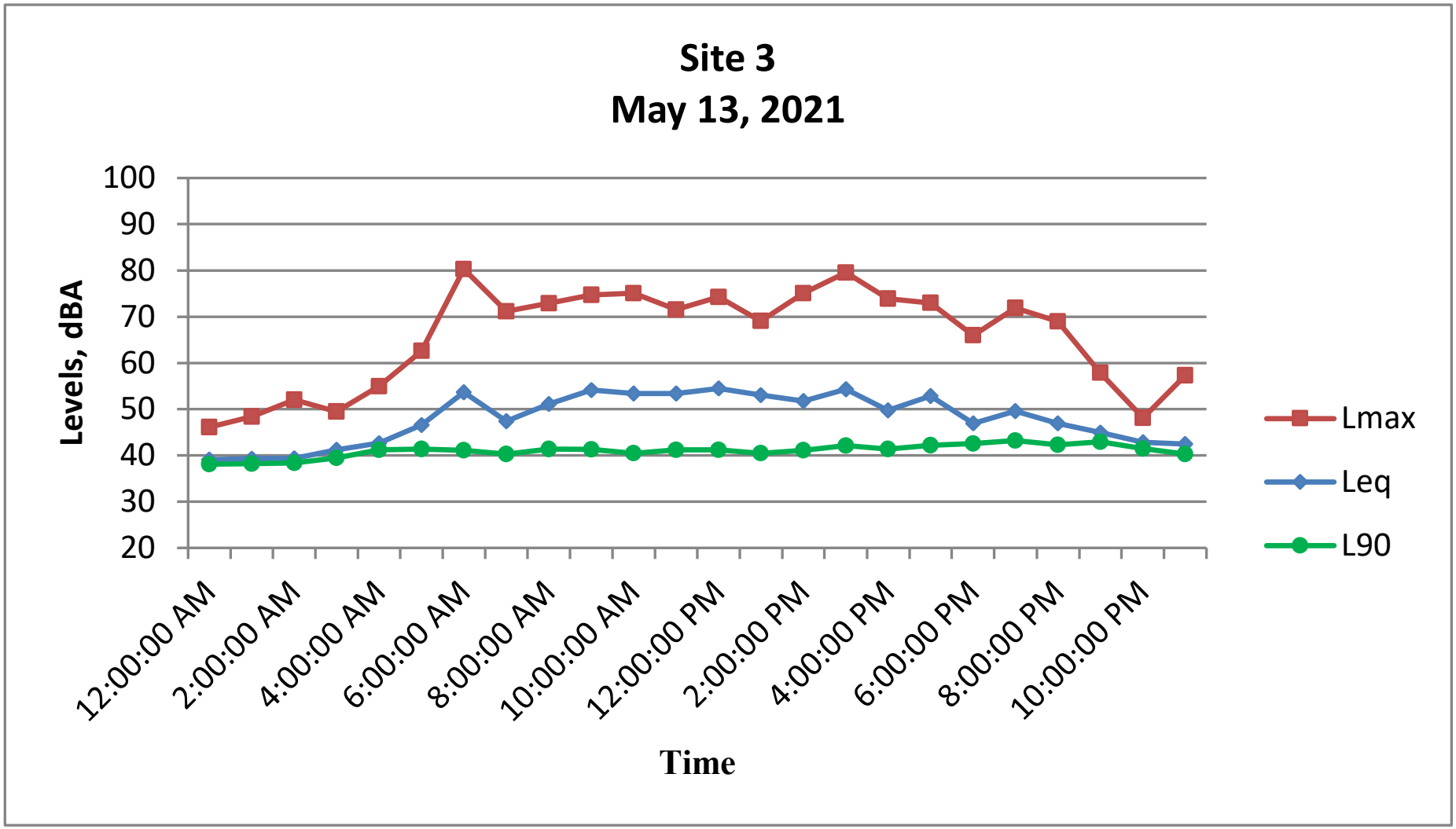
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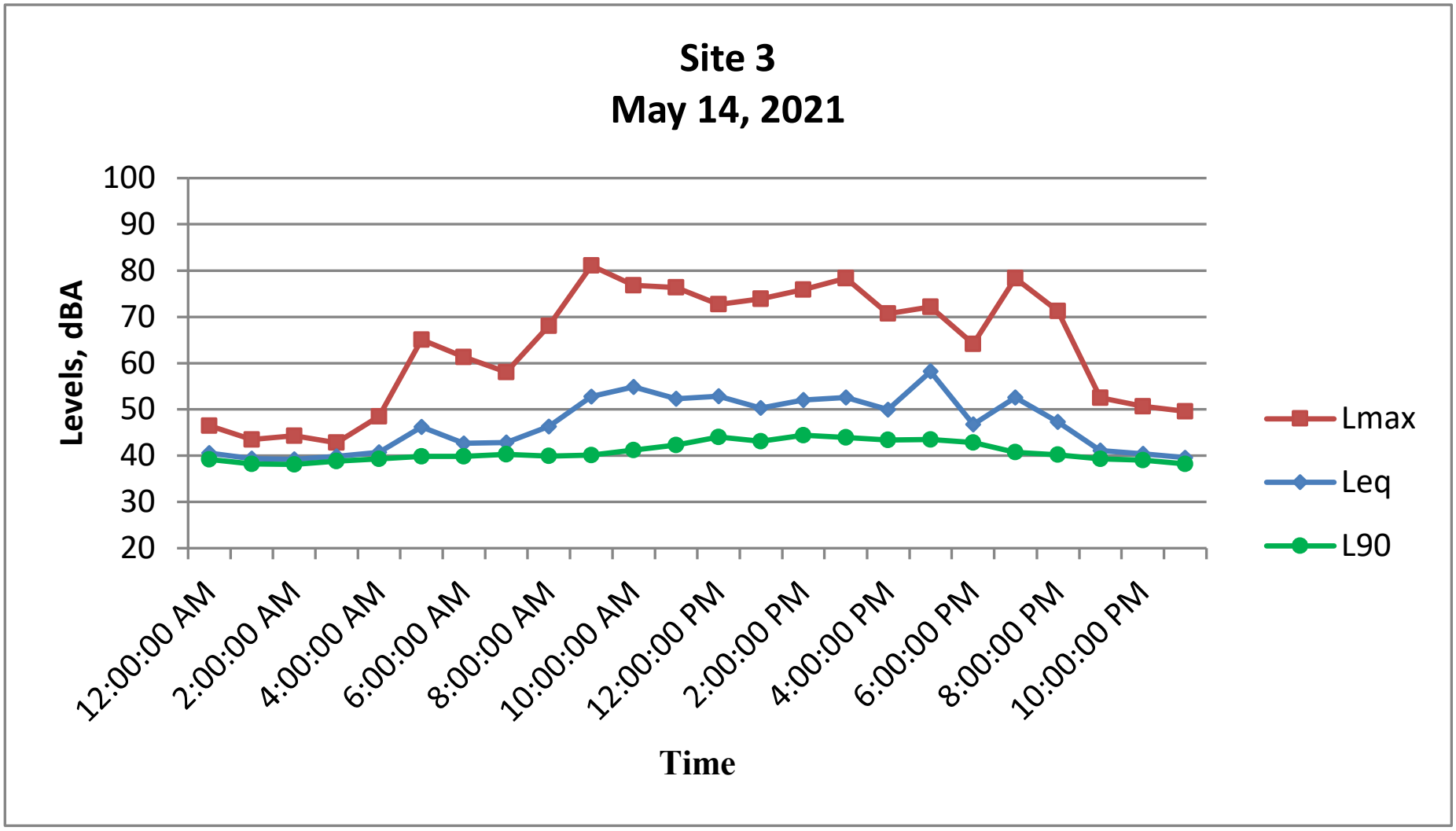
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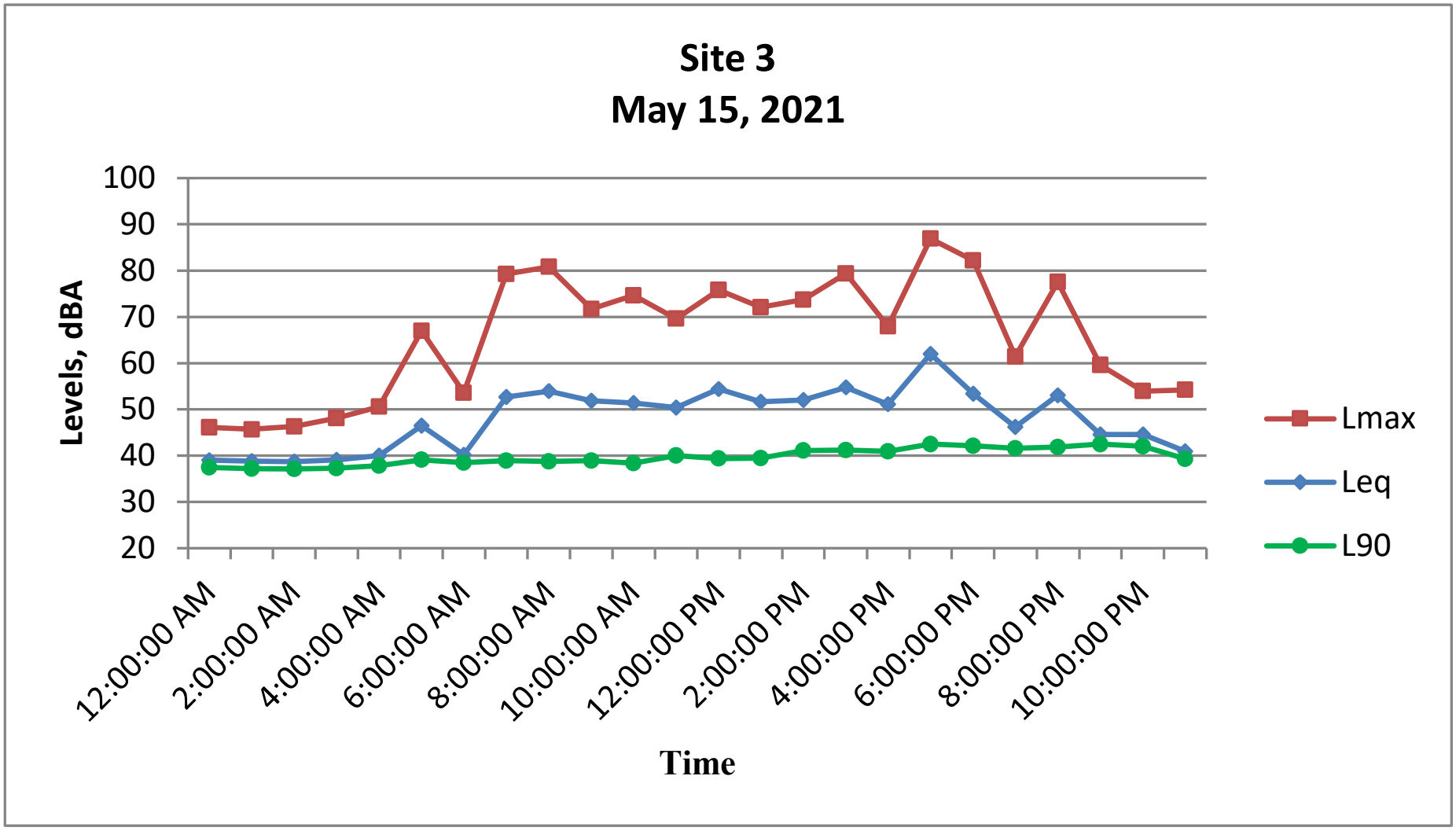
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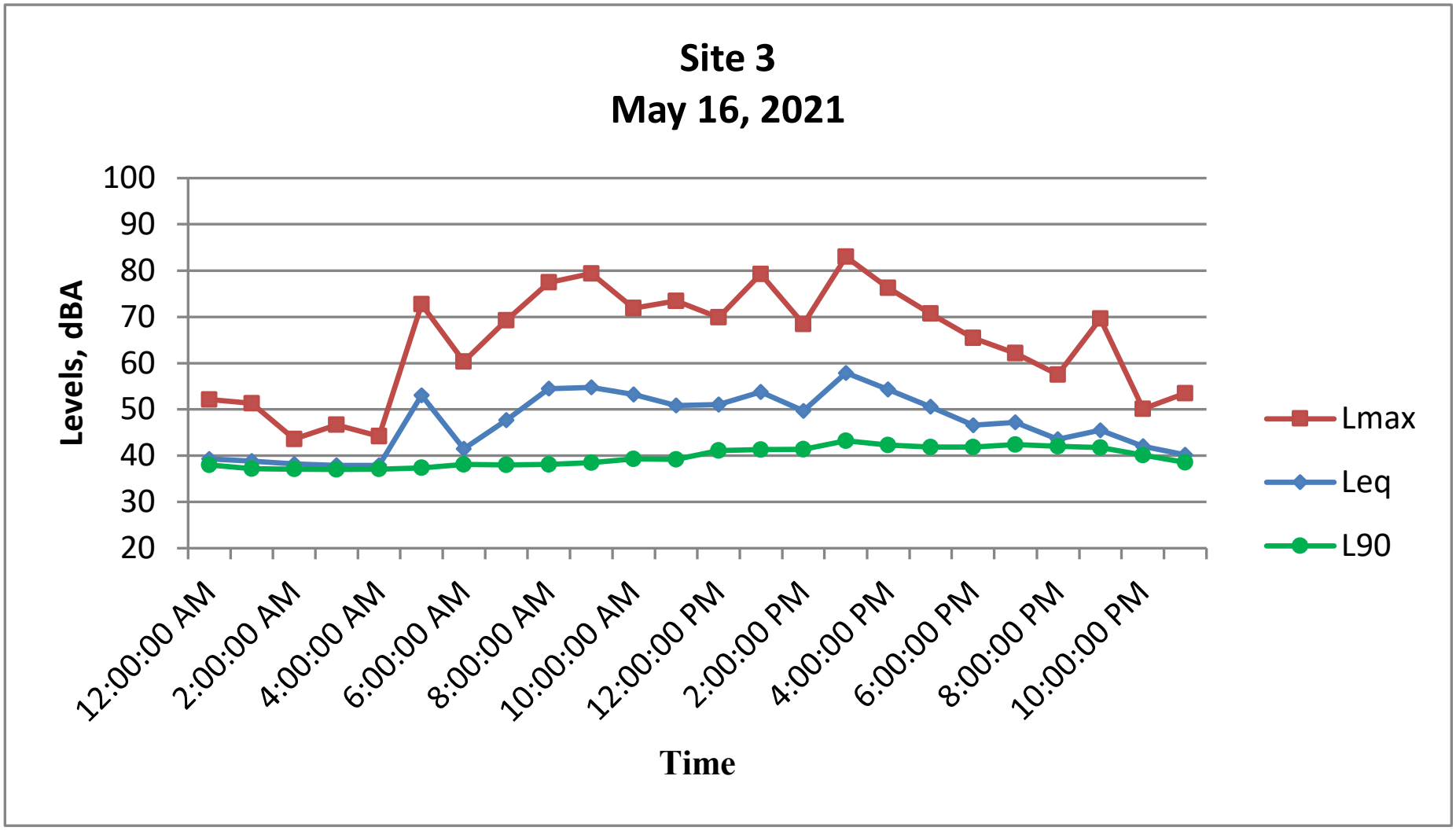
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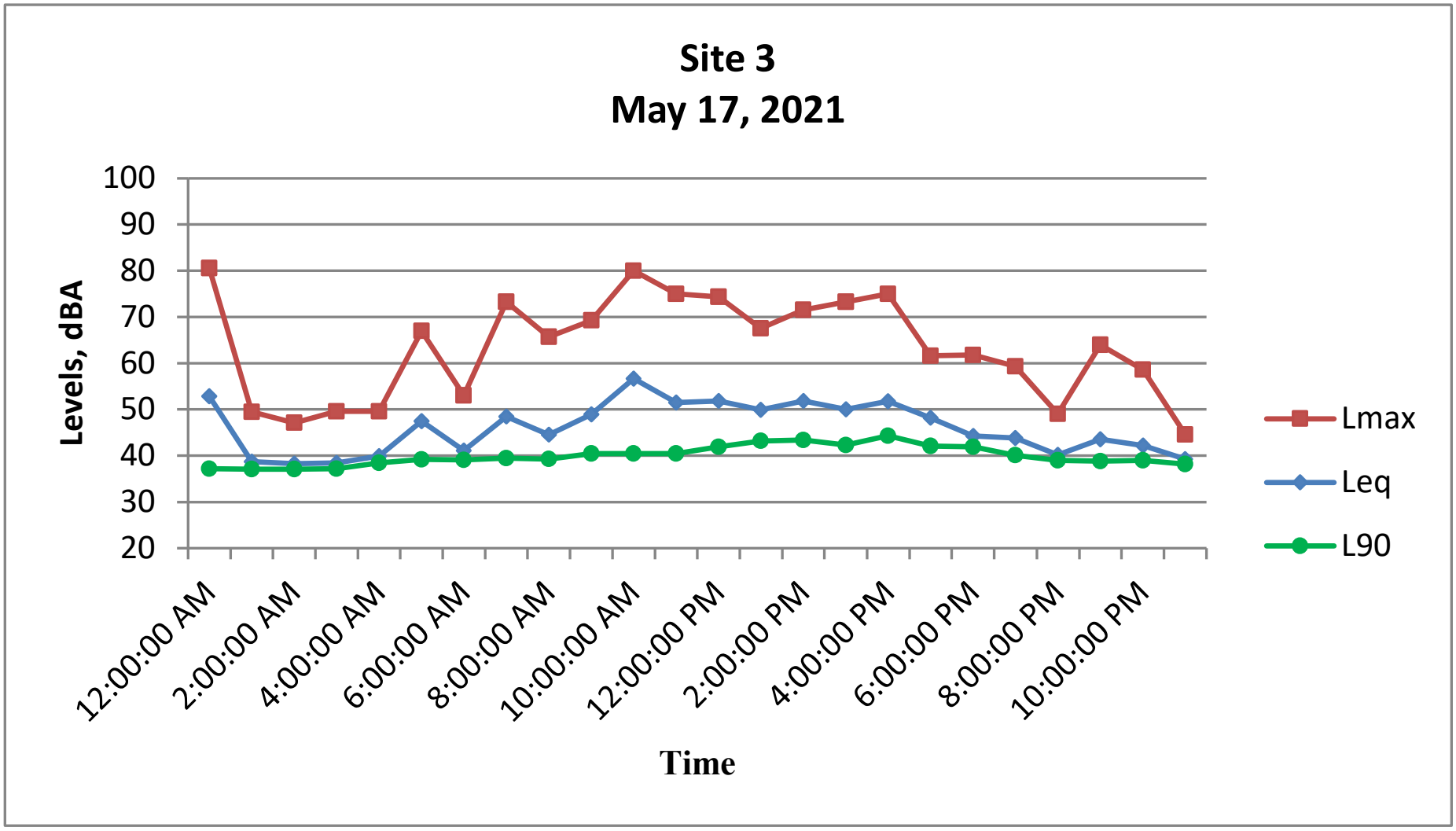
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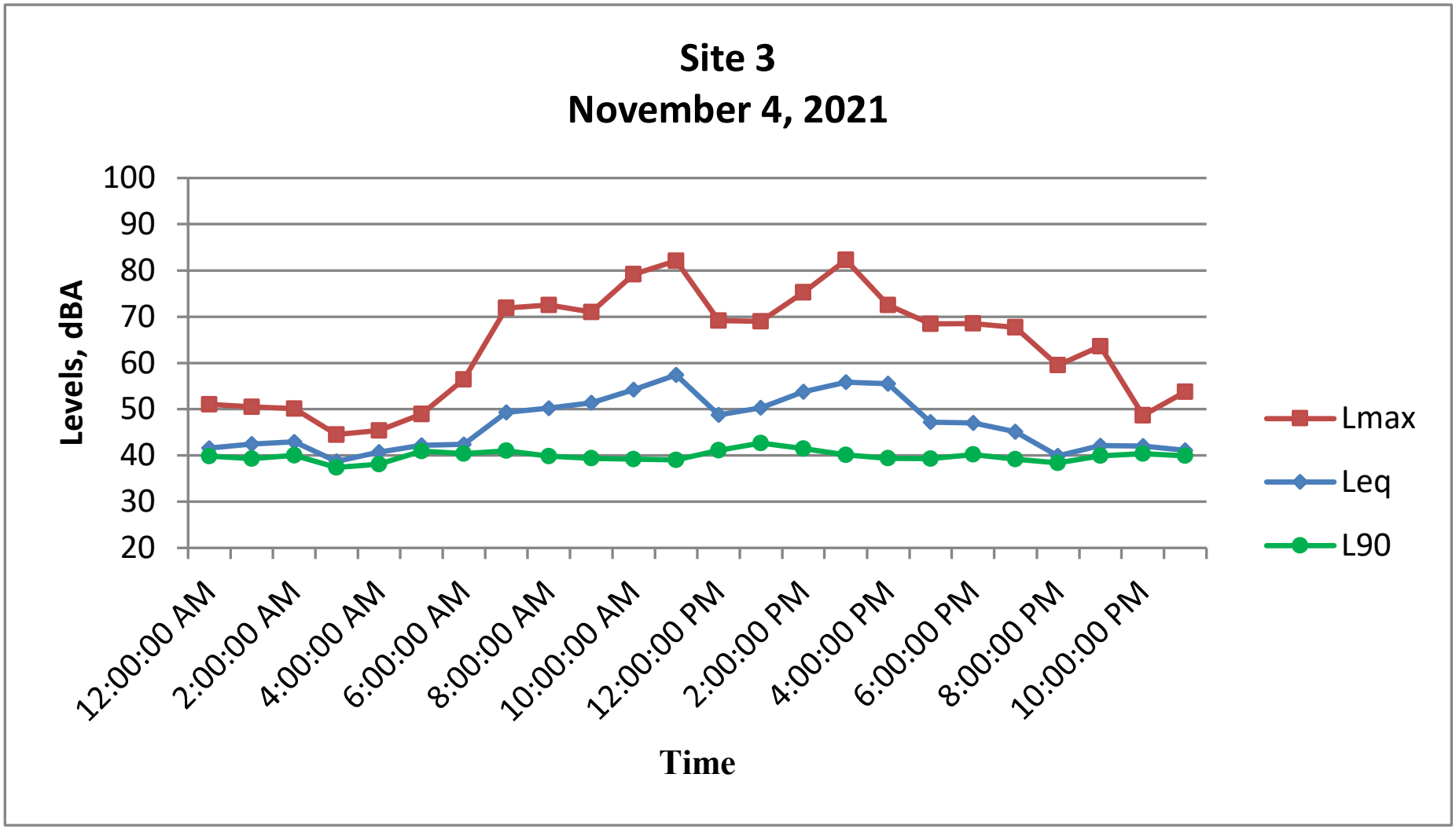
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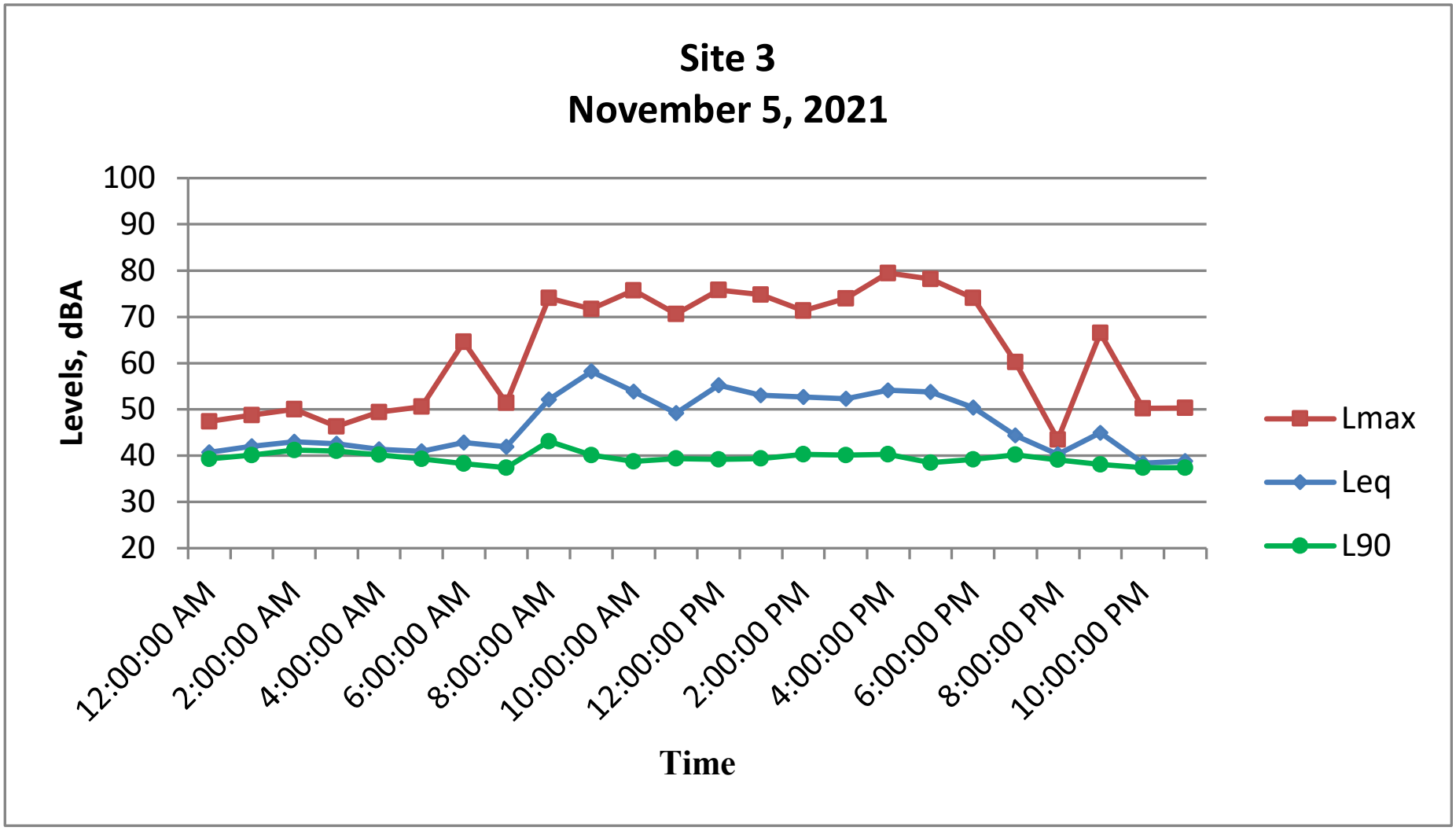
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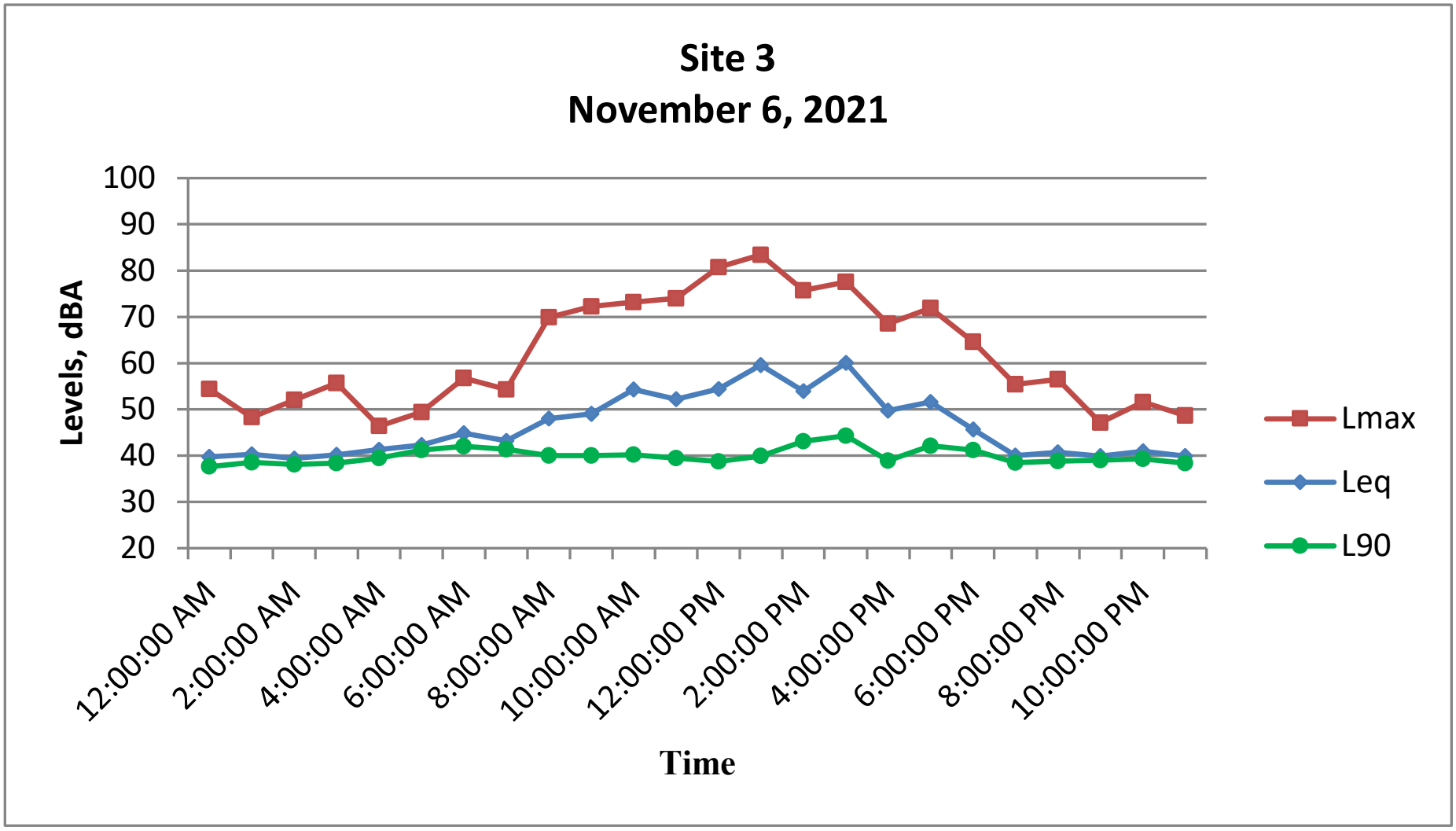
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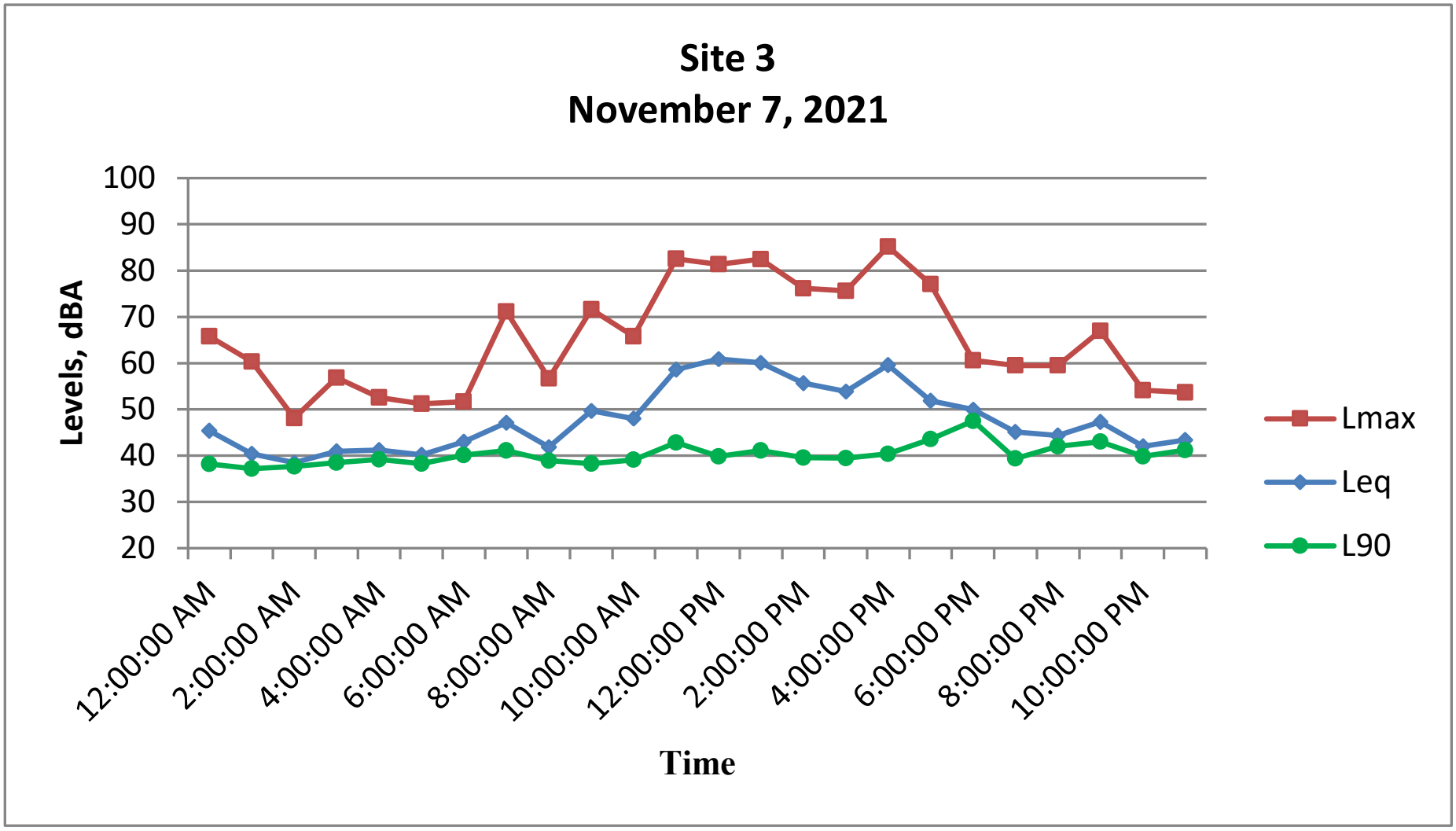
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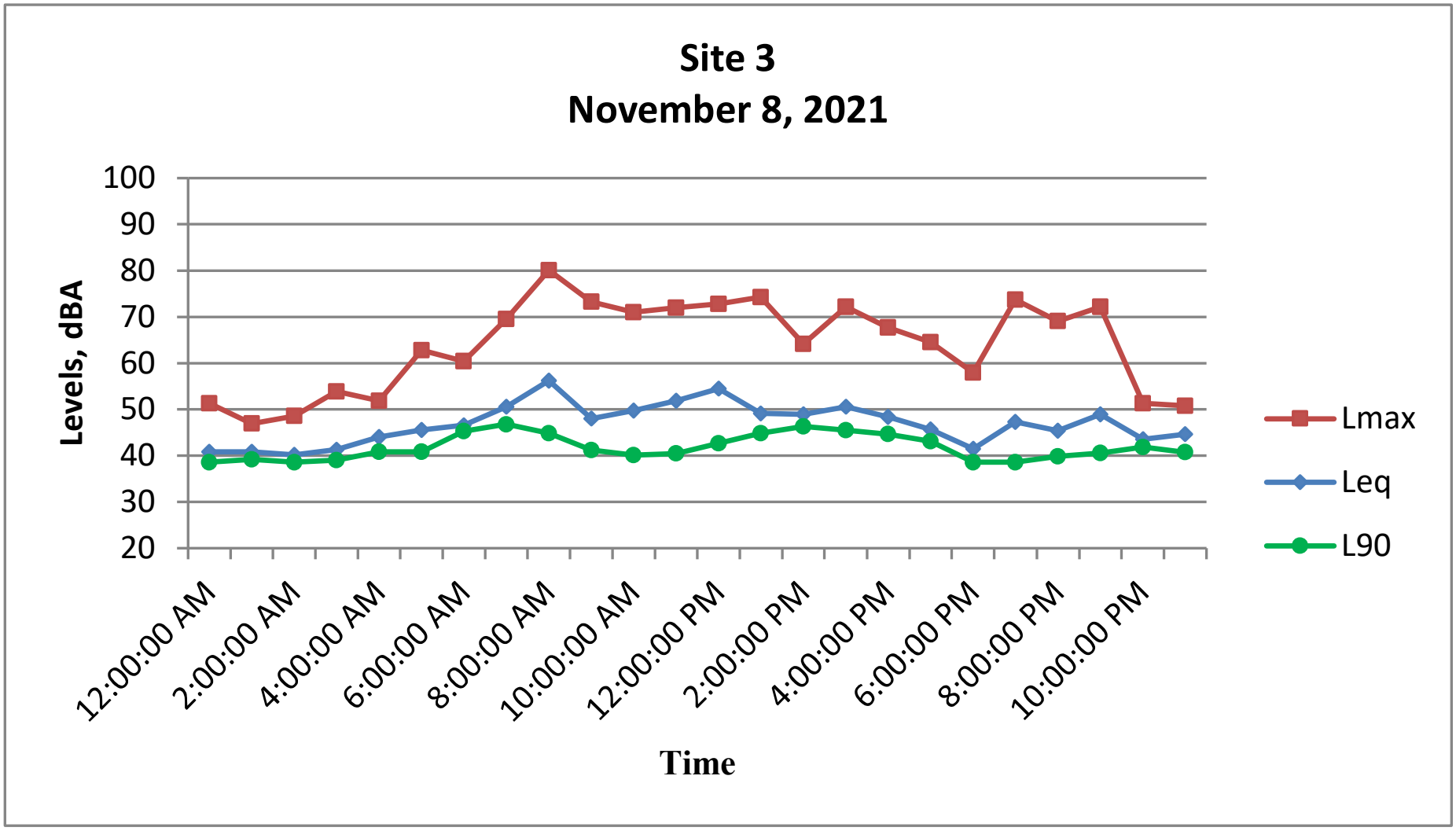
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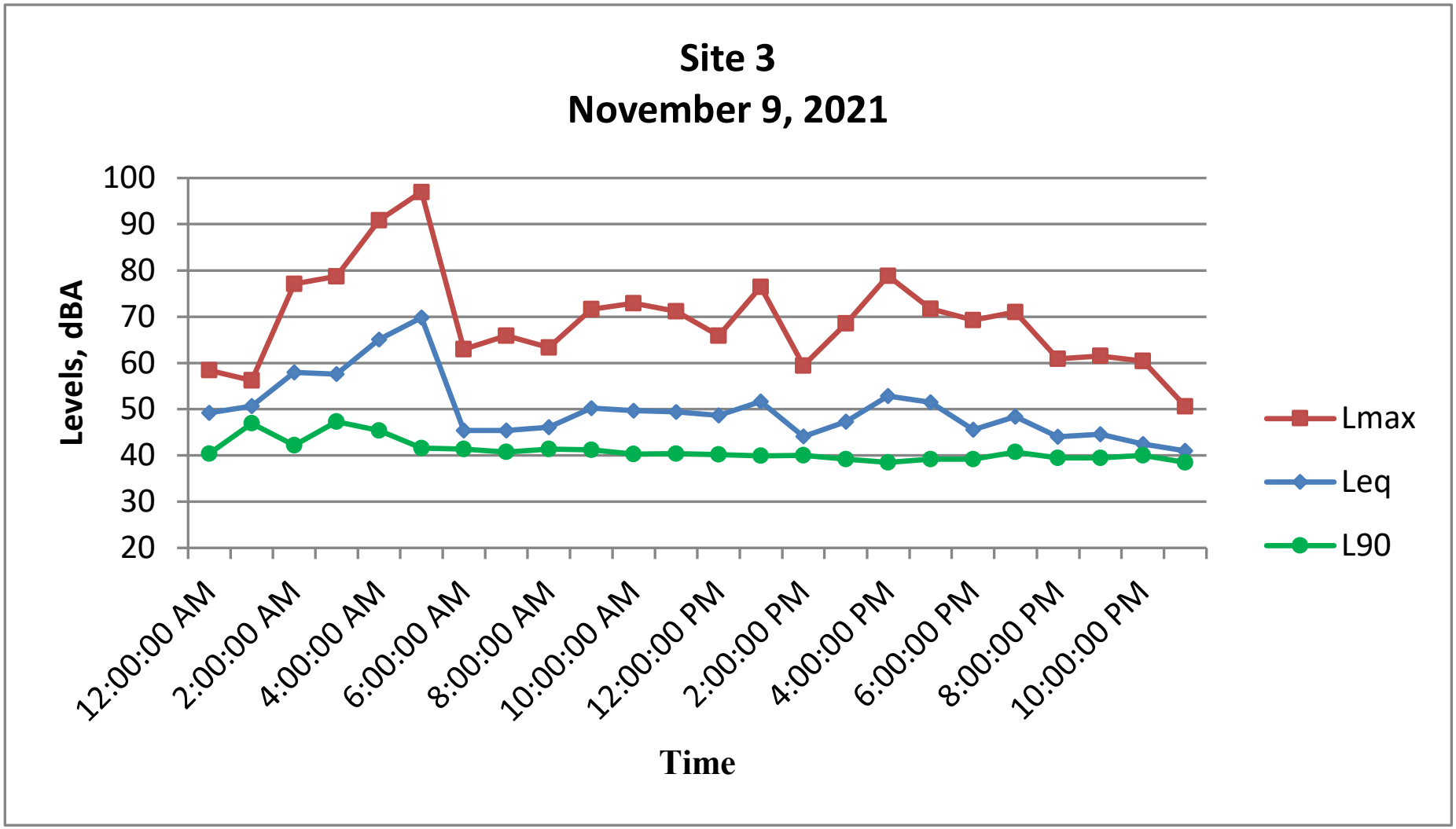
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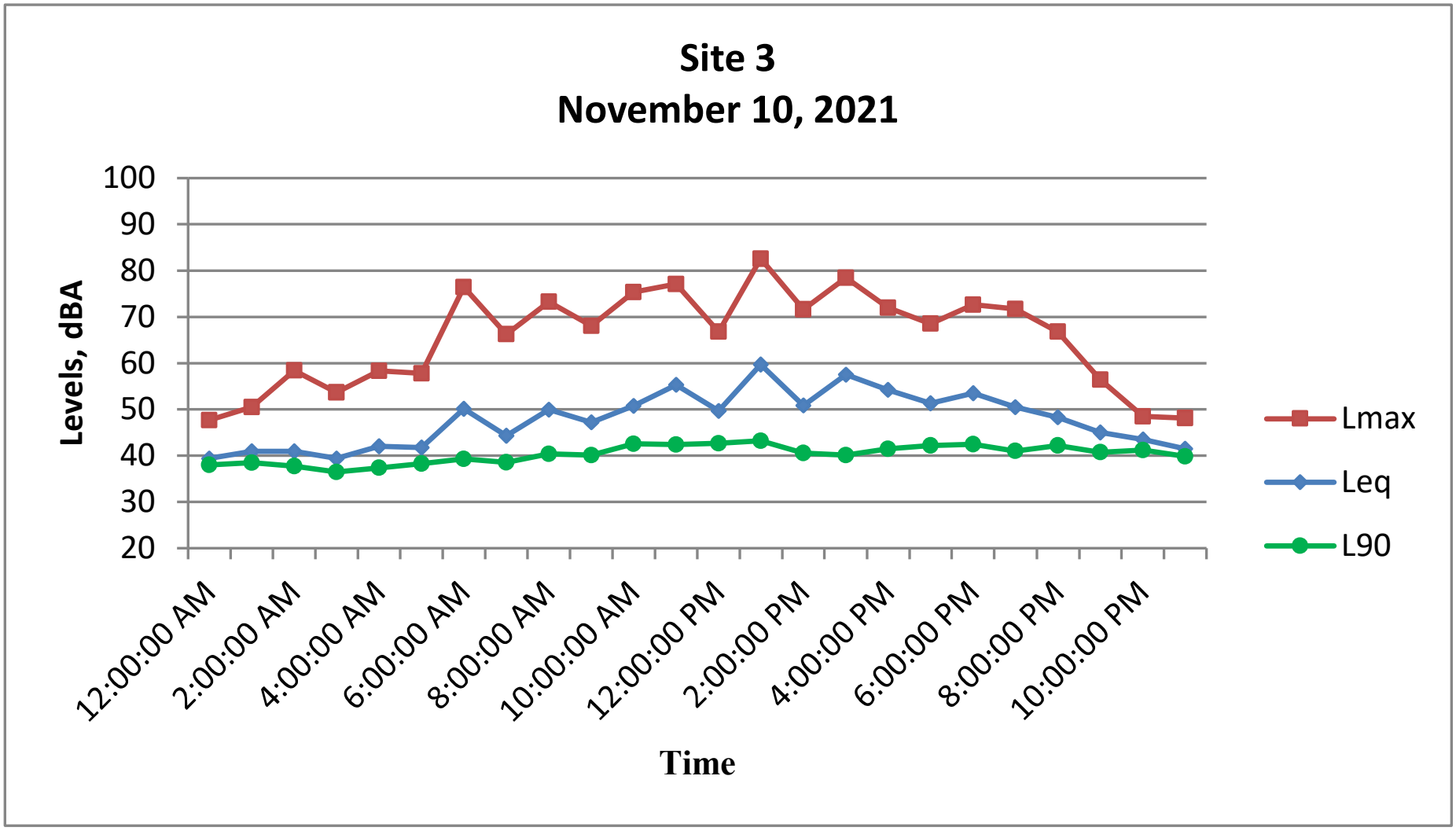
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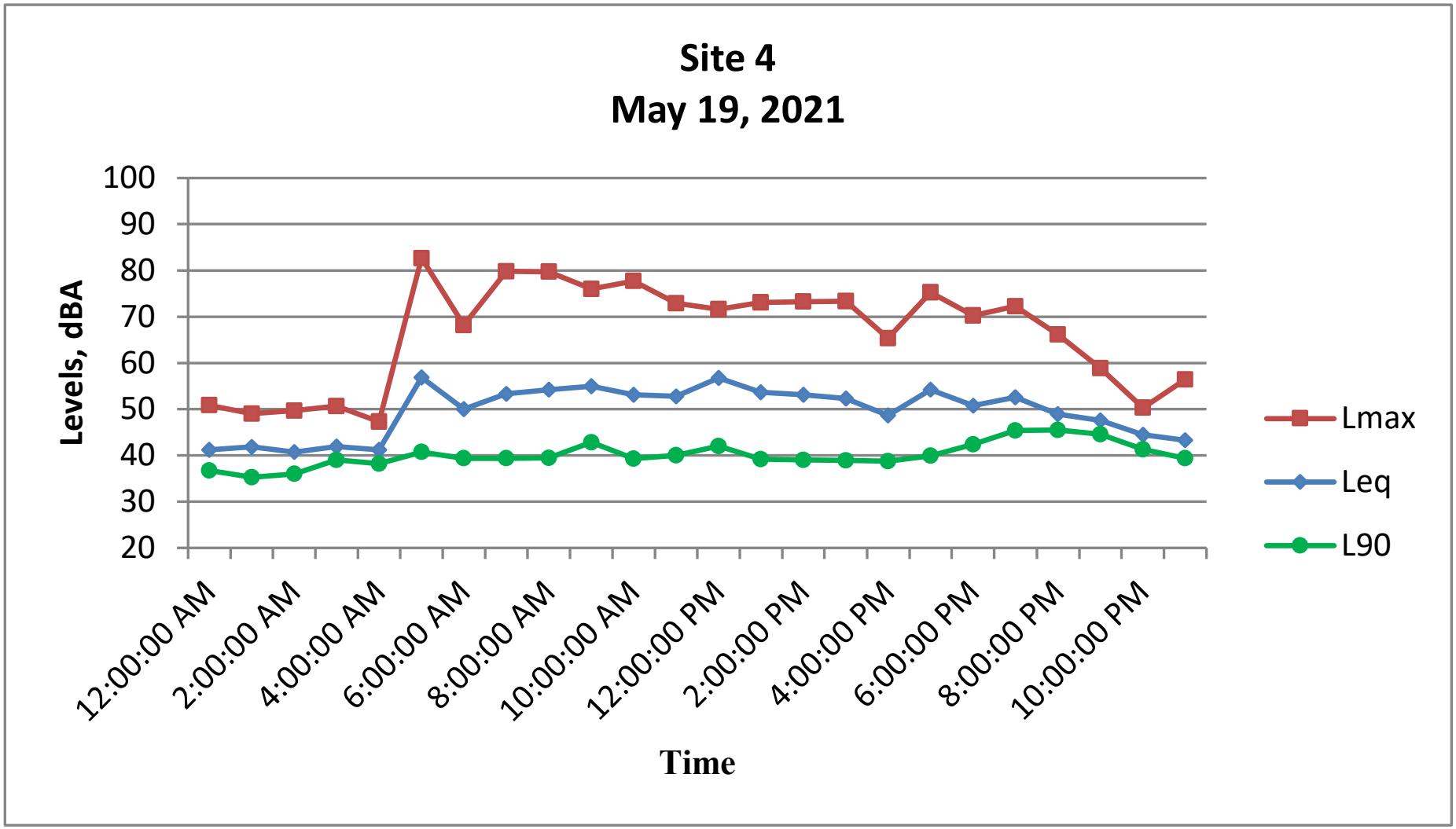
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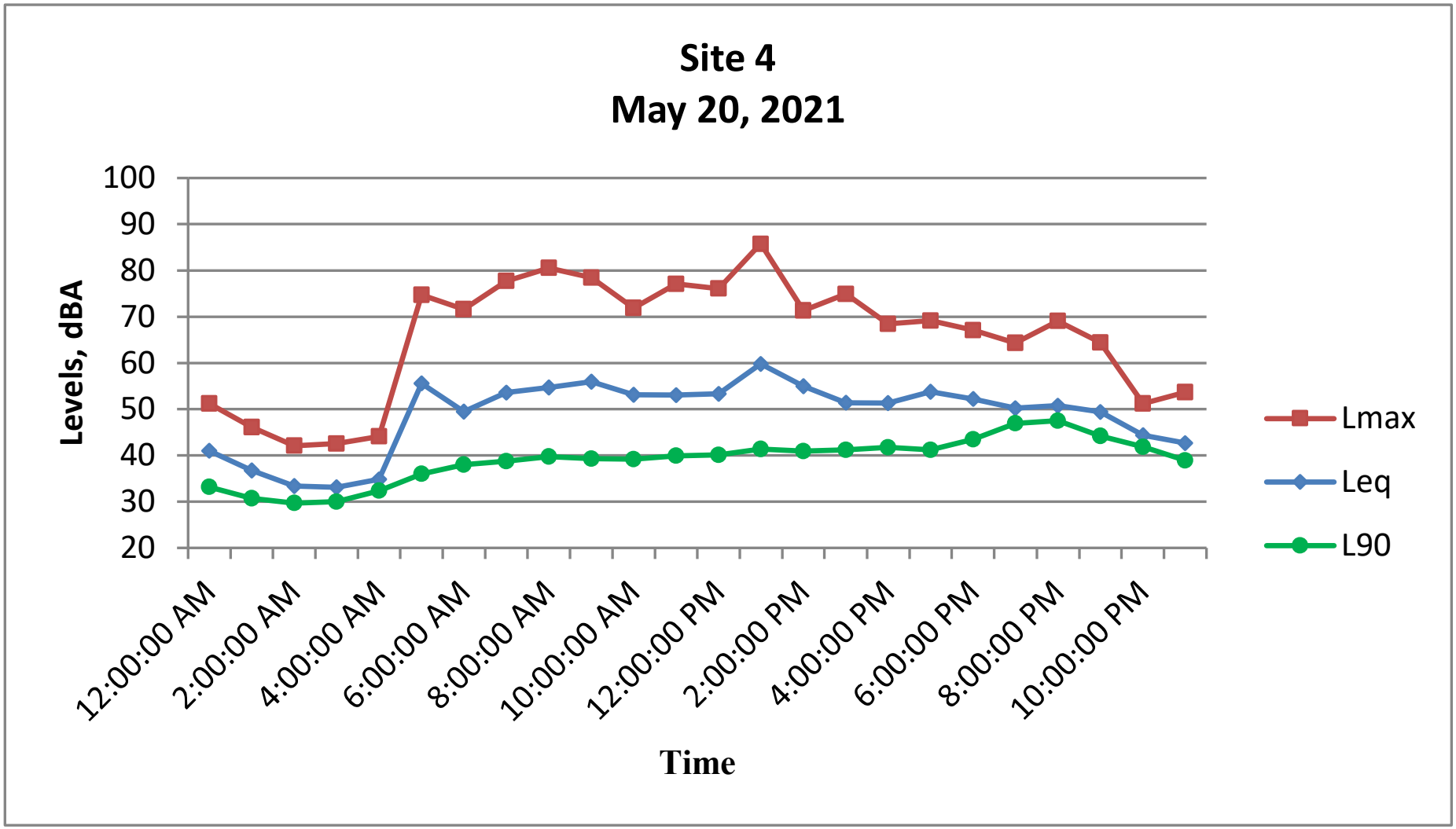
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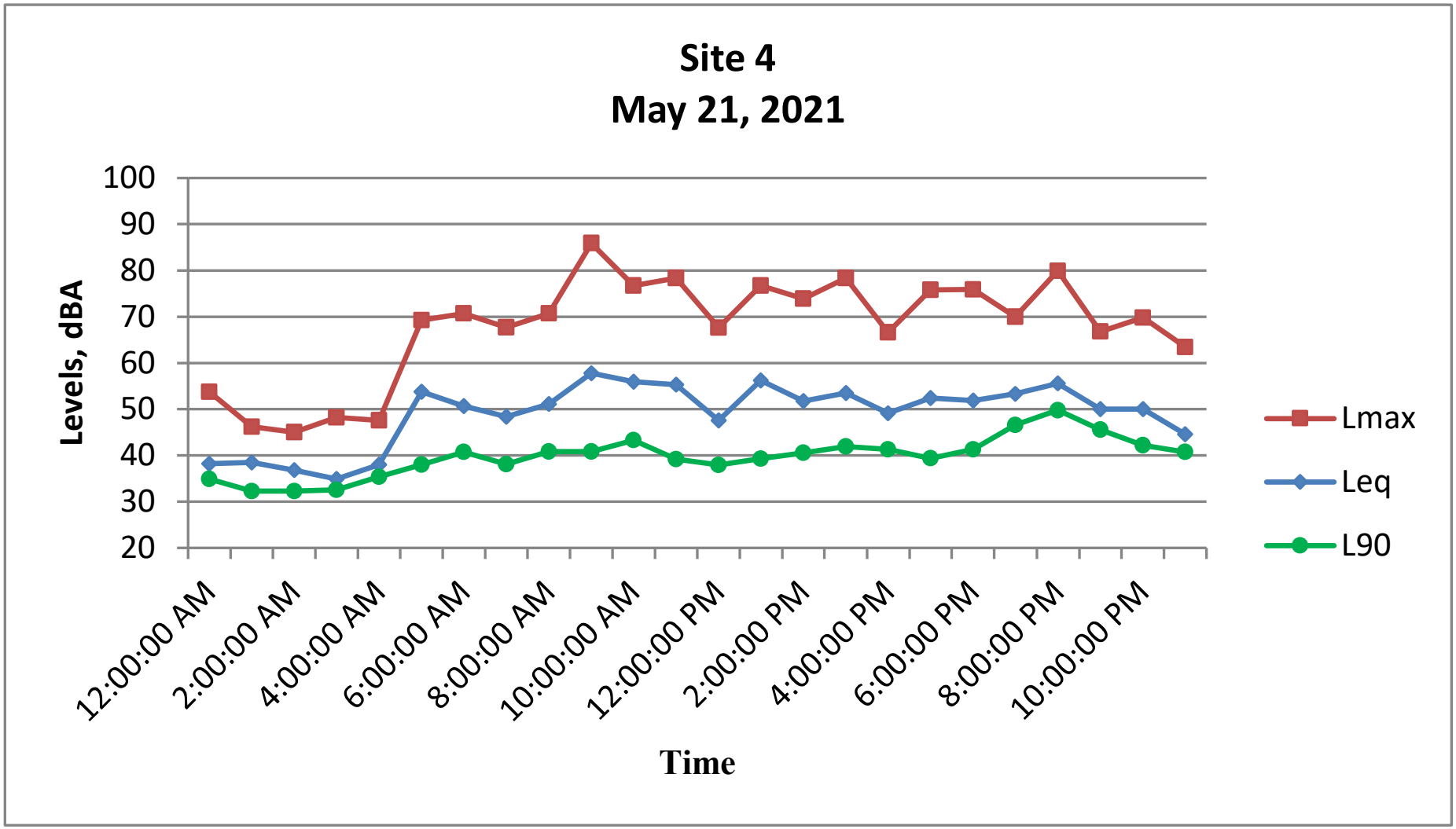
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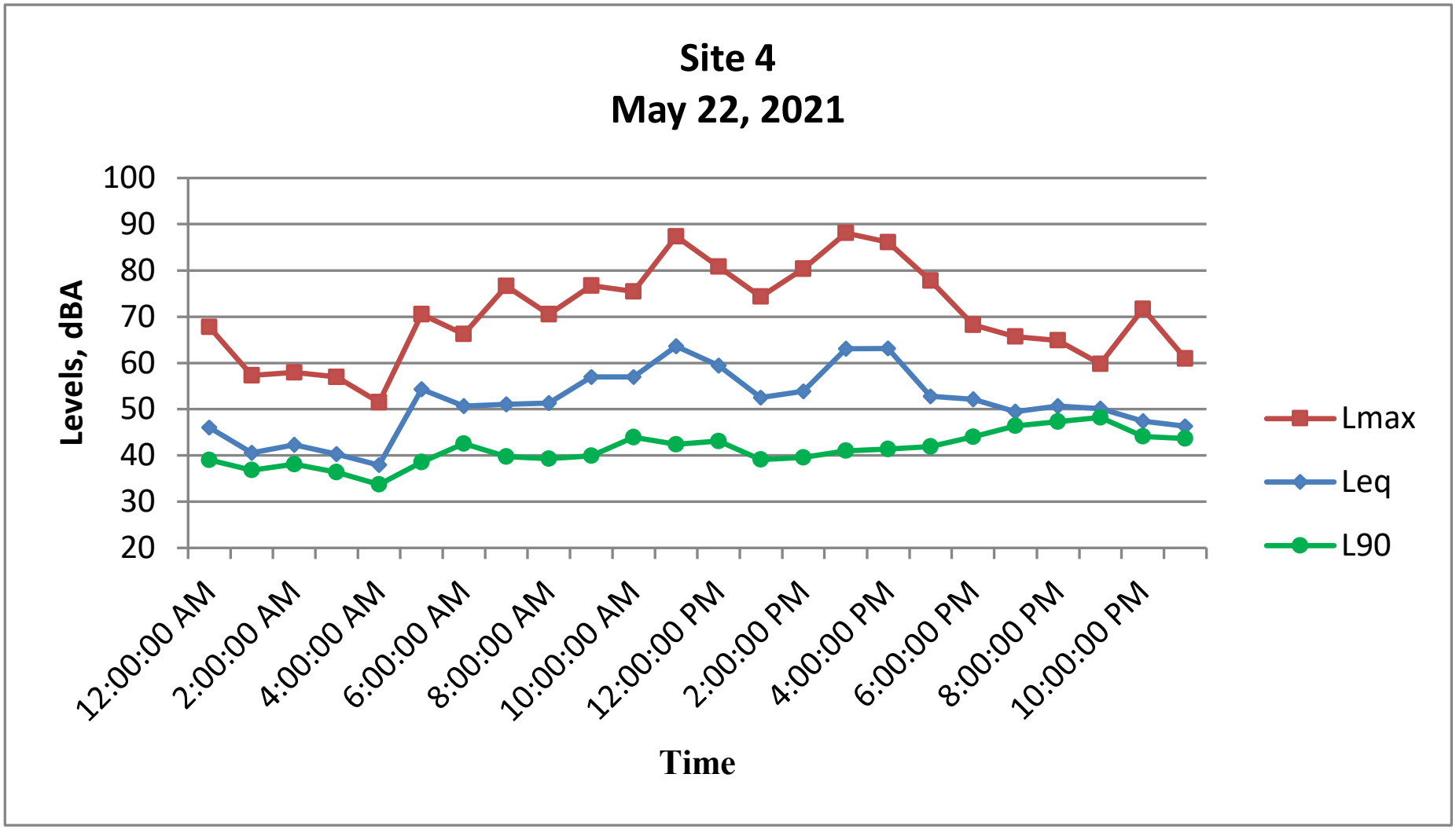
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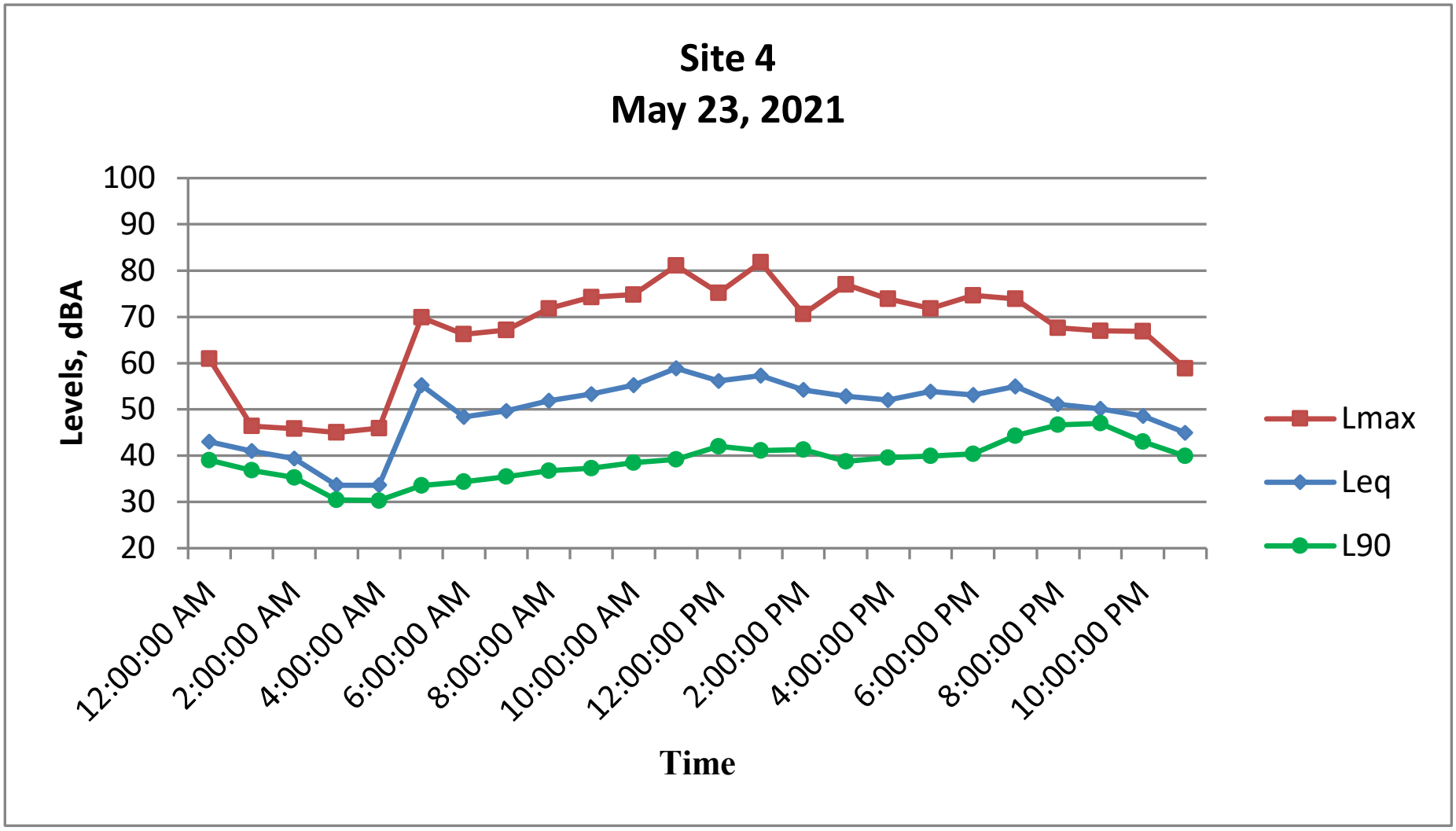
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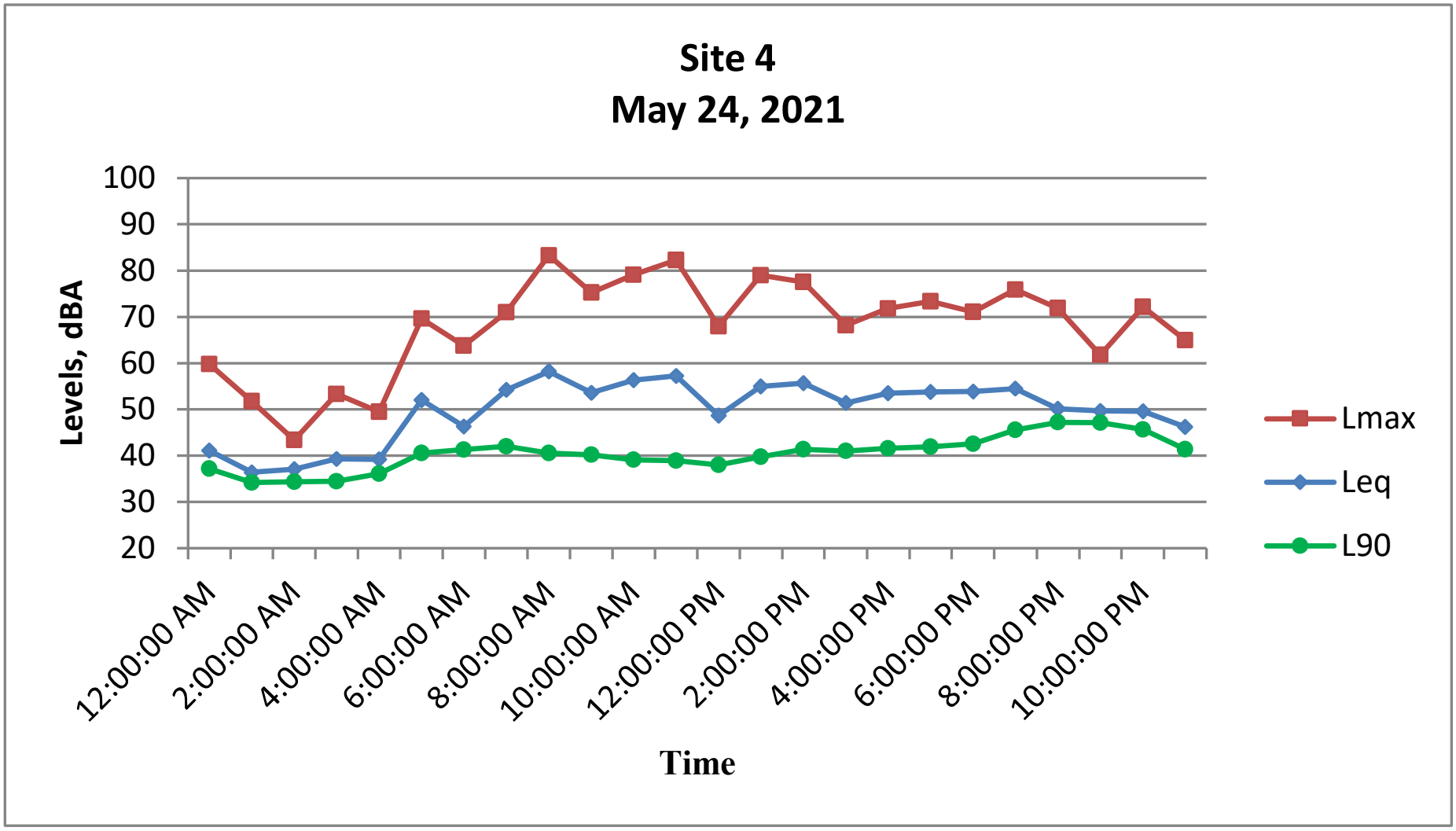
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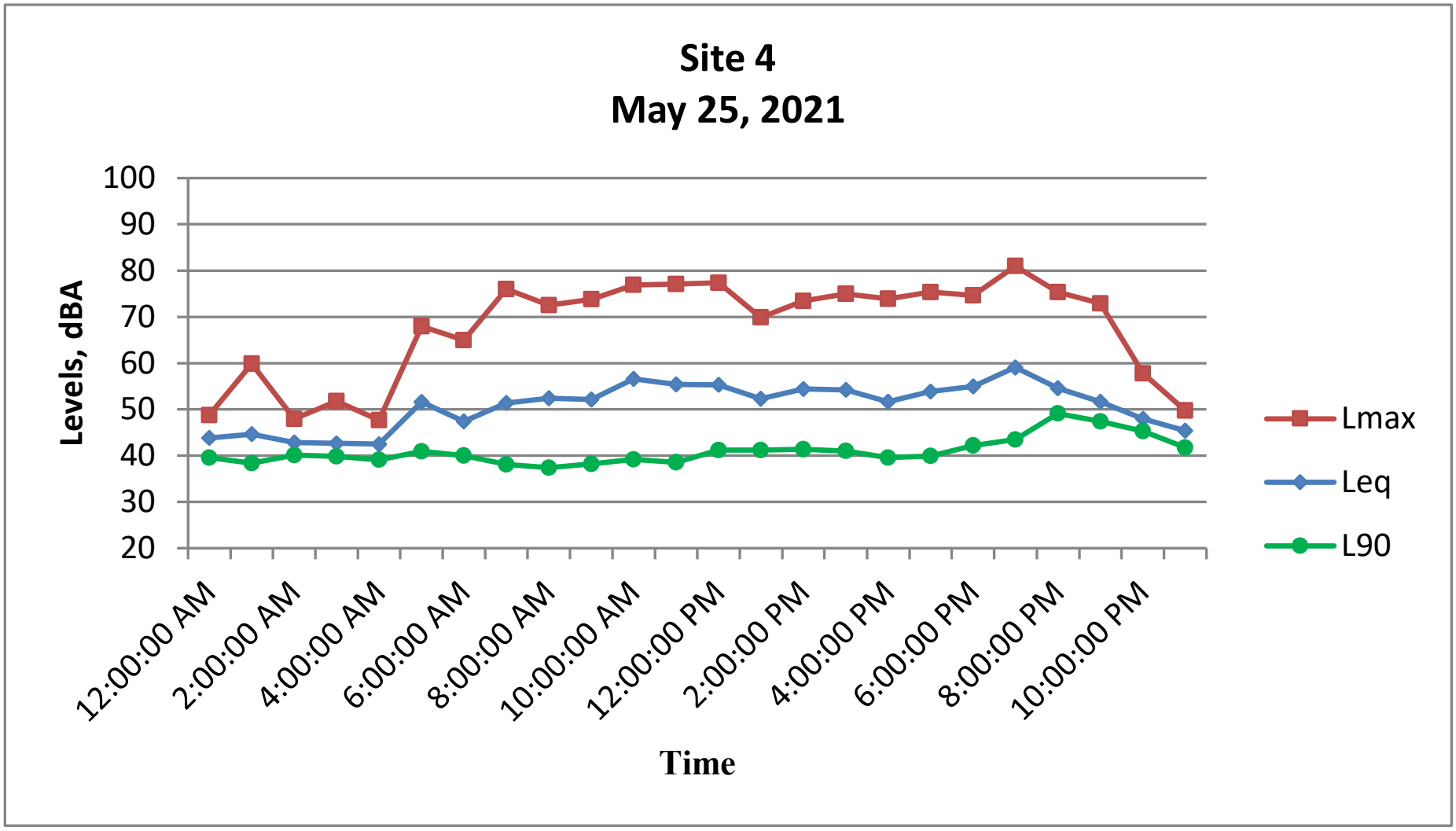
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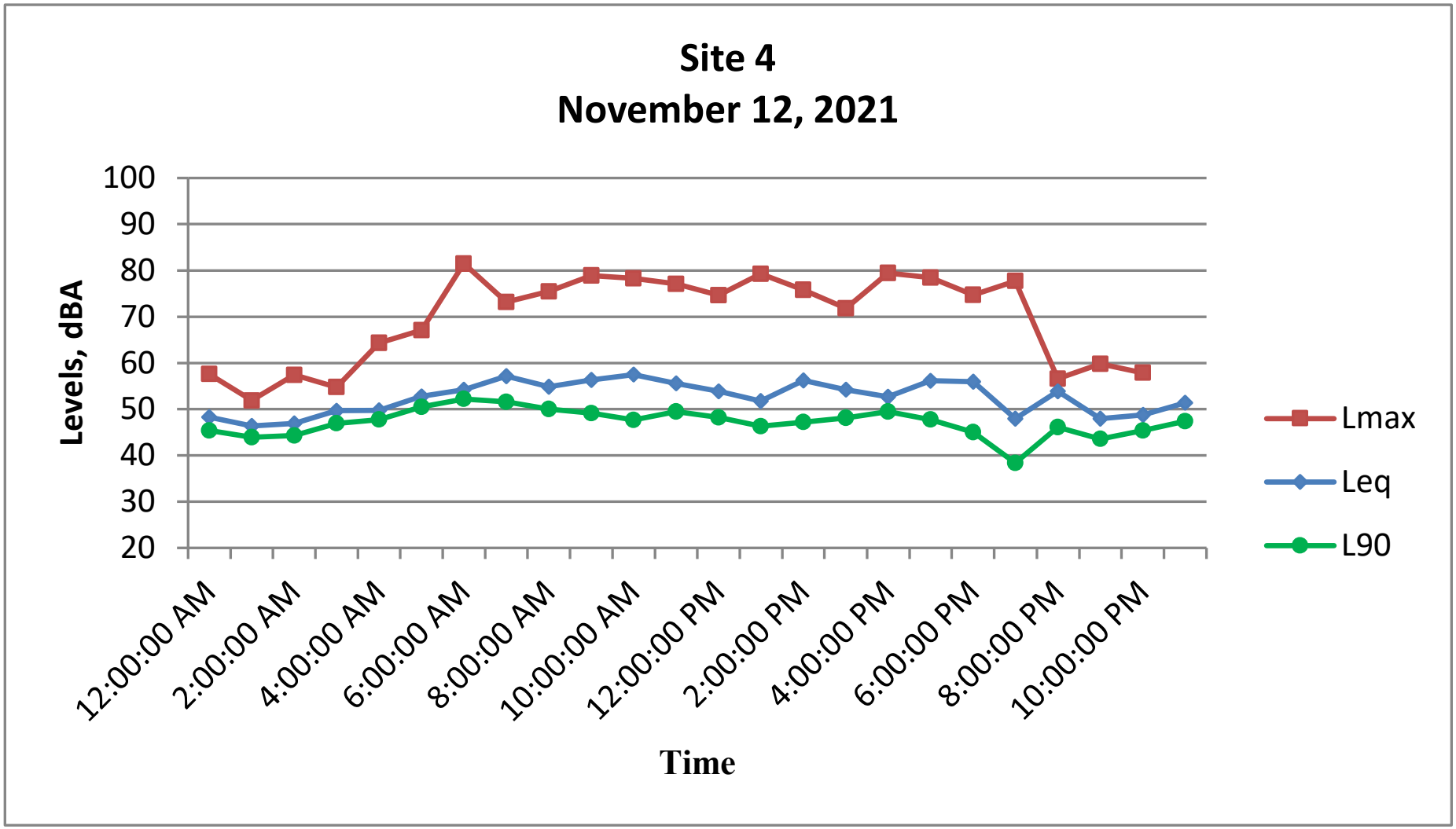
Site 4
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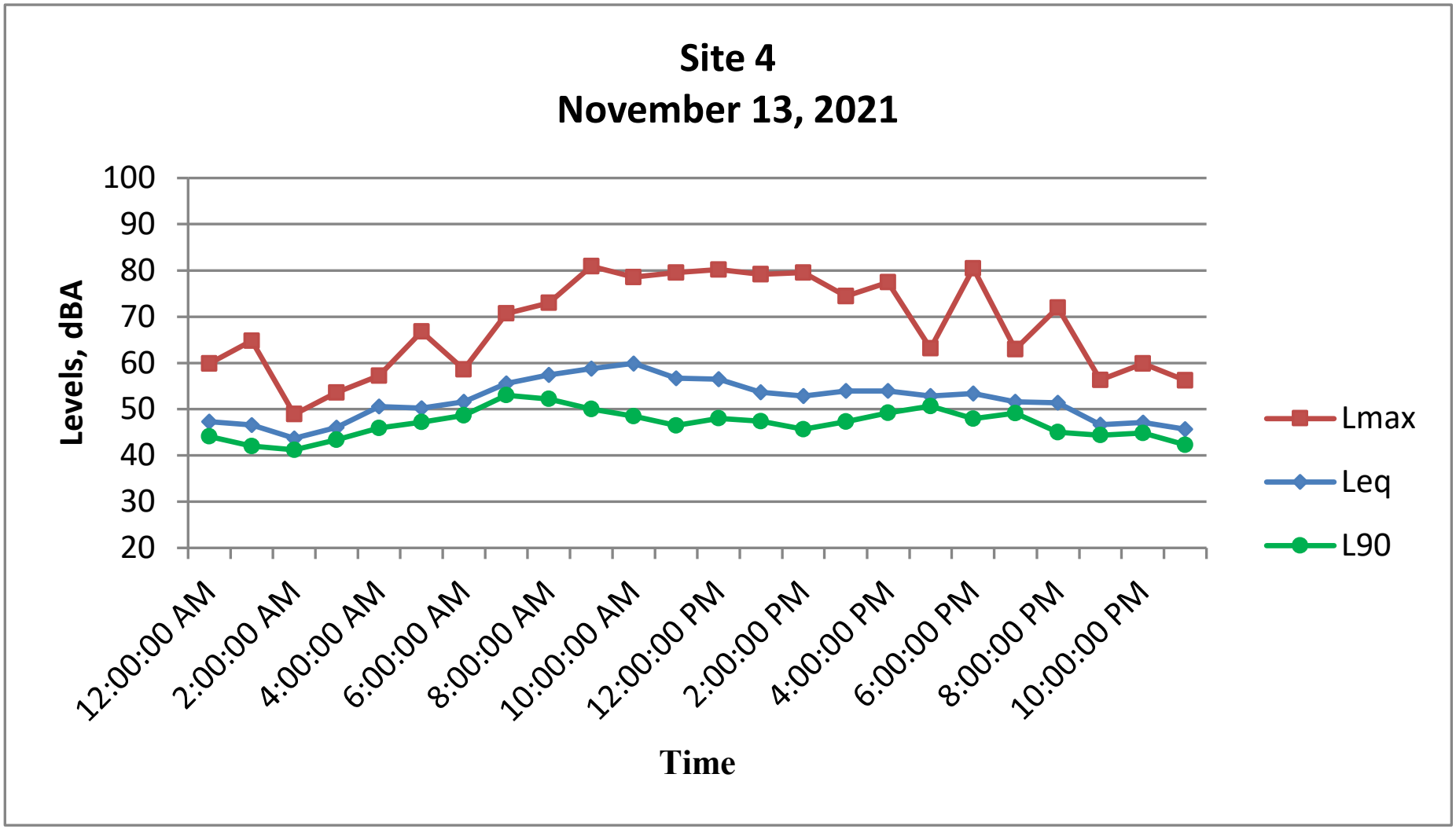
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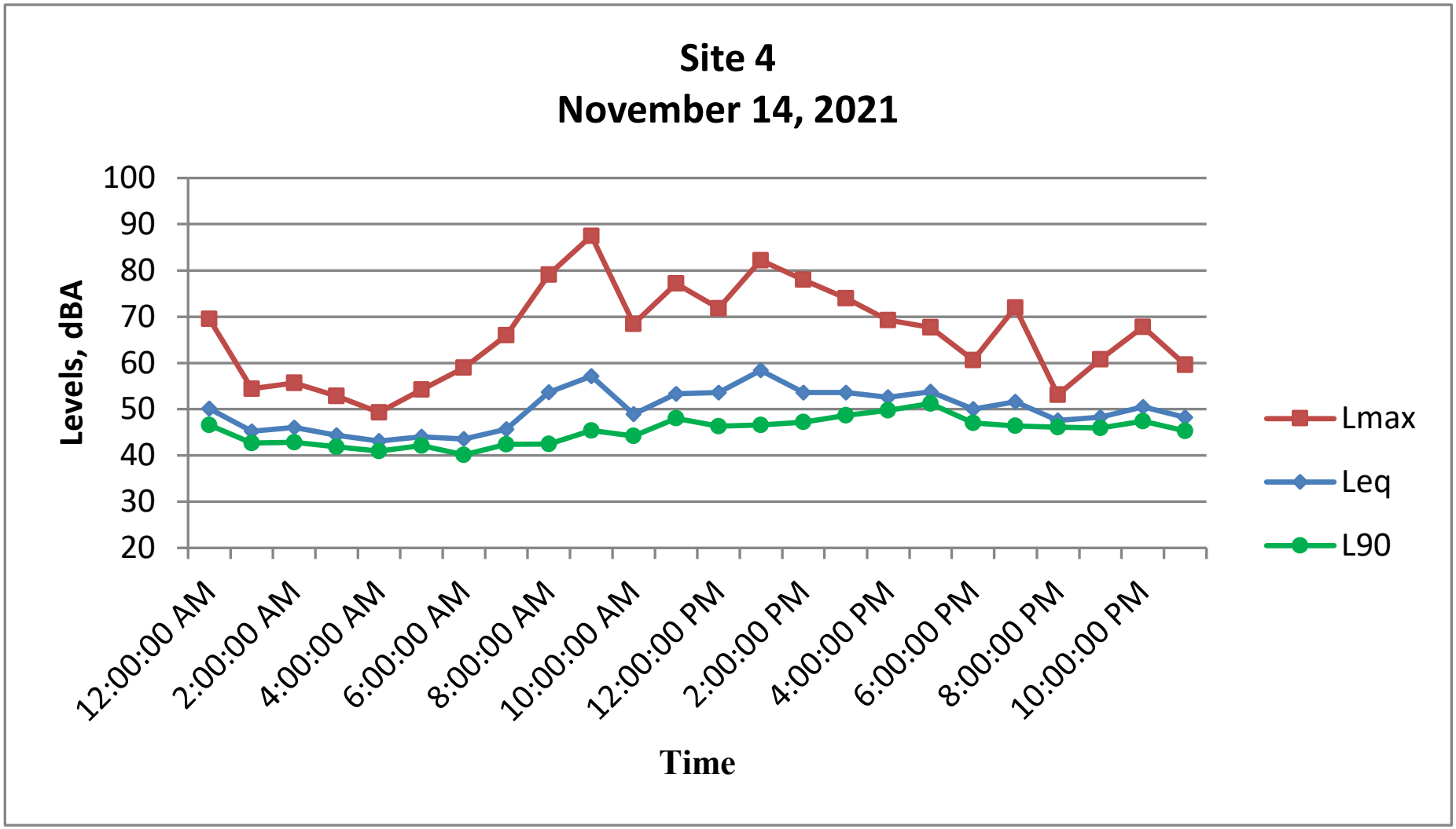
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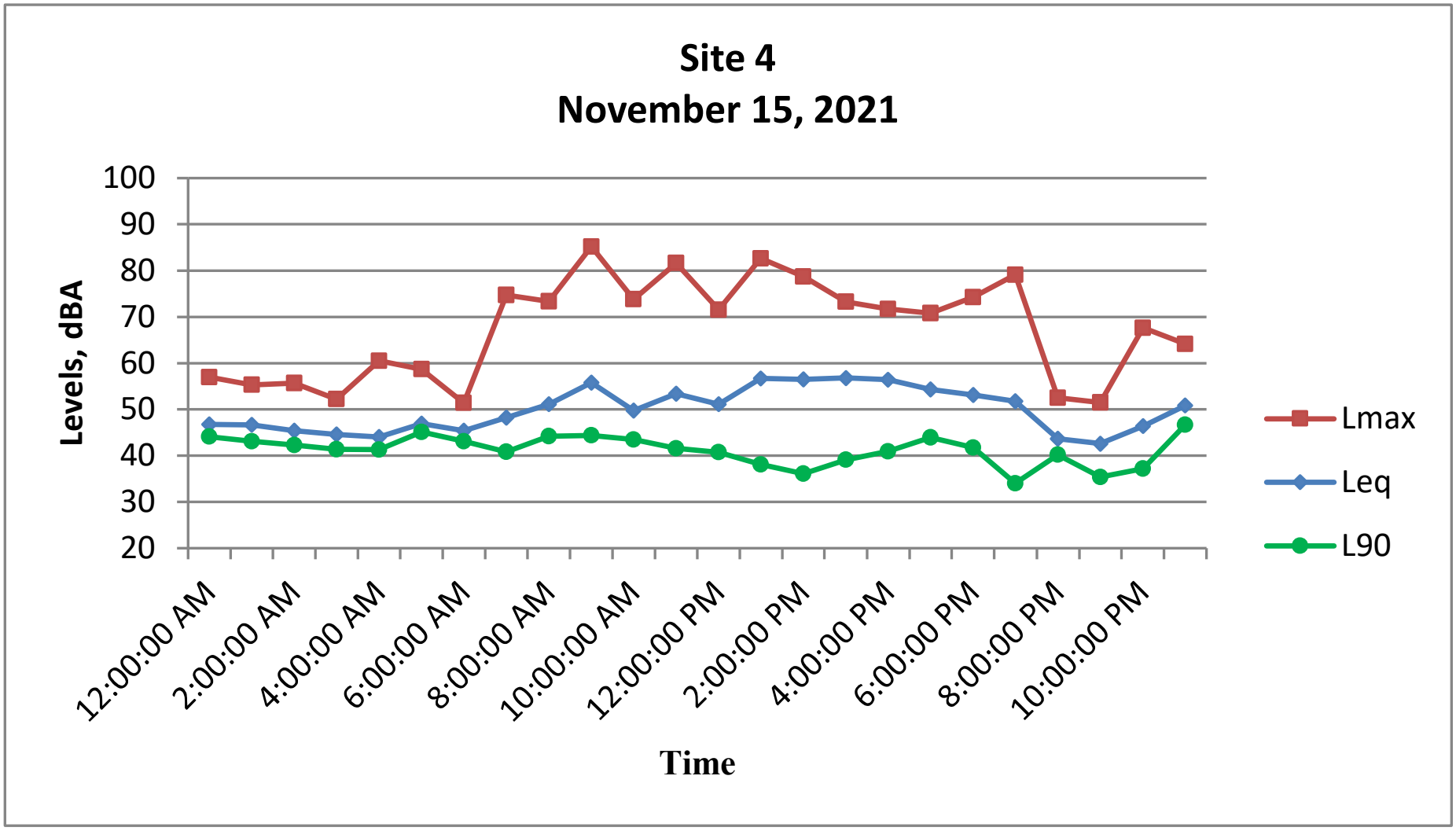
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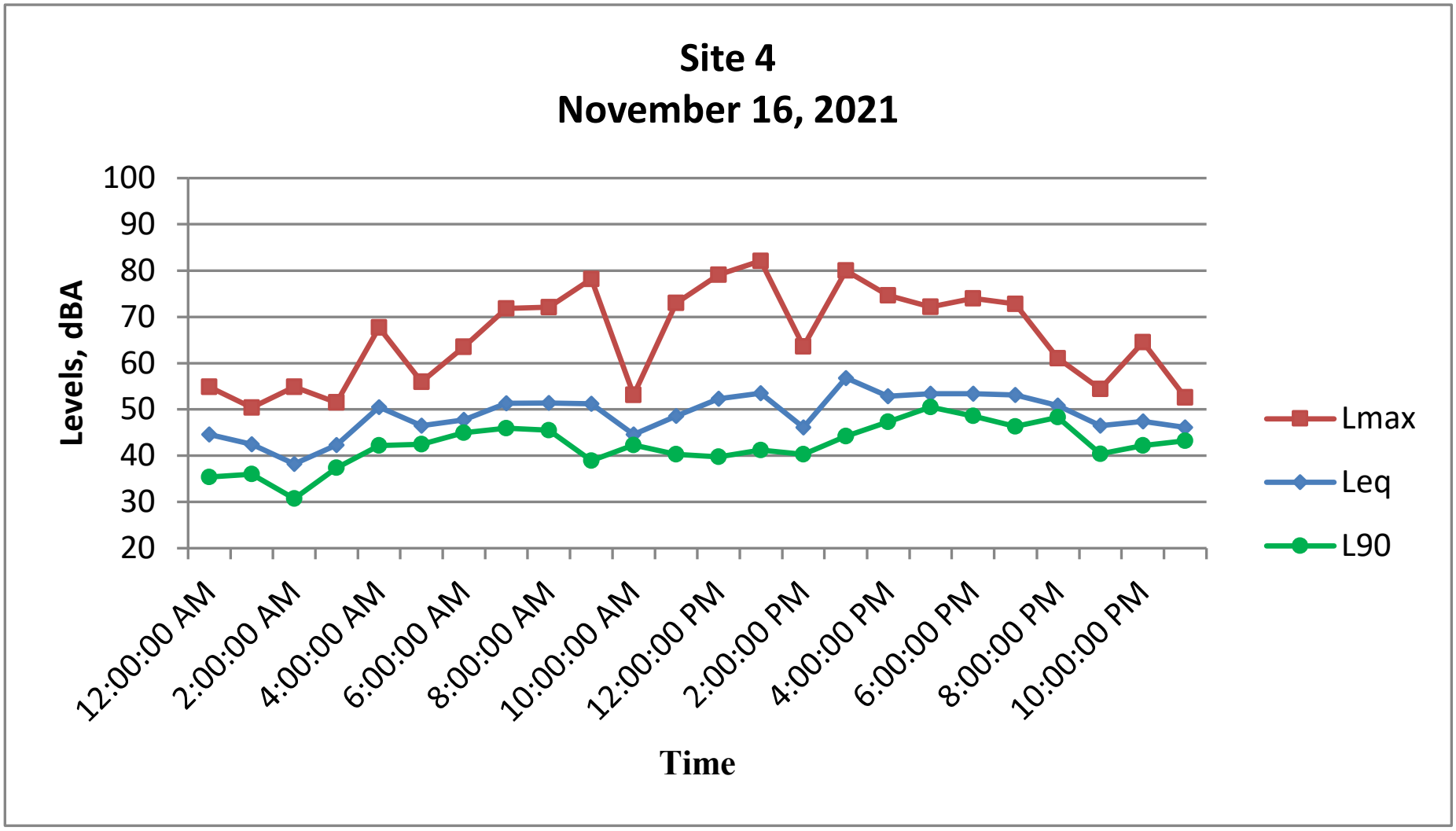
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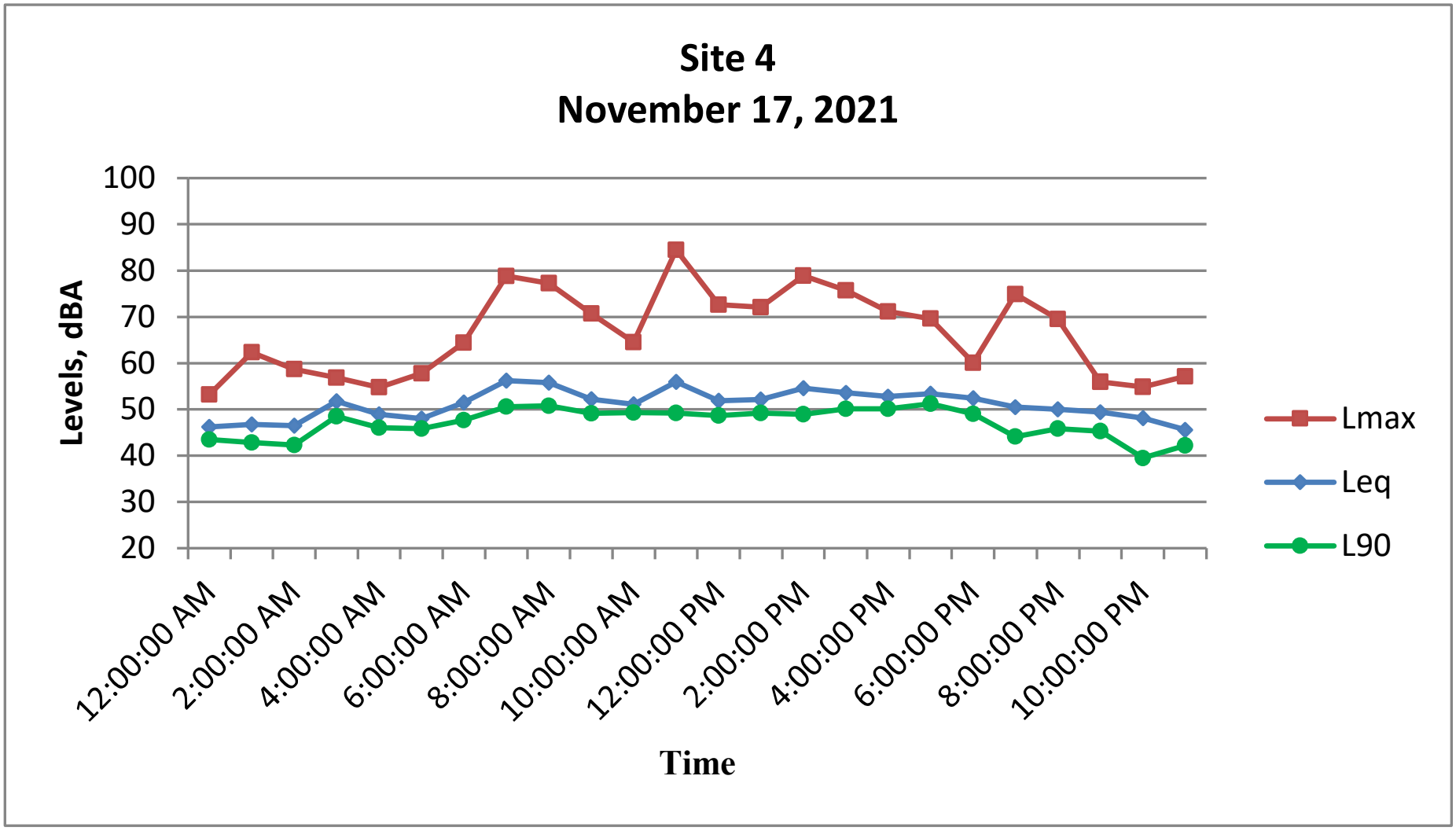
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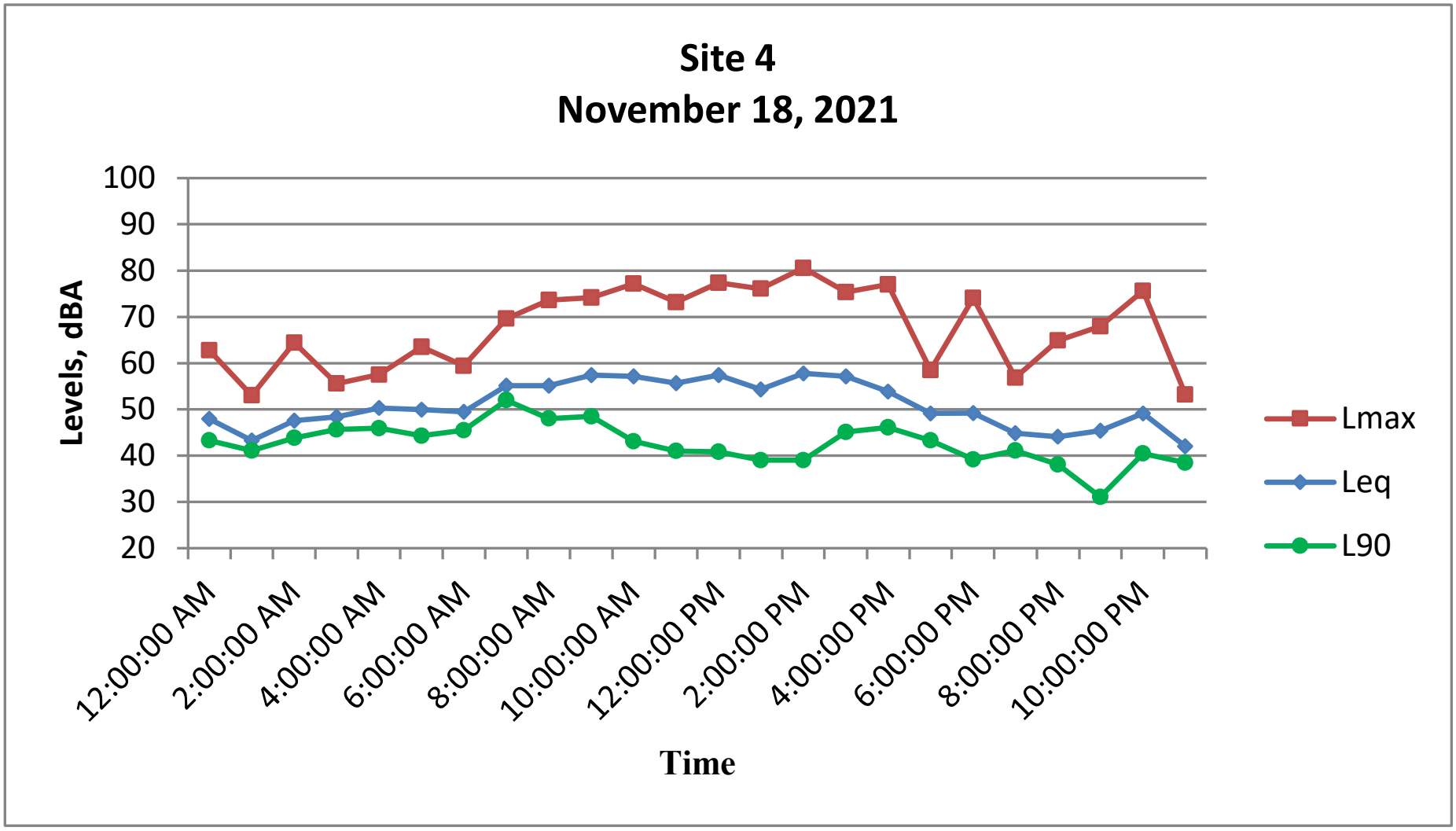
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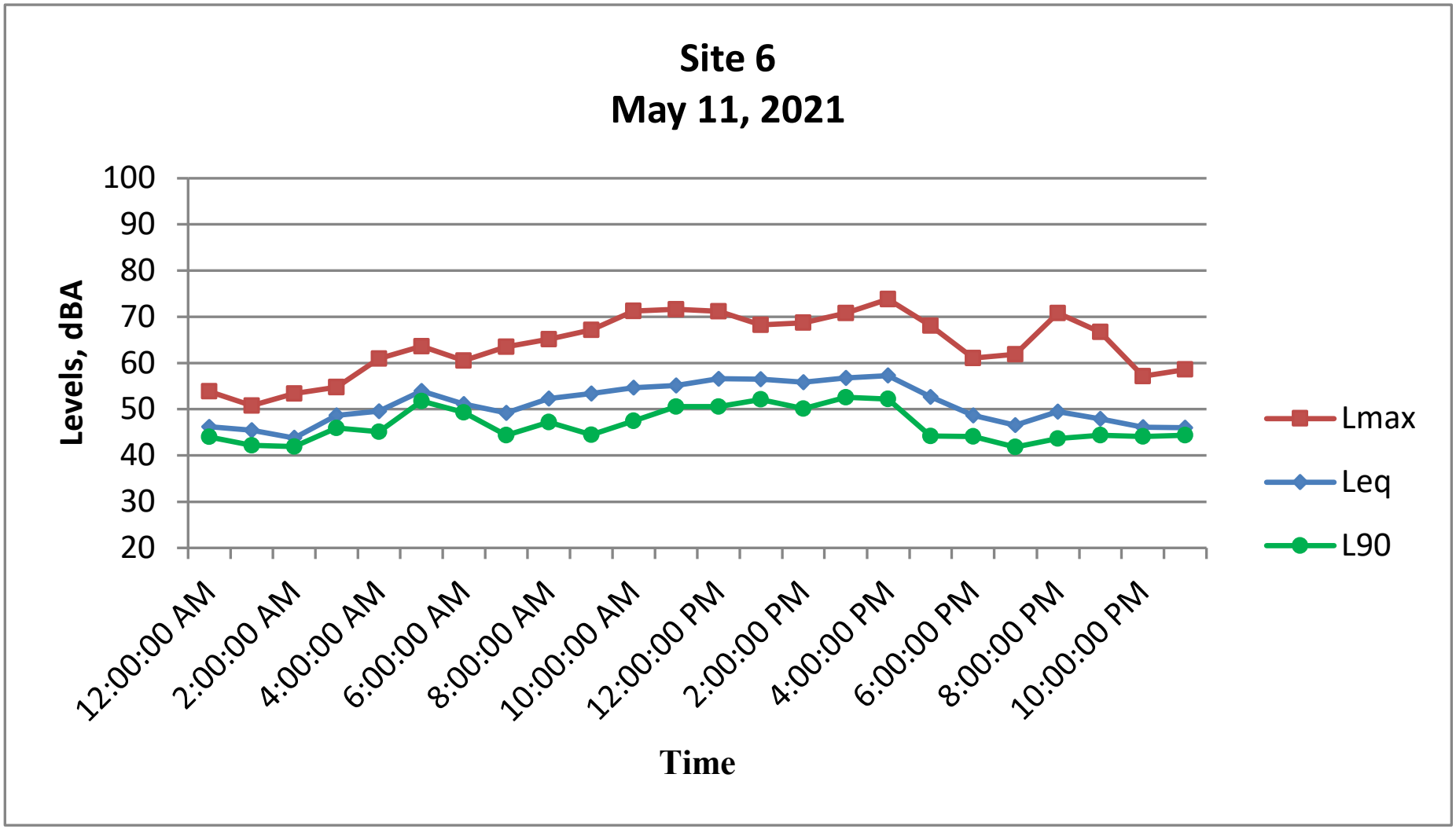
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May 11, 2021
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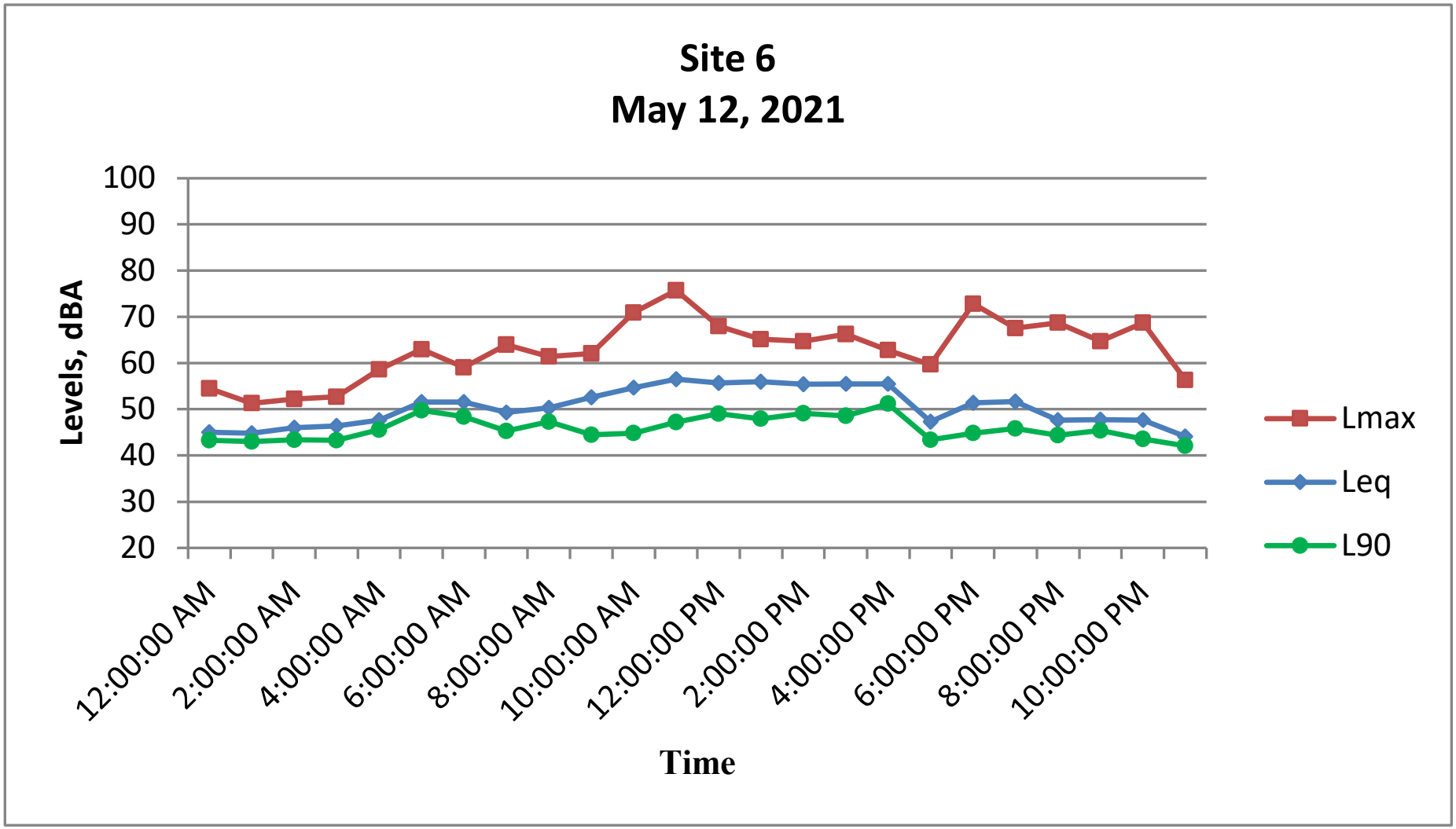
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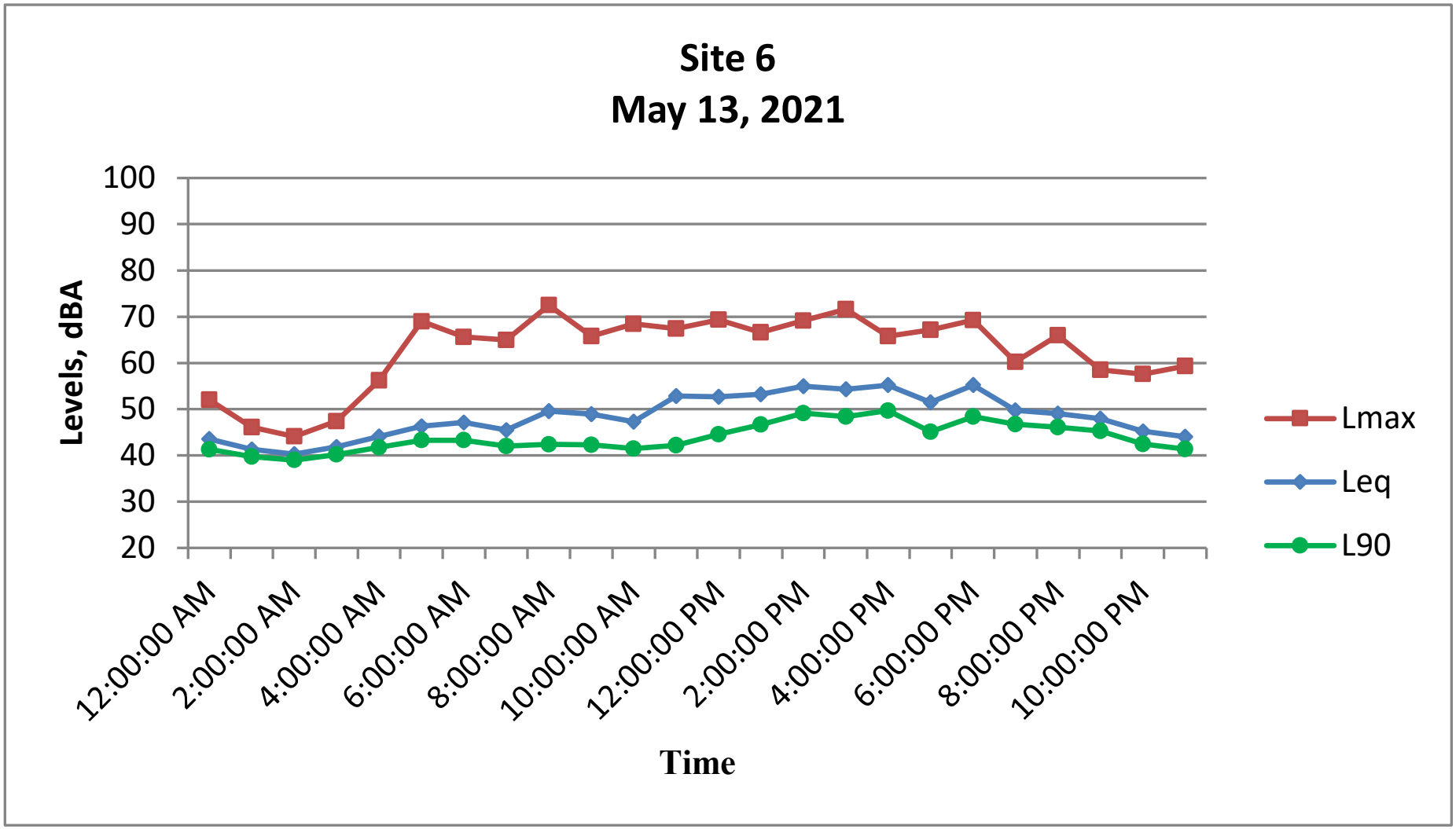
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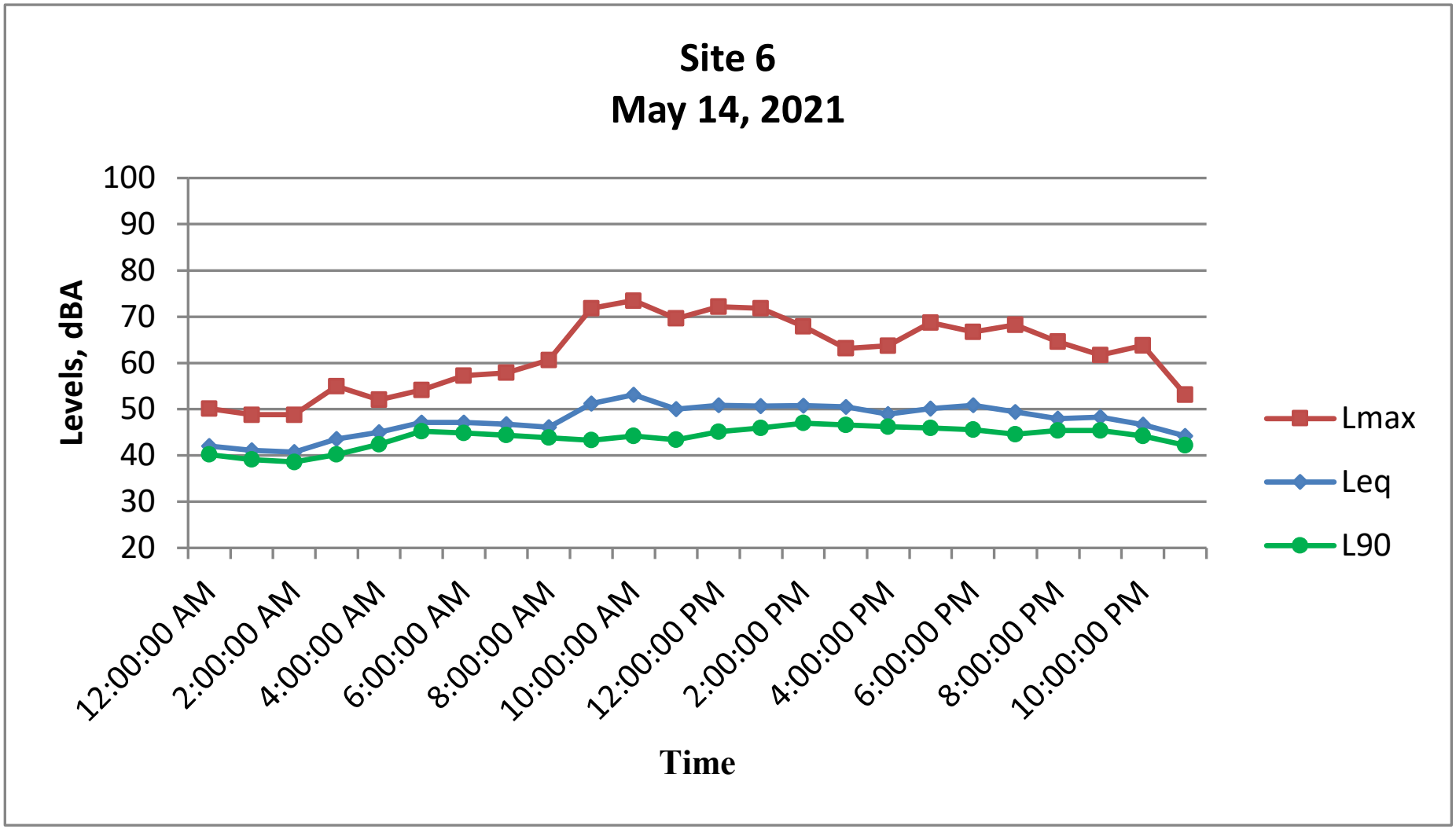
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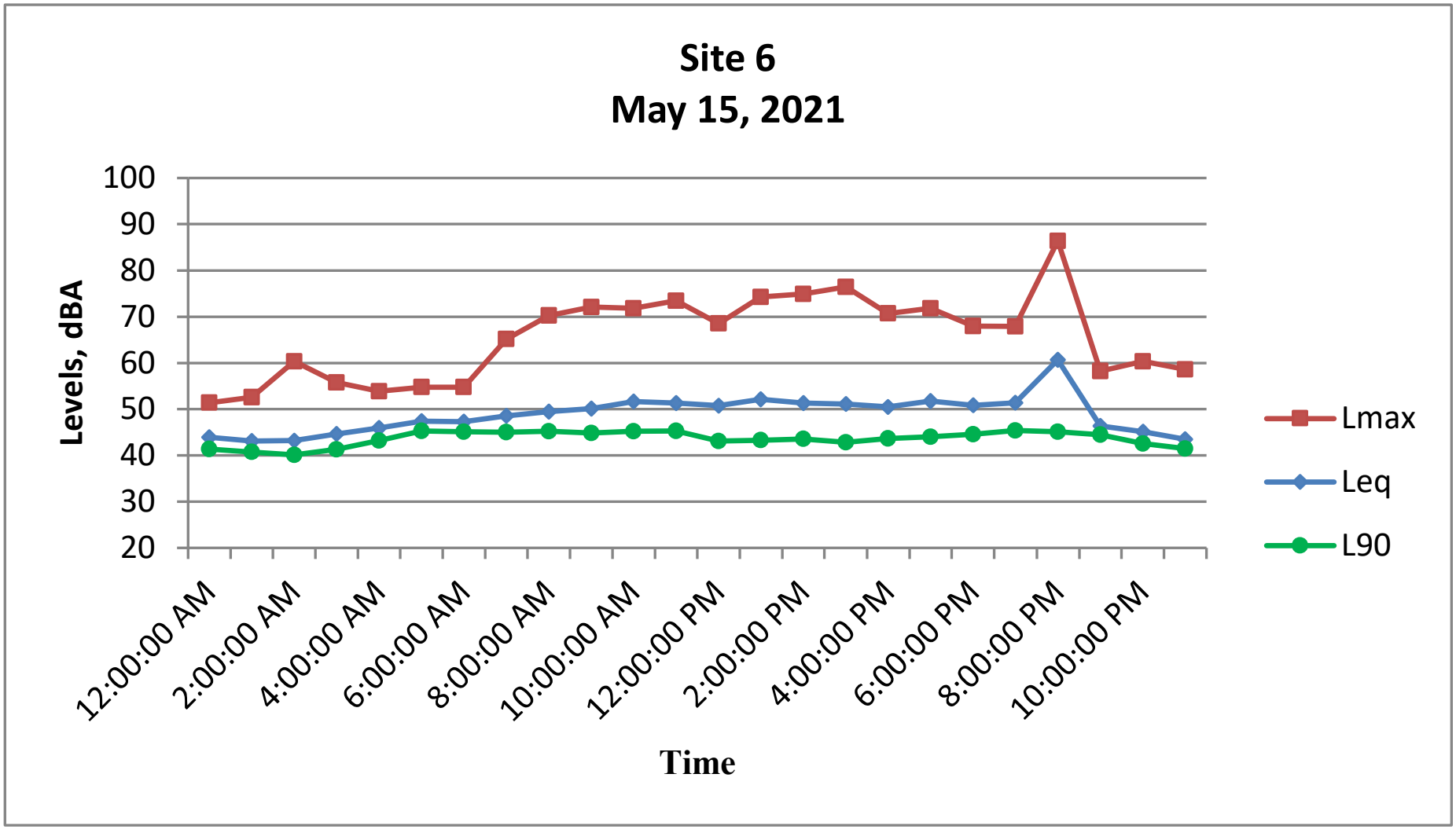
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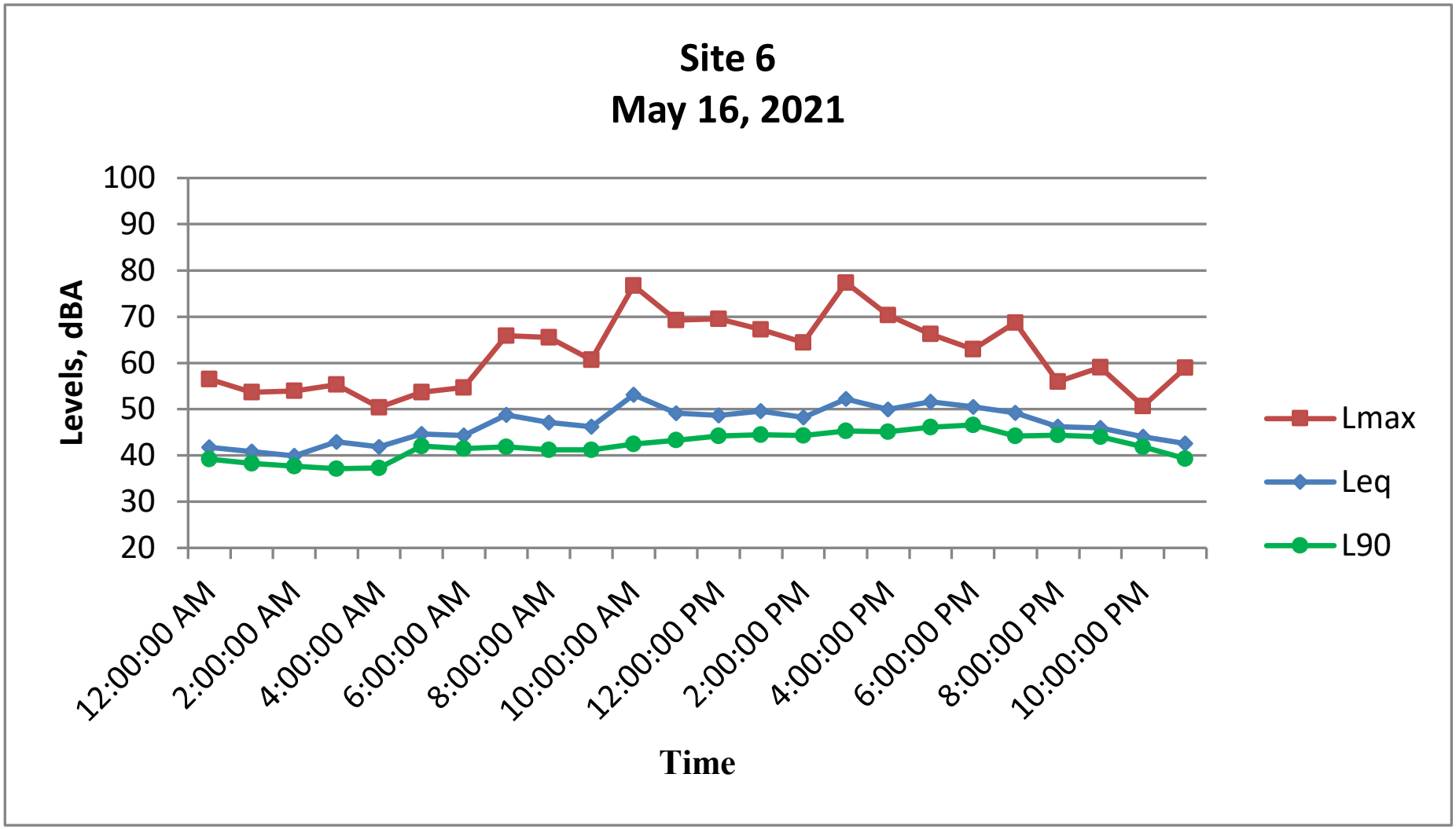
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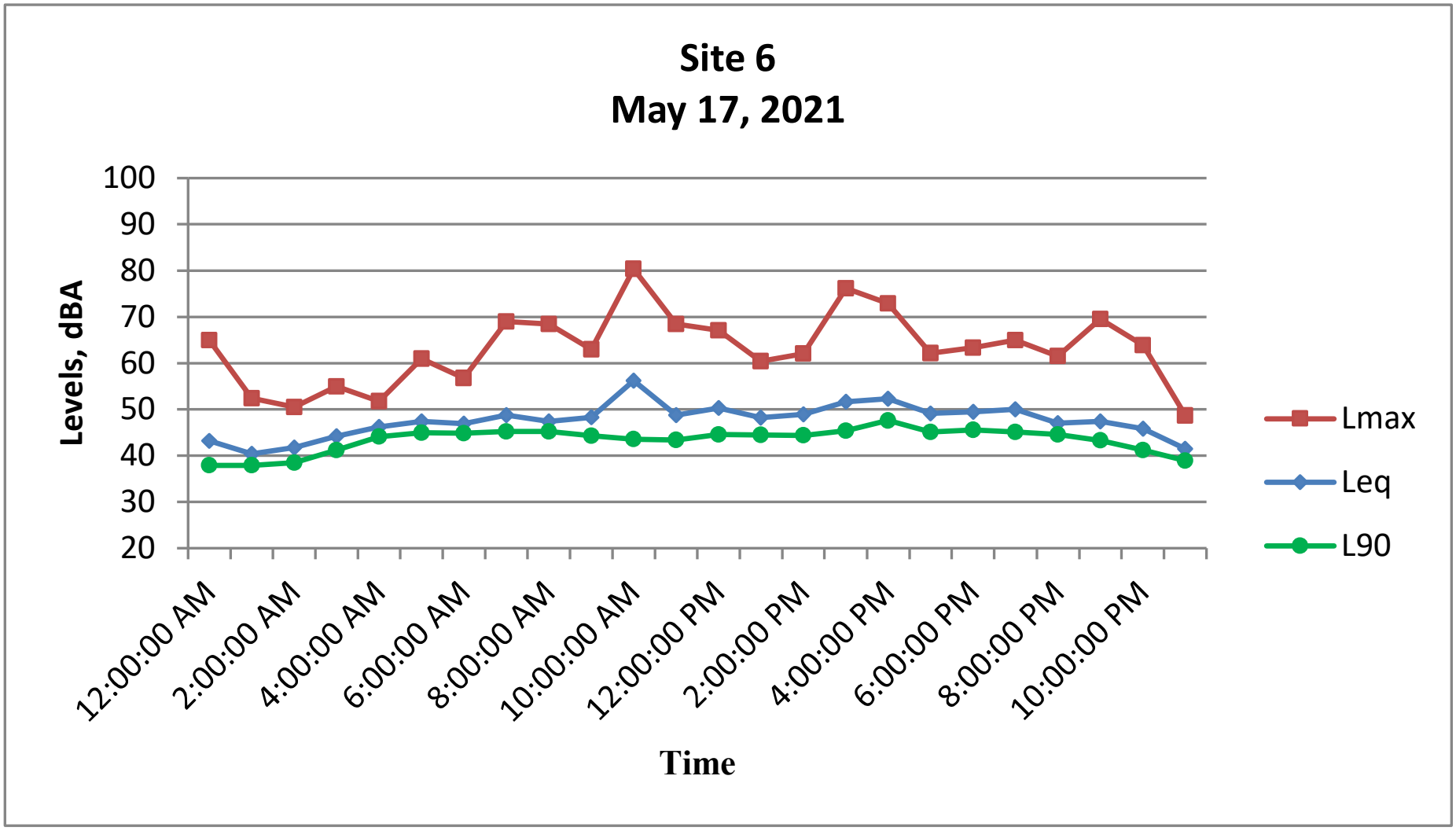
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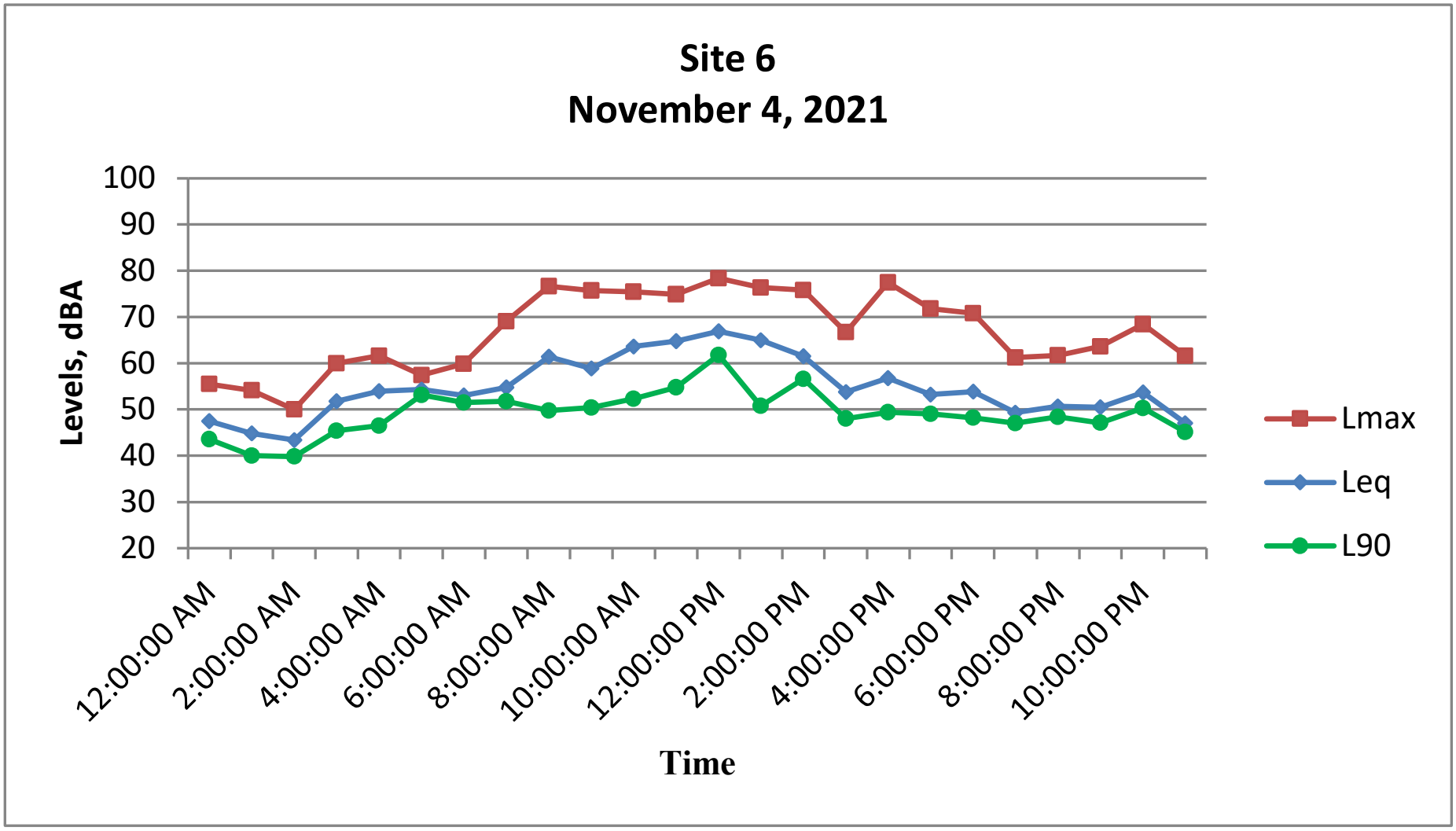
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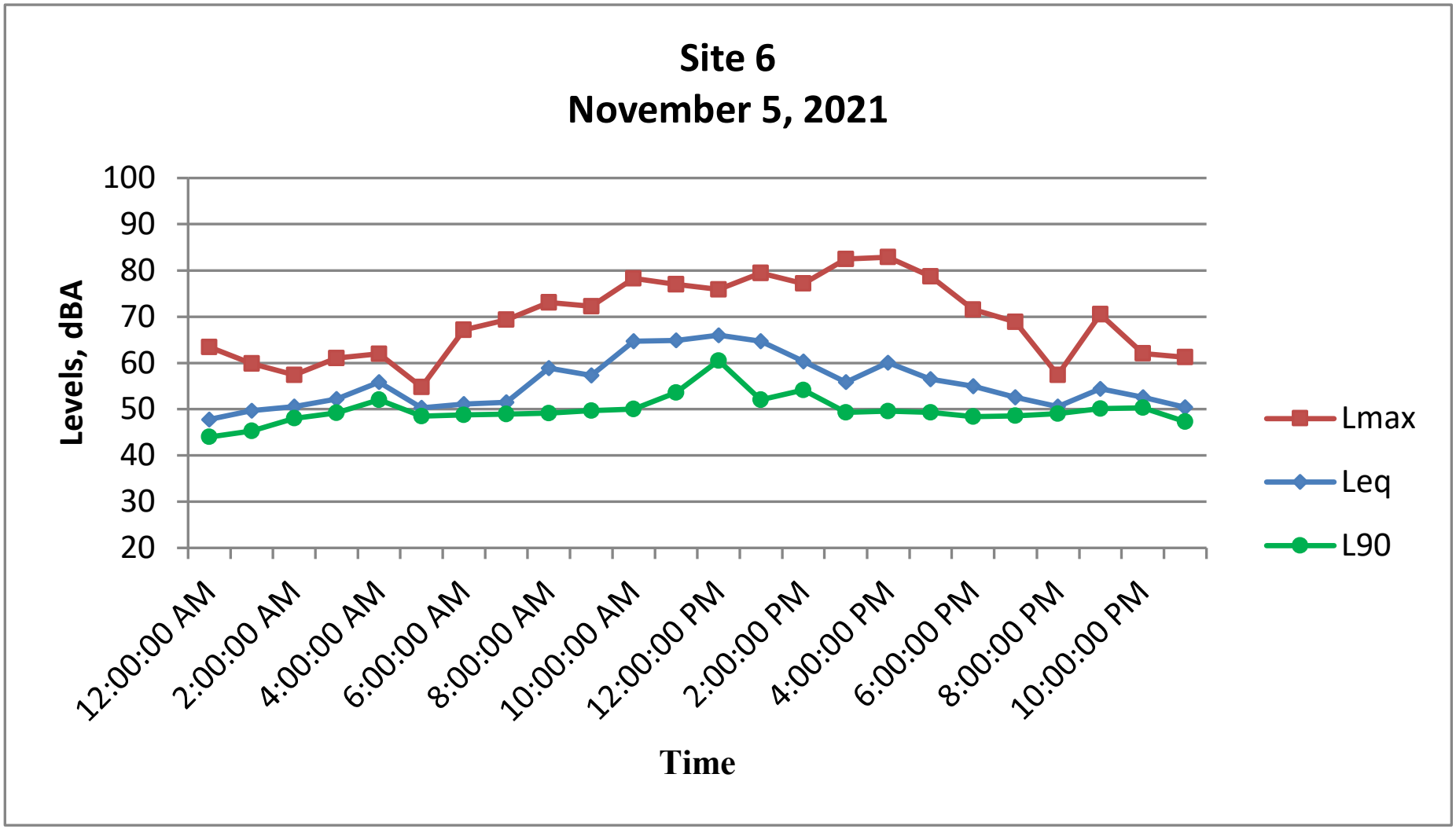
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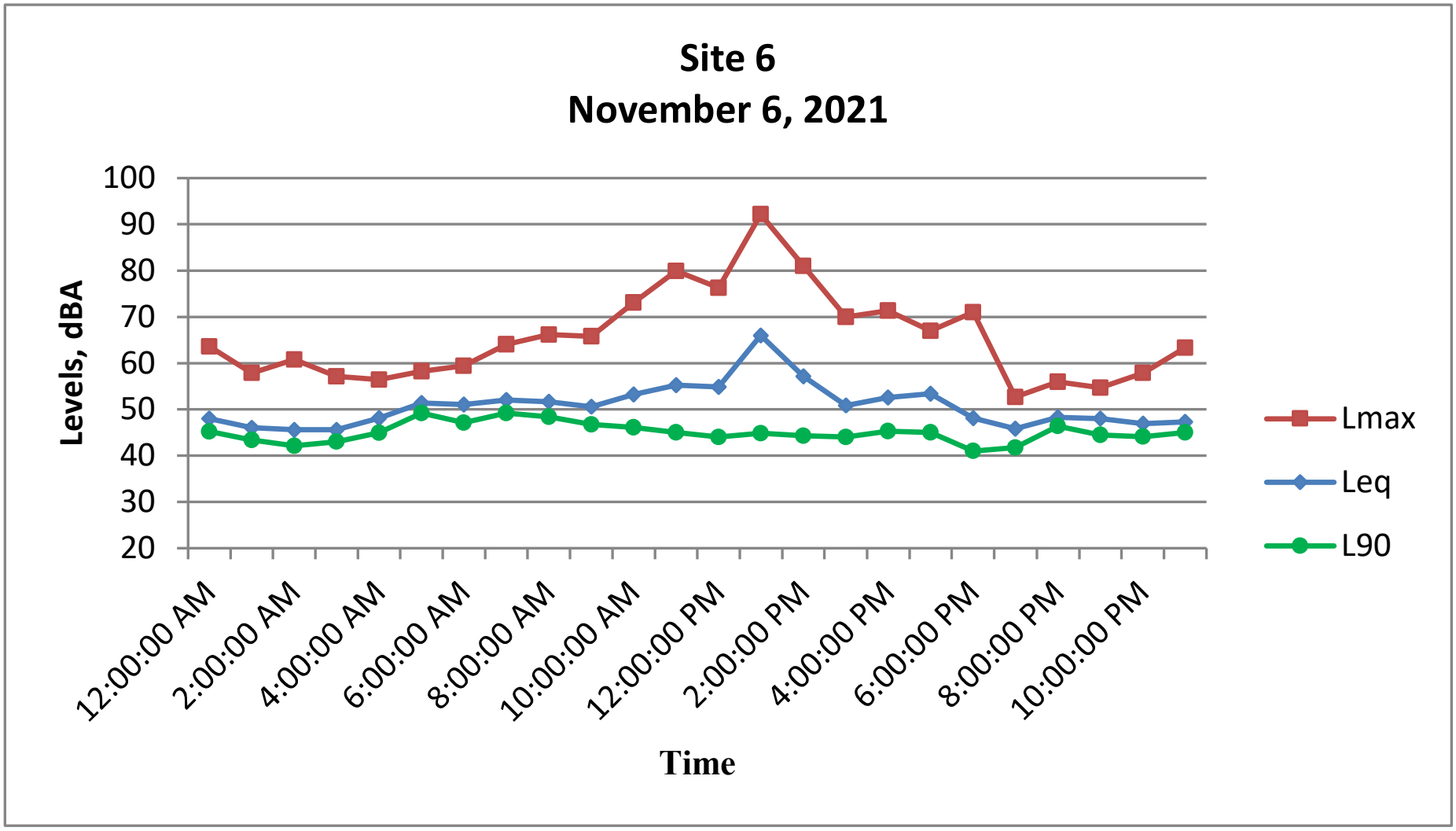
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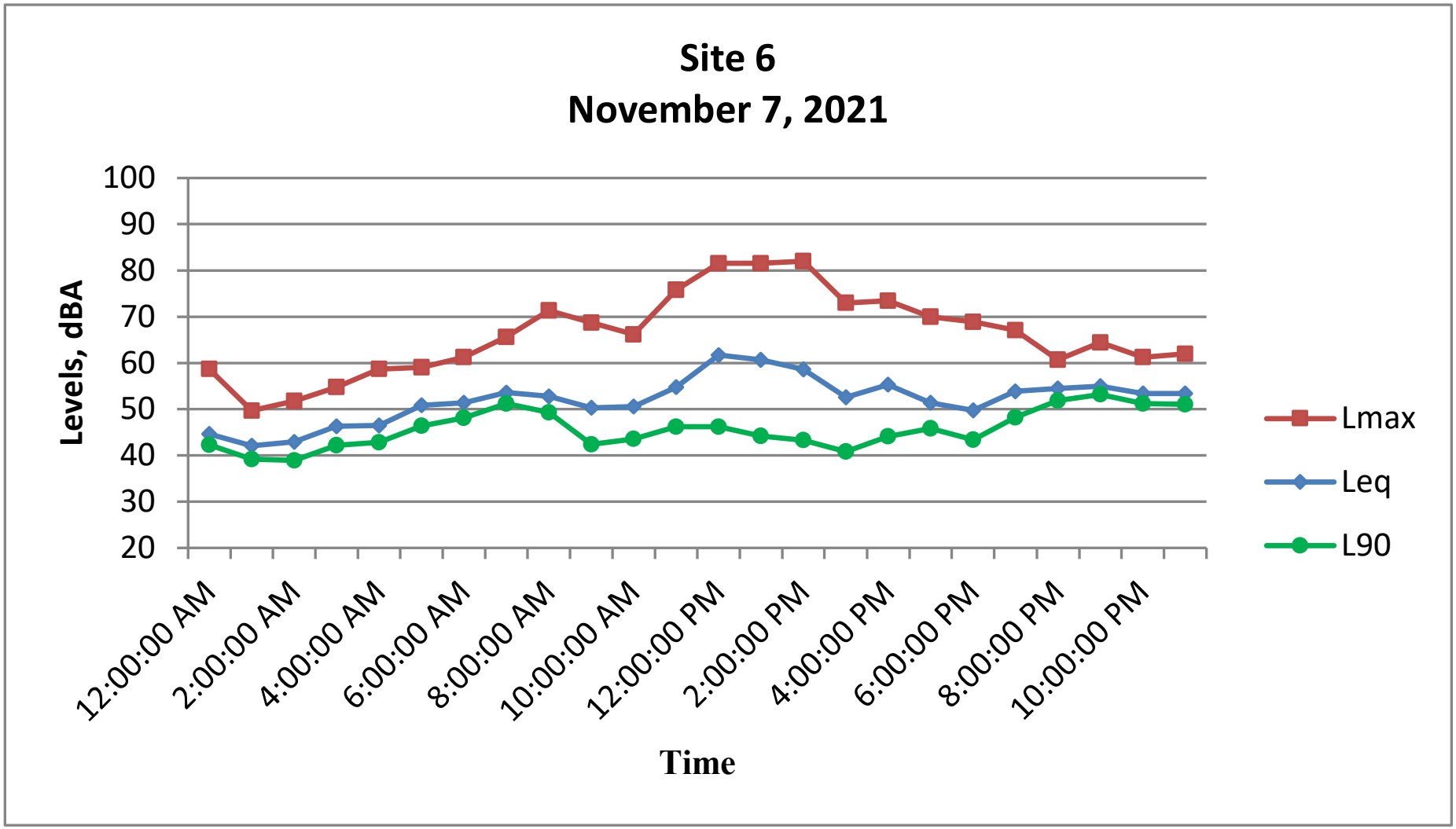
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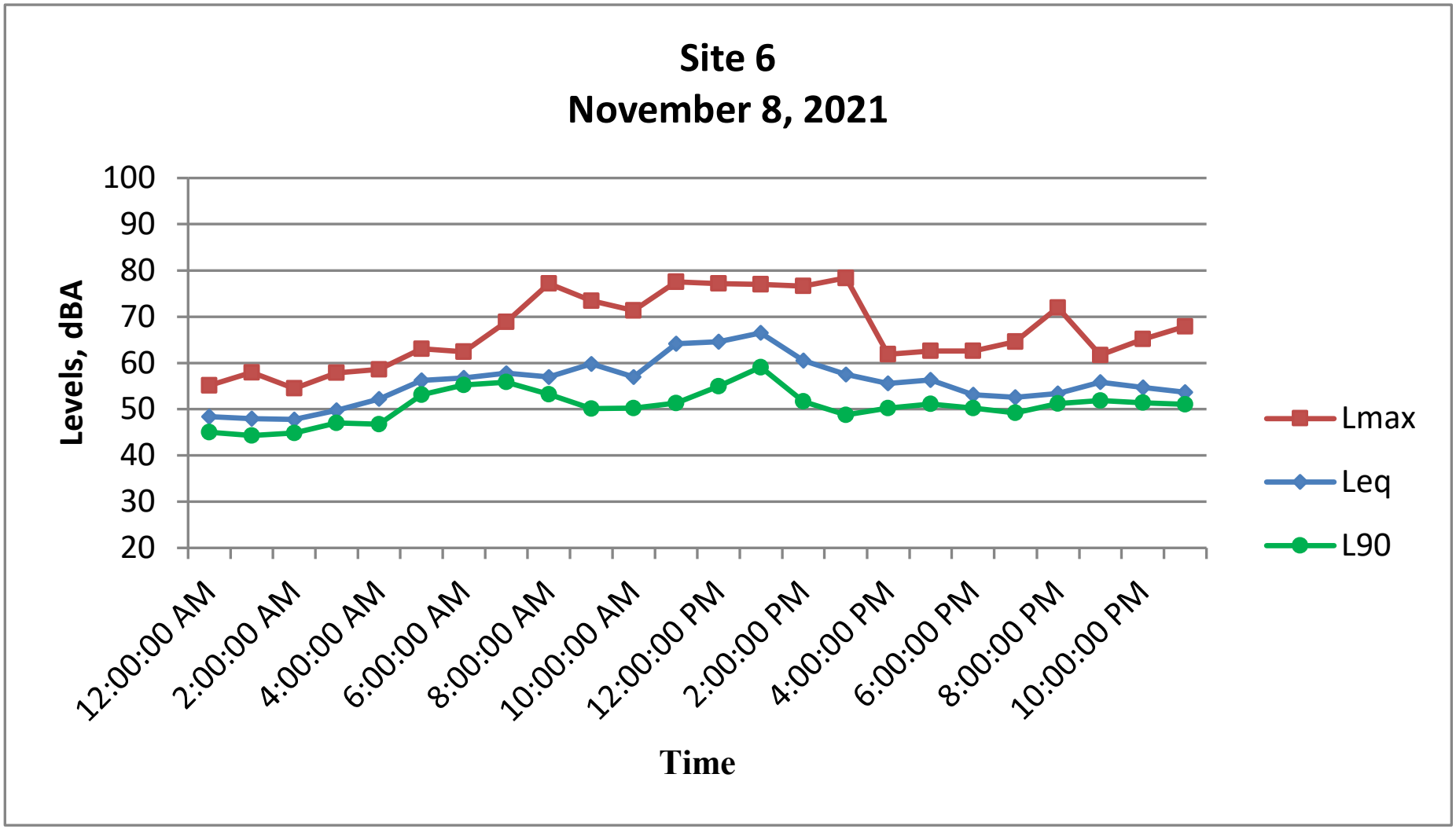
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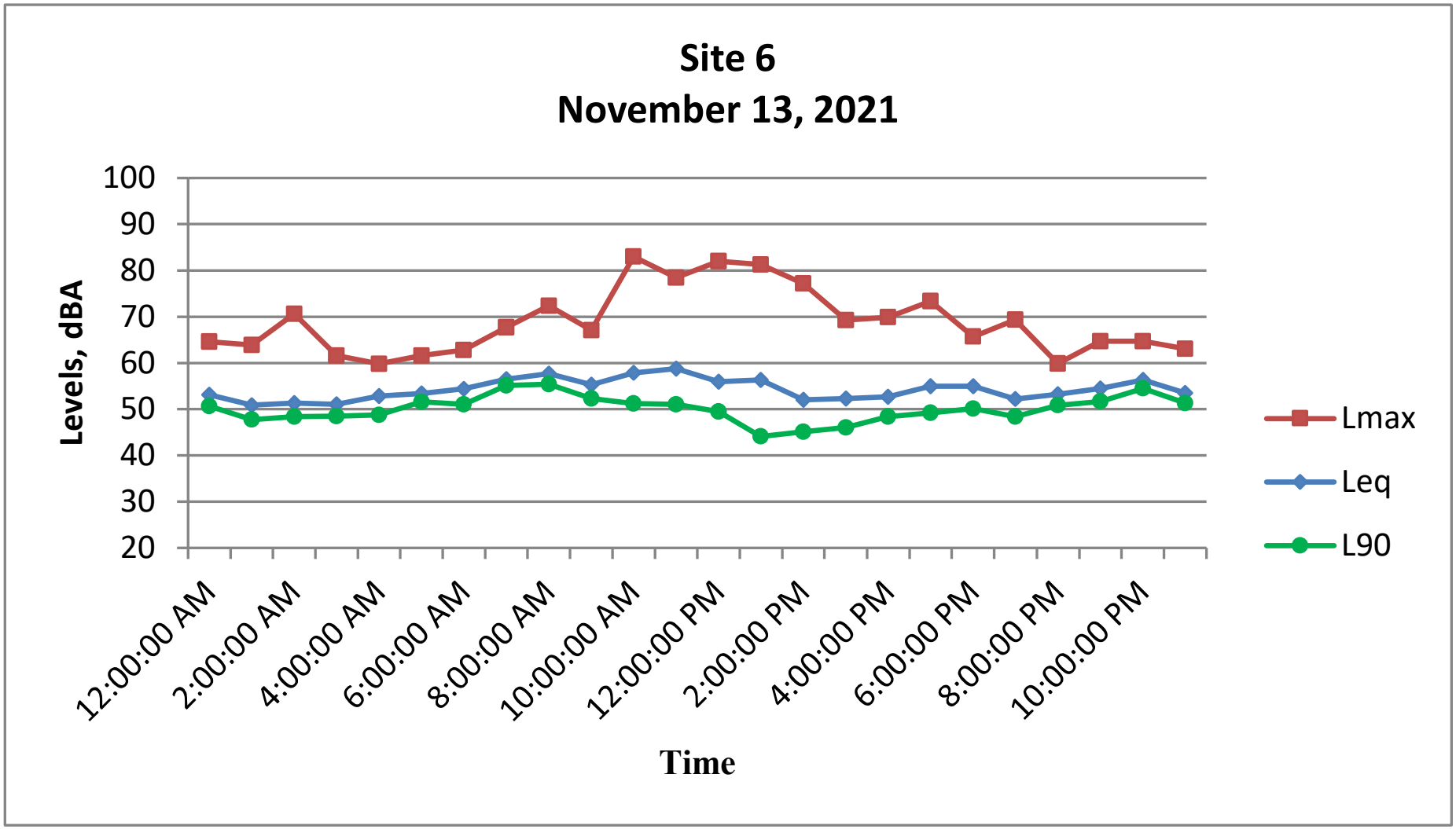
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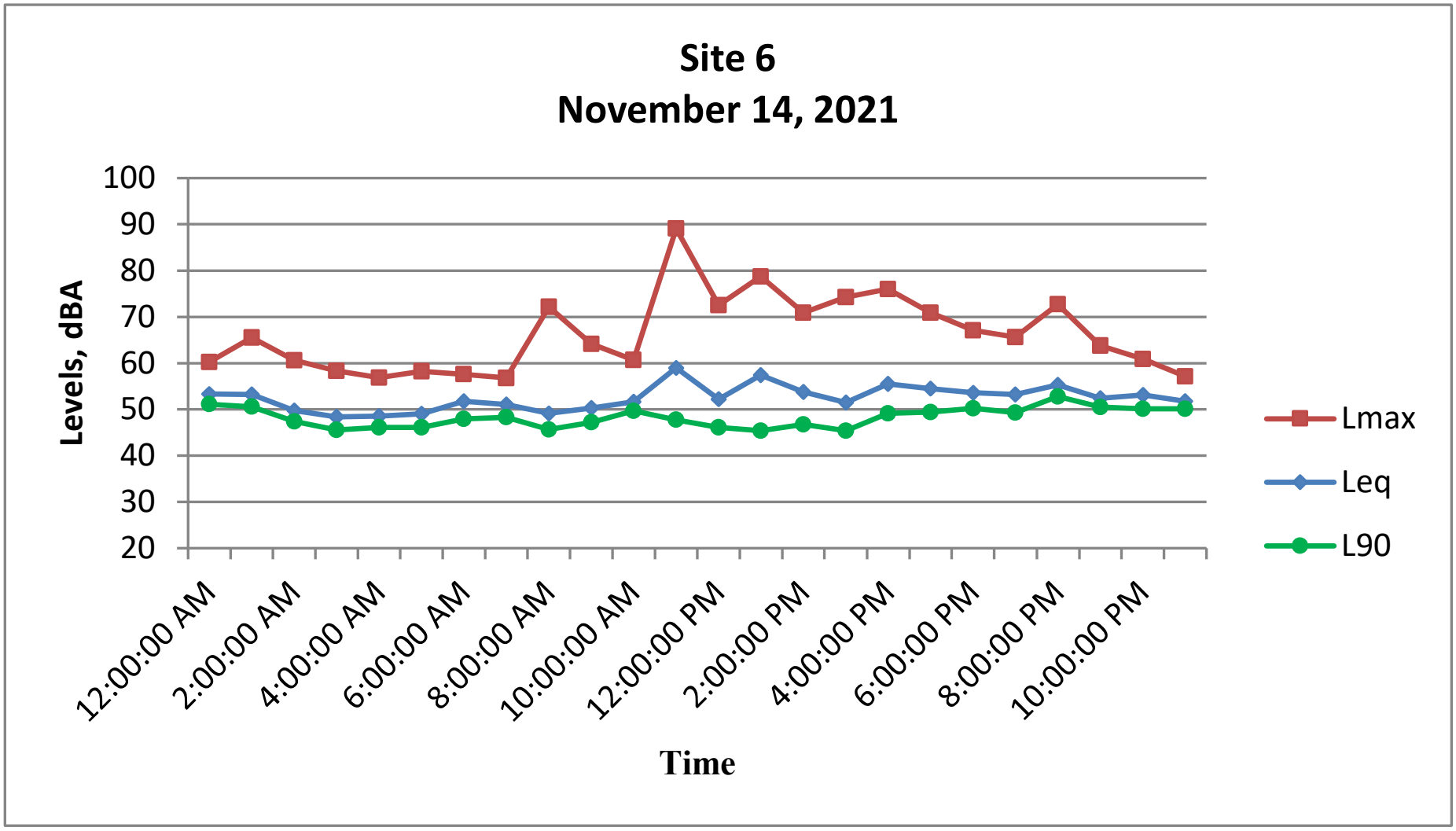
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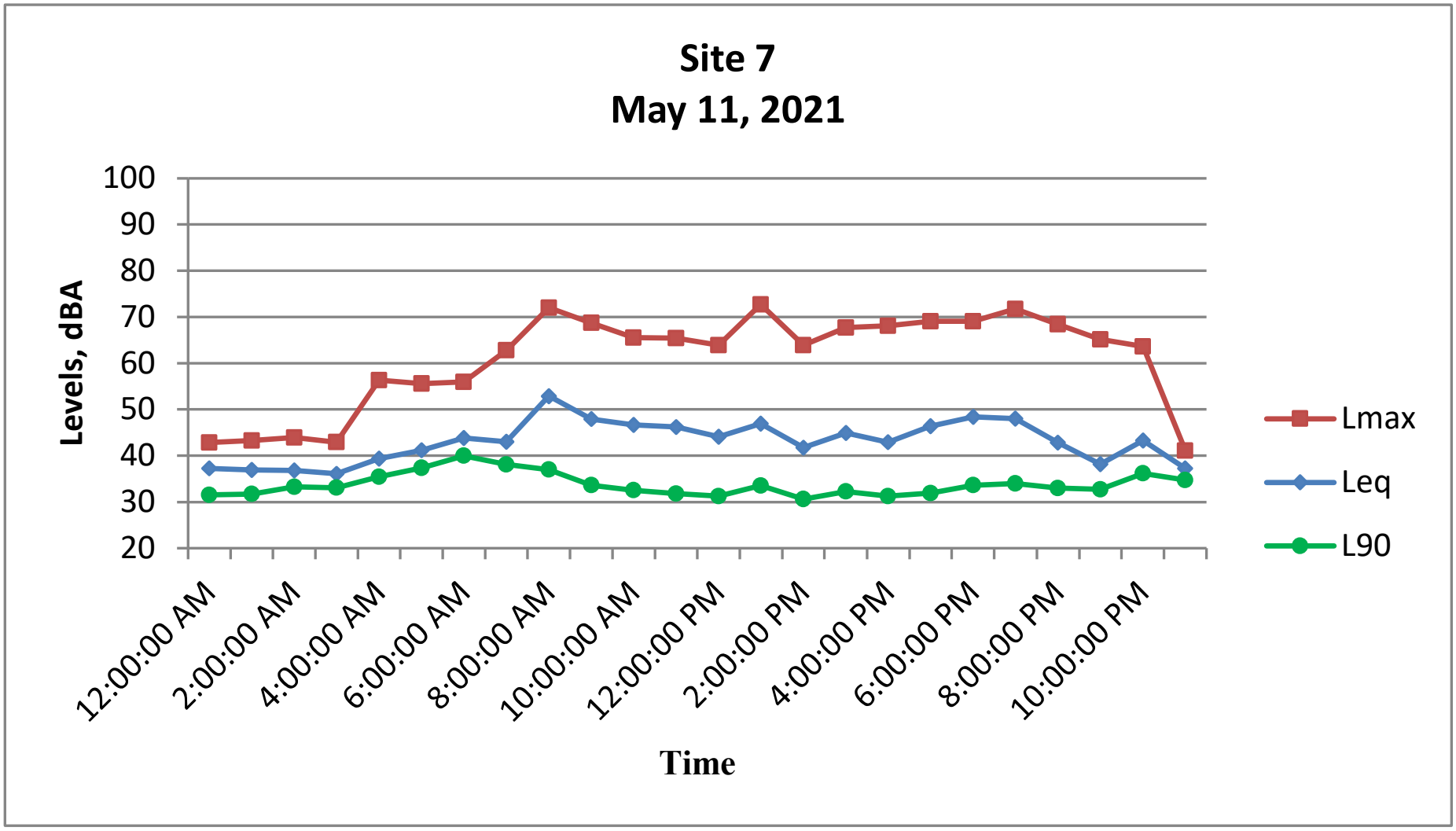
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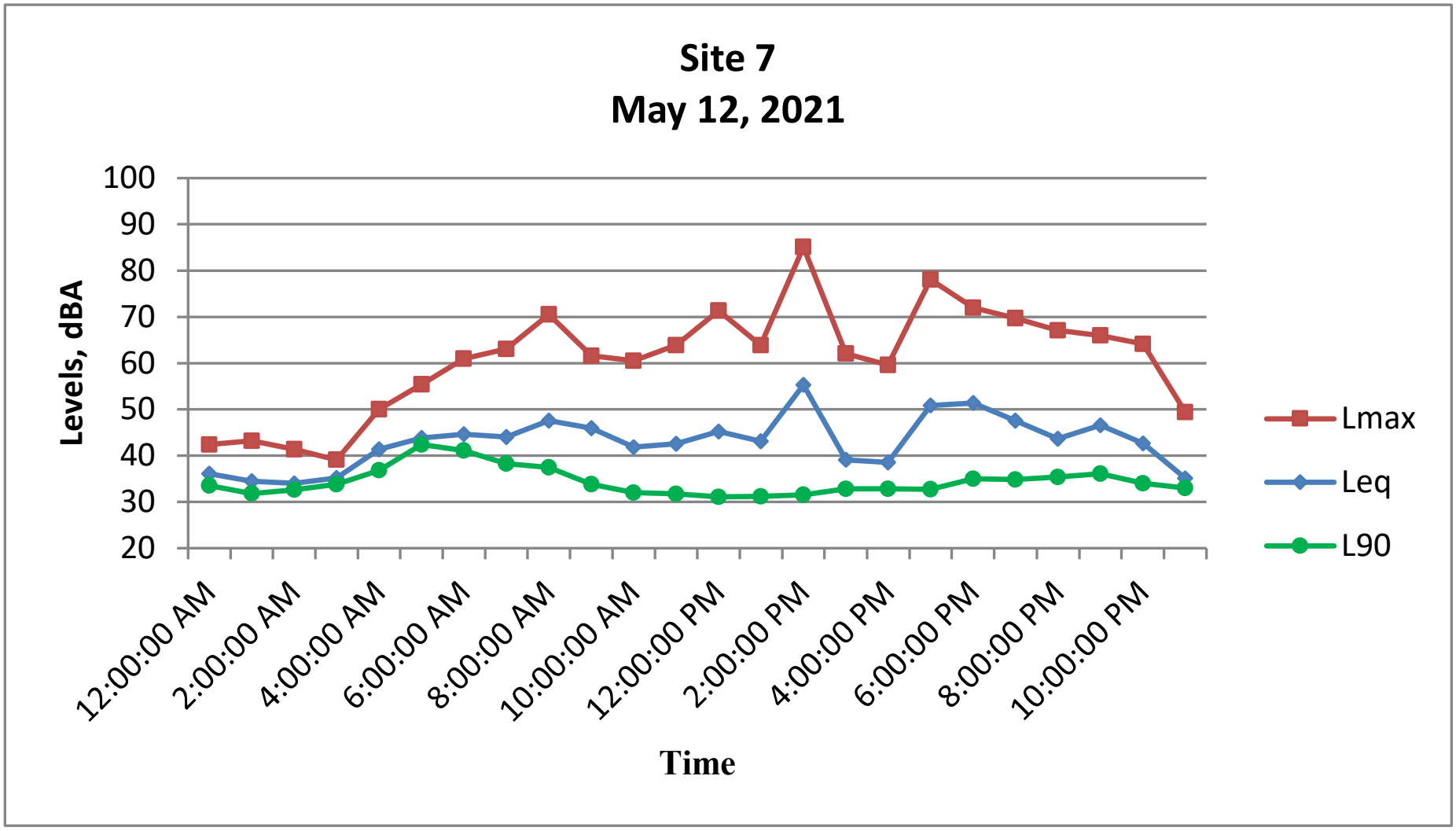
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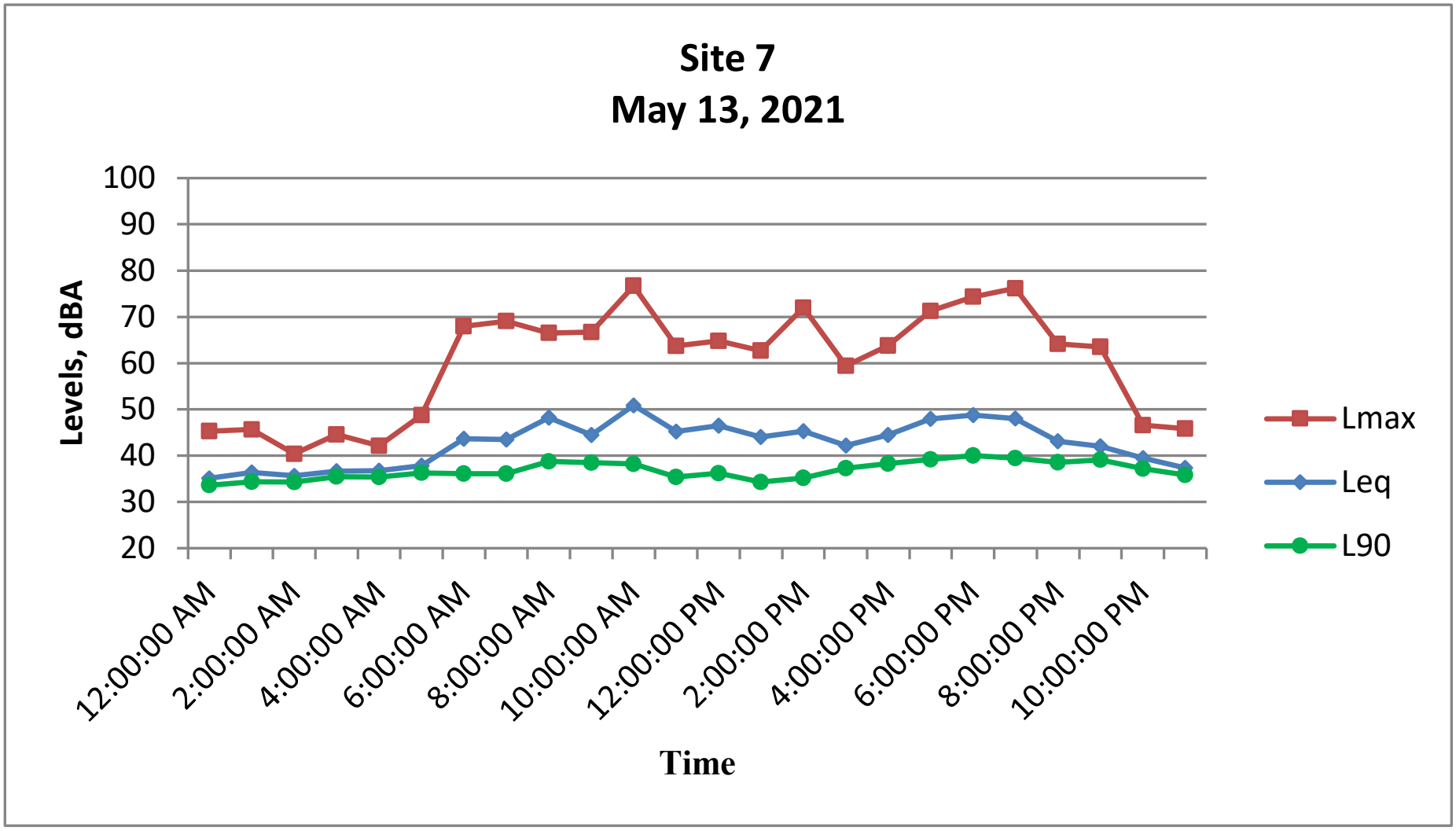
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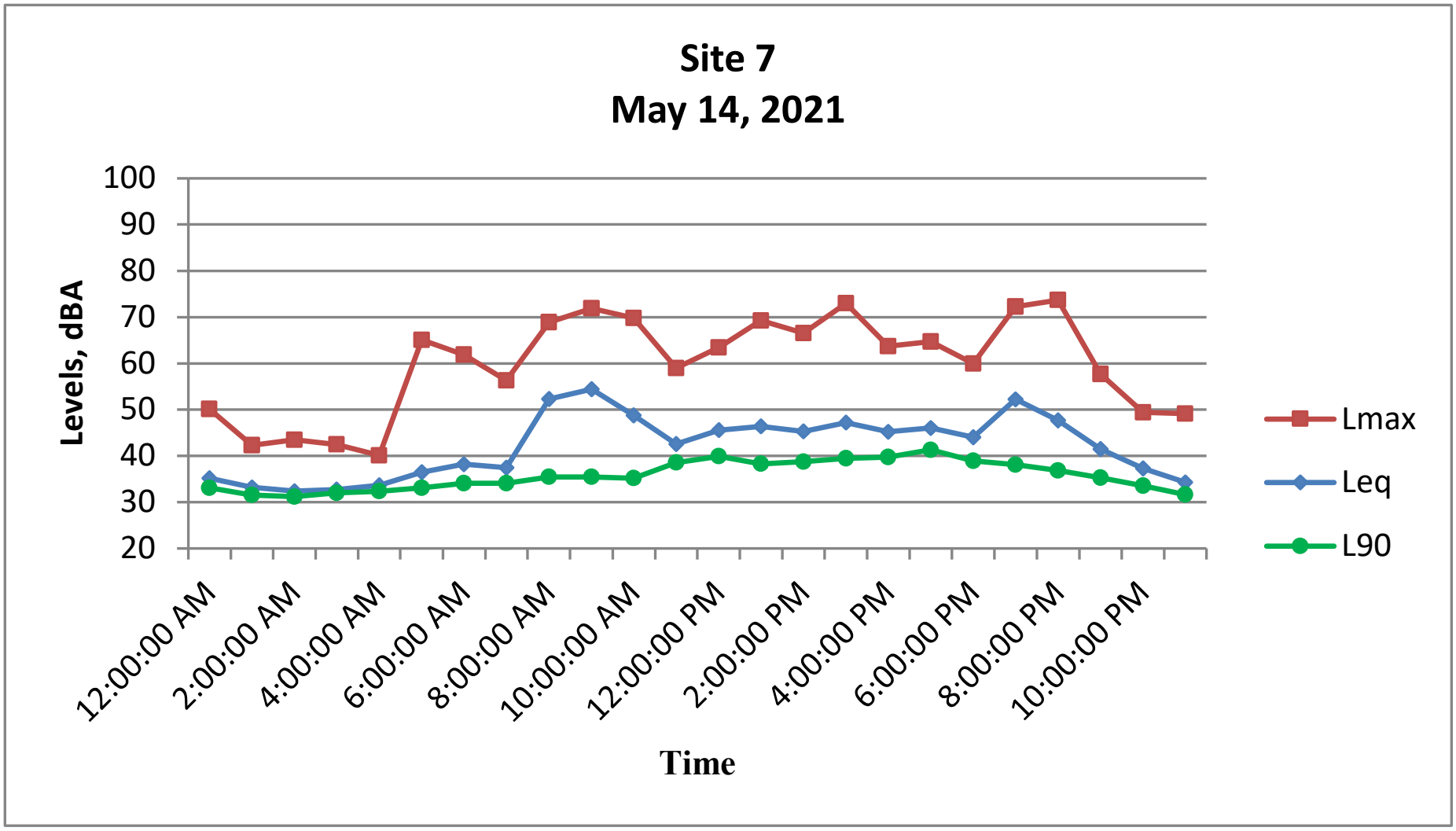
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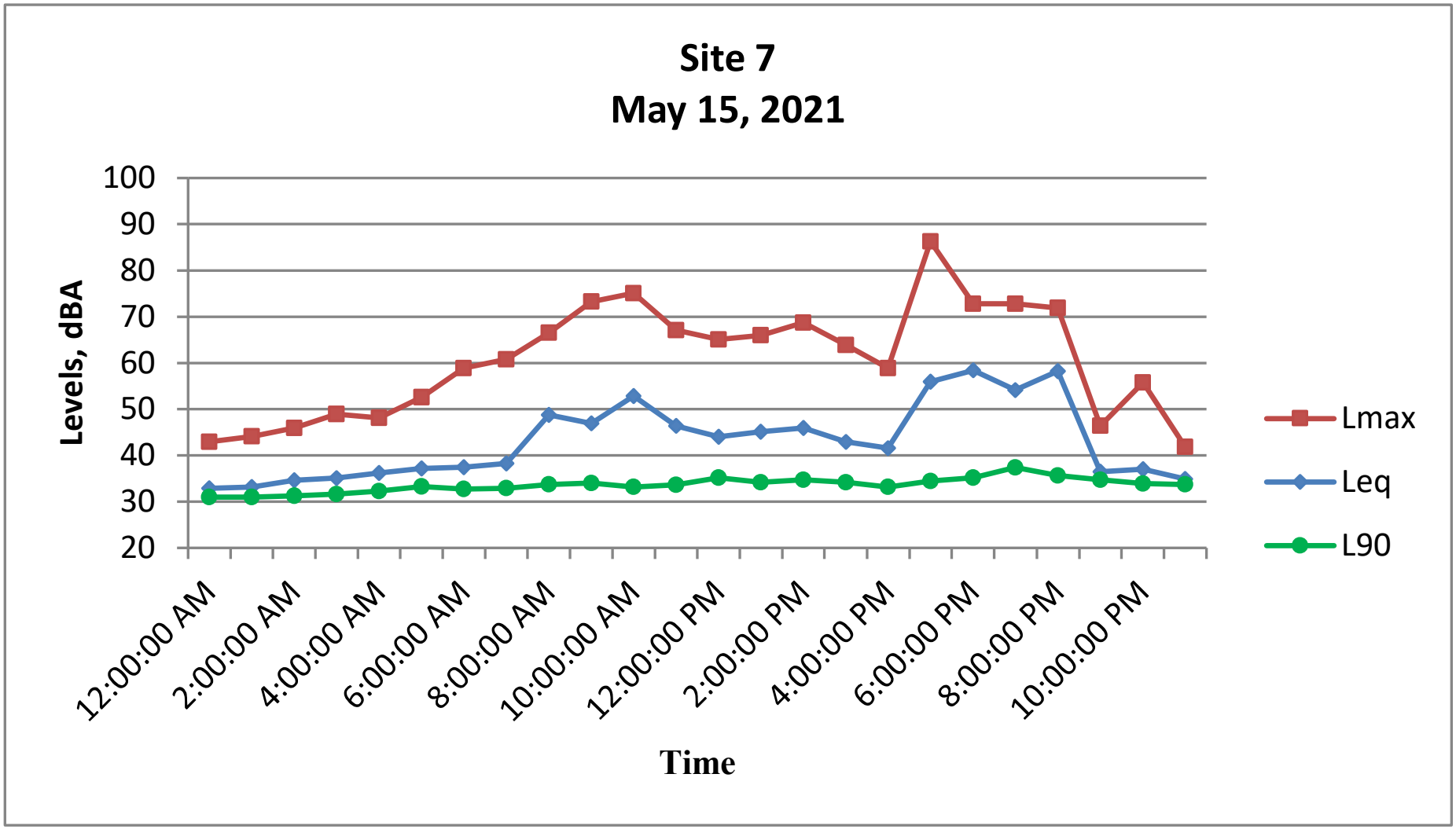
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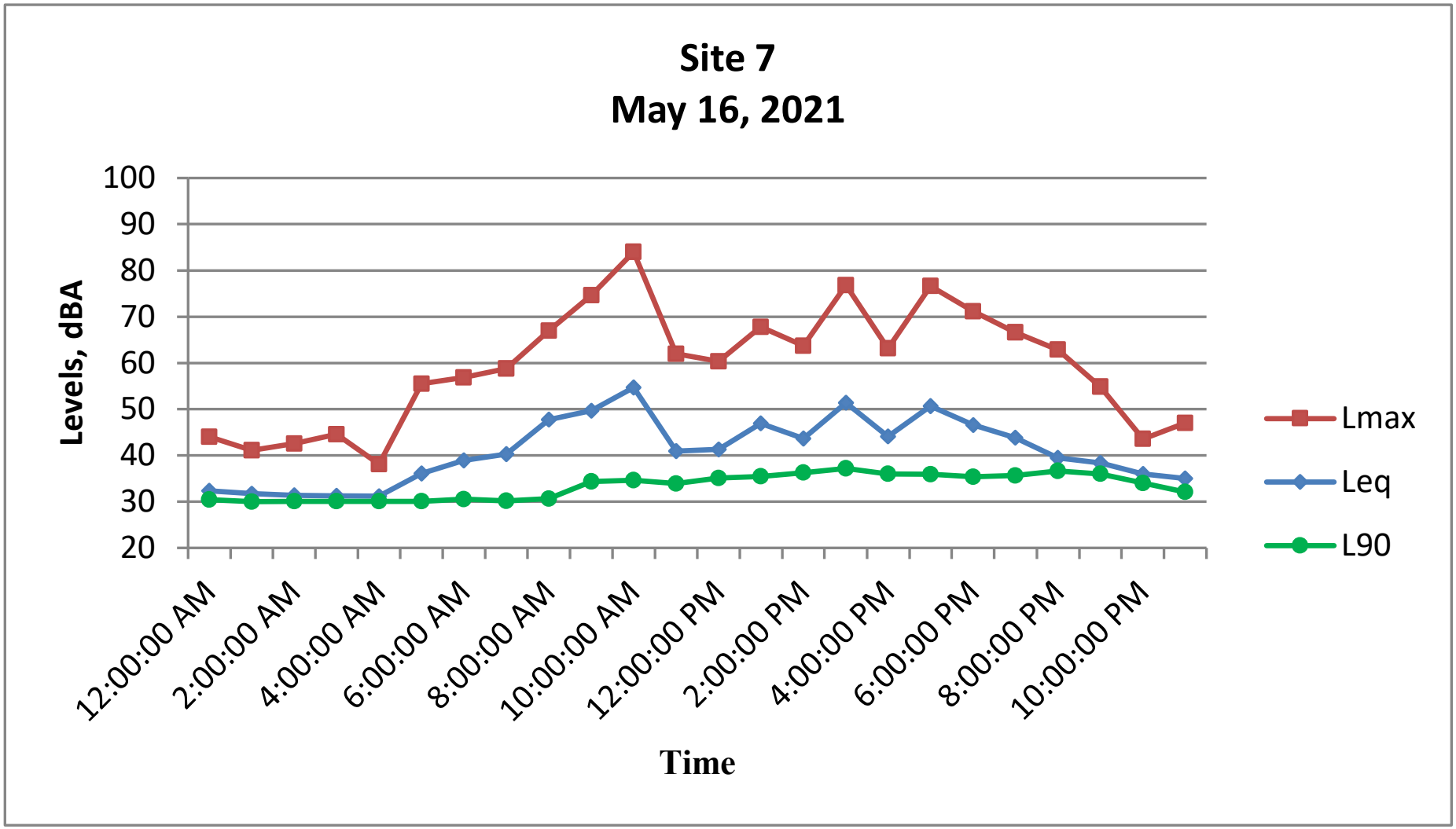
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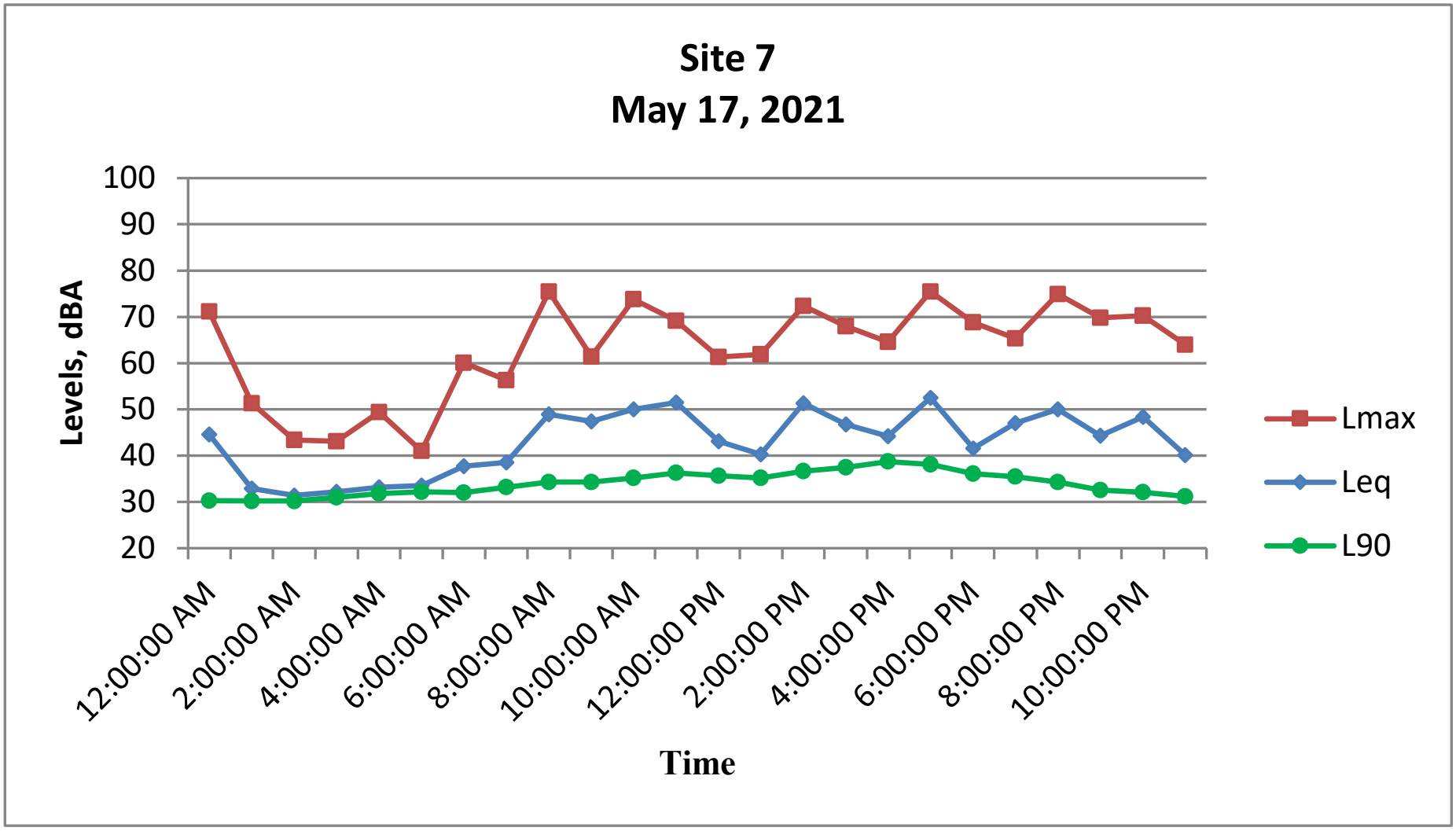
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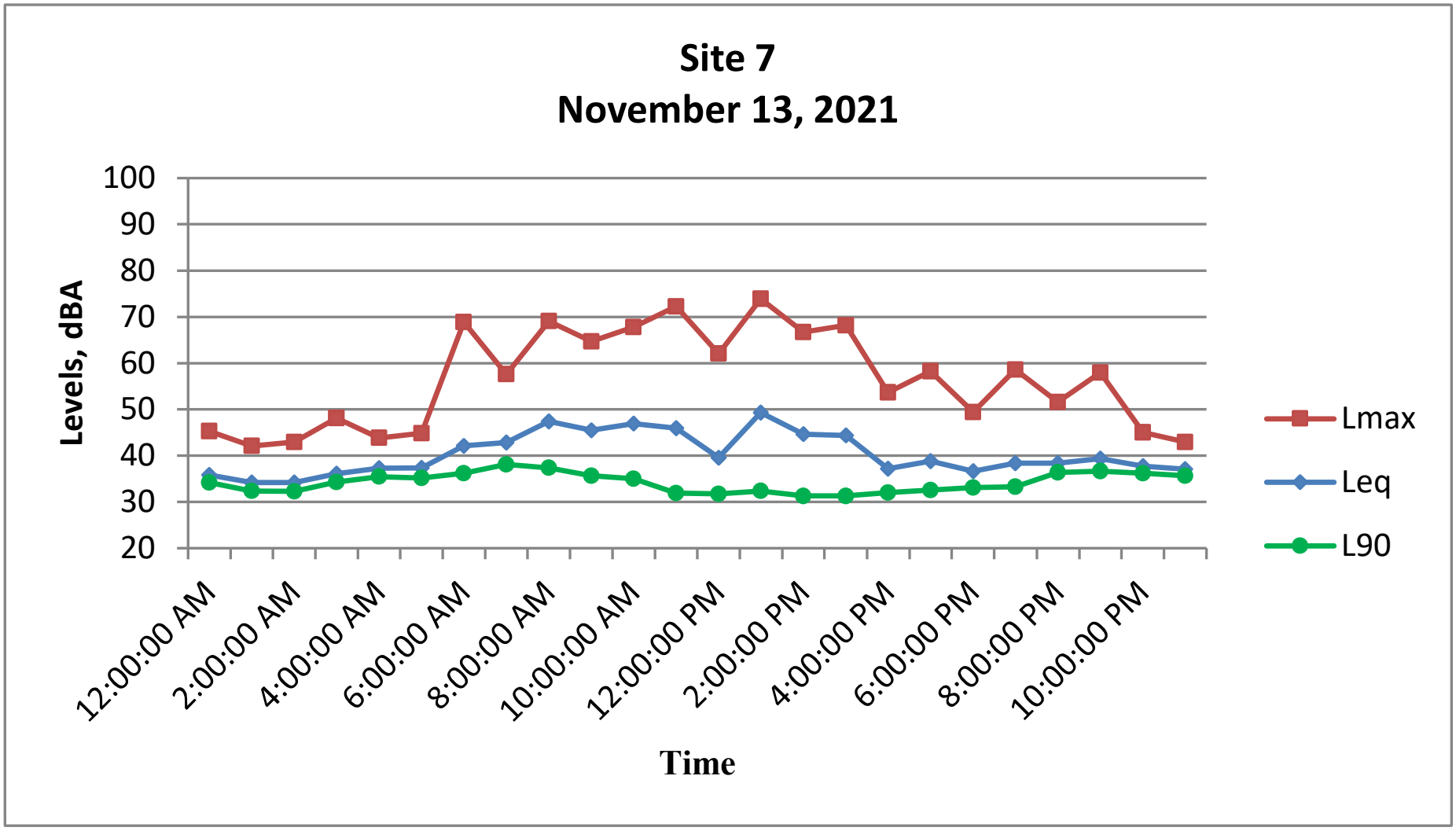
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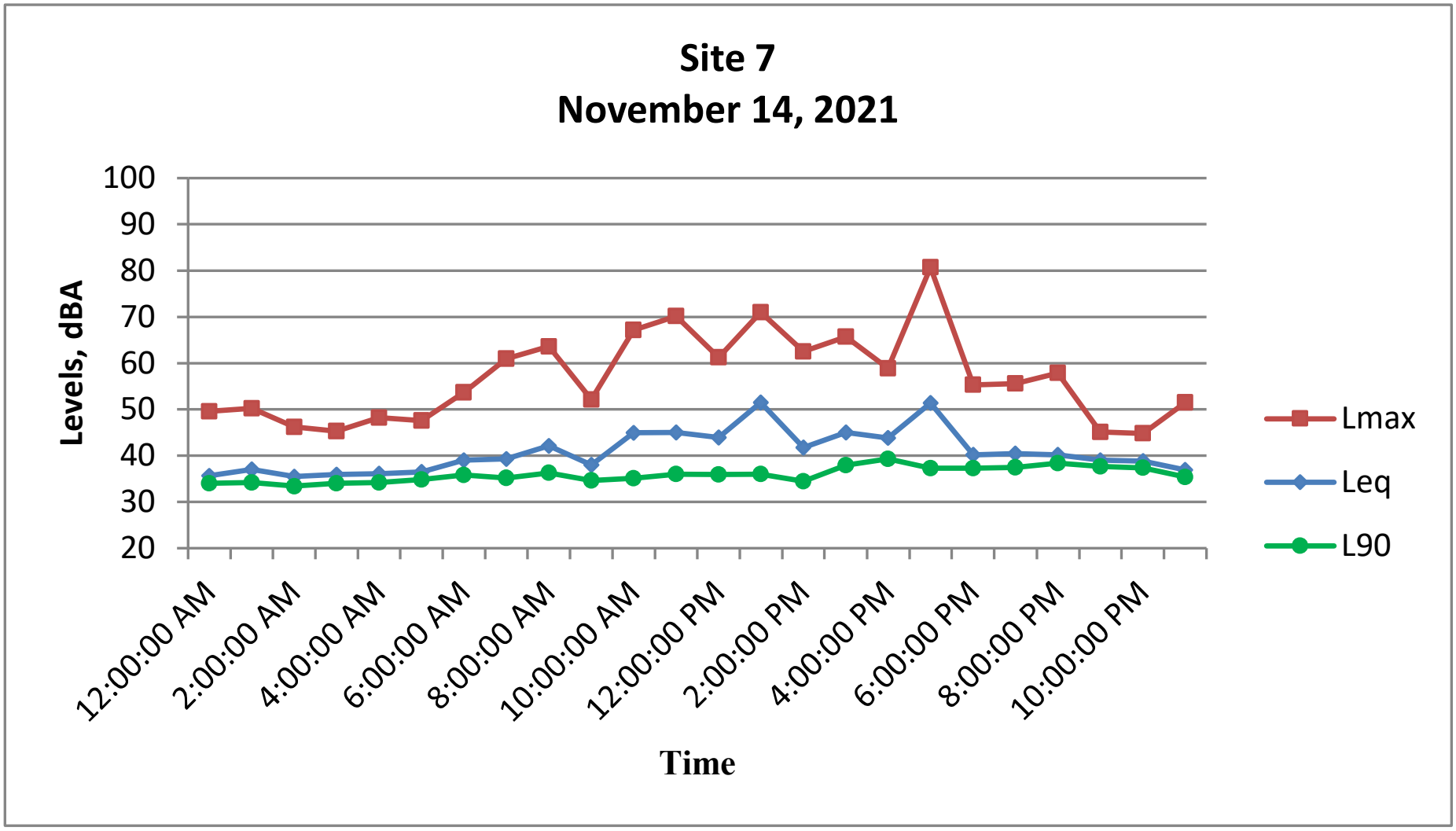
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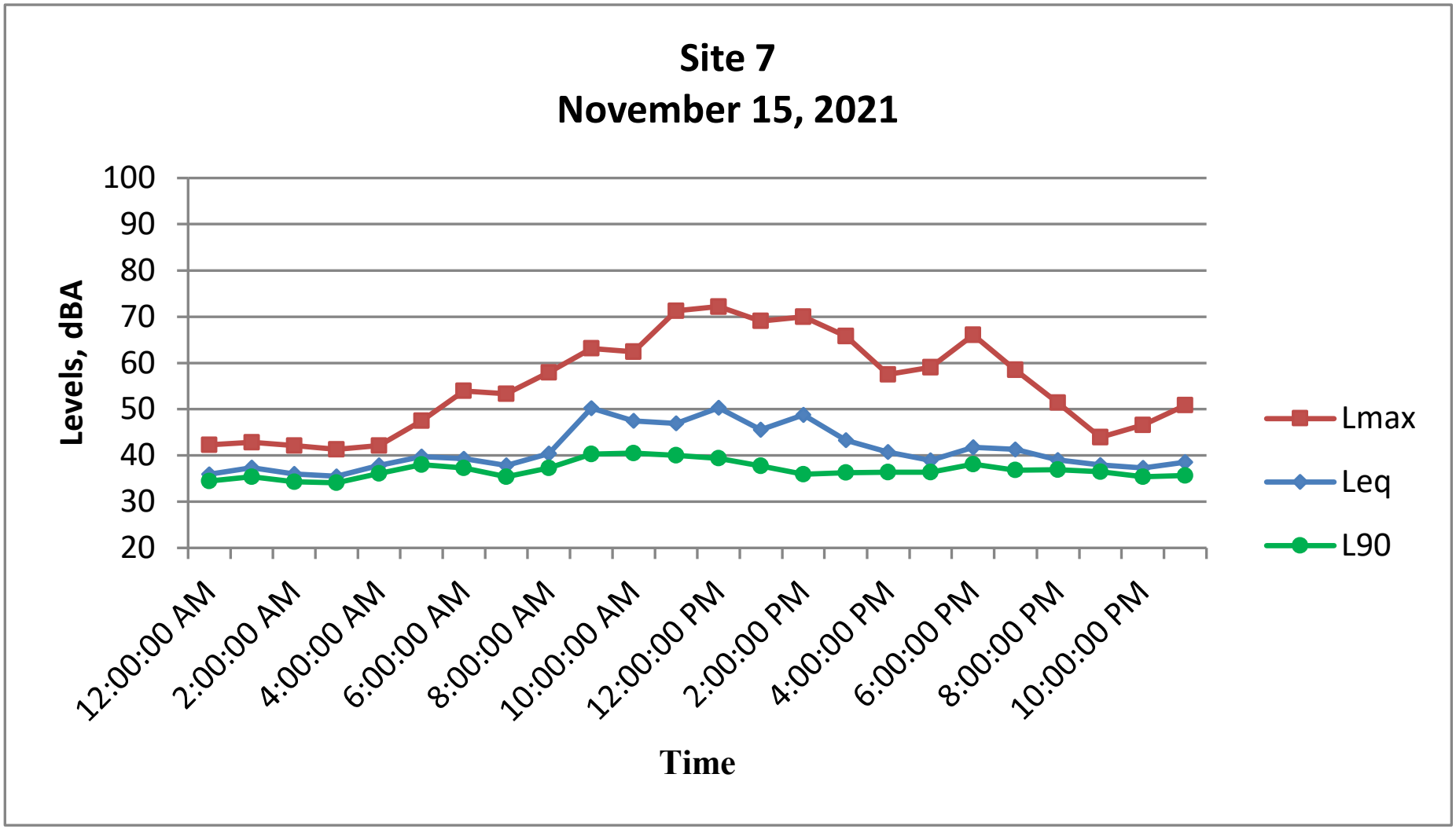
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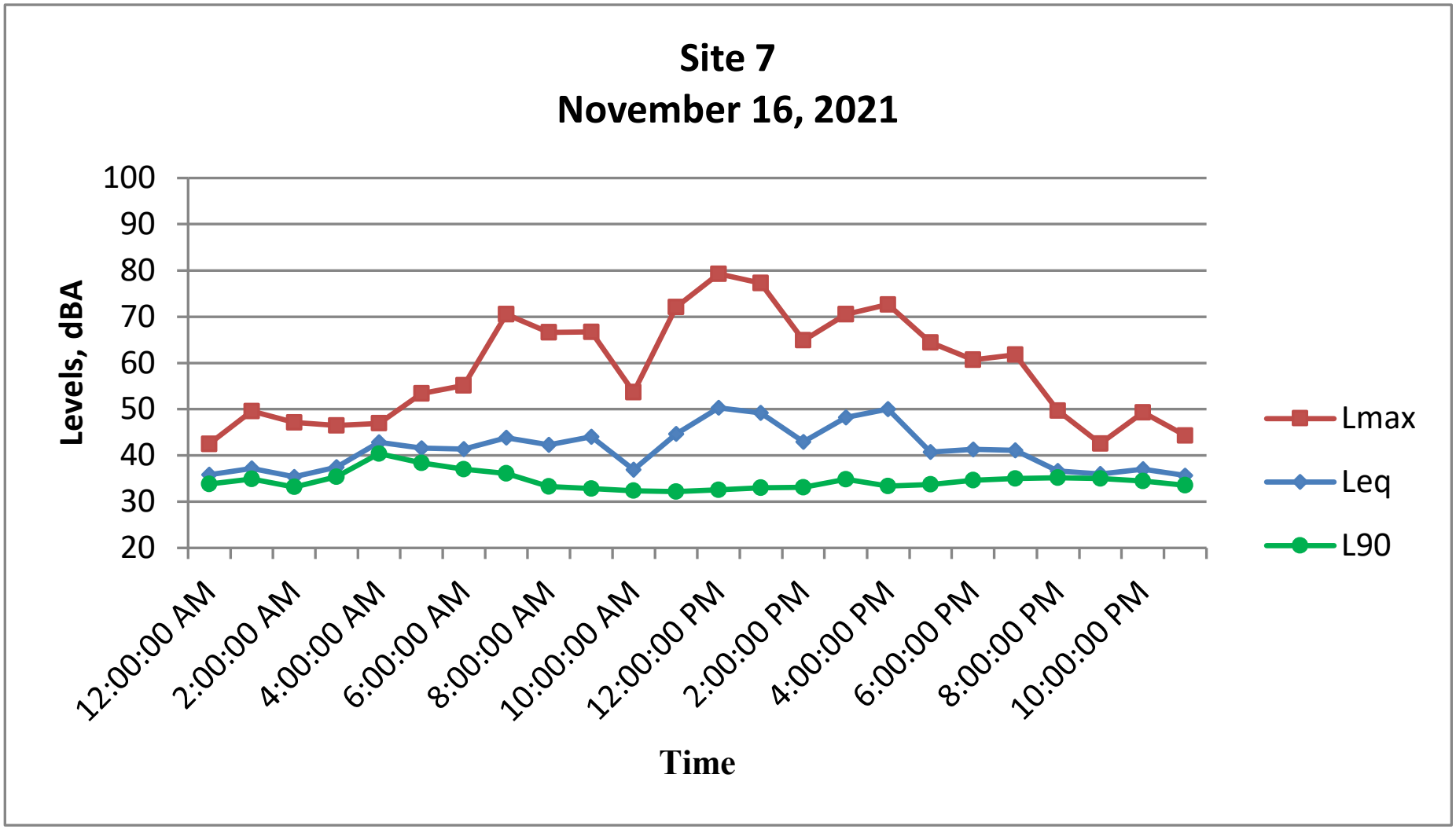
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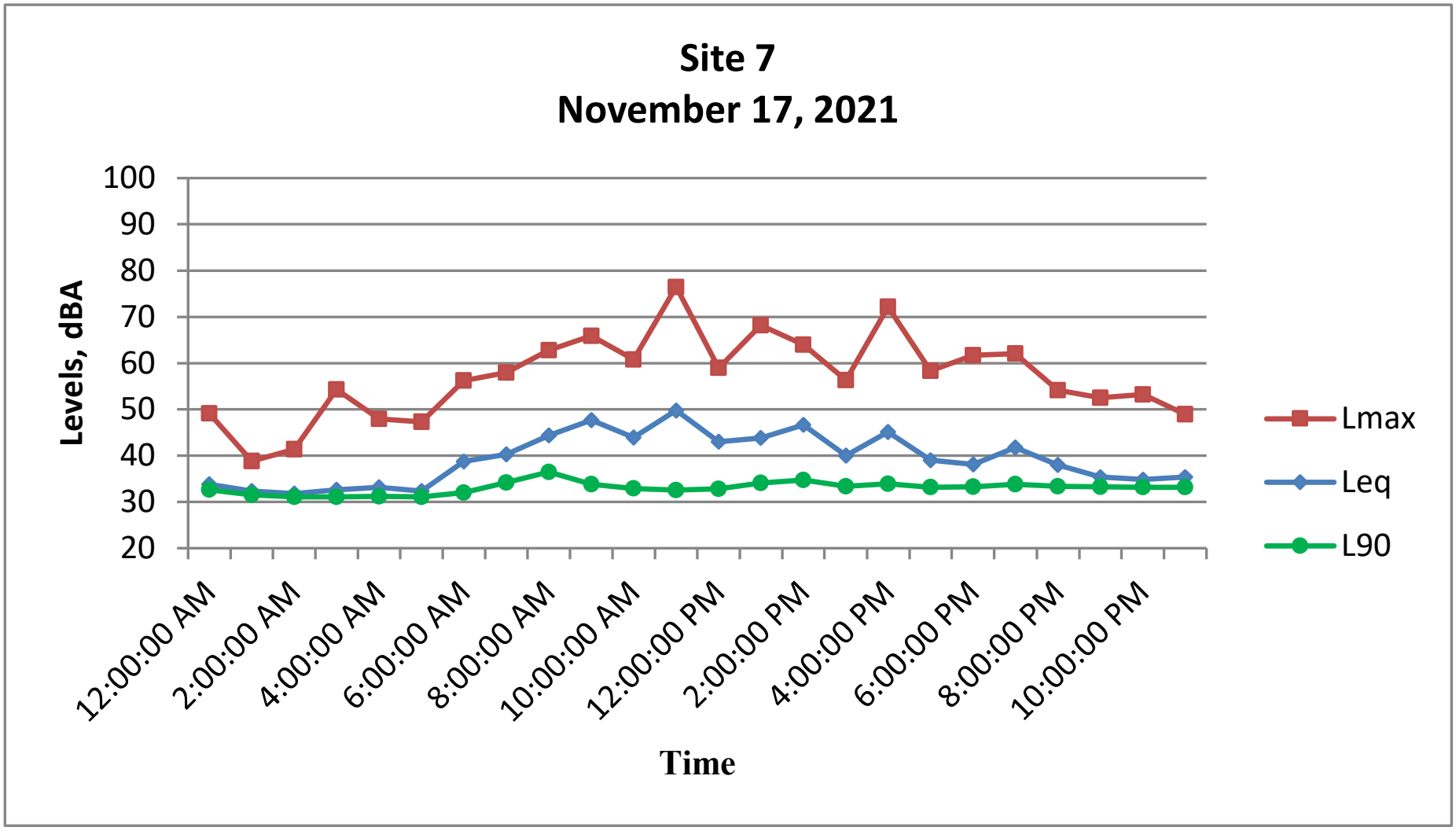
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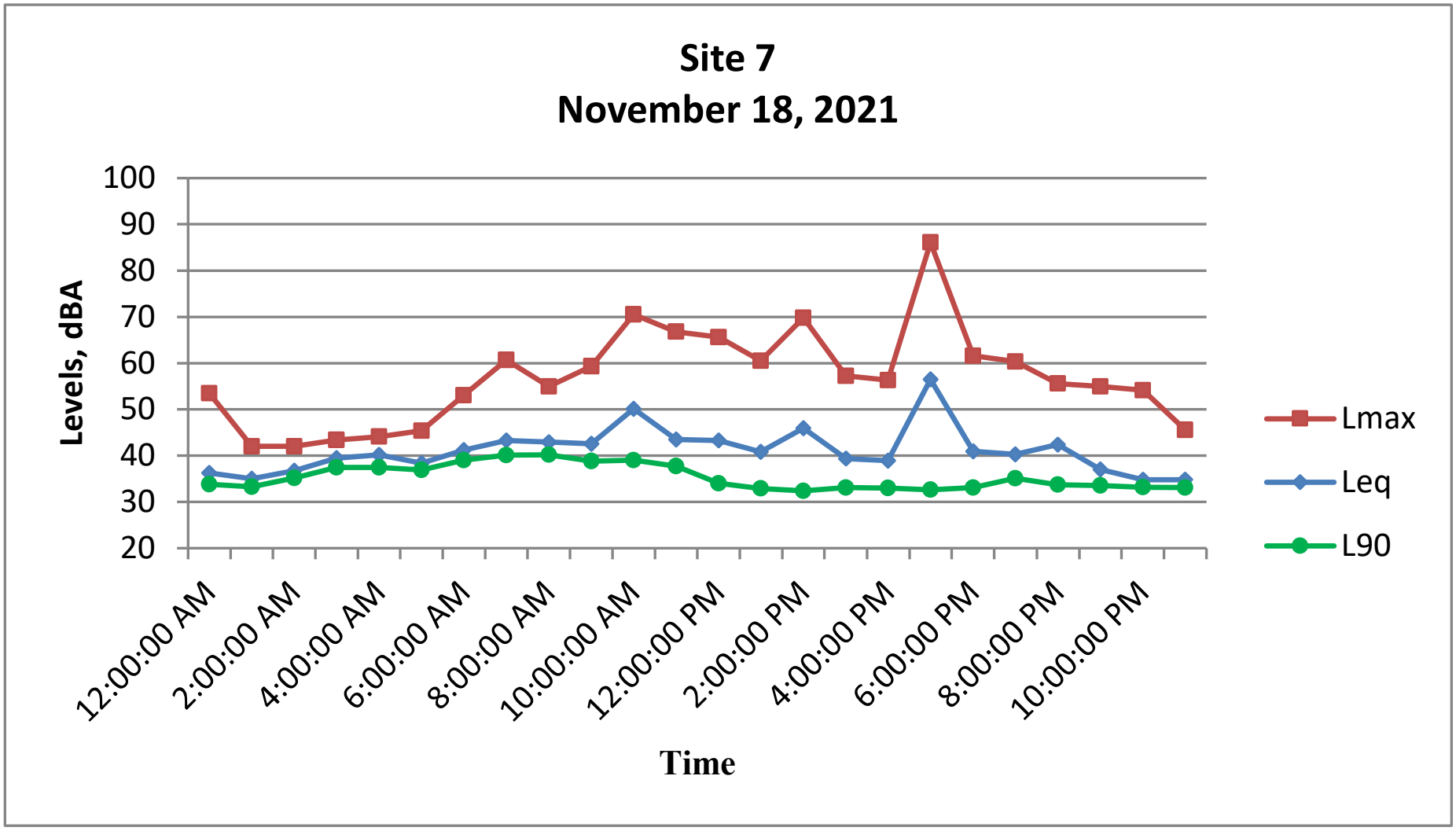
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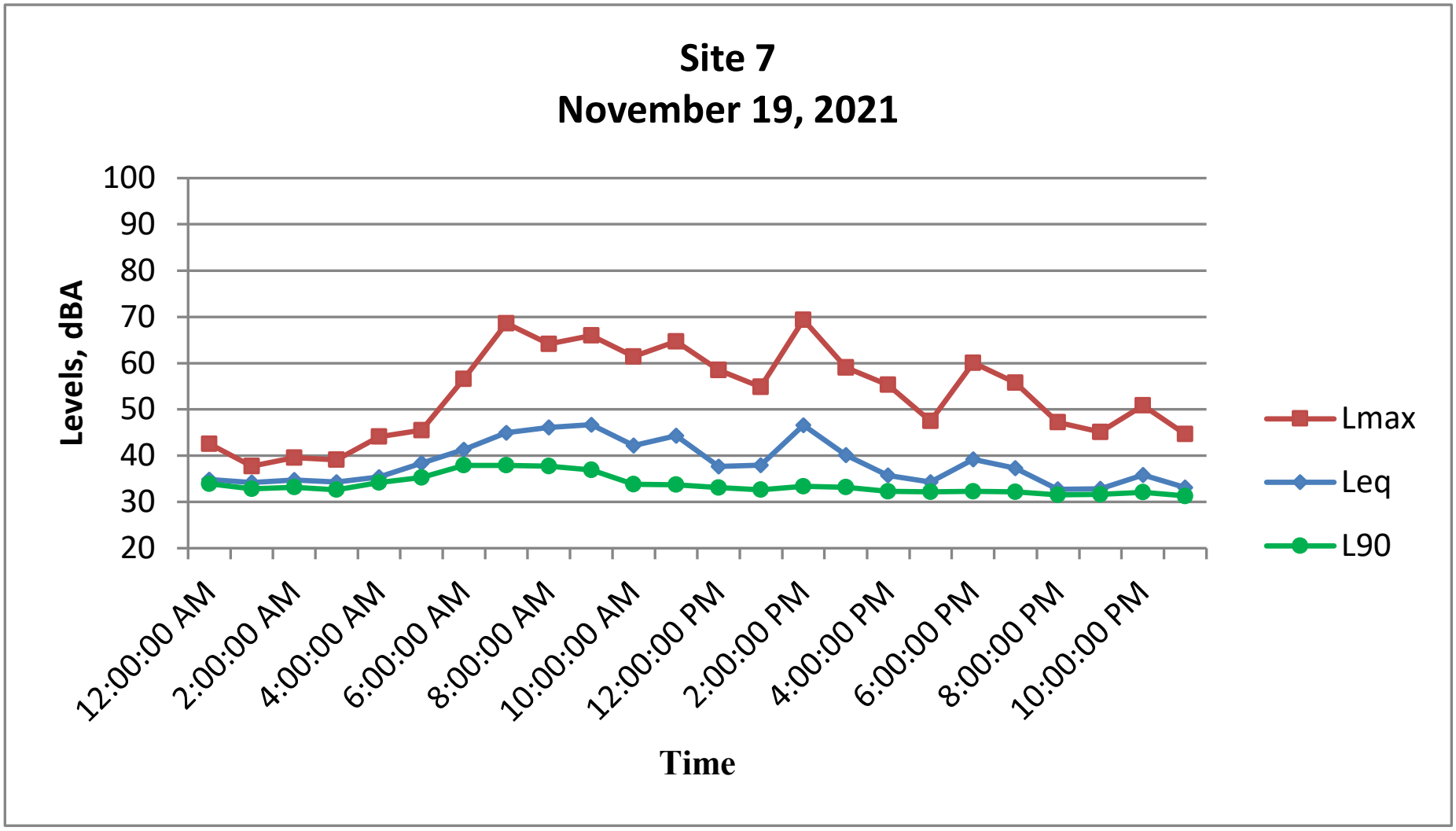
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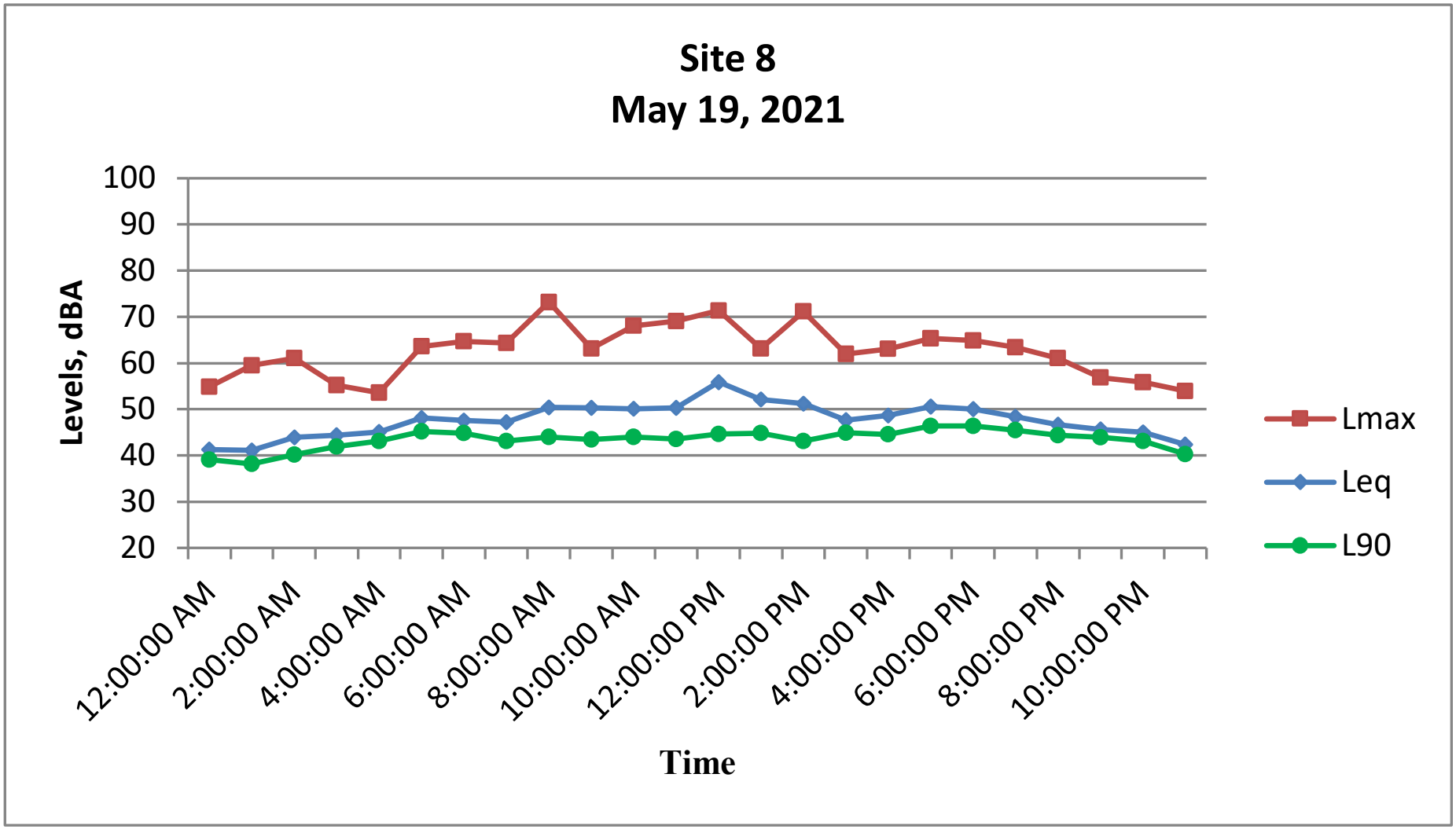
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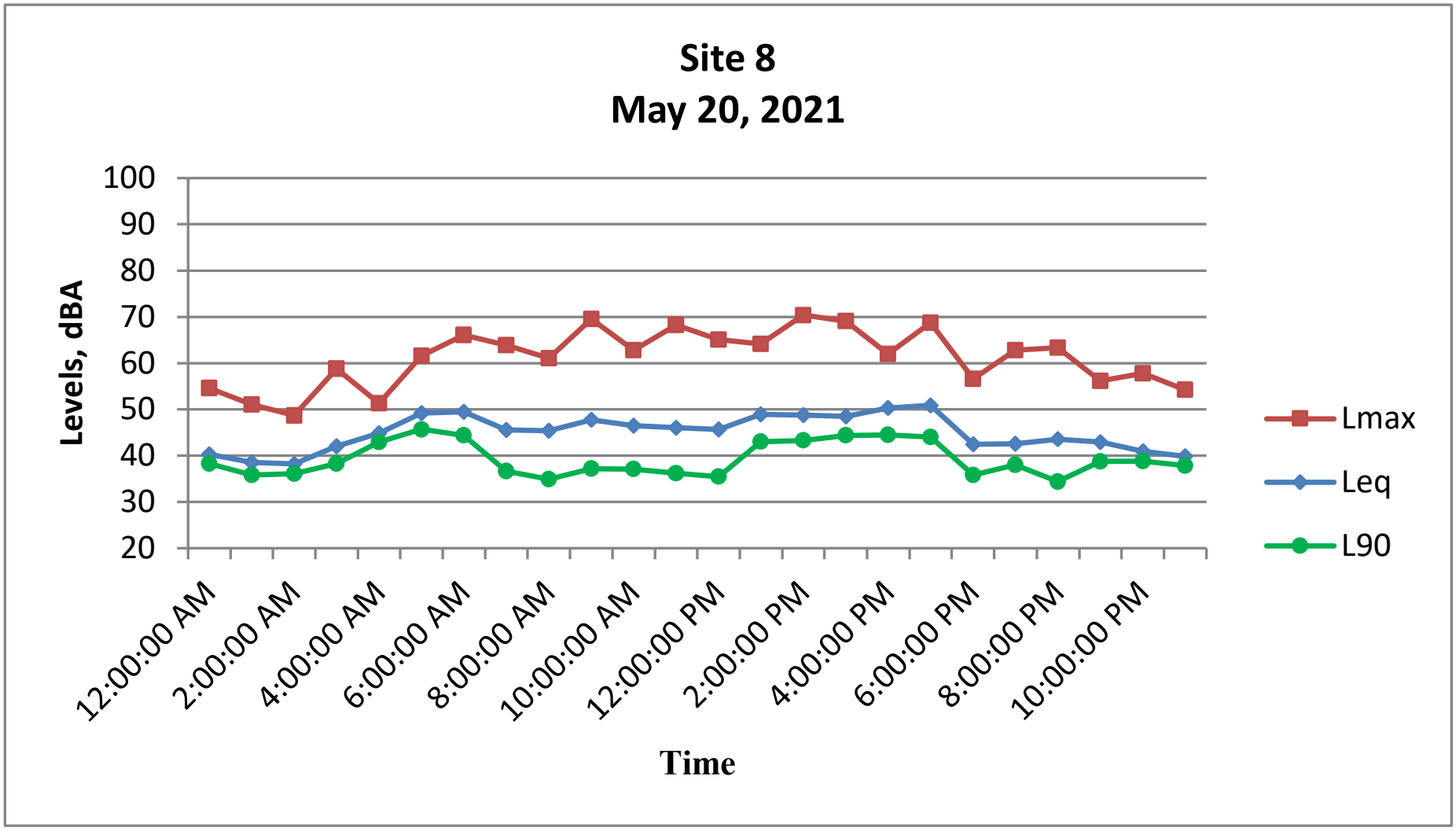
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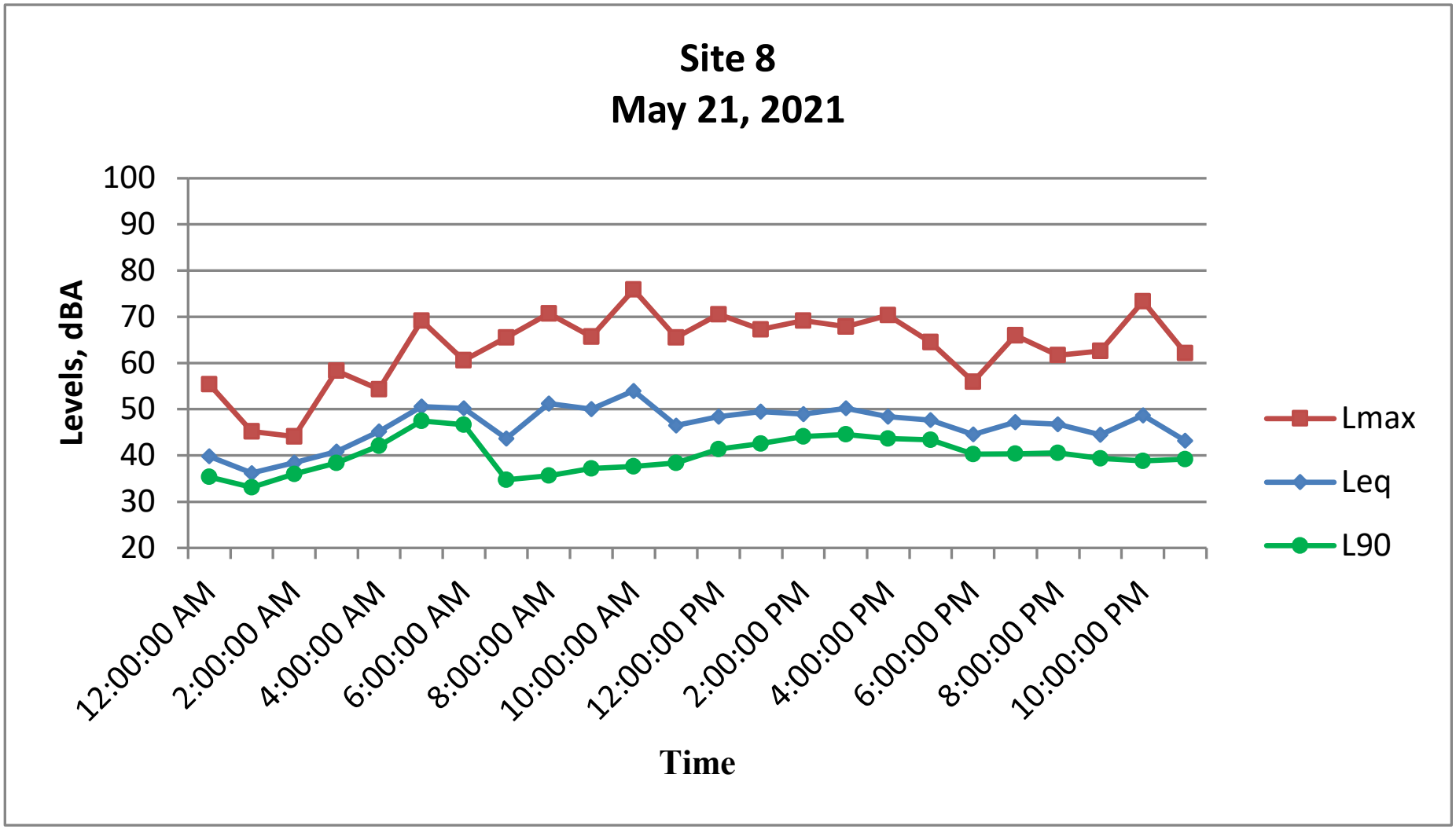
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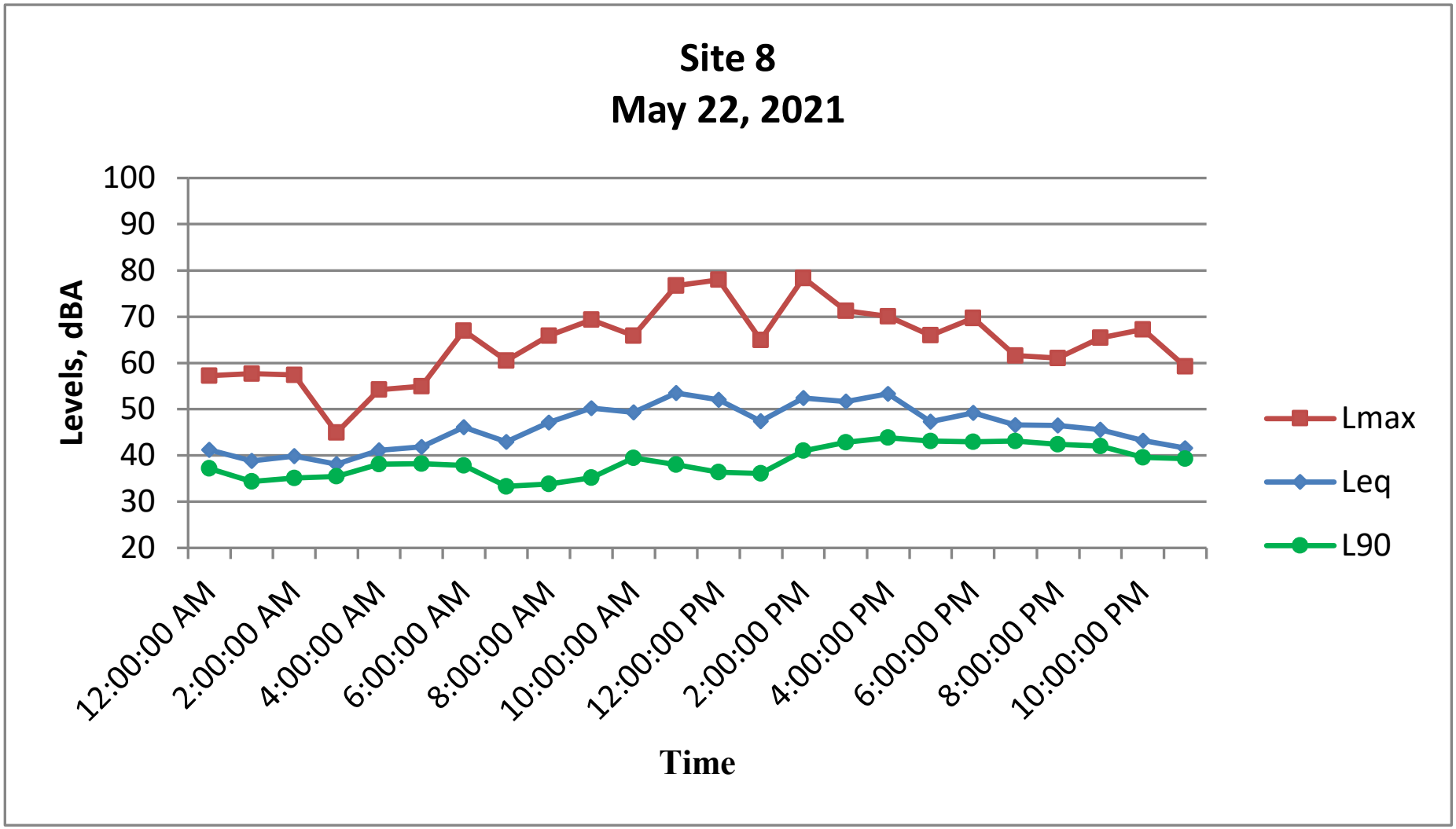
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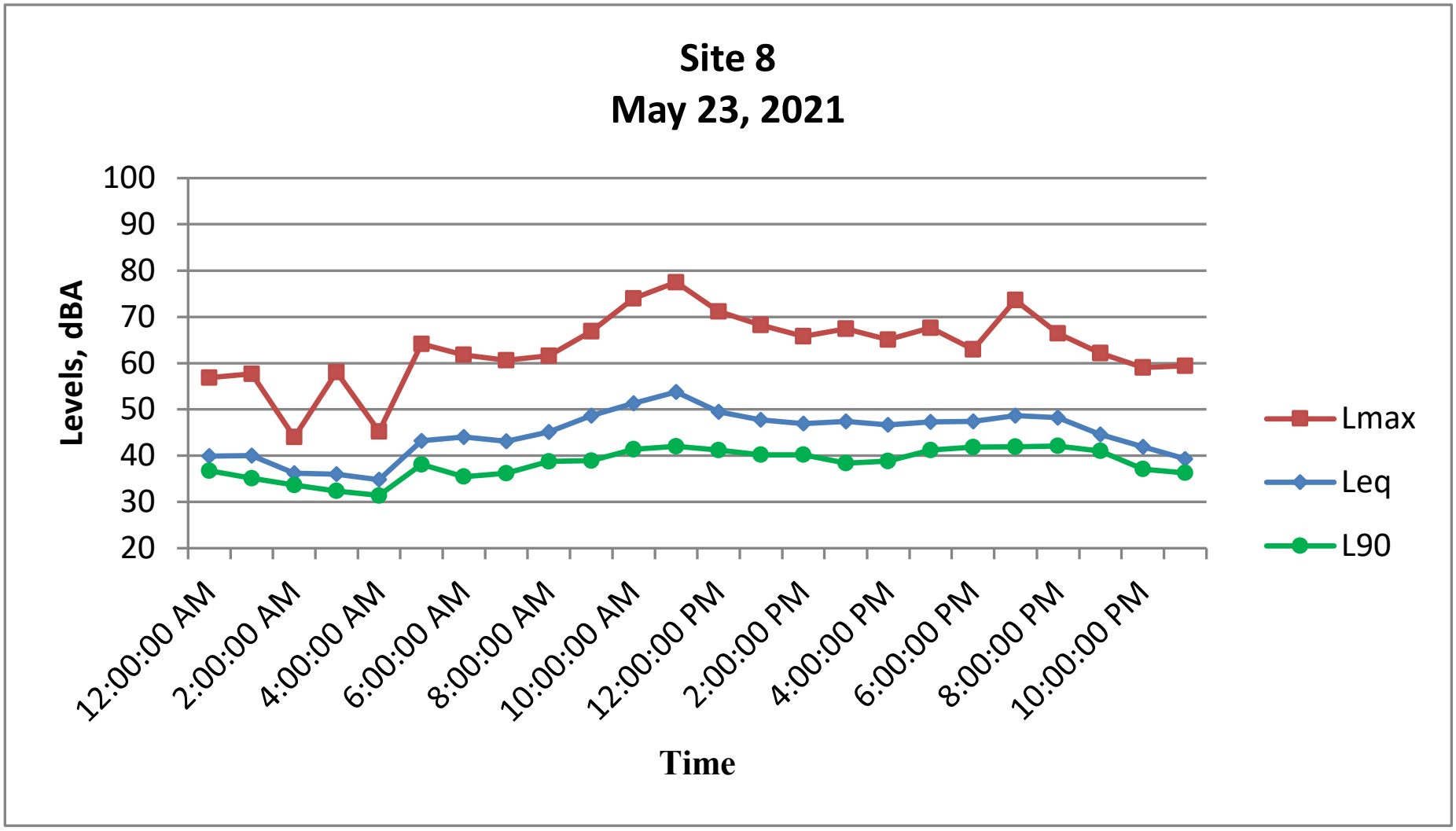
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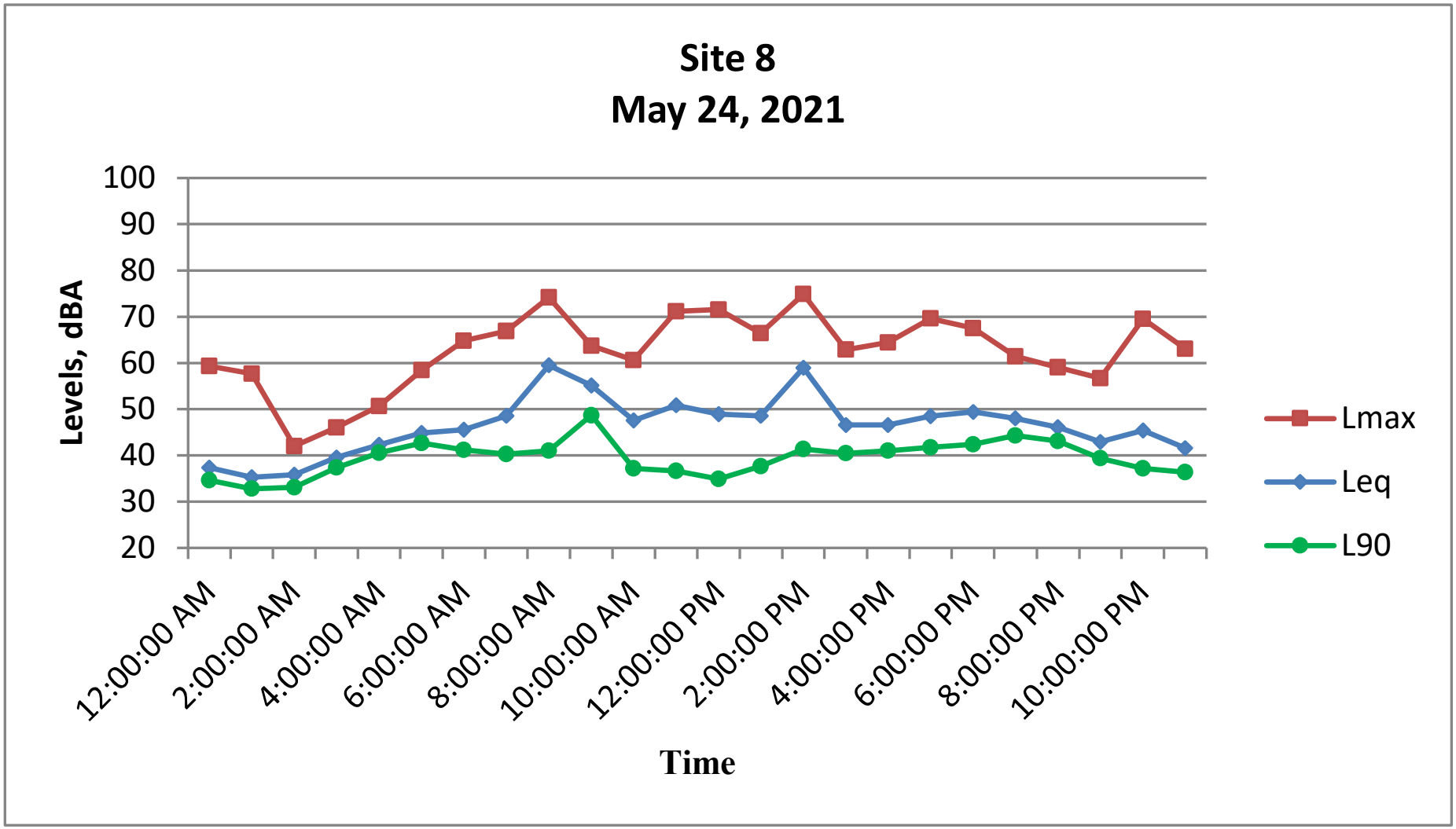
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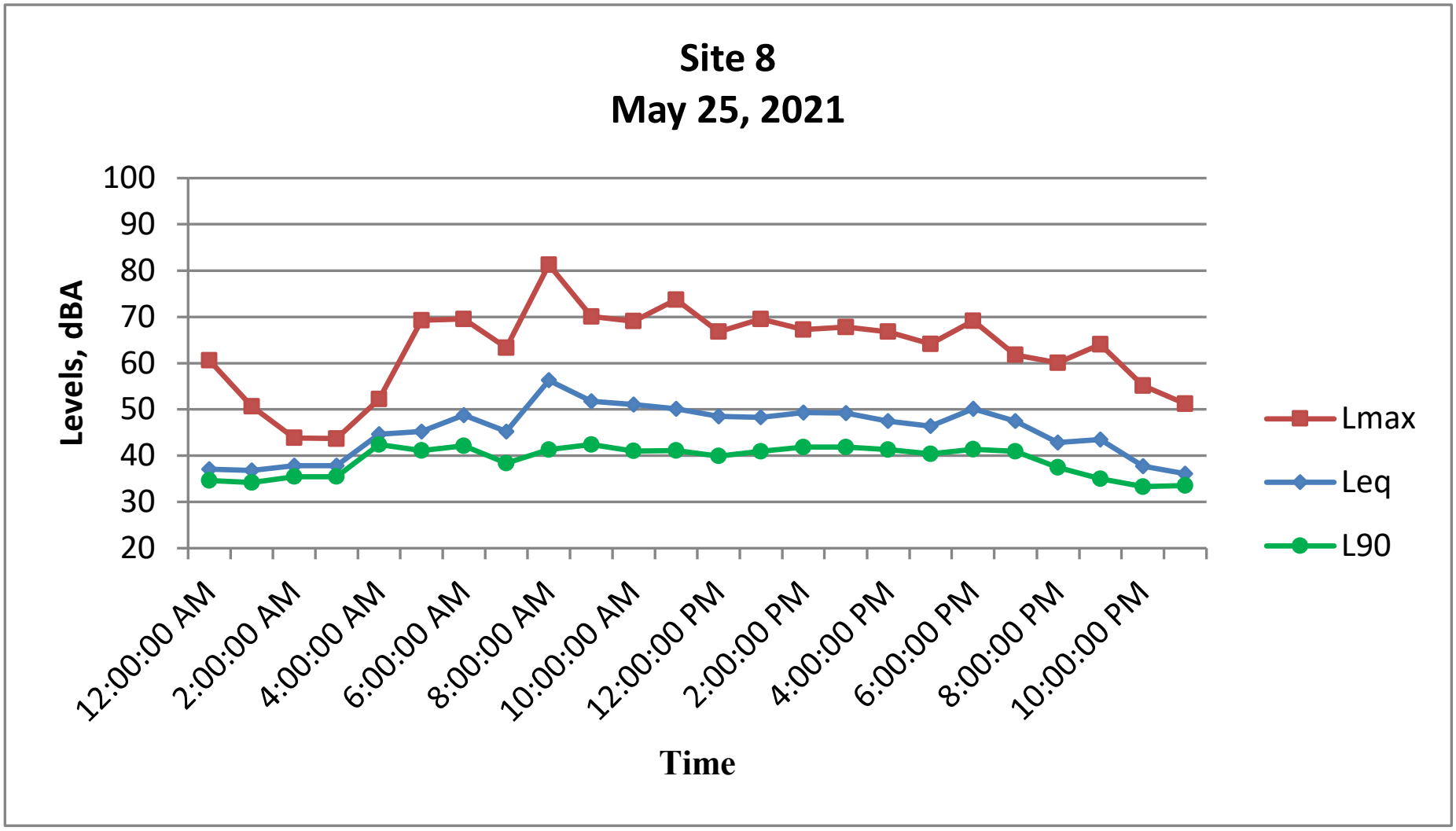
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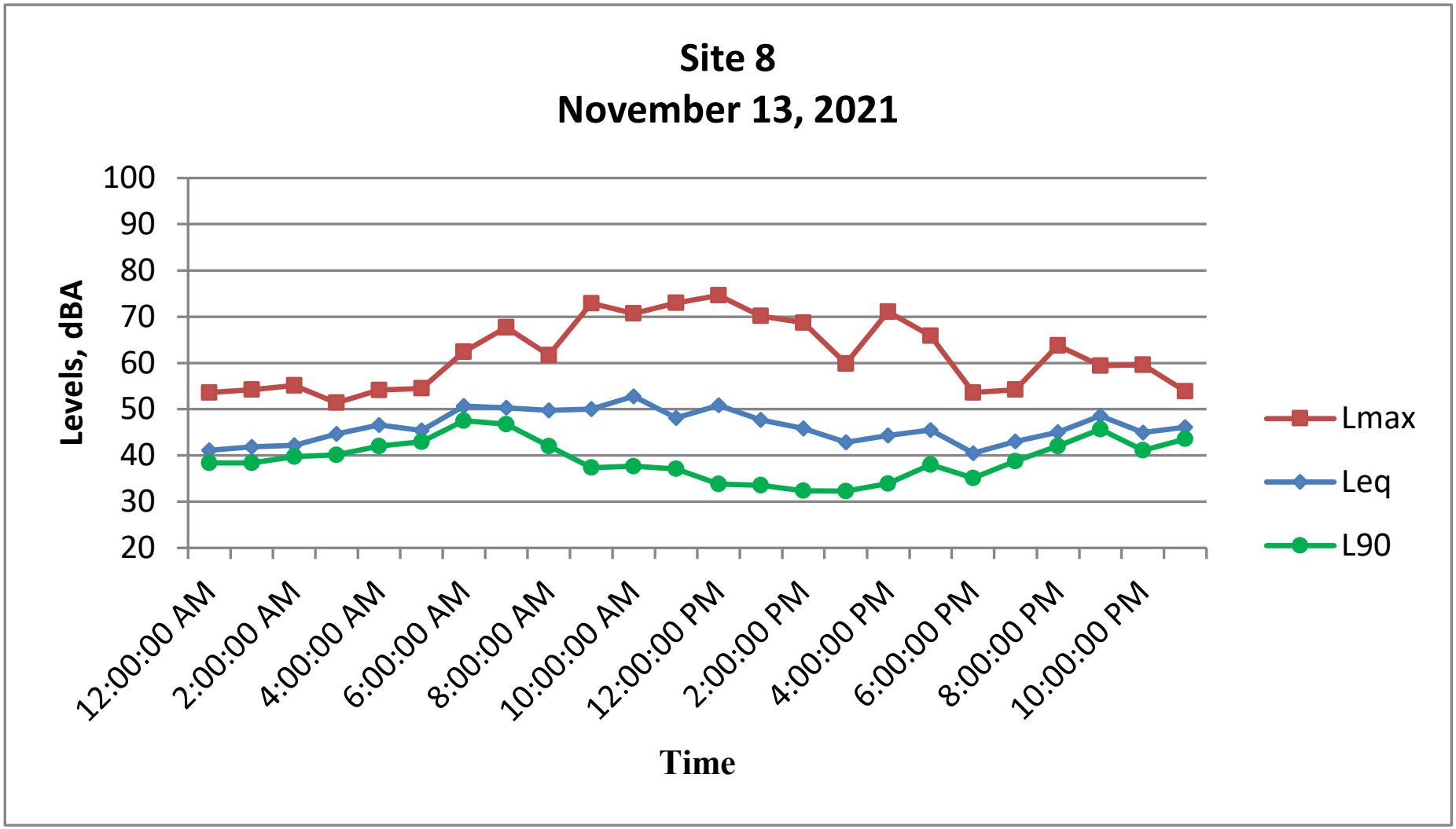
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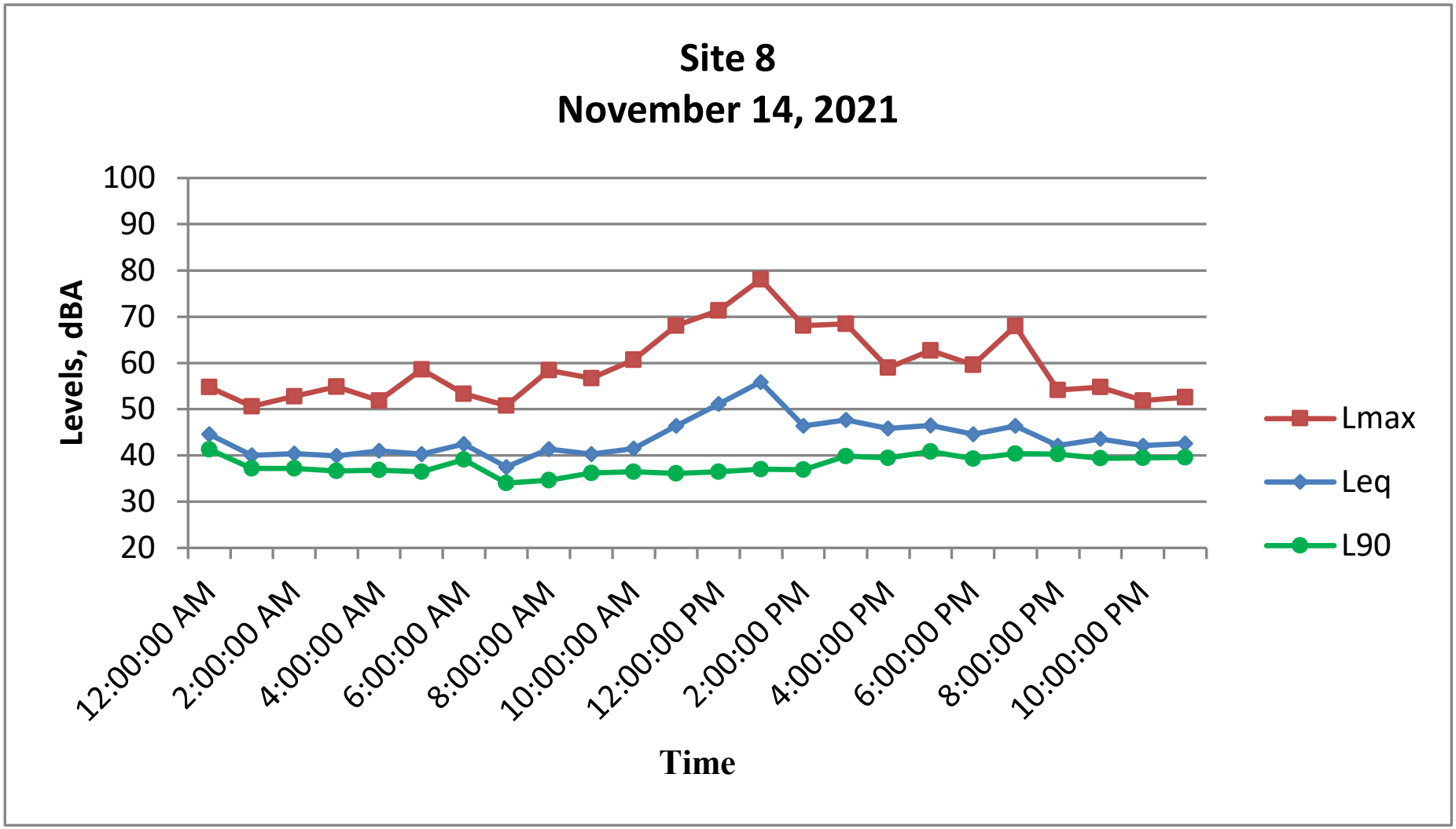
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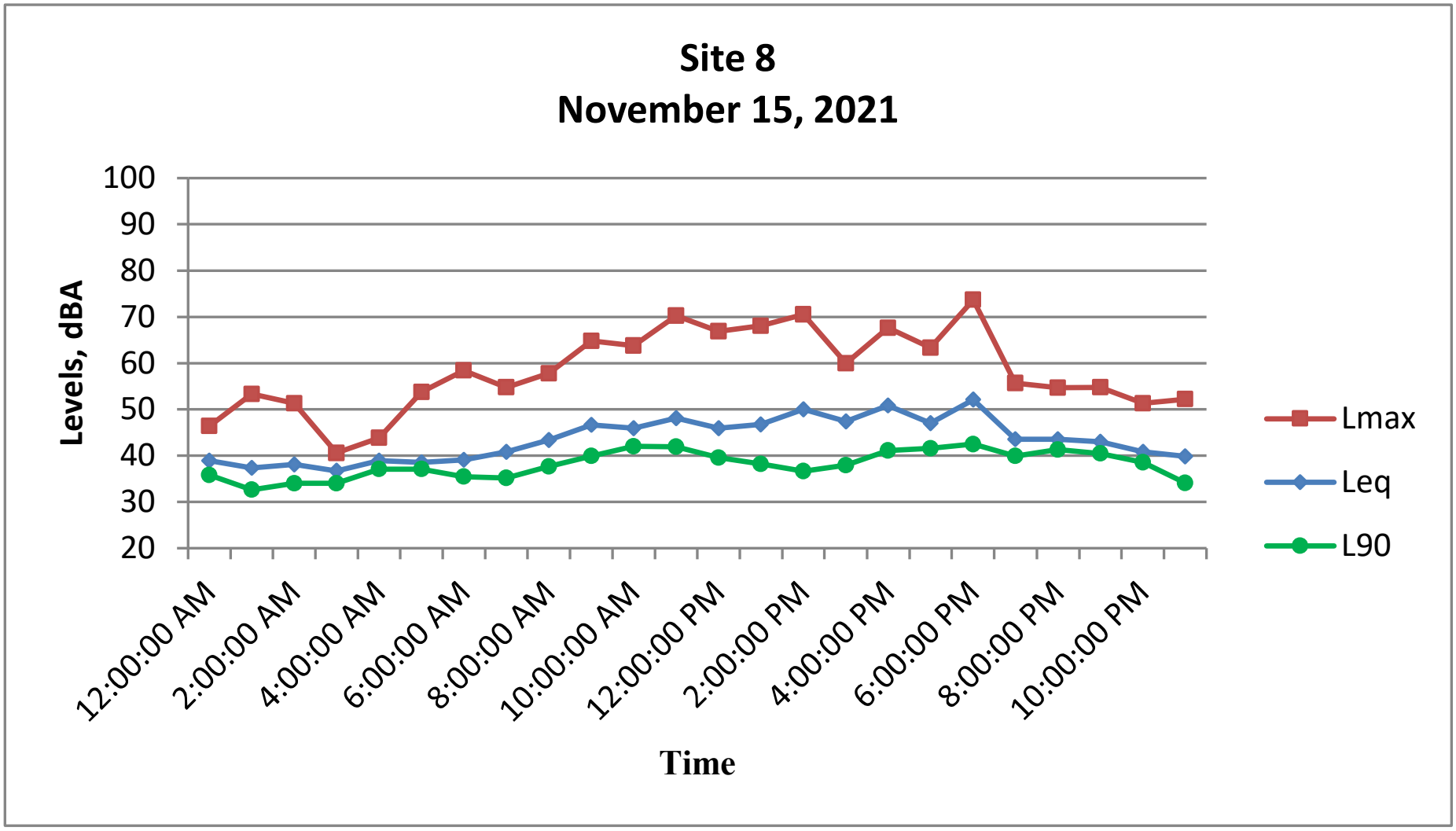
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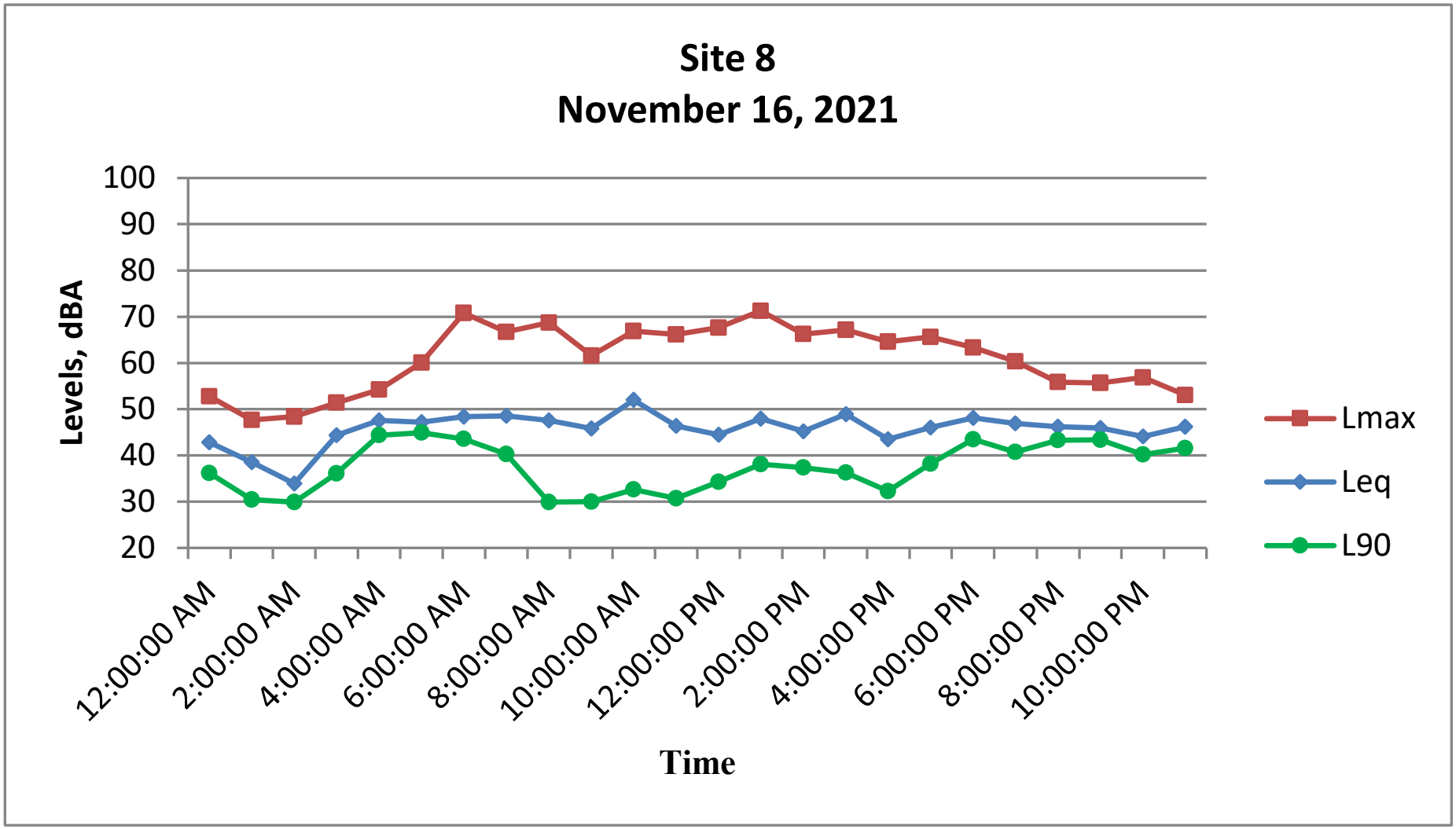
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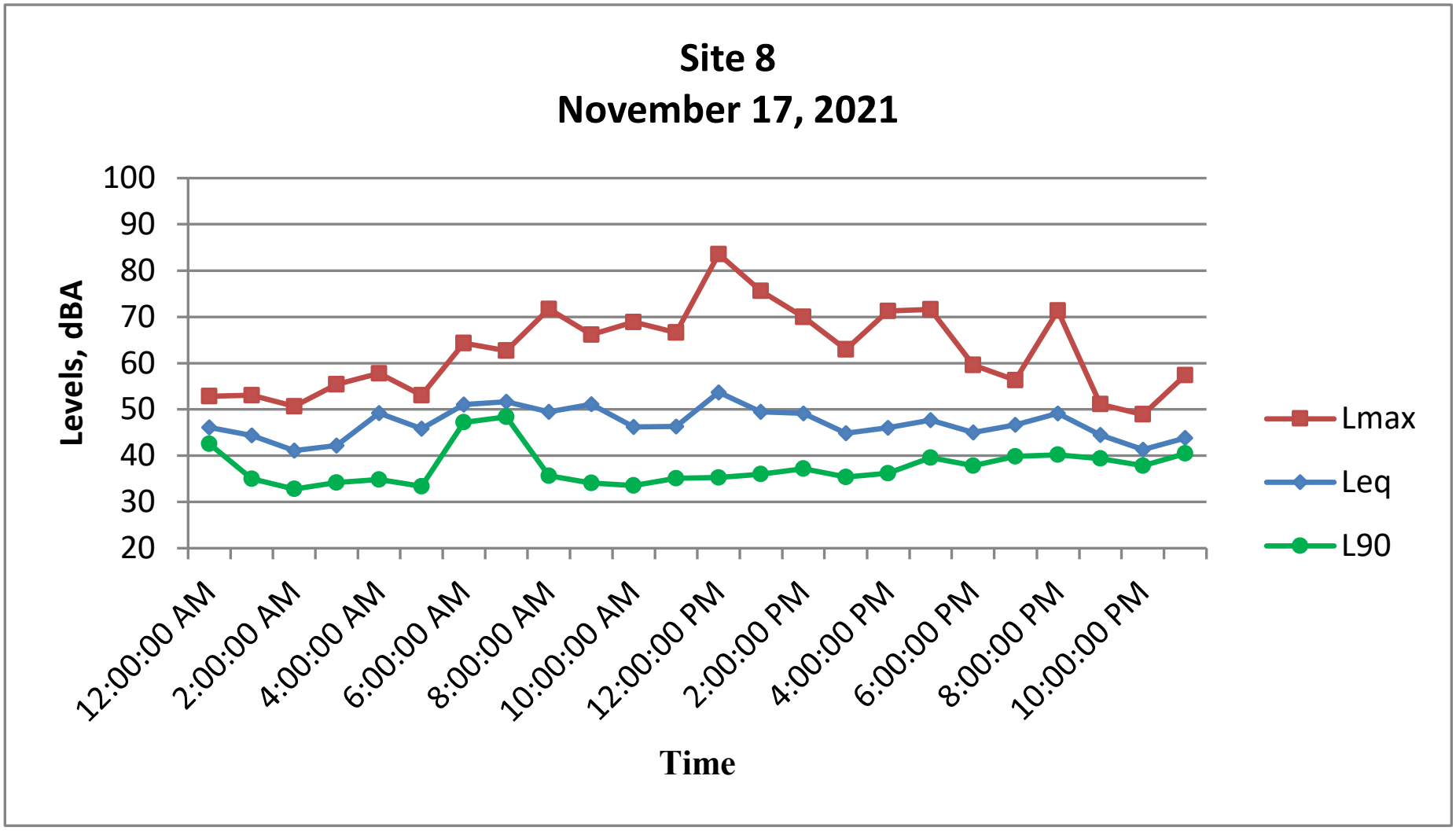
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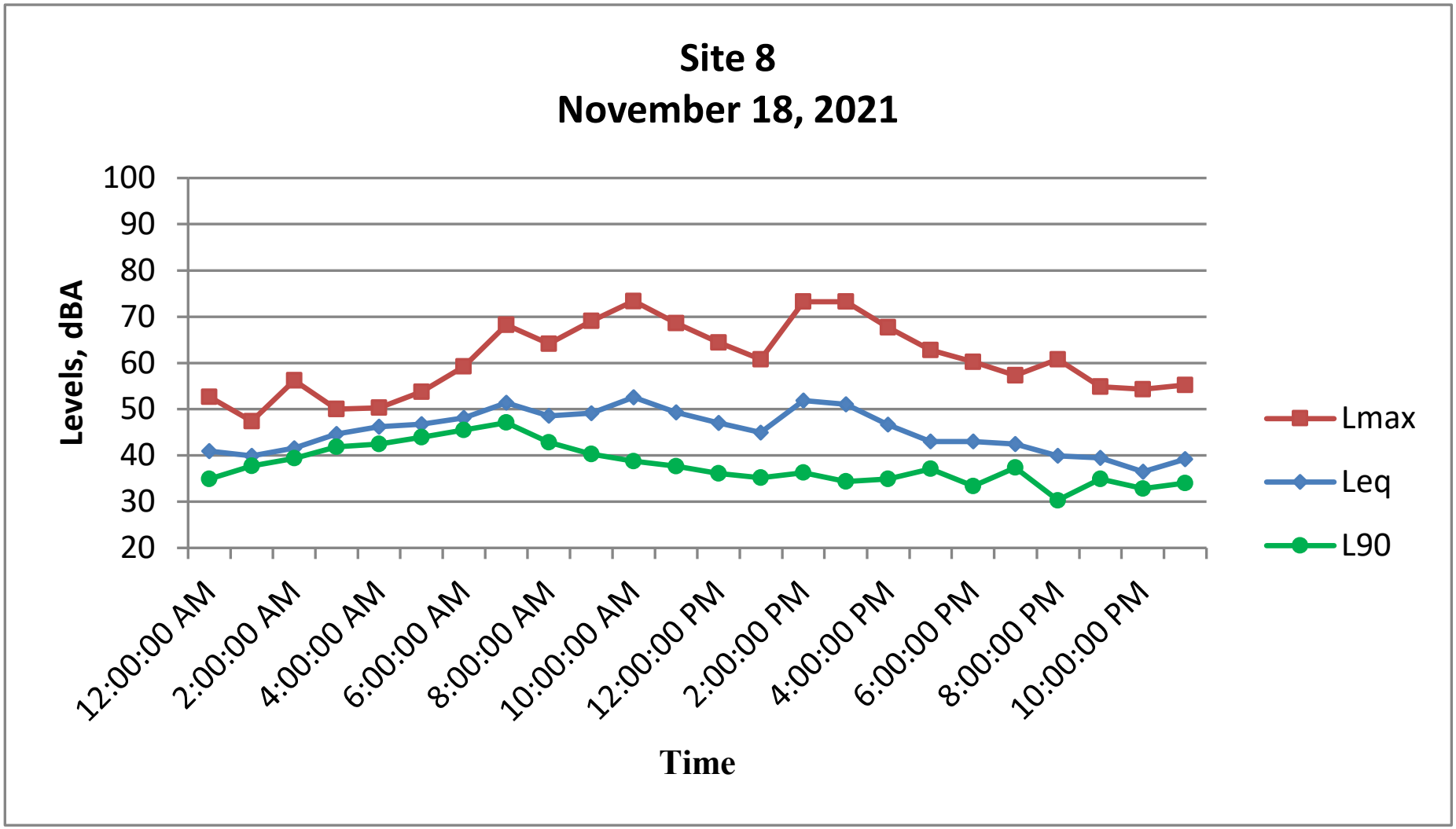
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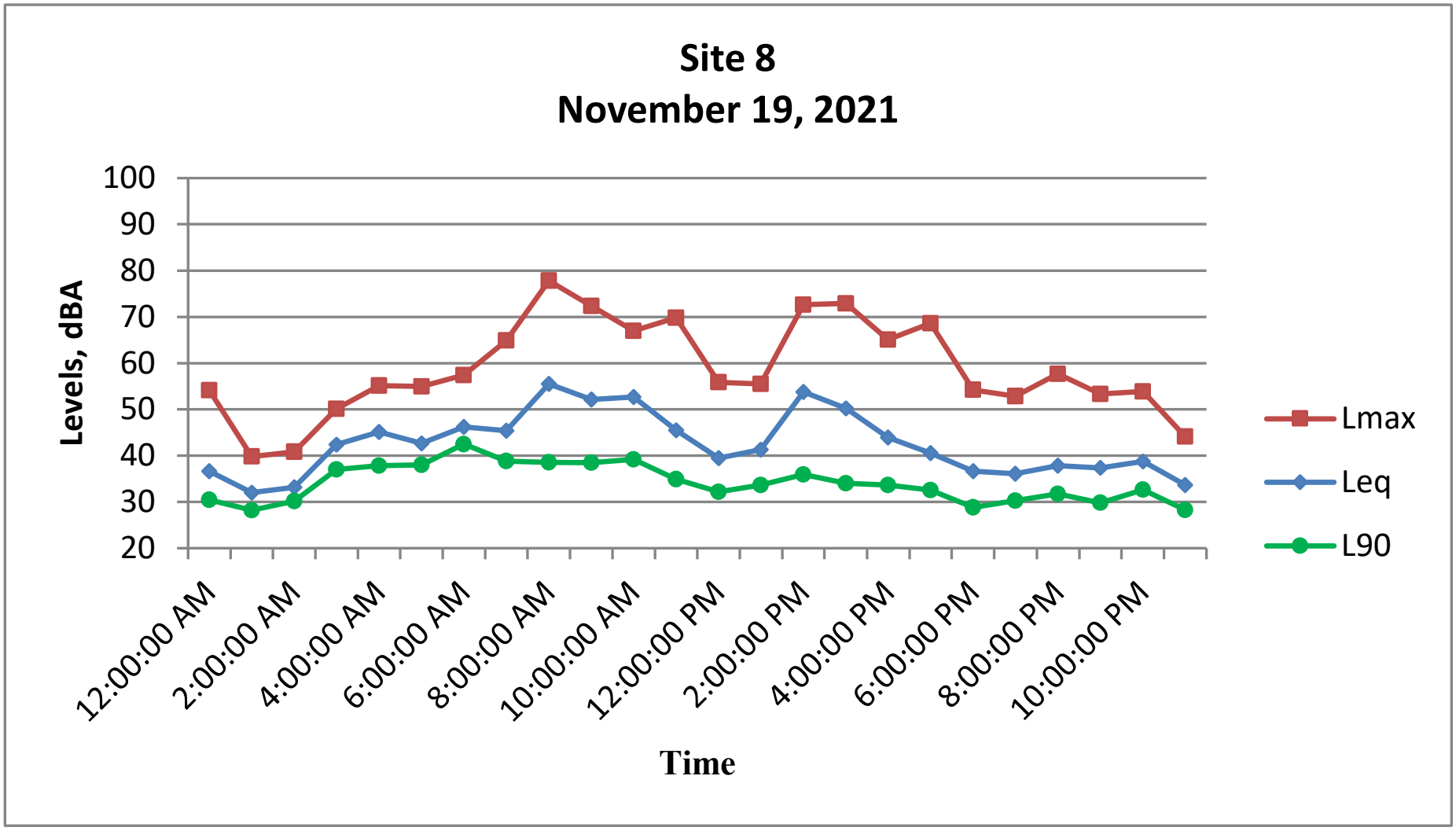
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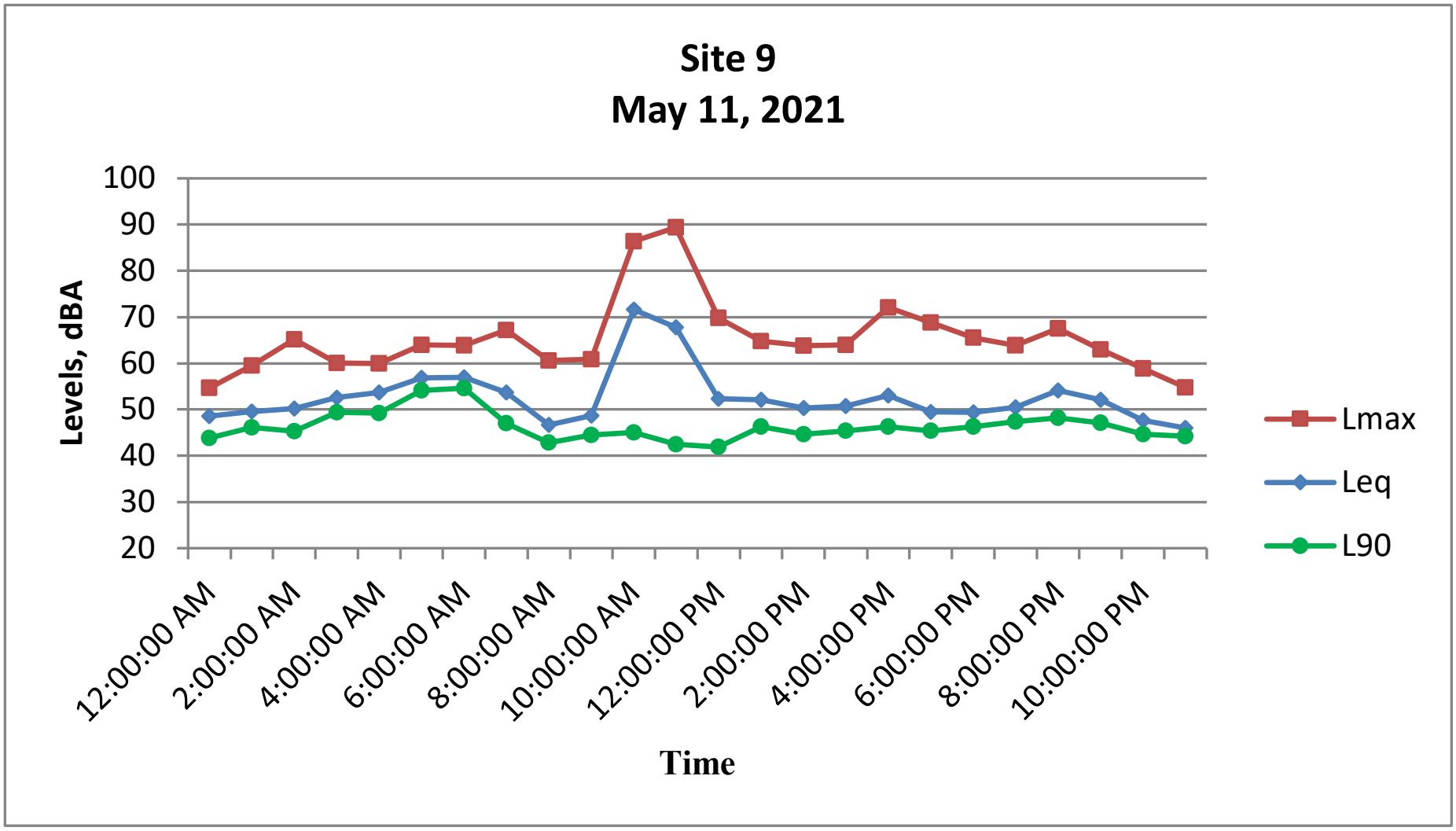
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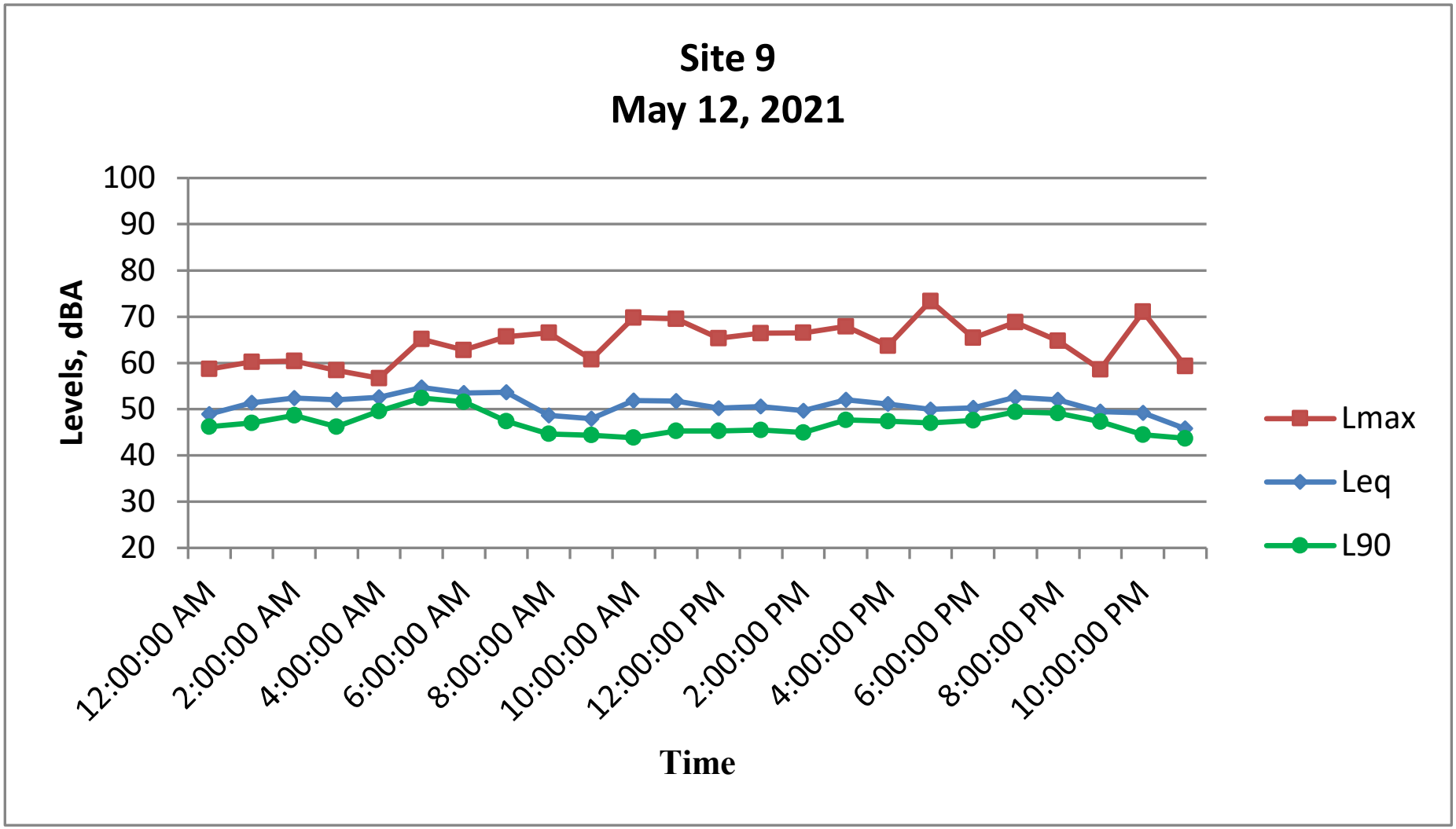
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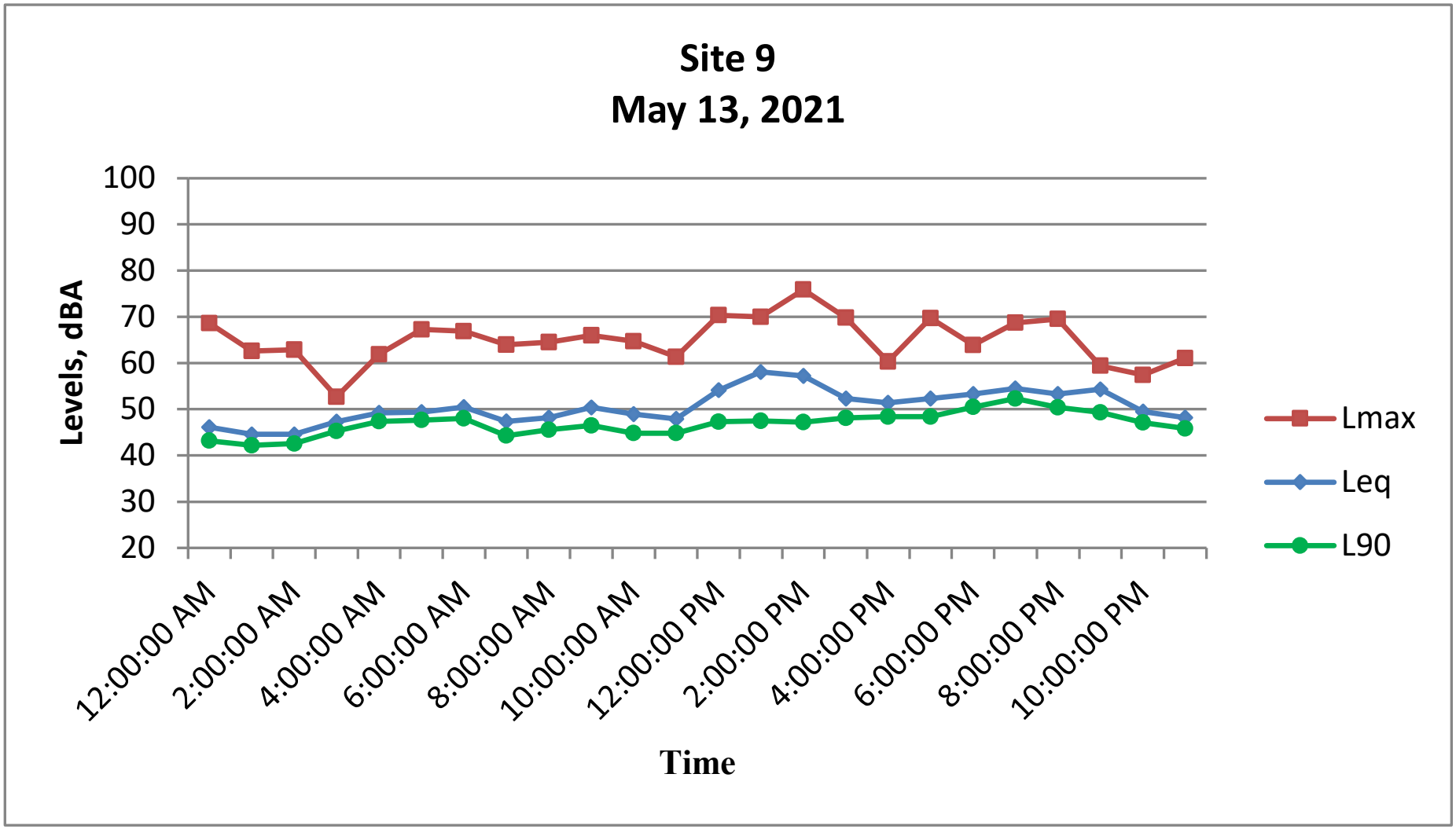
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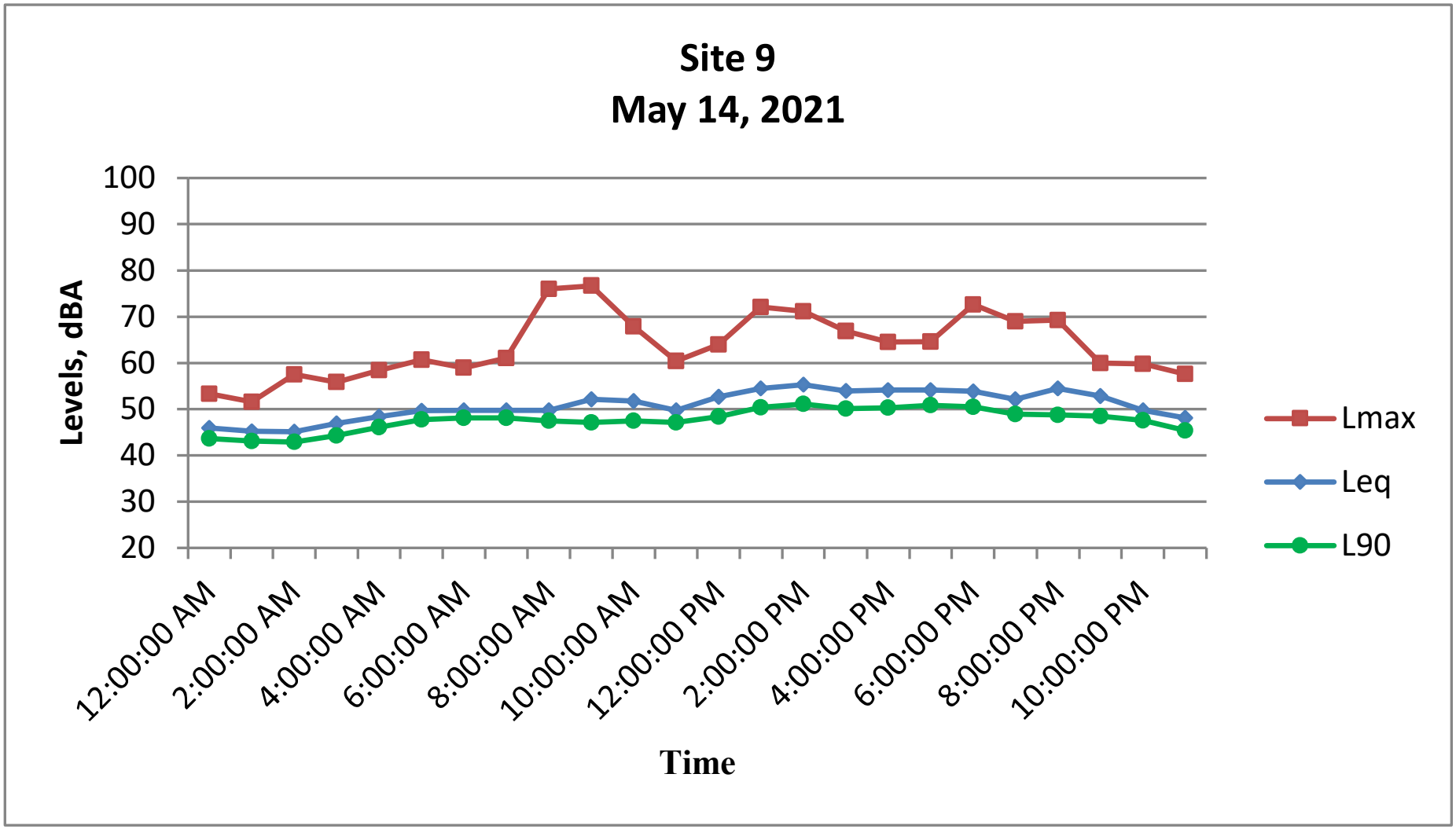
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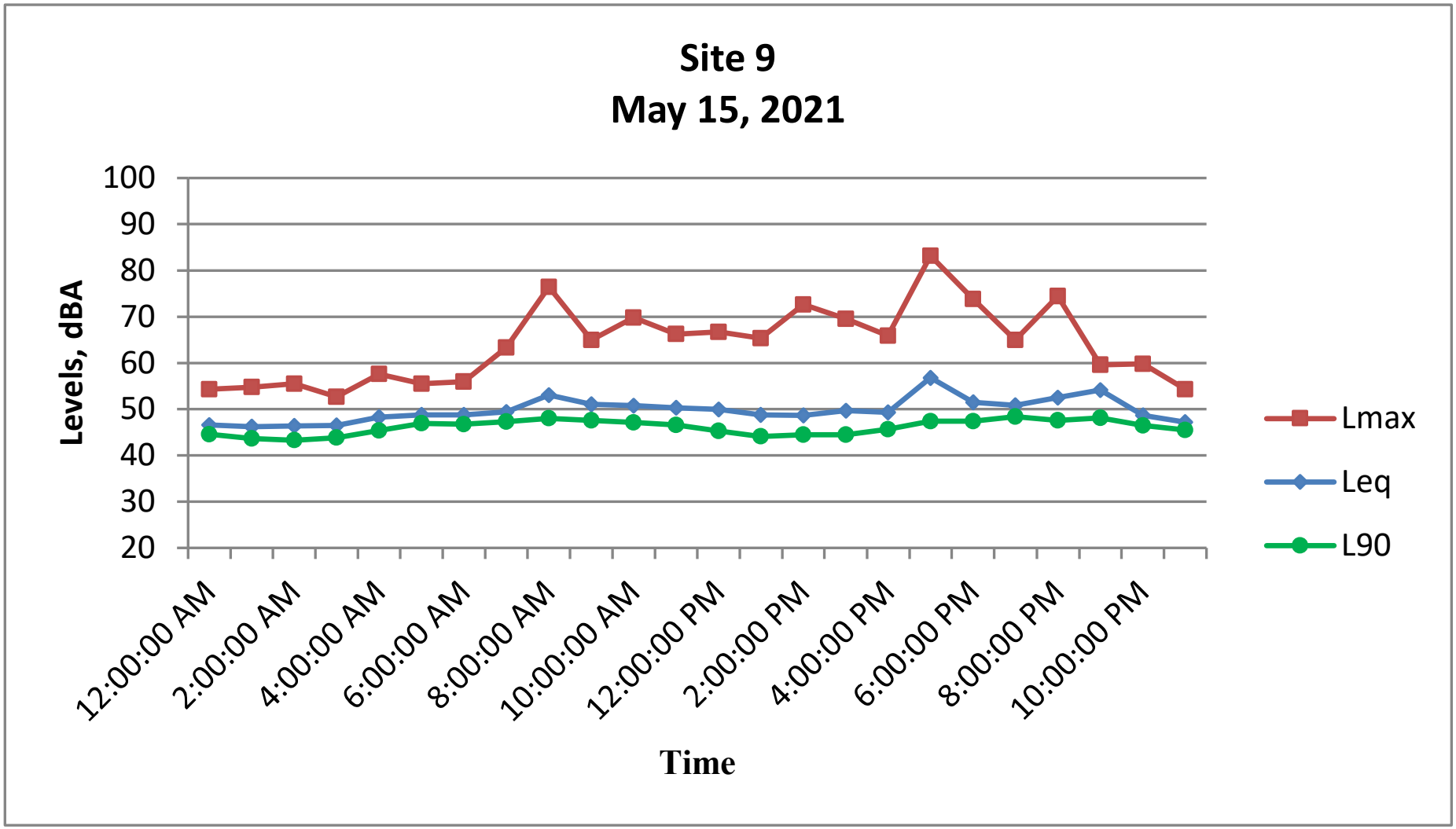
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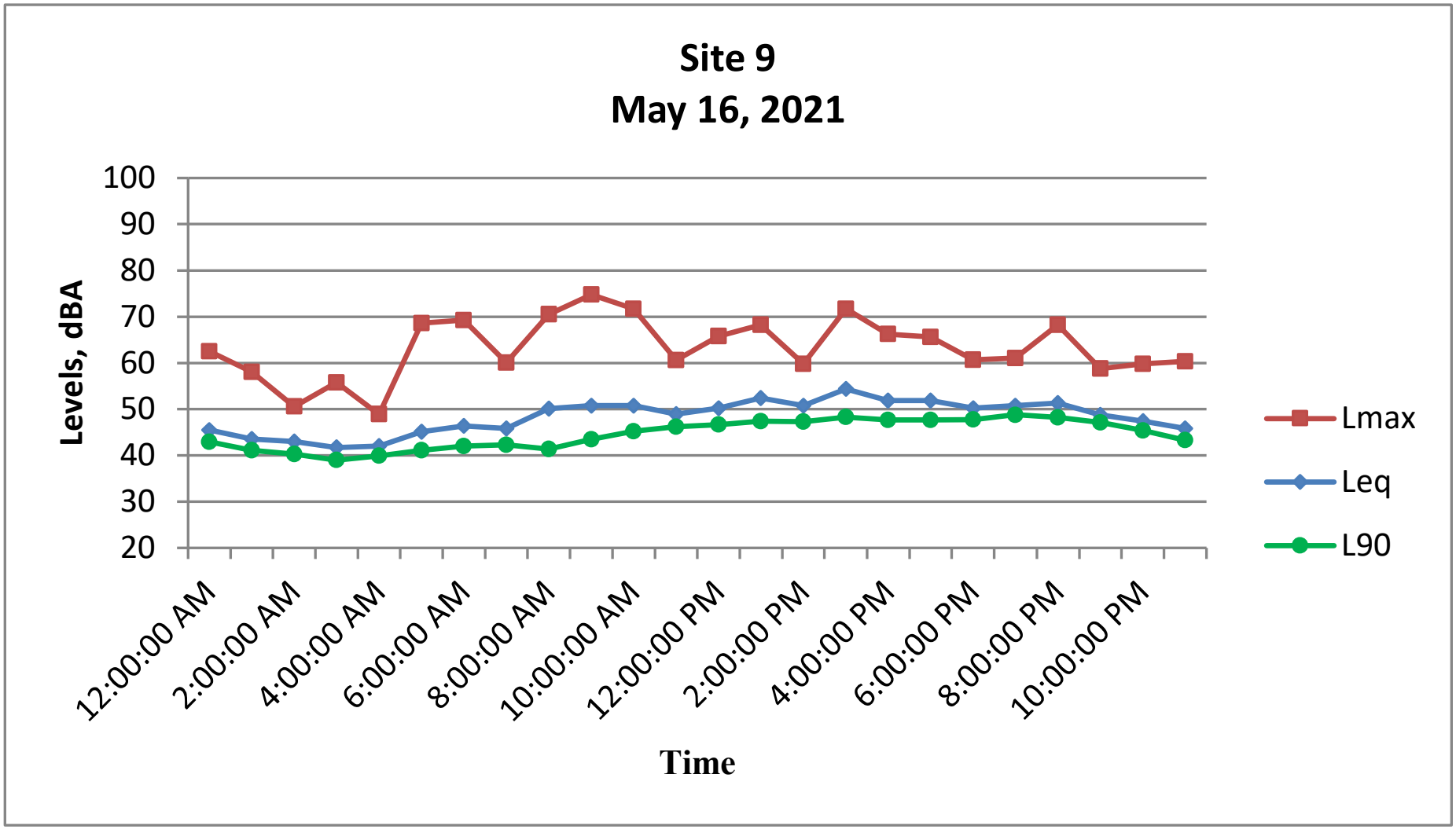
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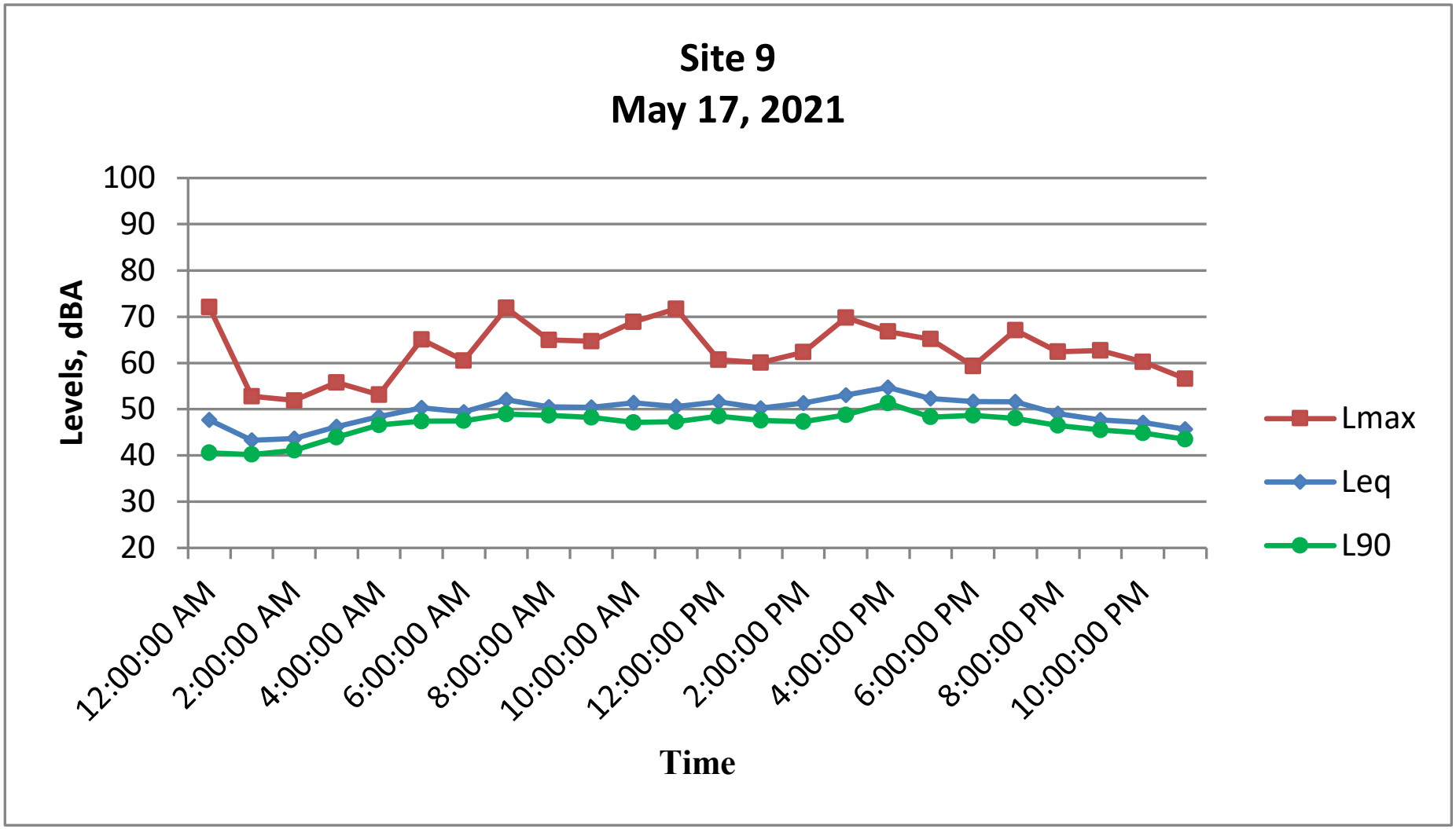
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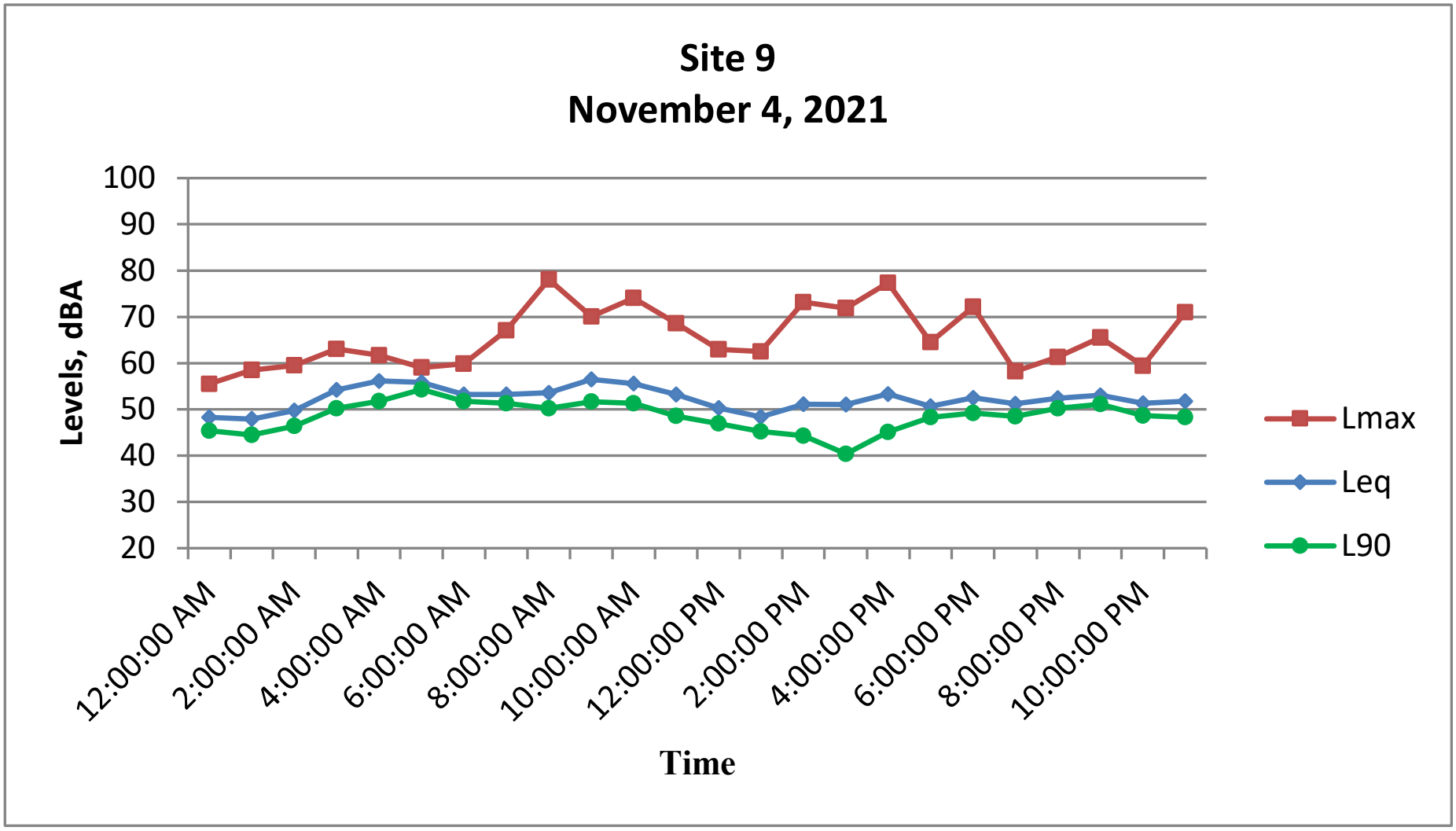
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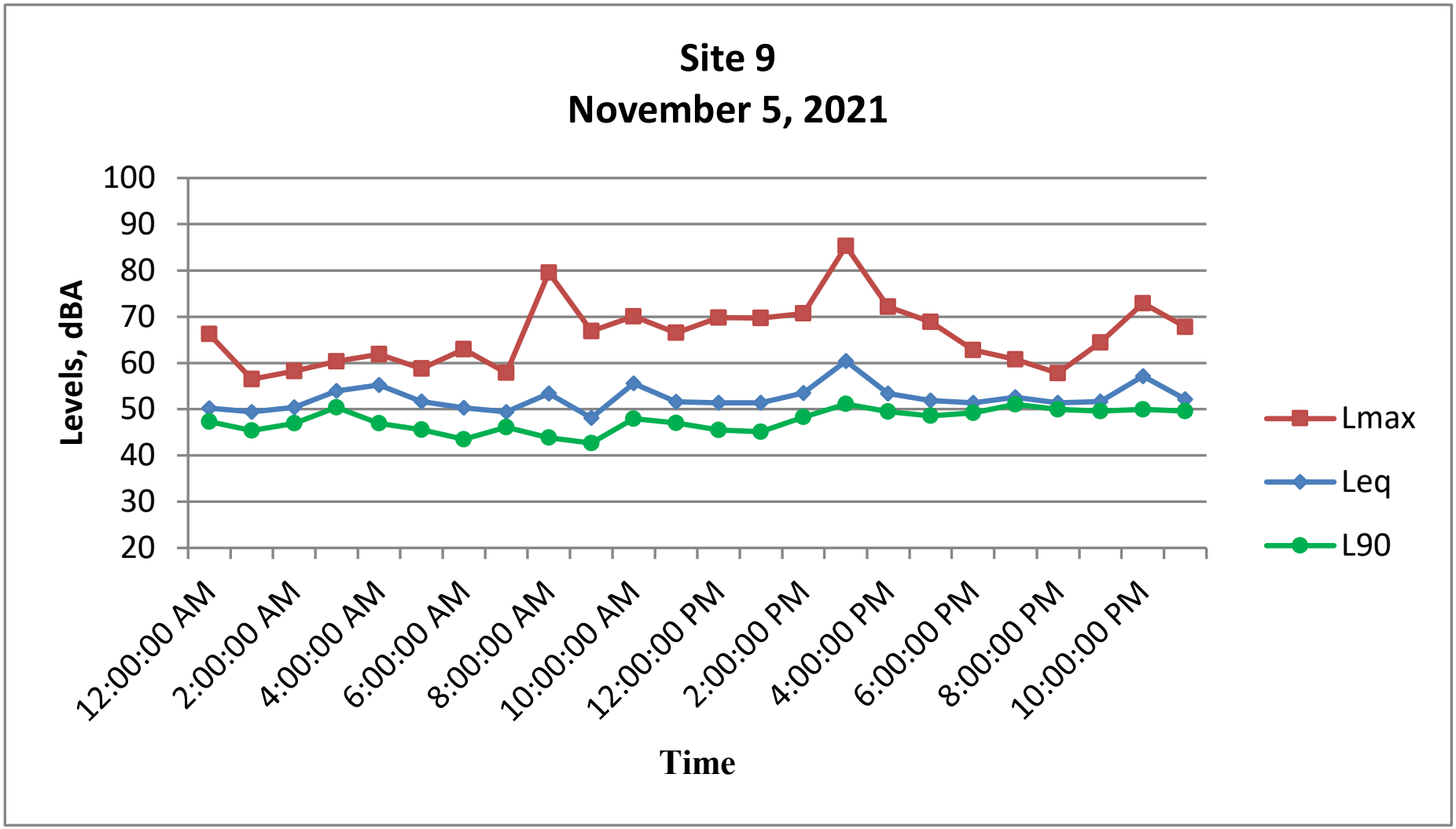
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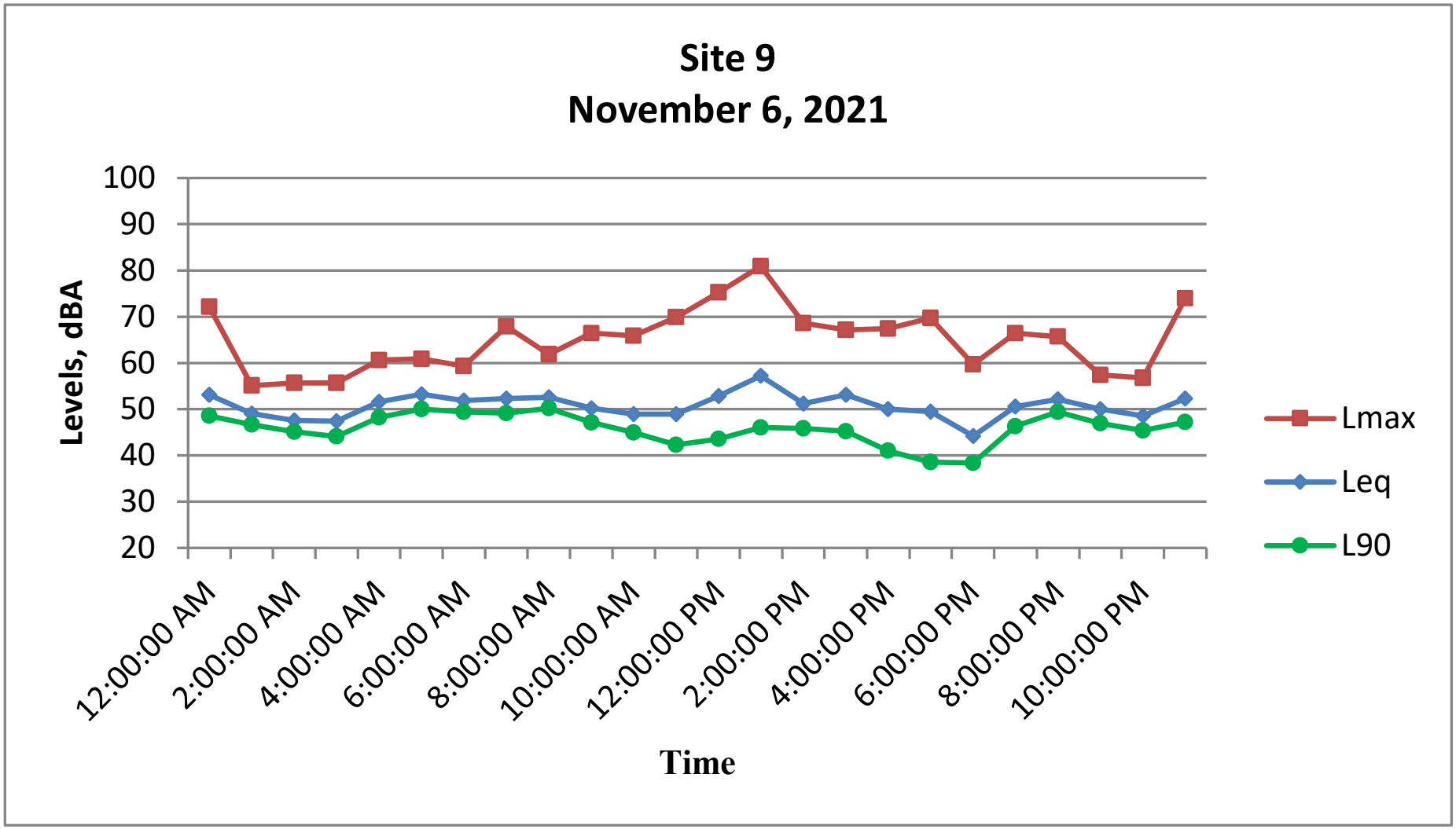
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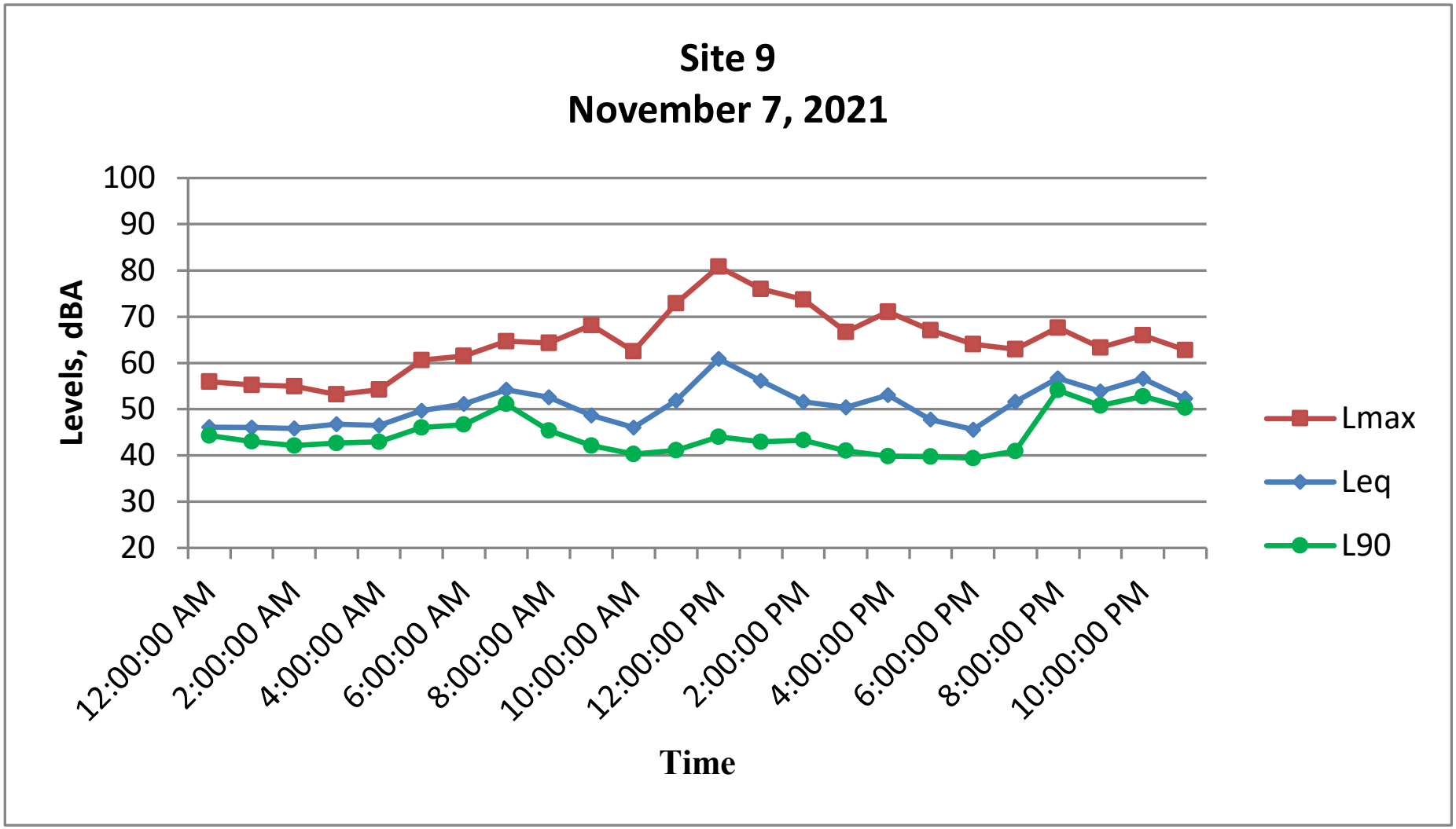
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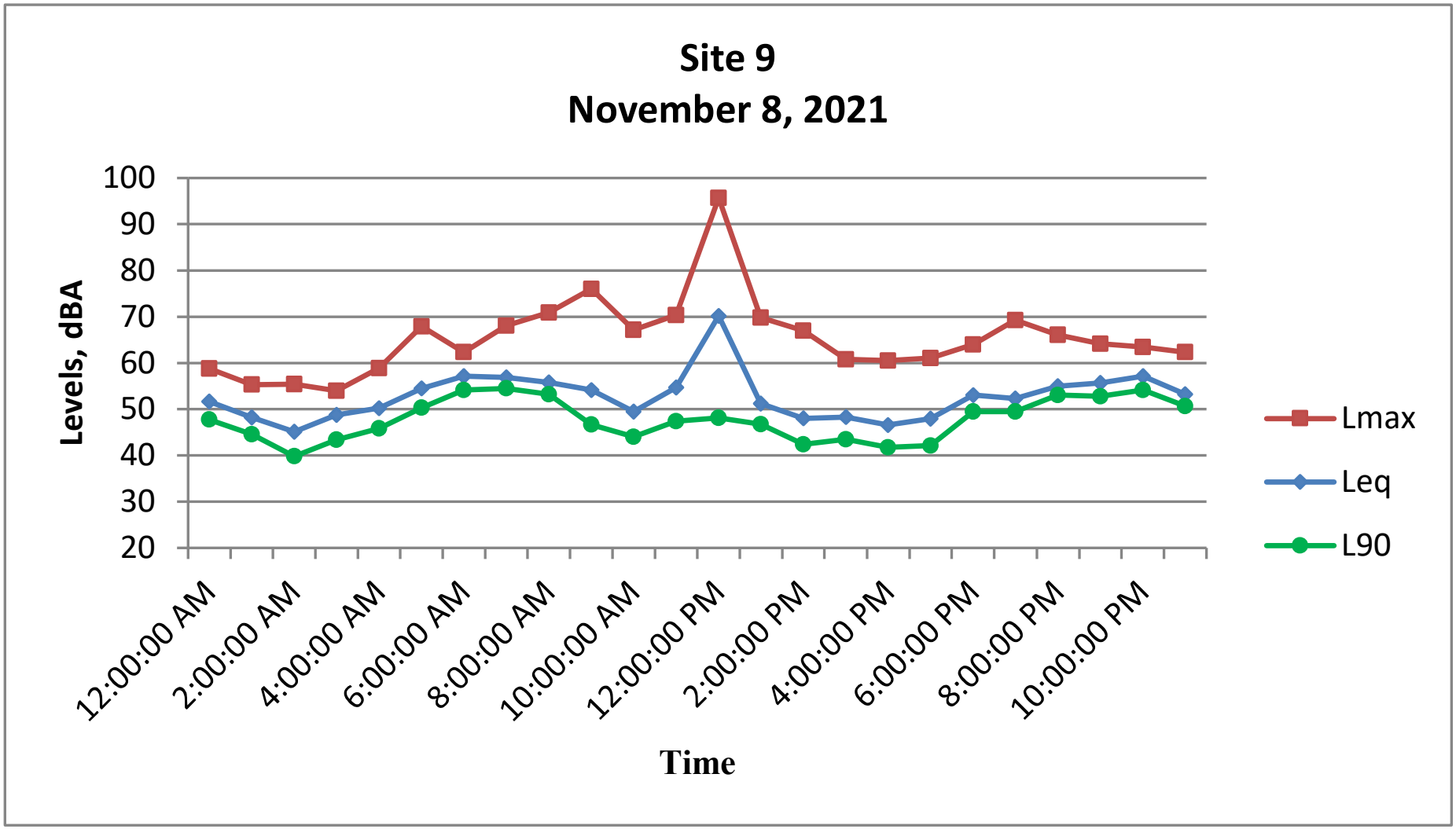
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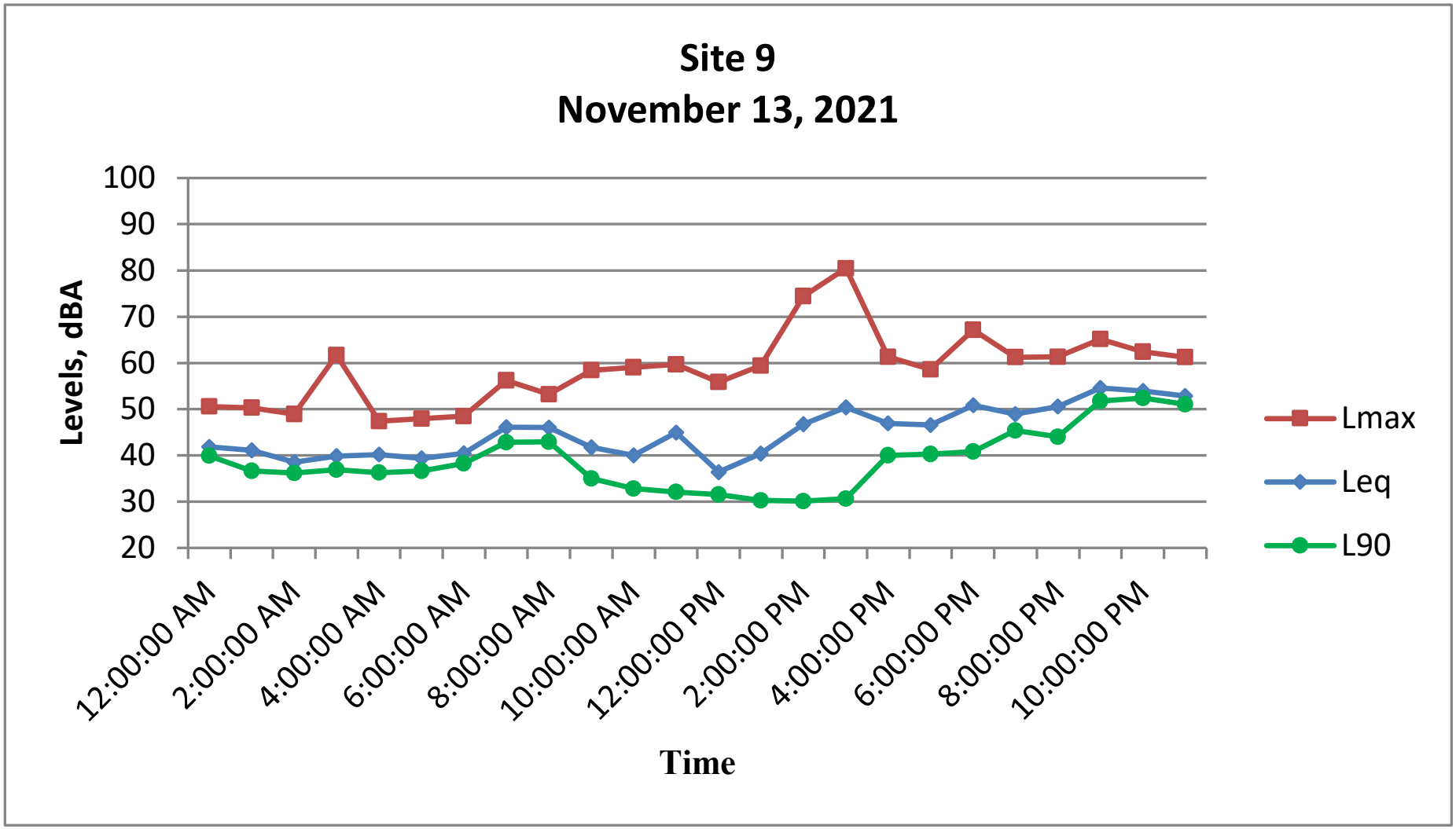
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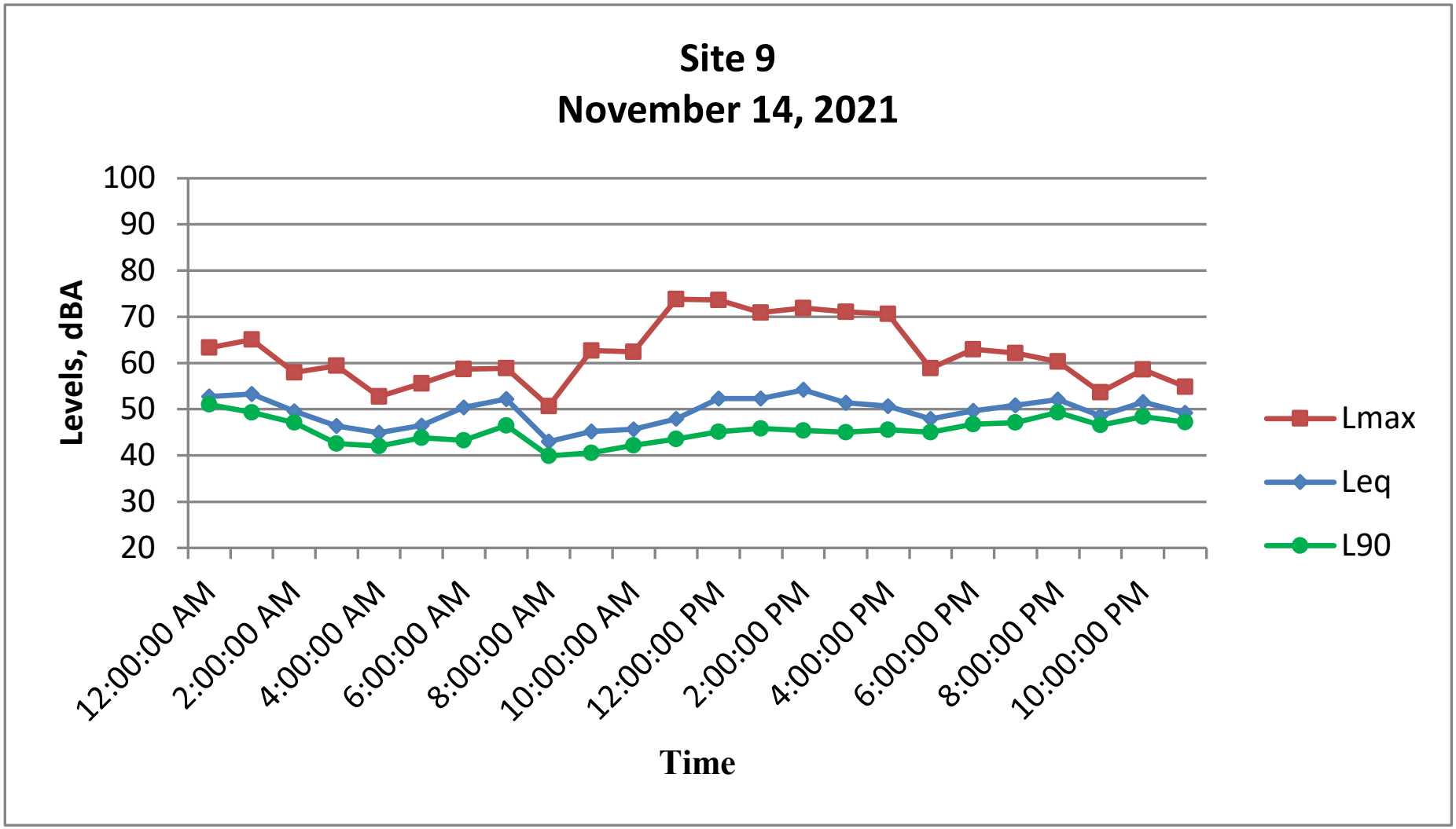
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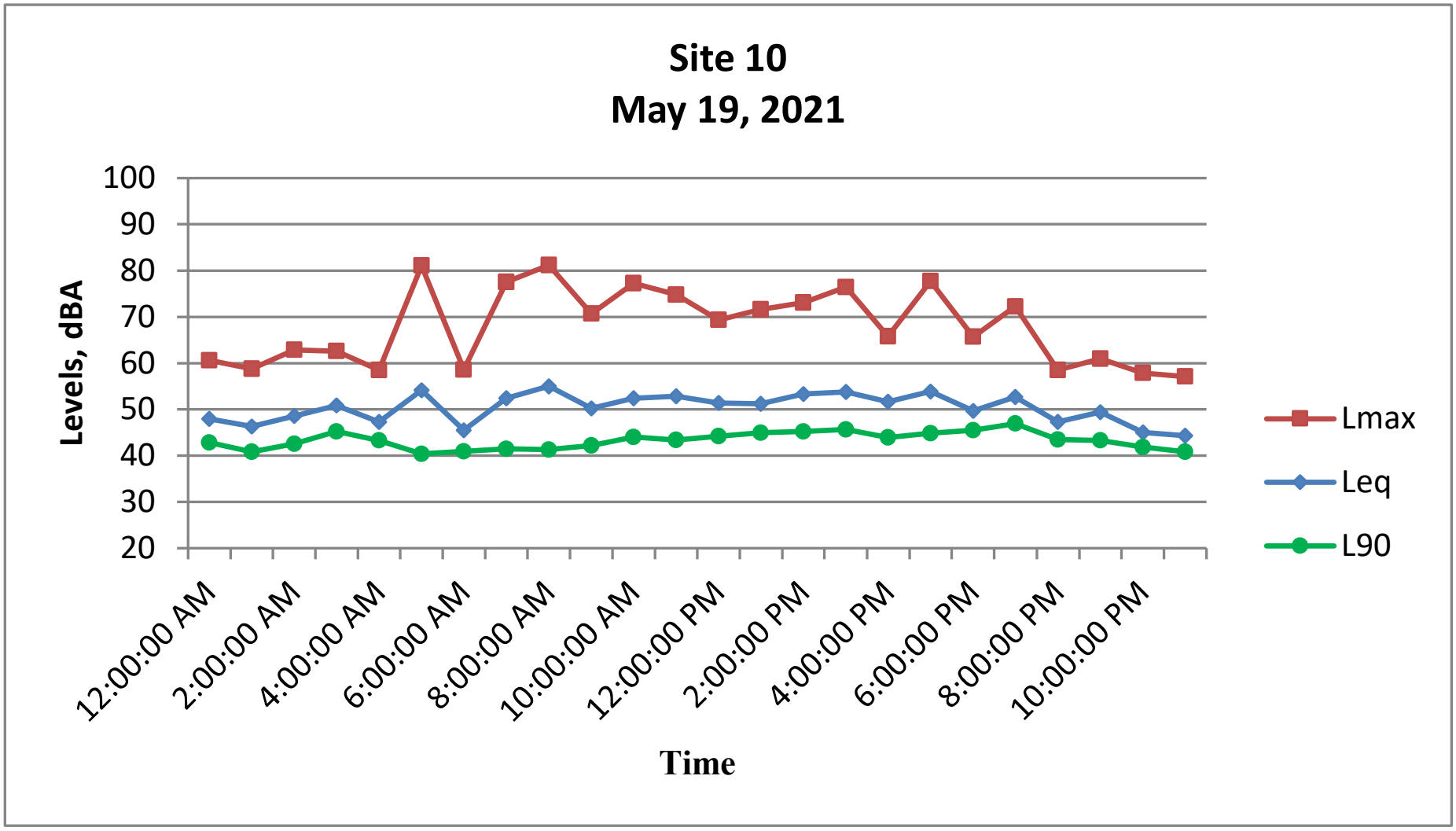
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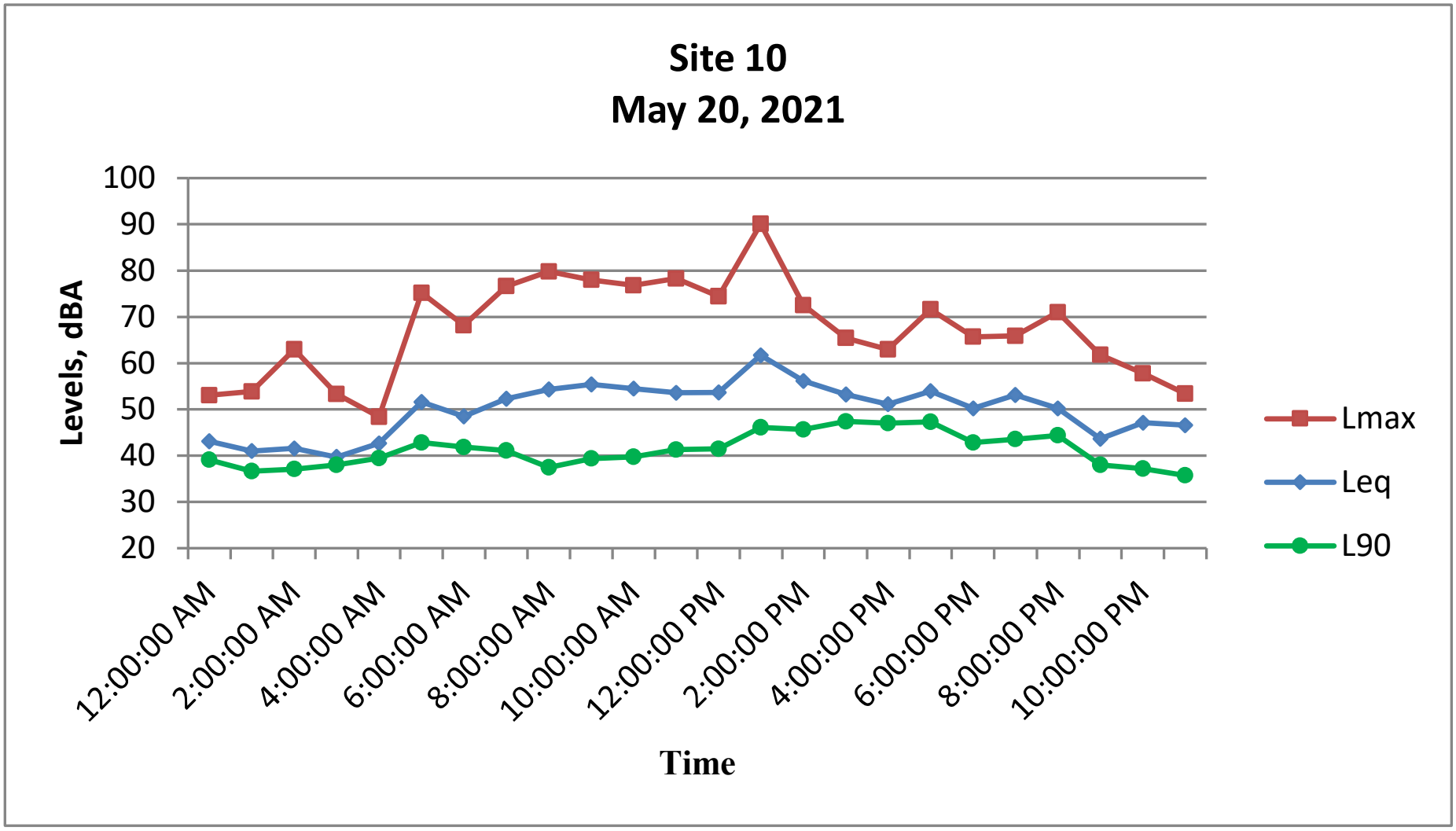
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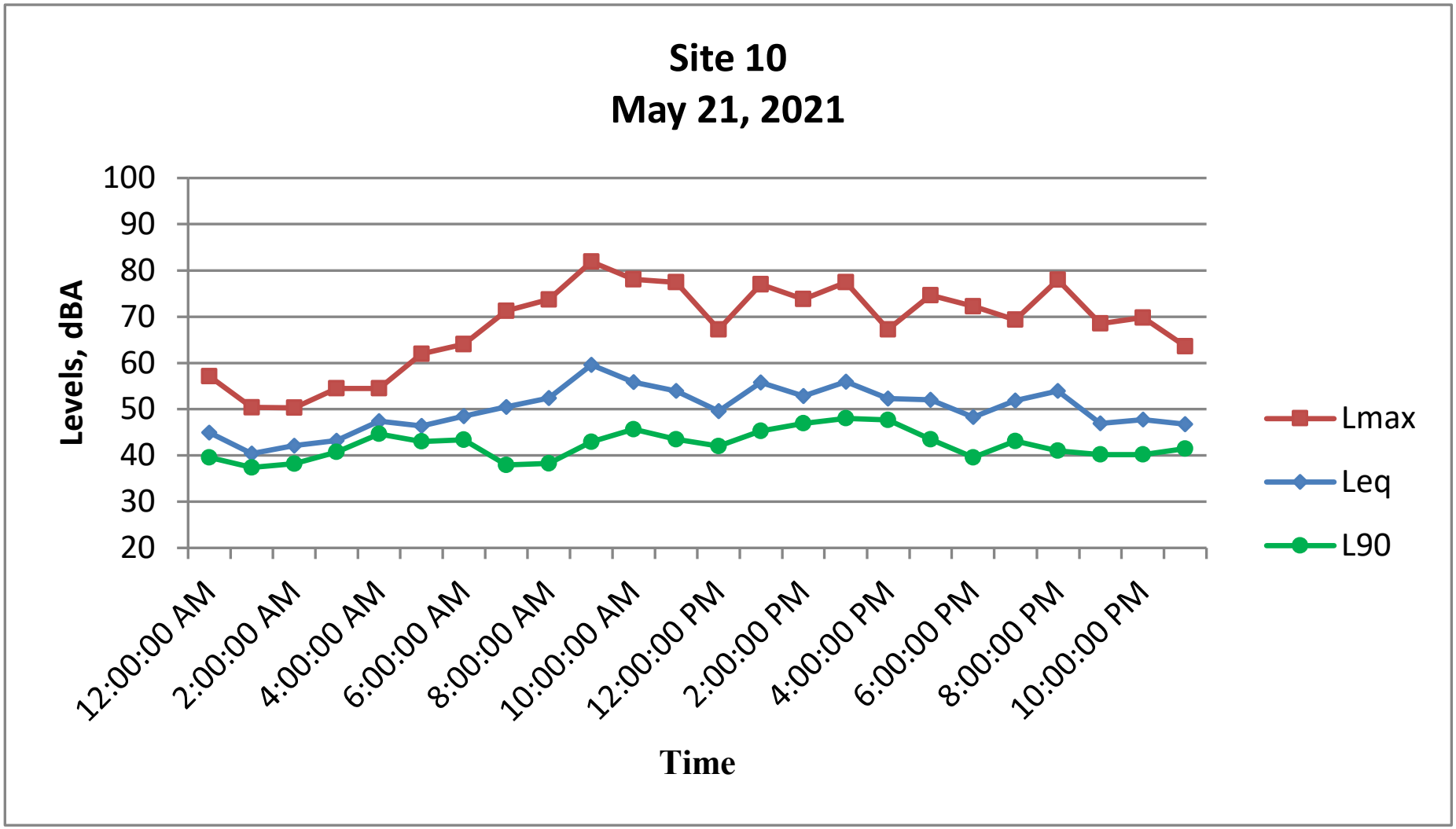
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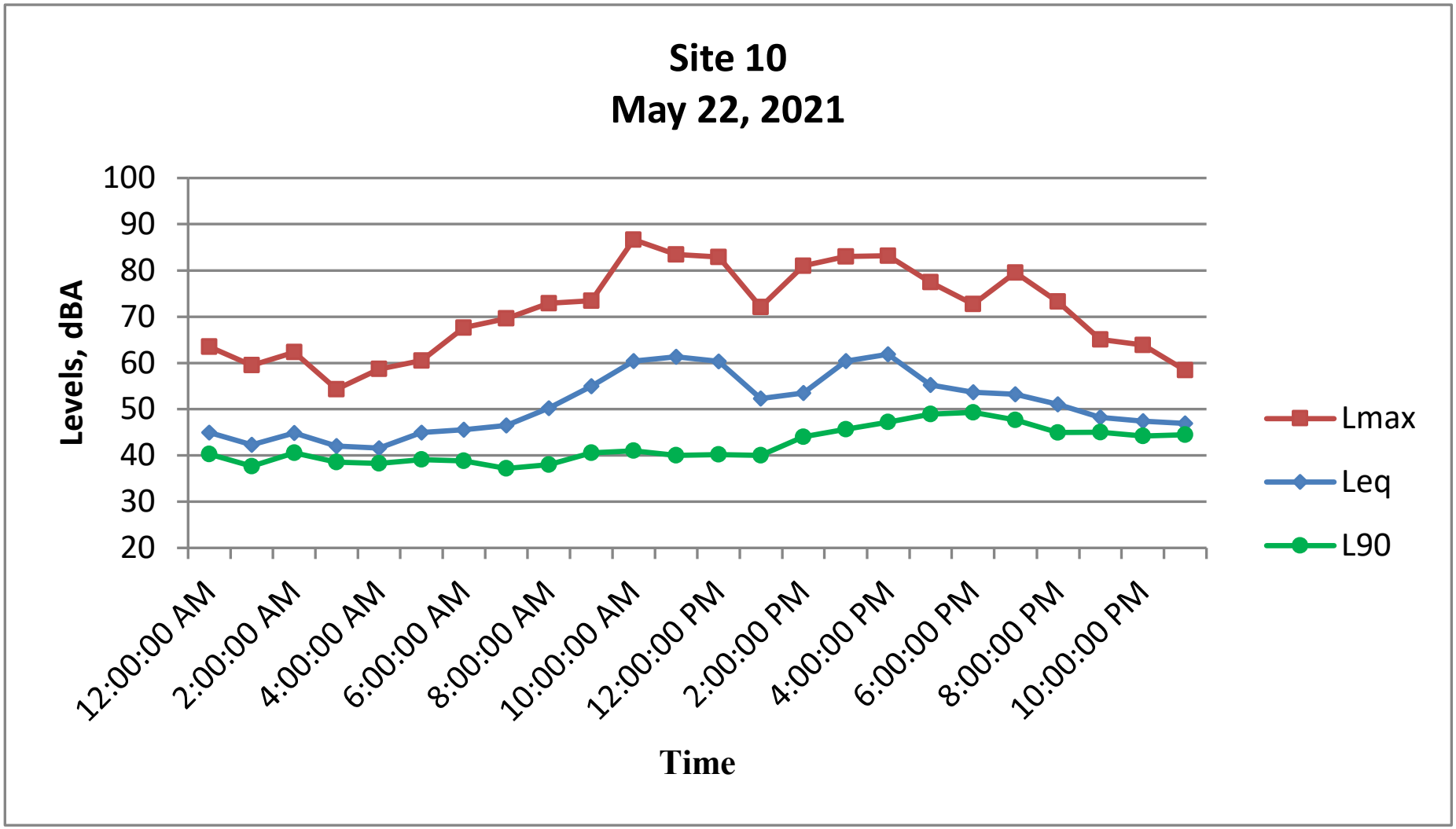
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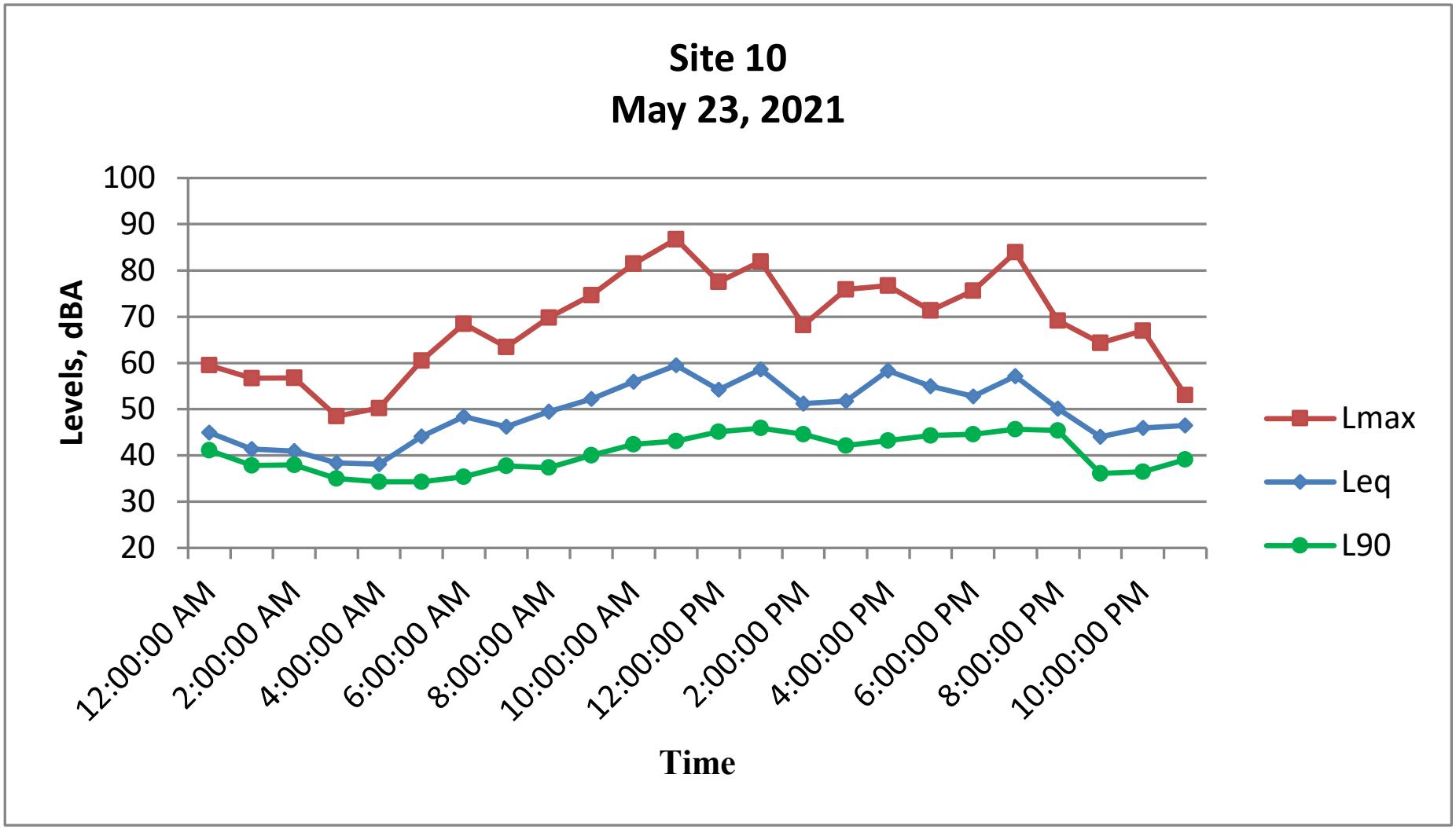
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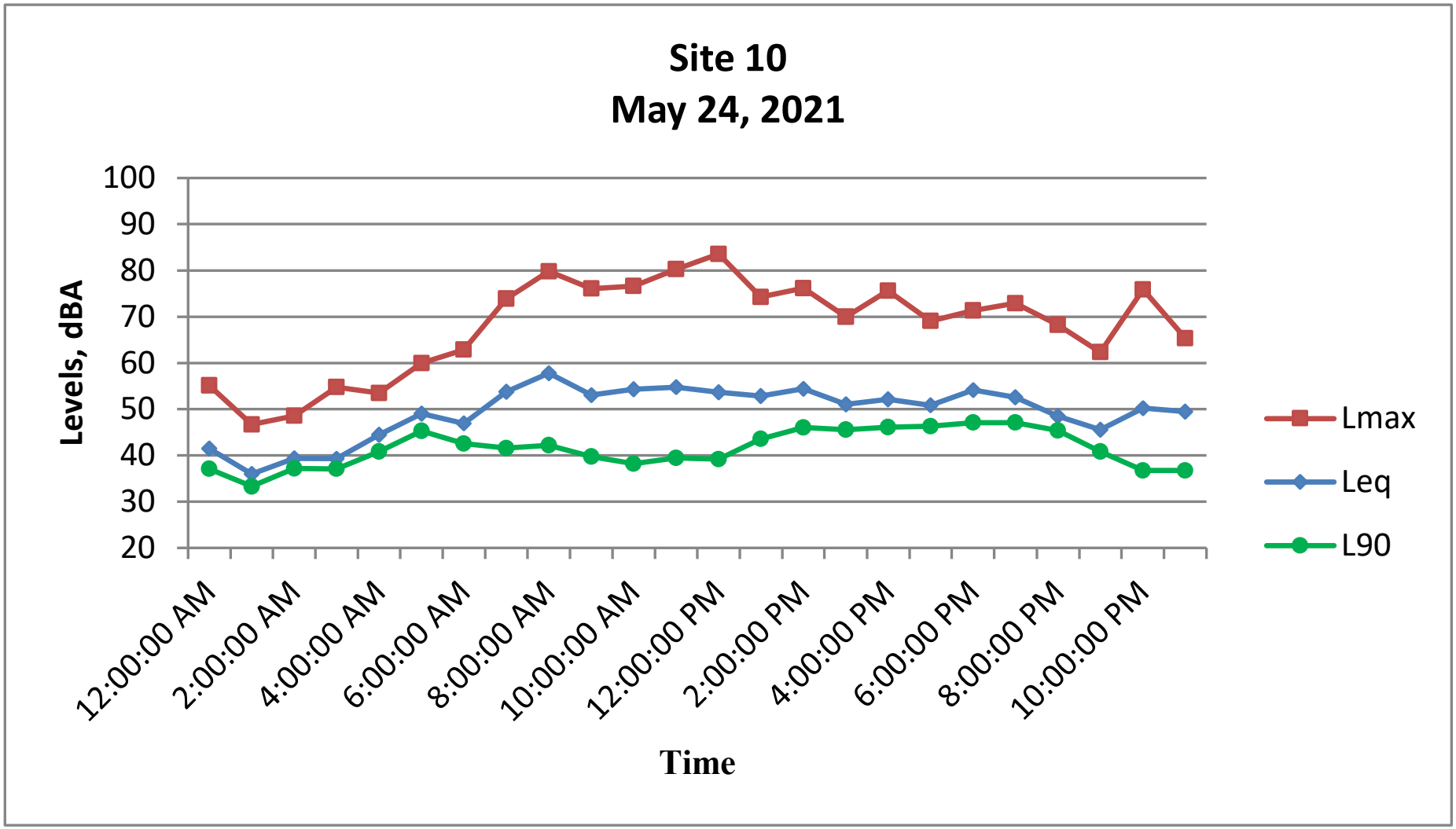
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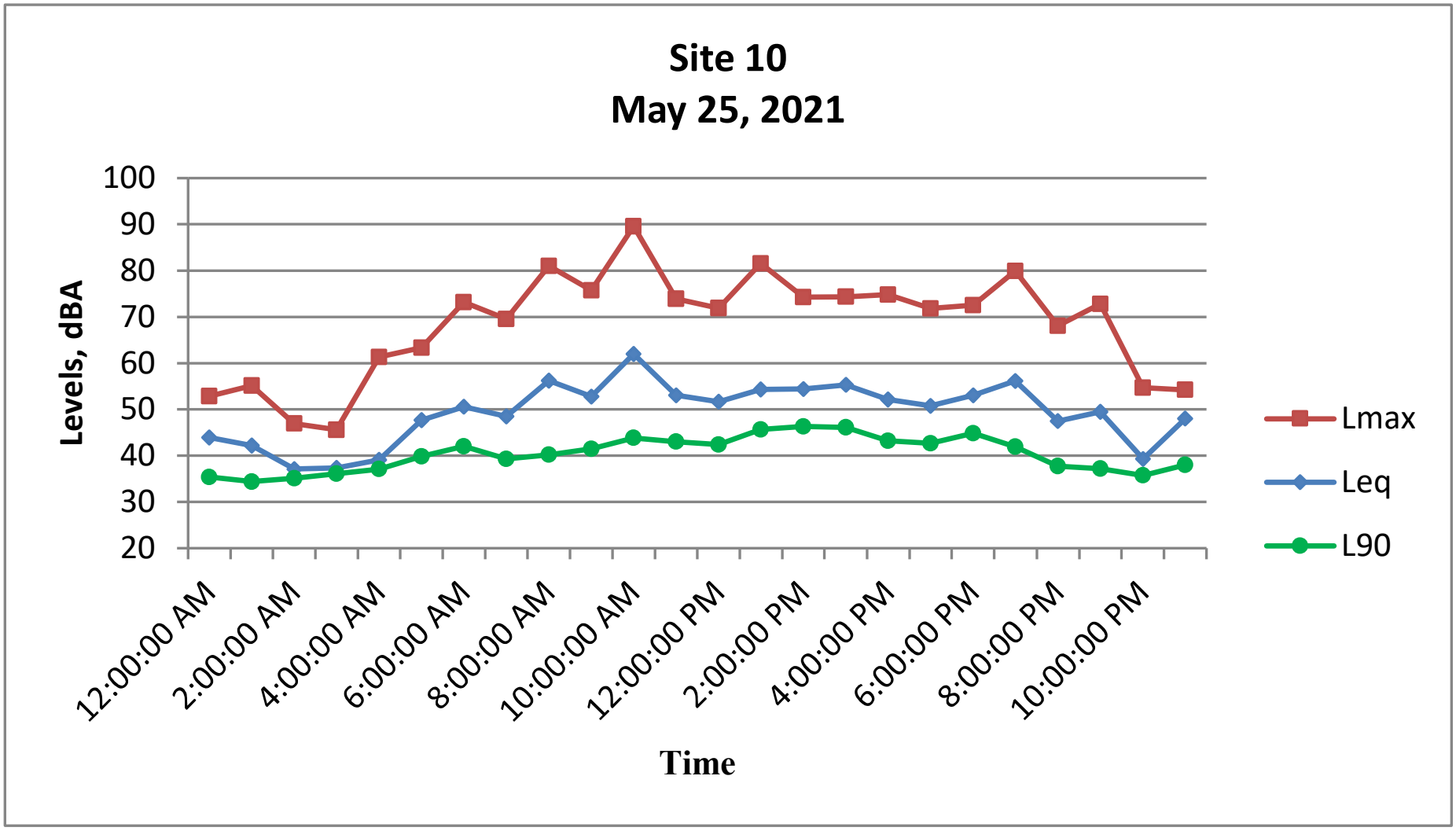
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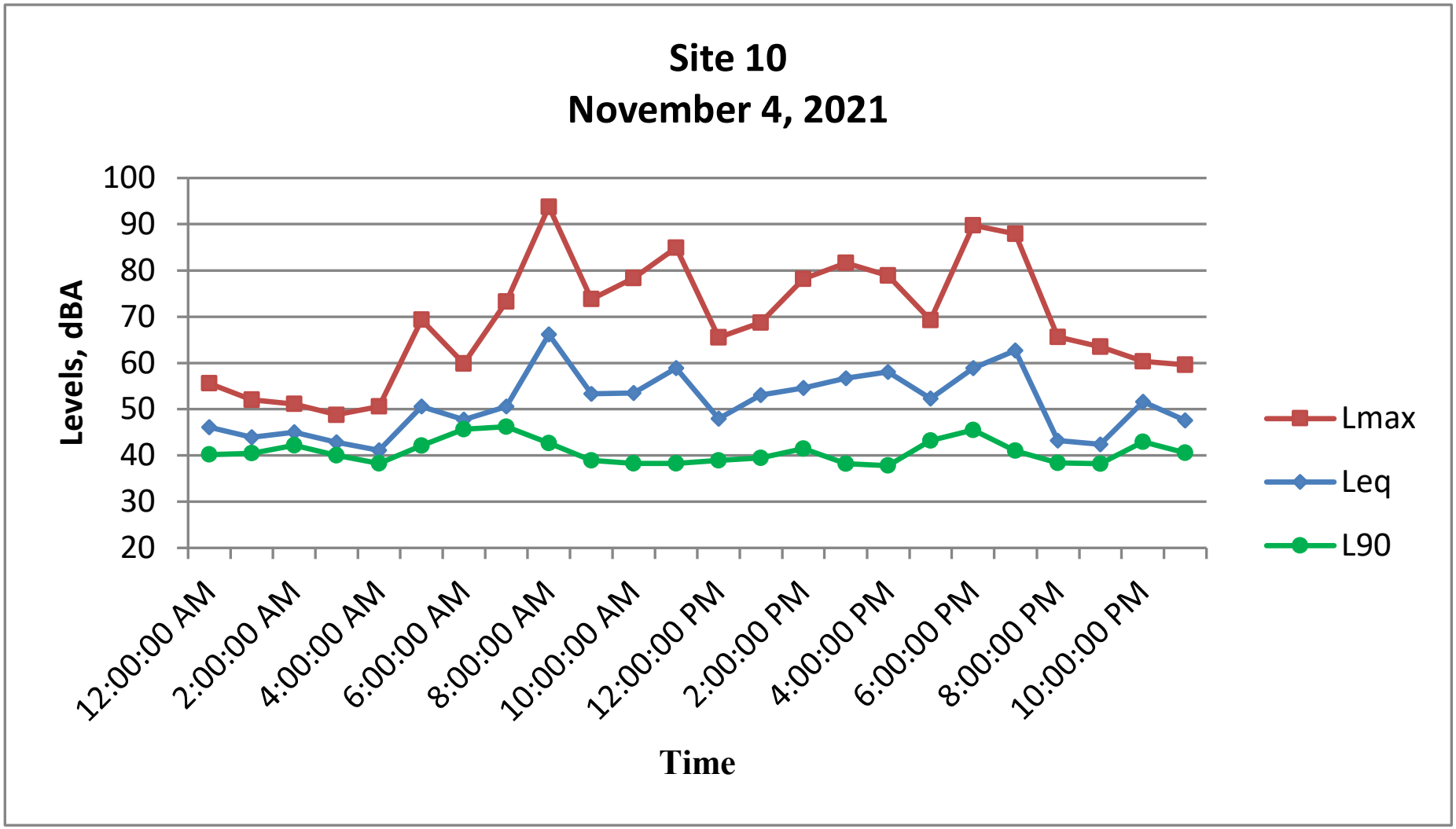
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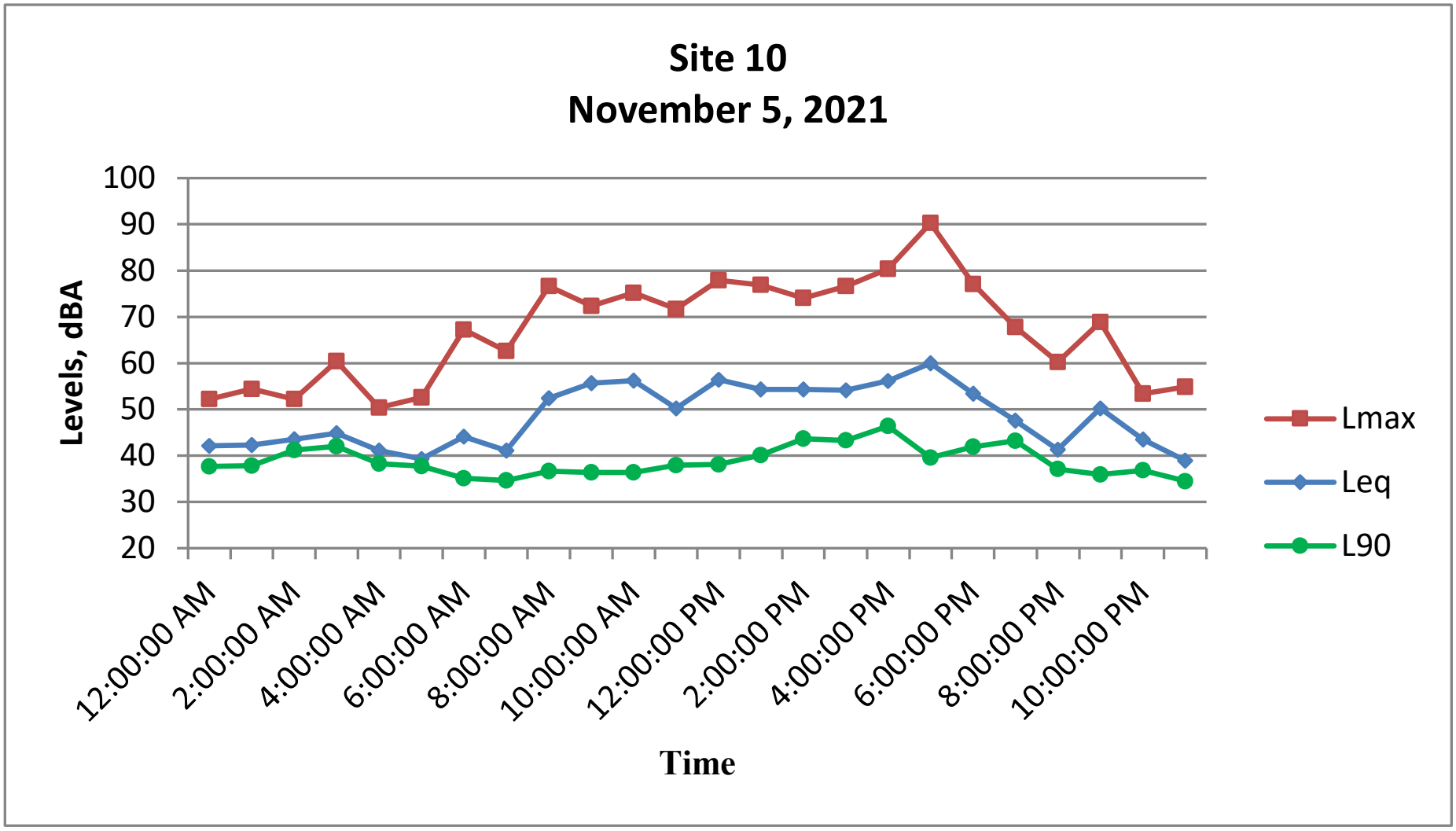
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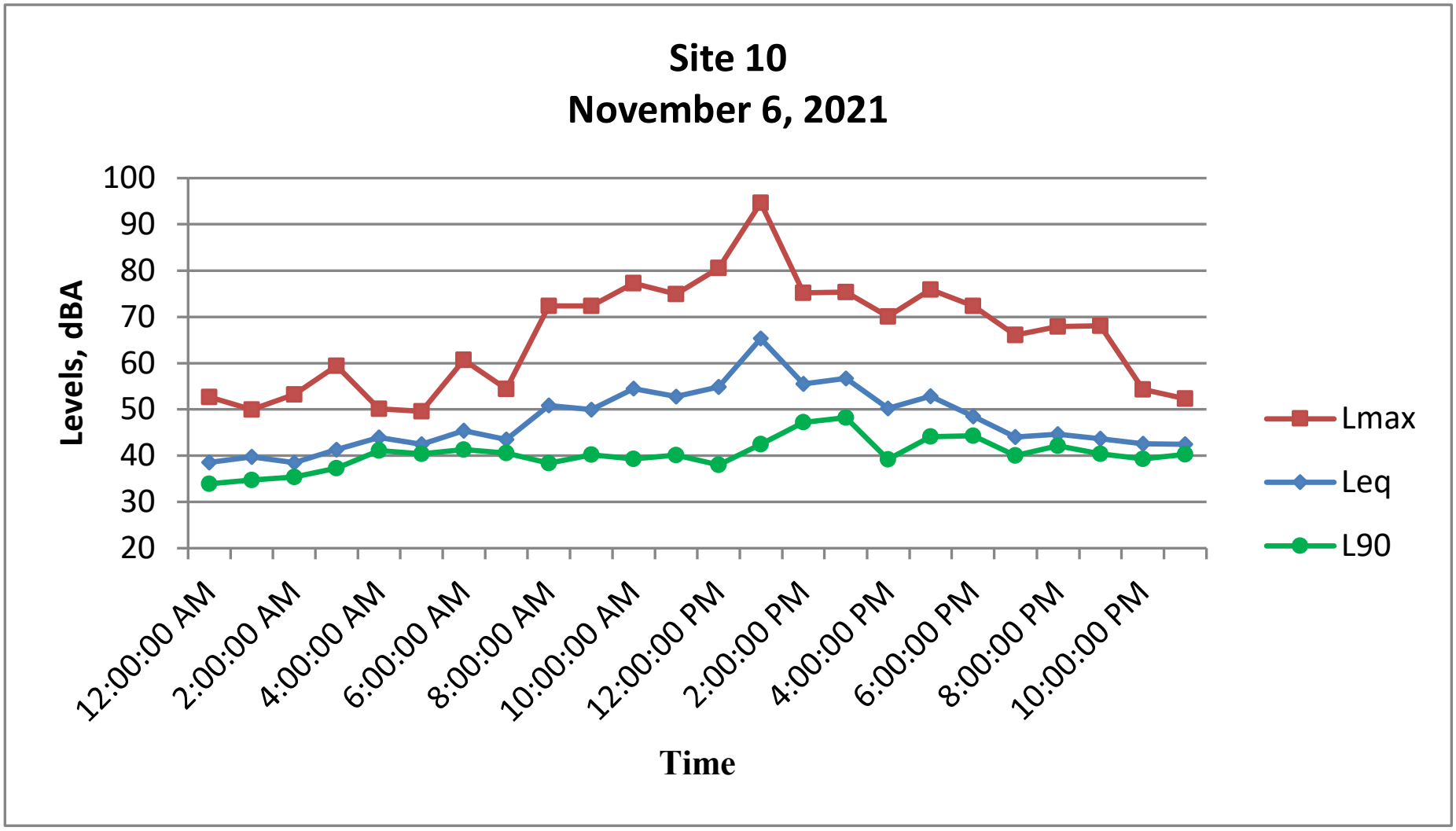
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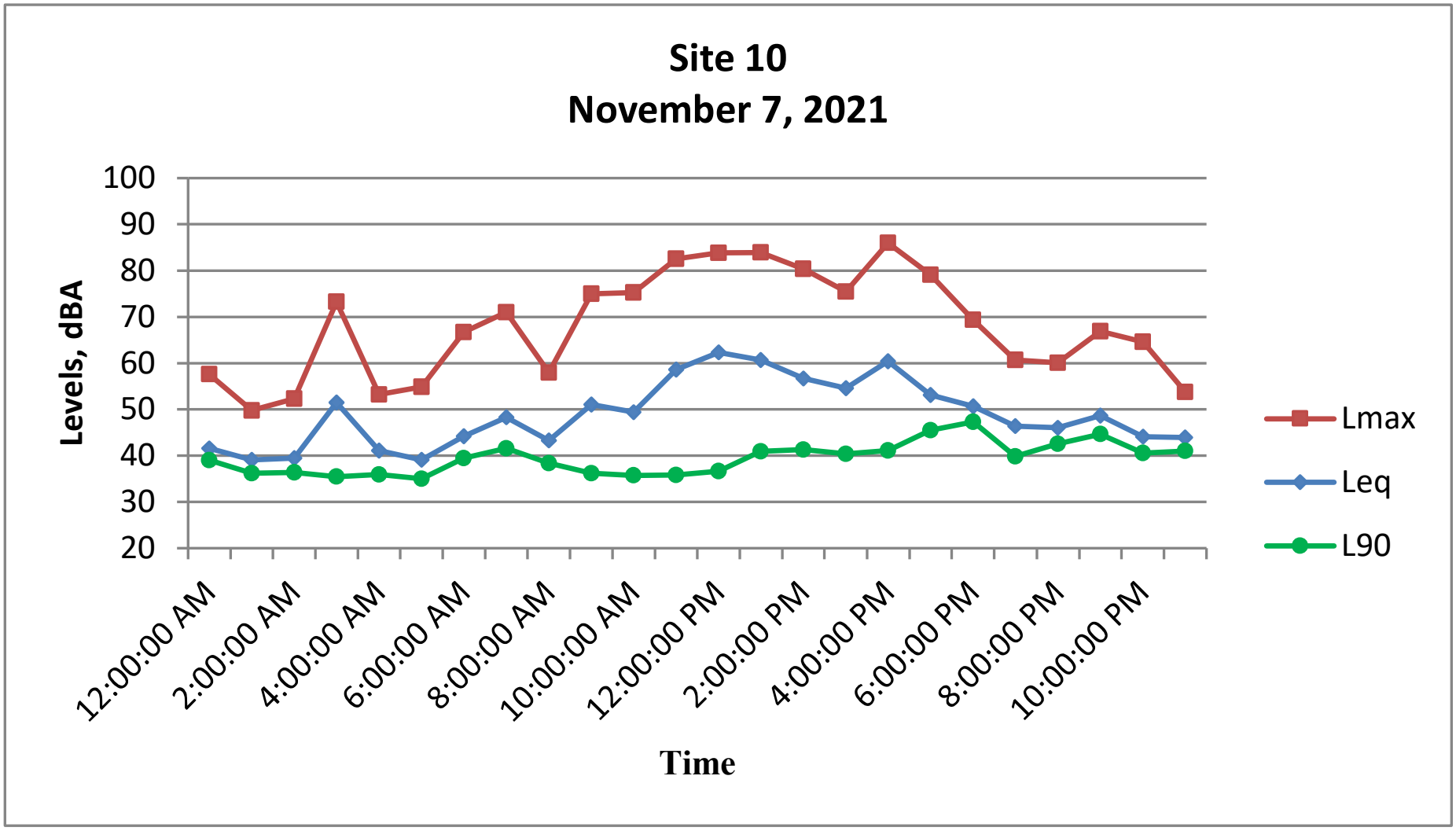
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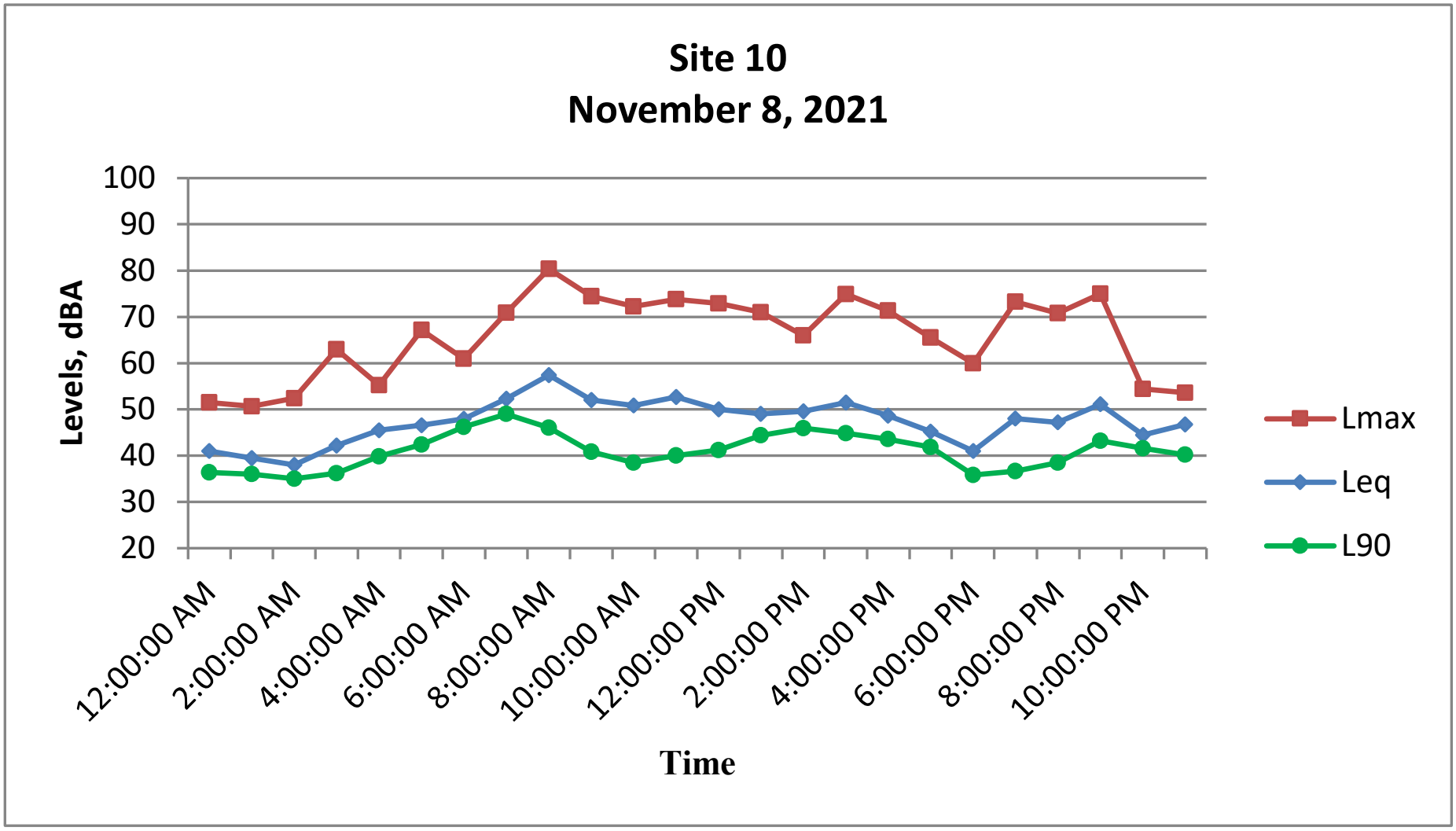
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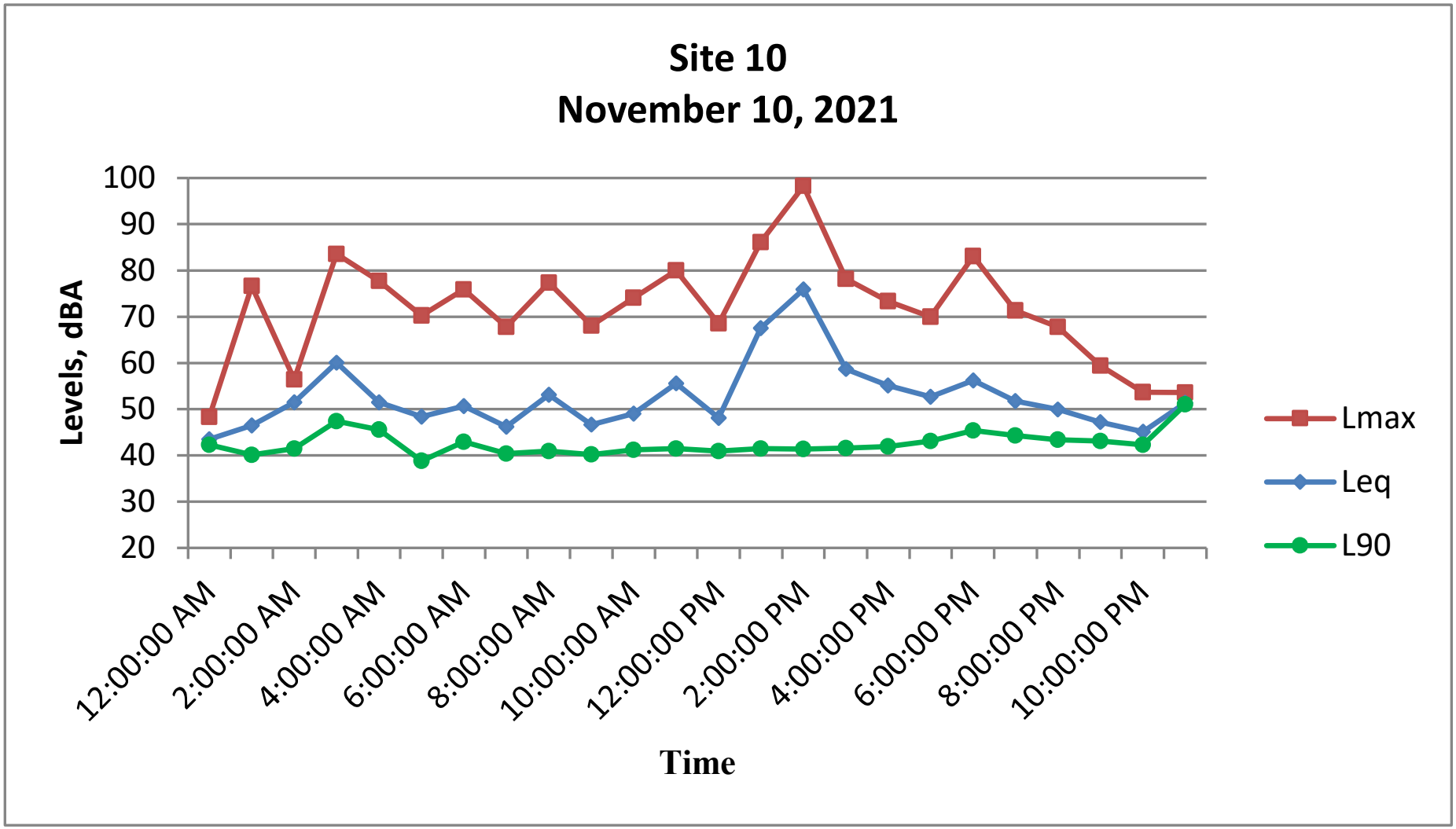
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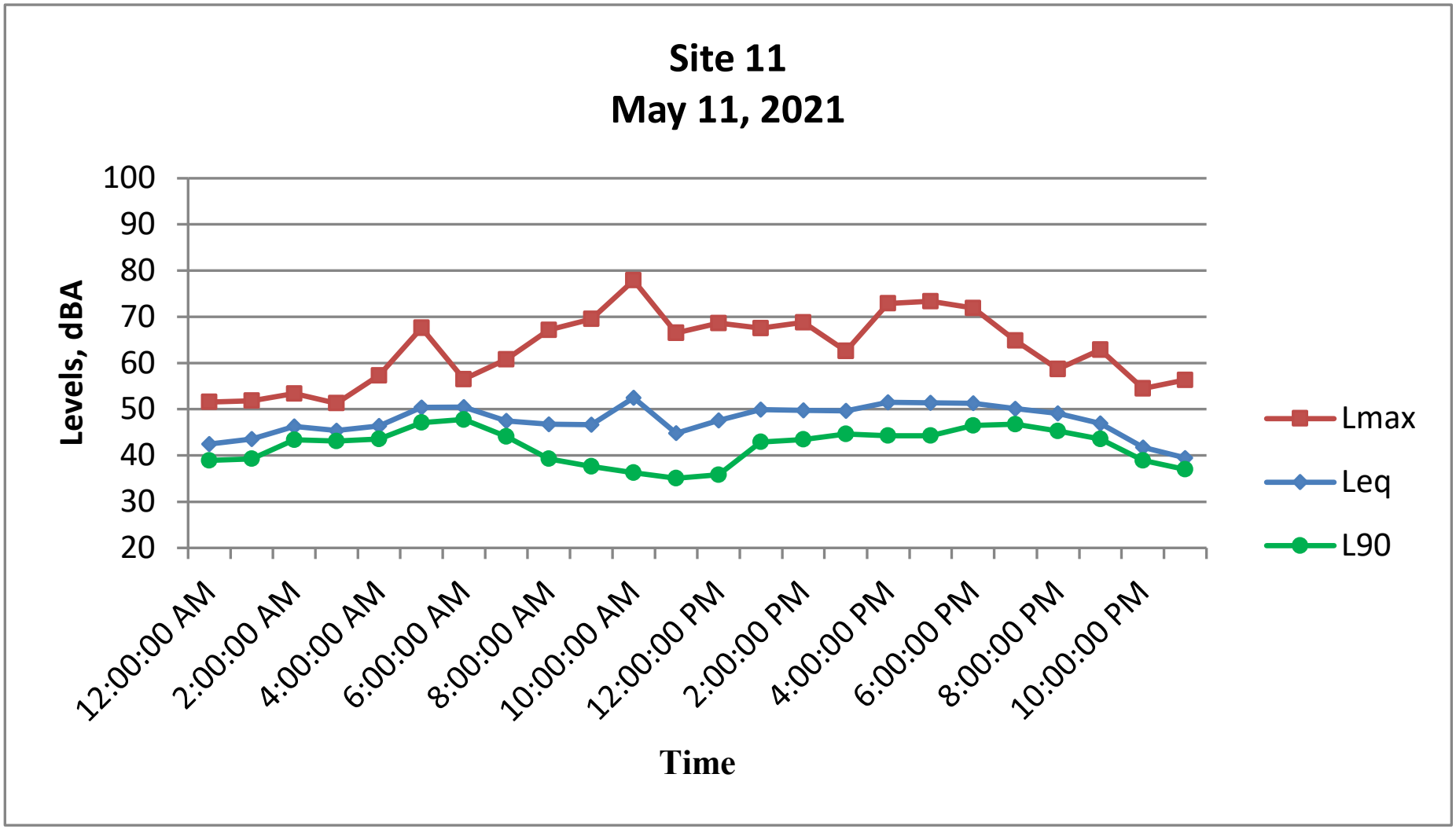
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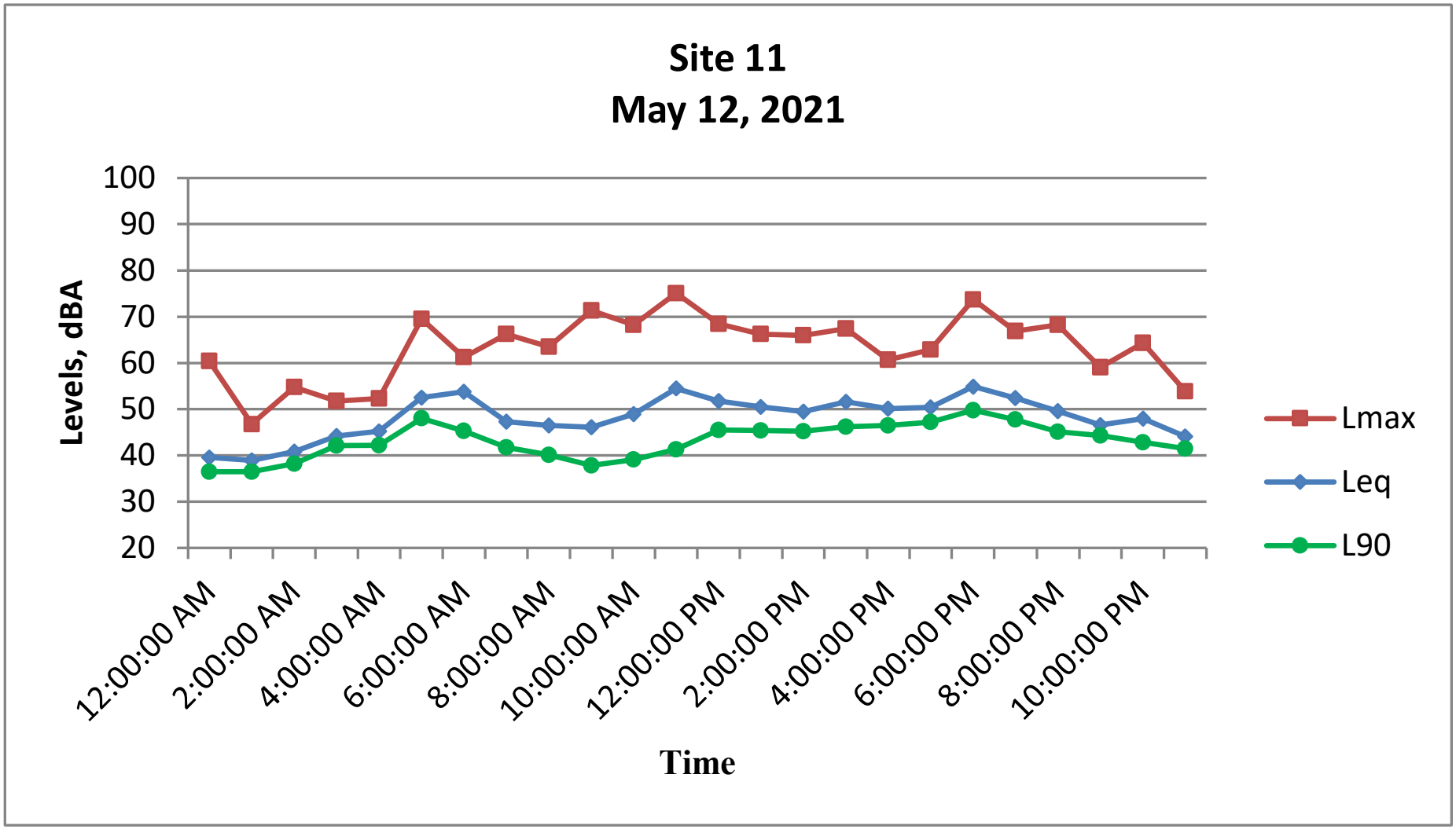
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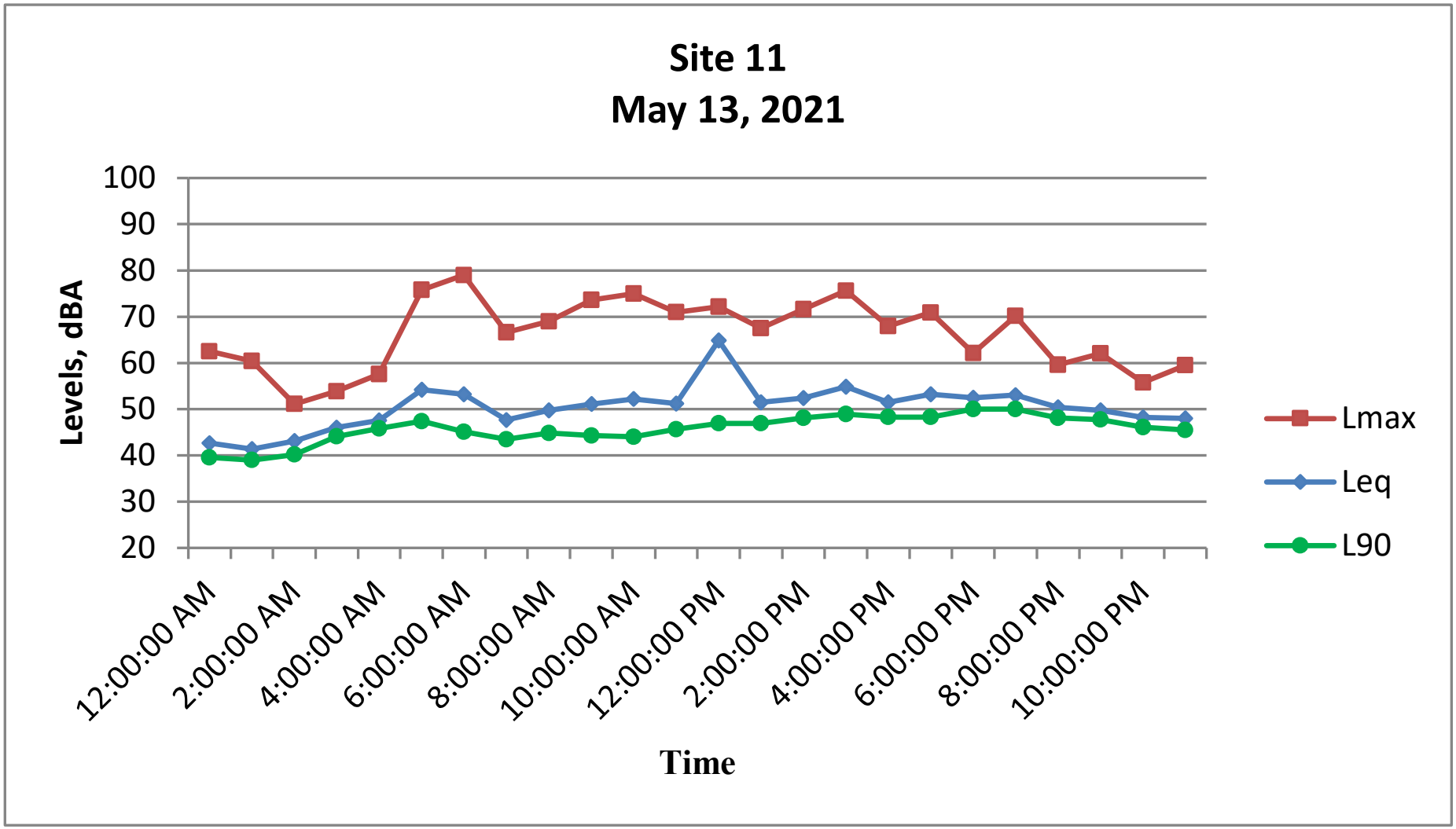
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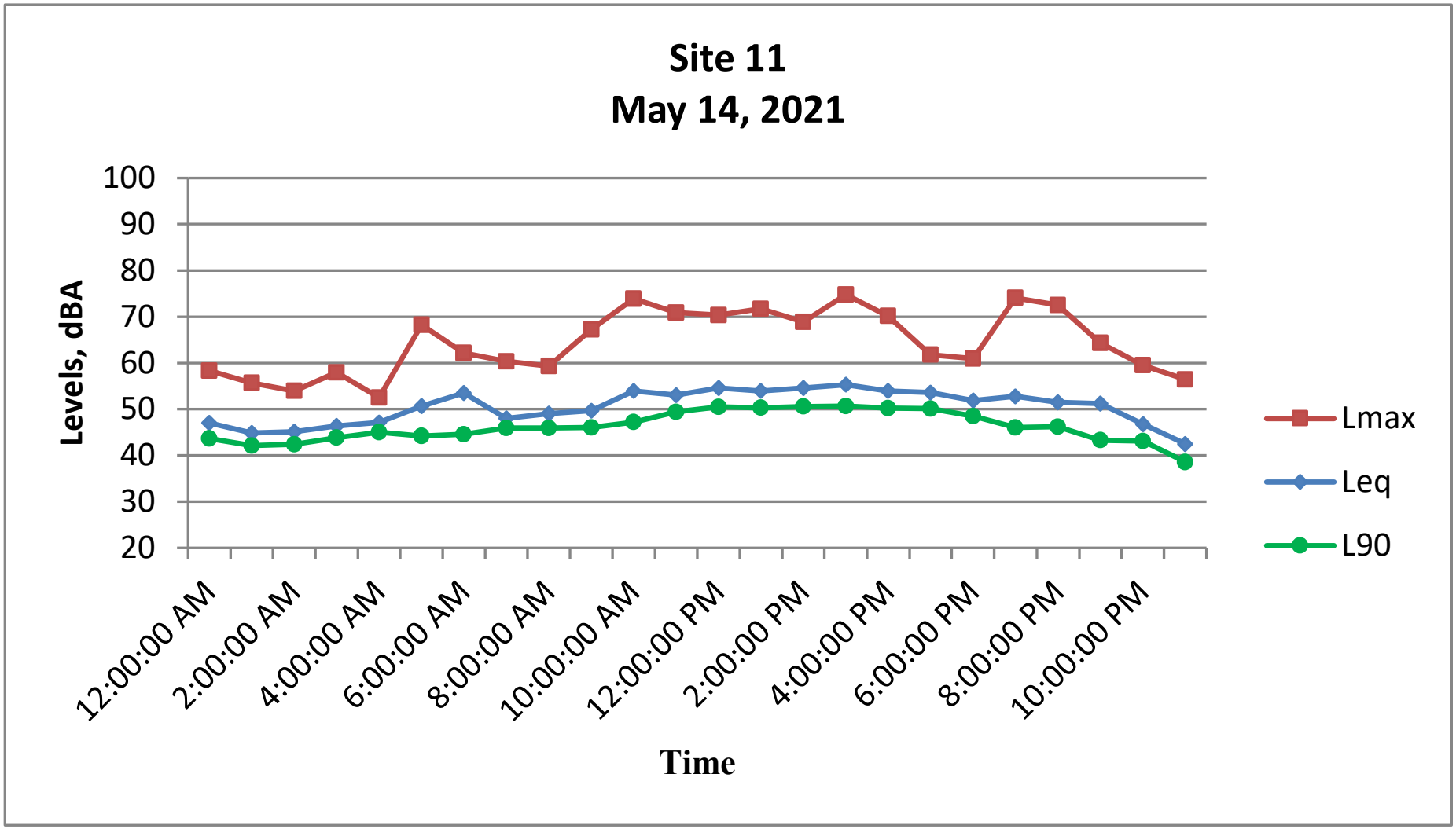
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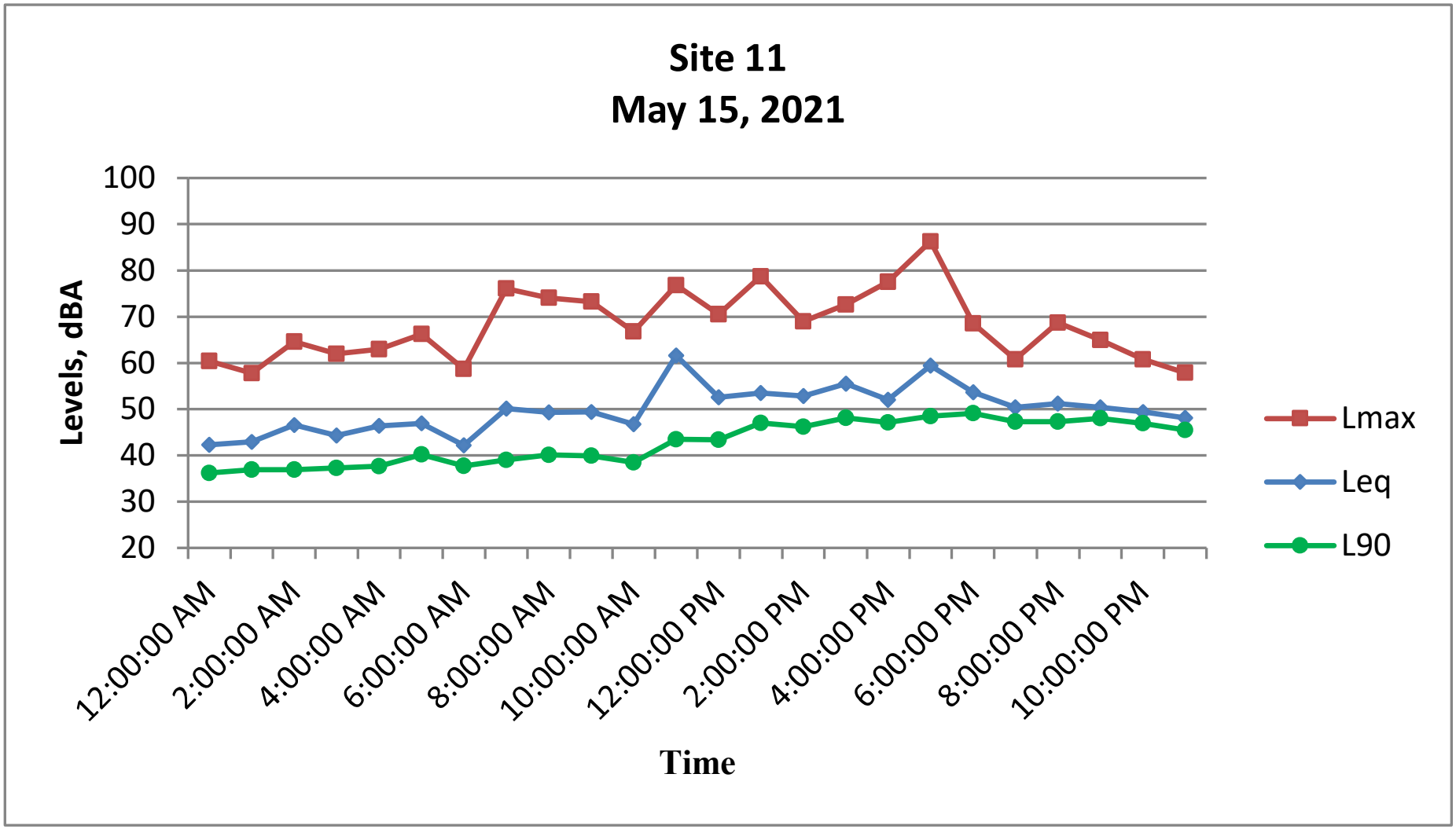
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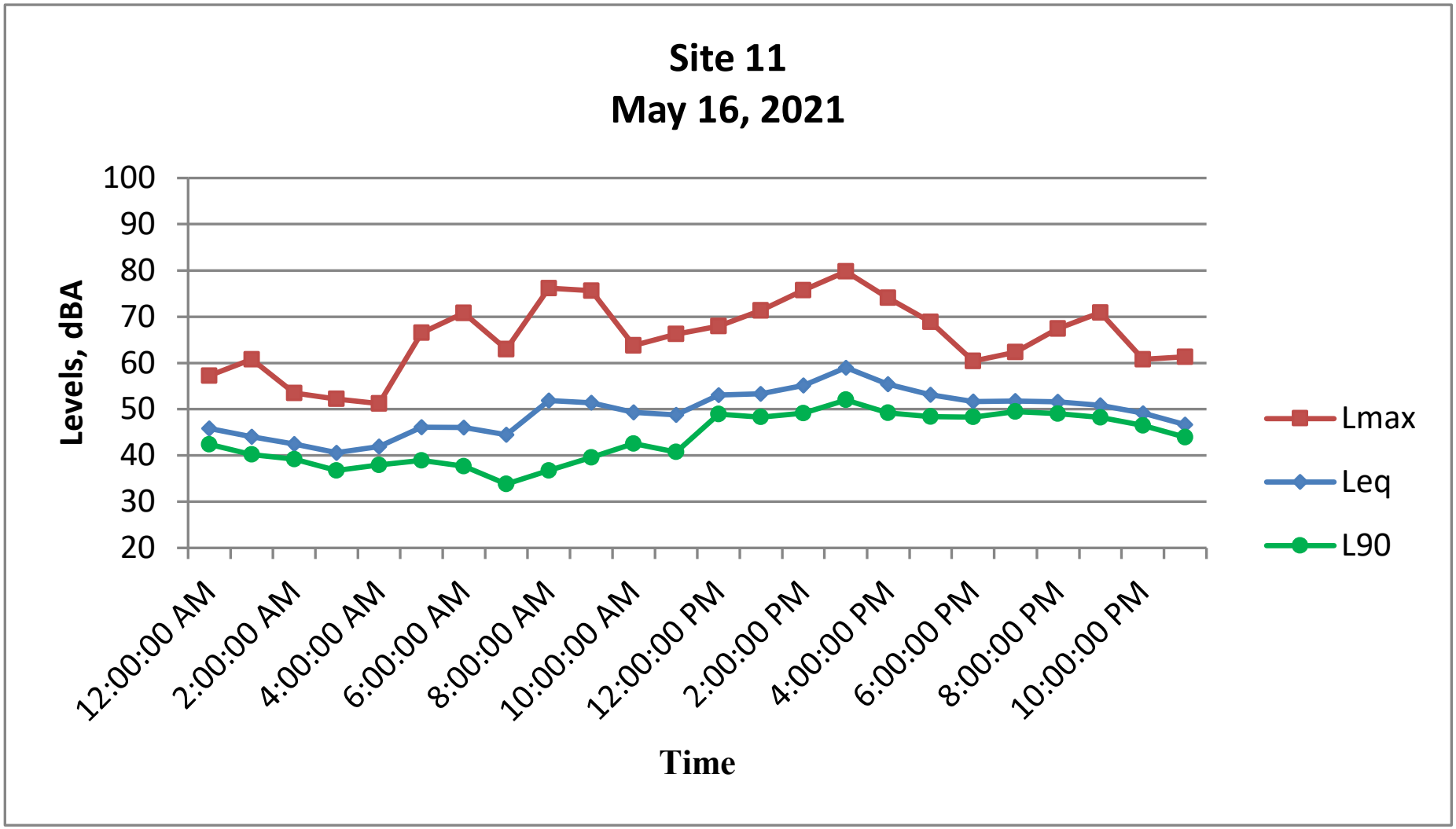
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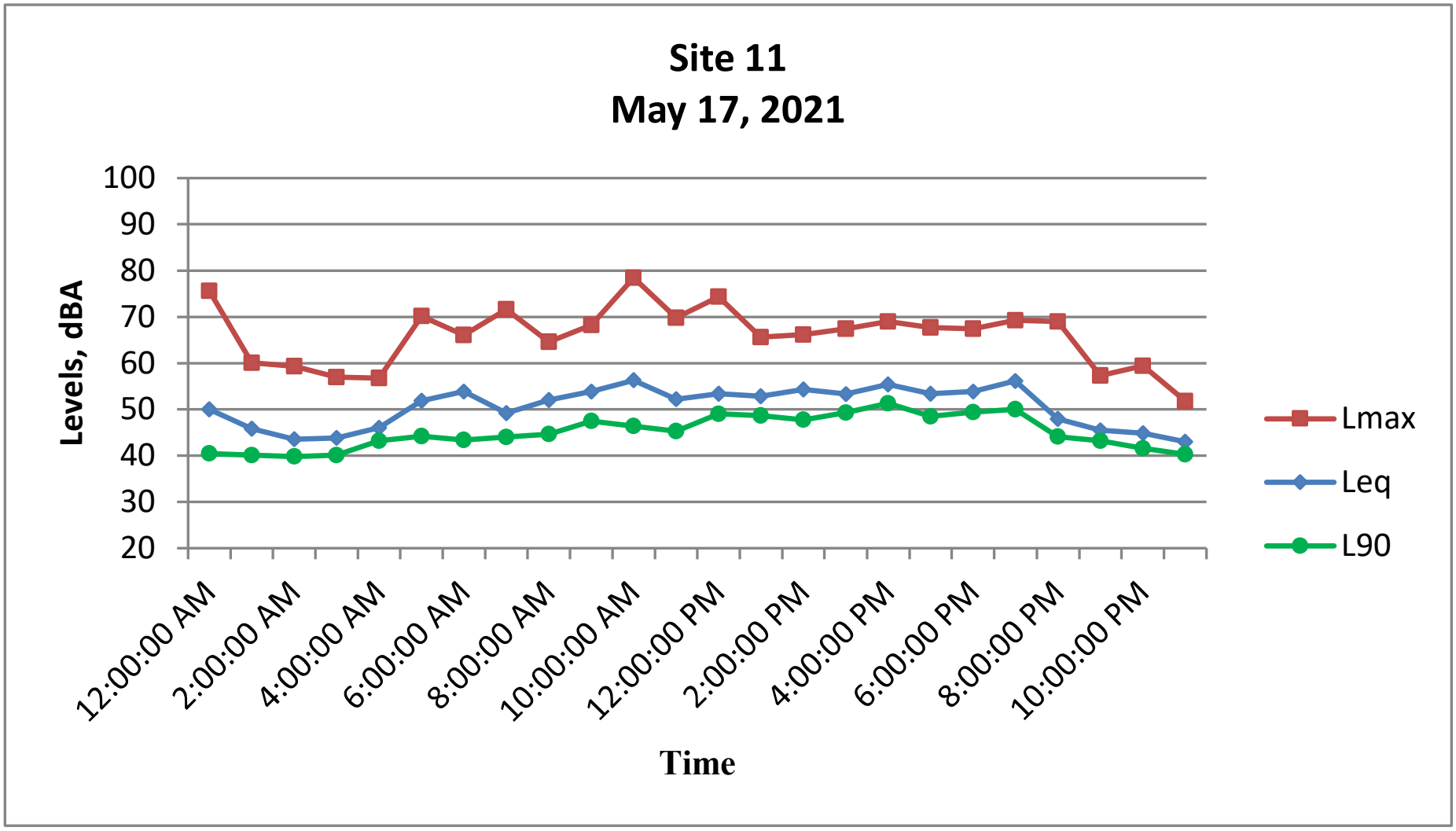
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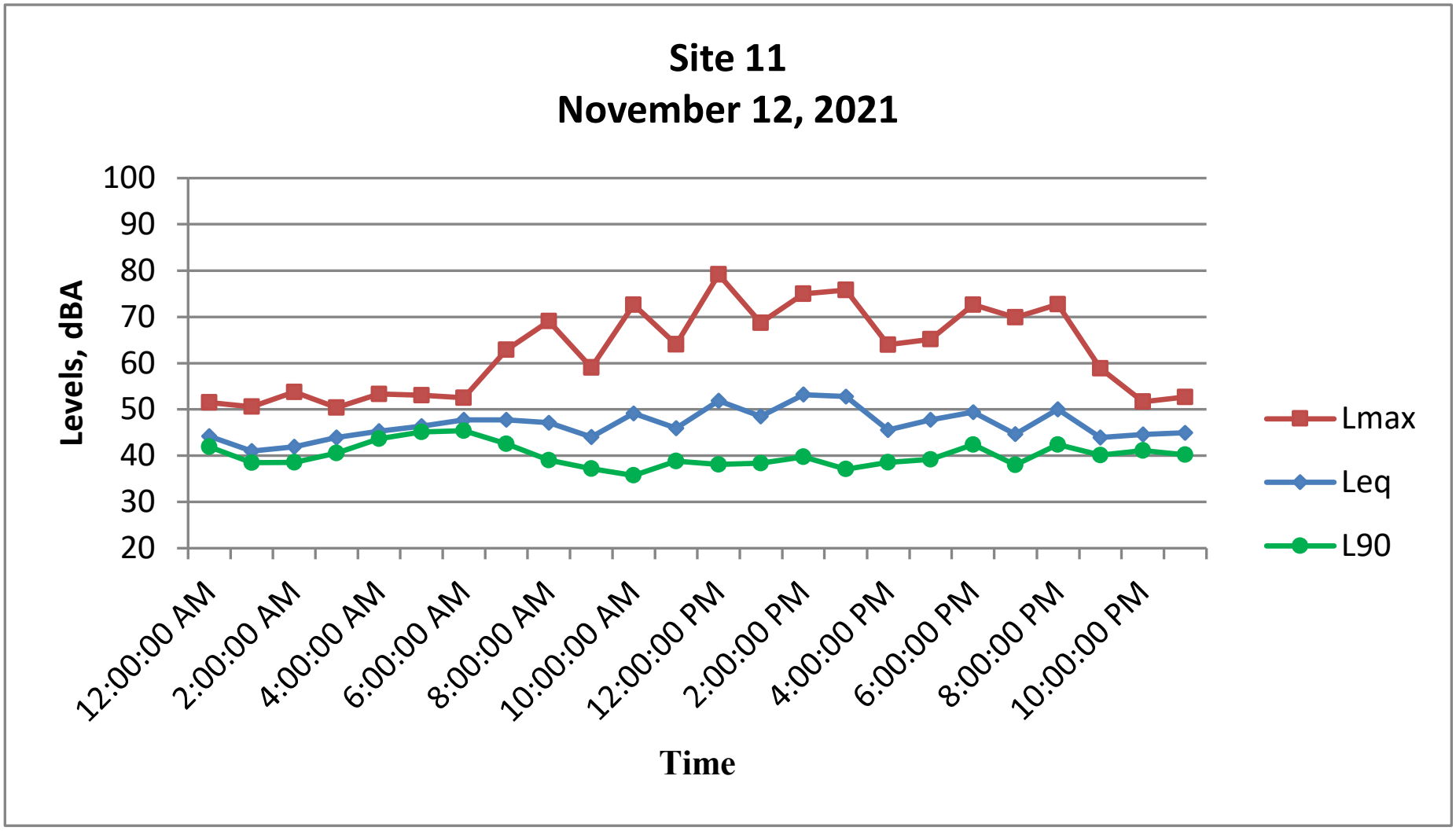
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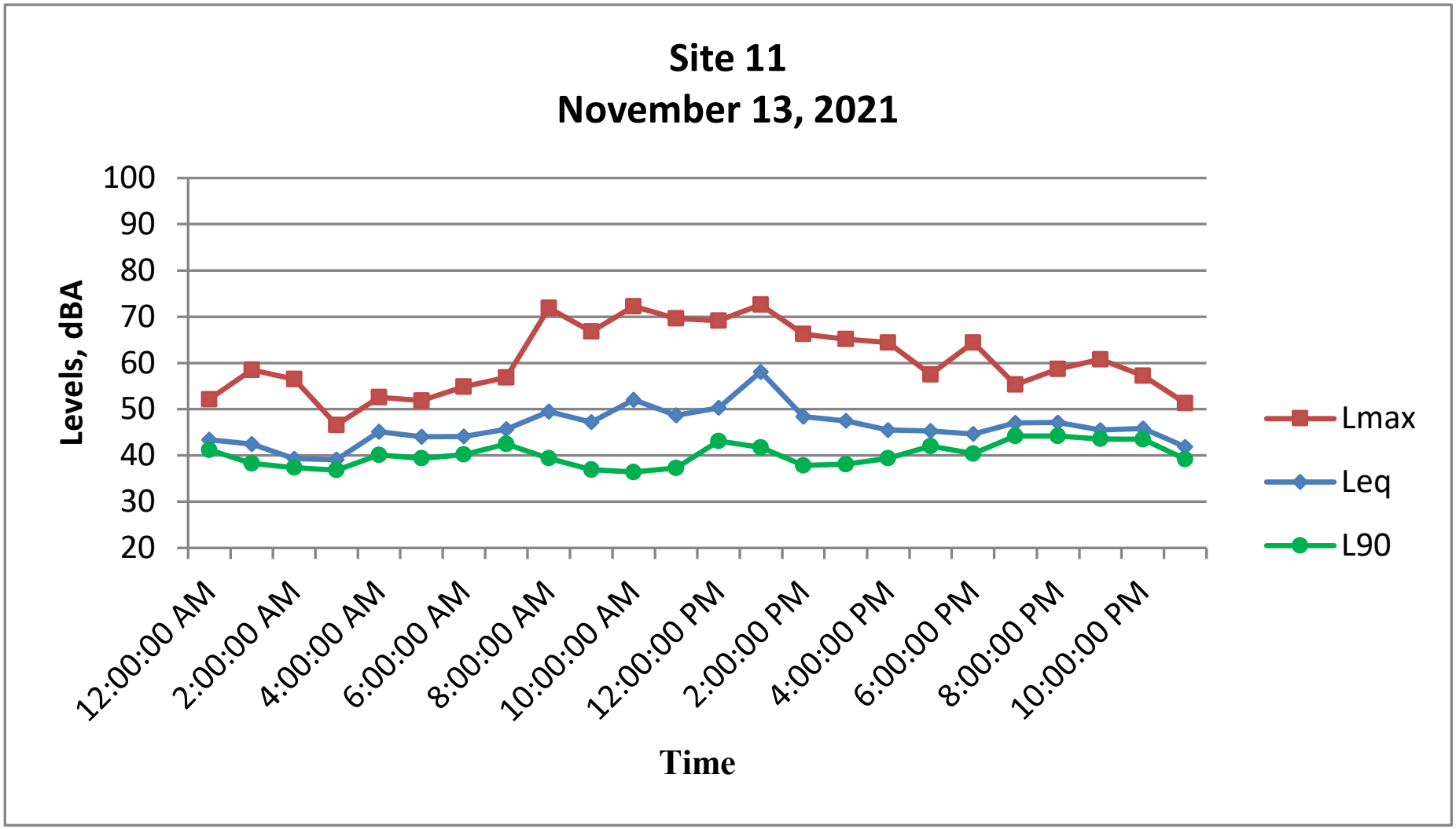
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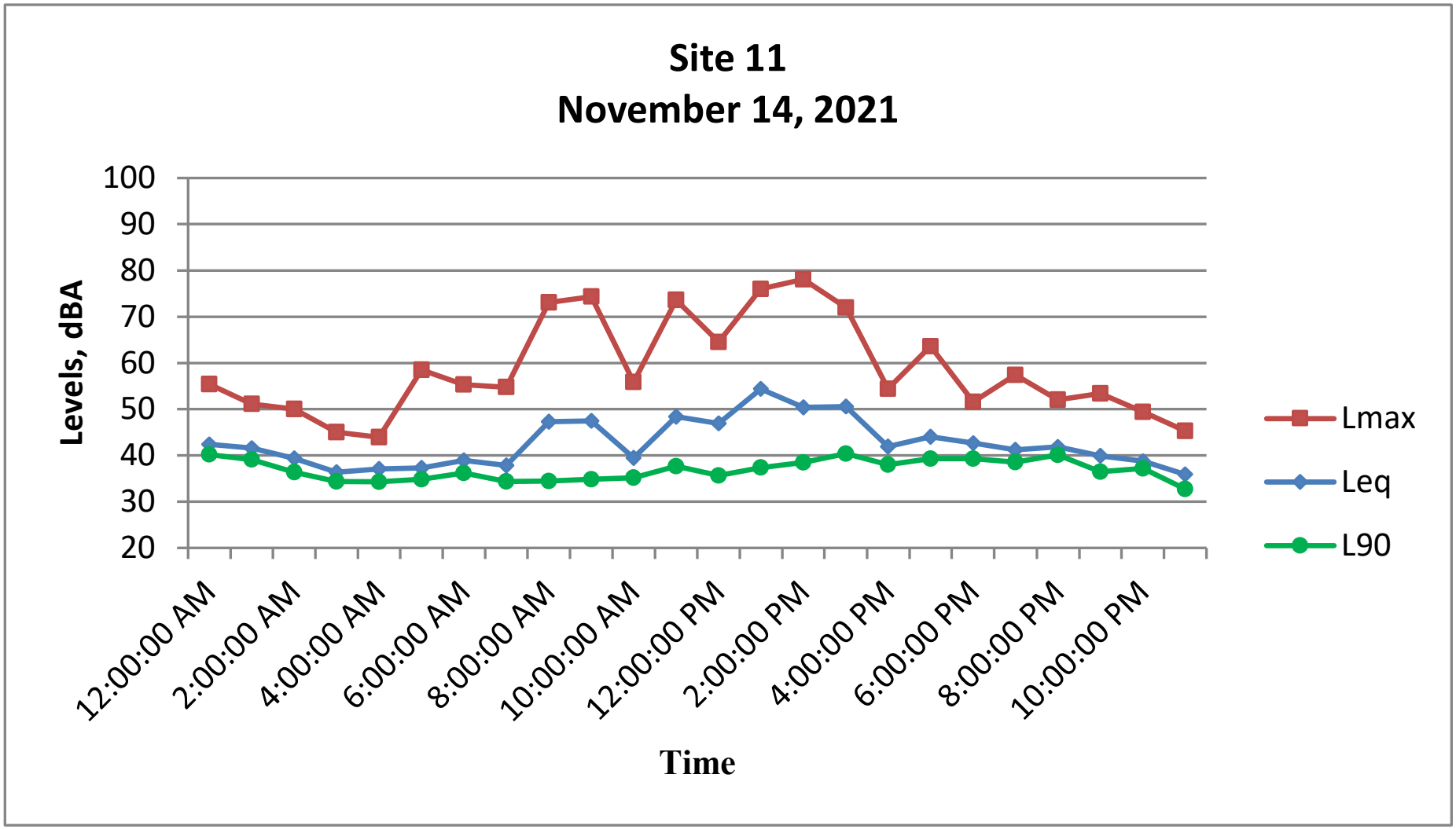
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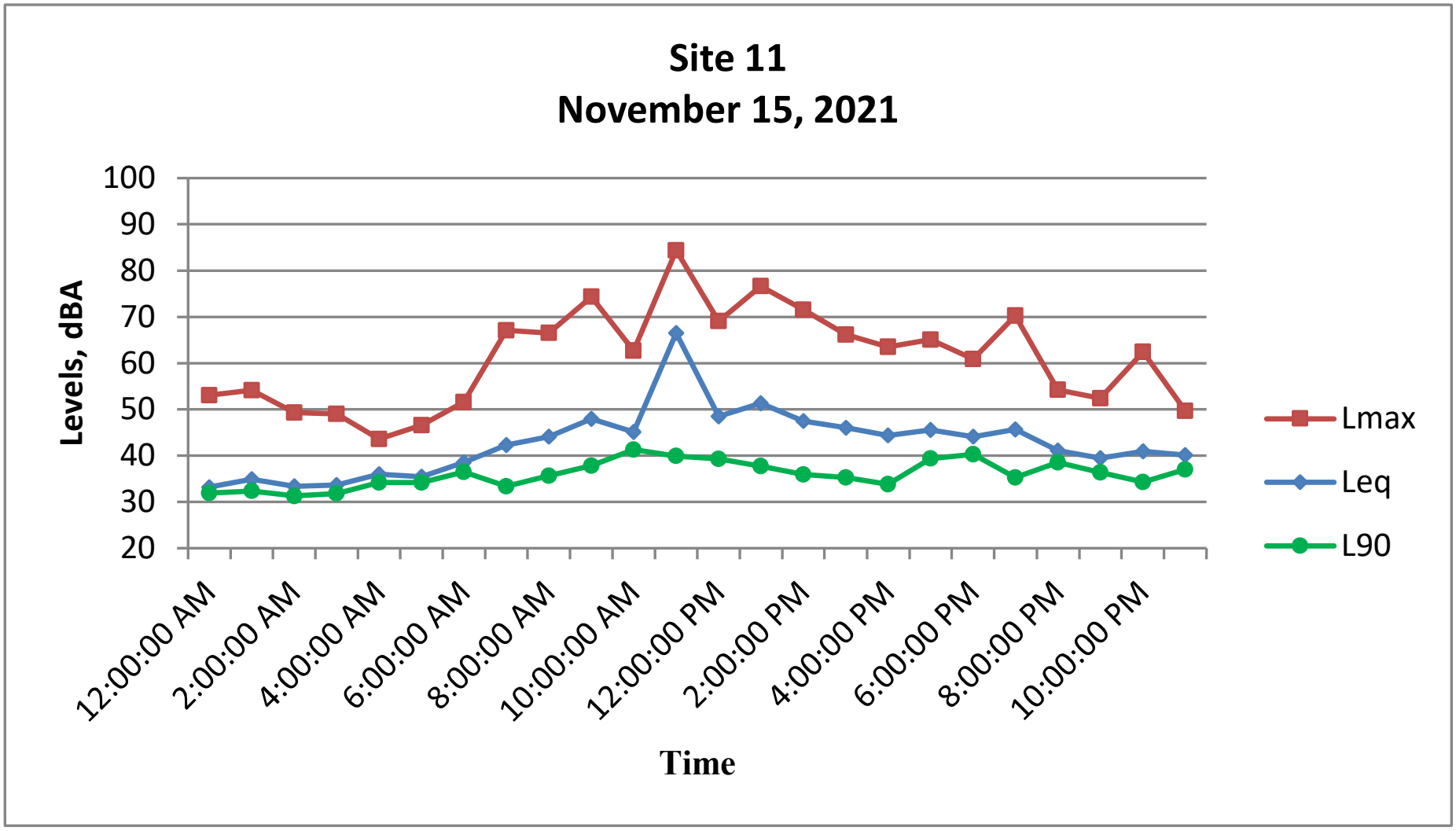
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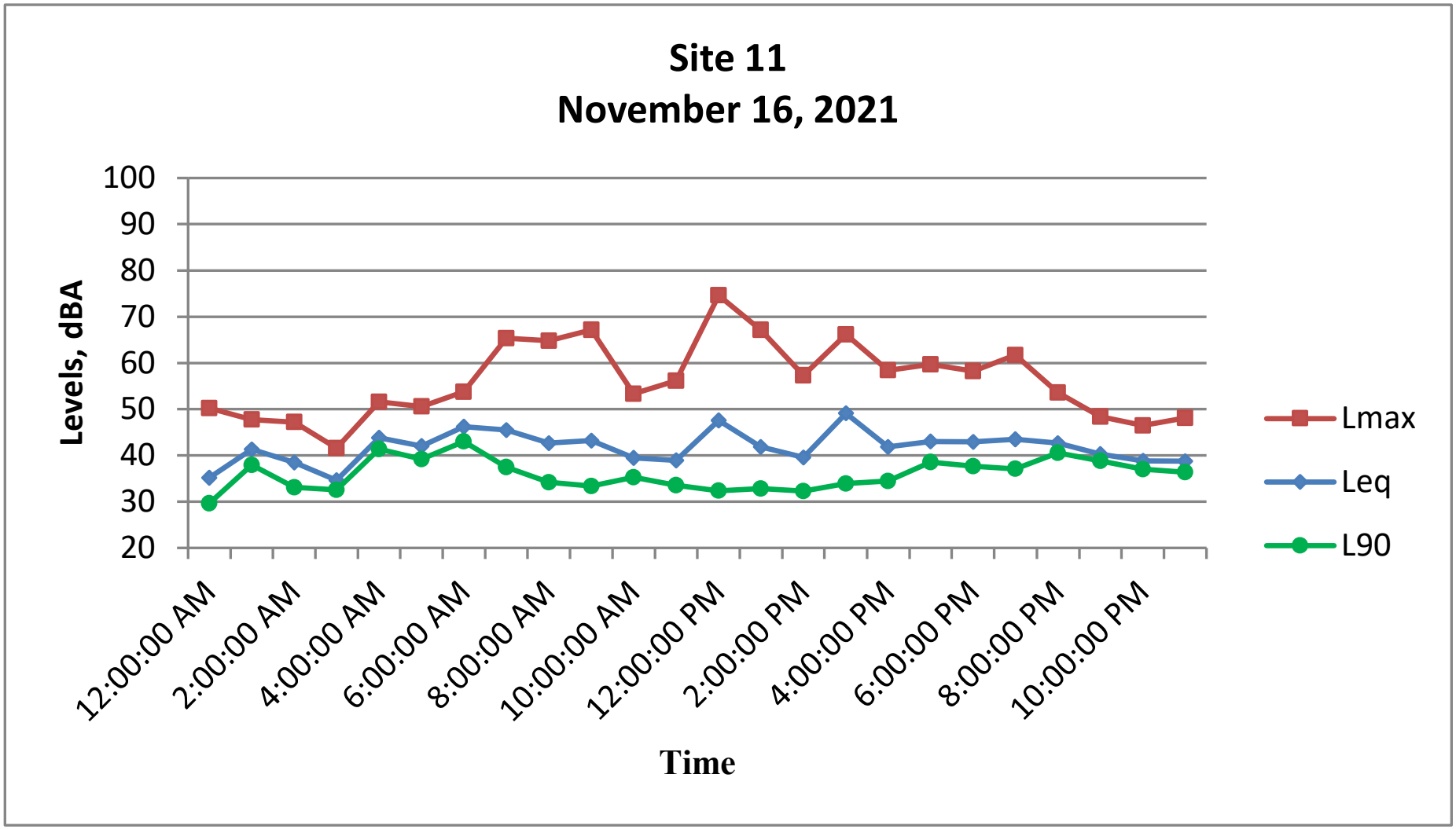
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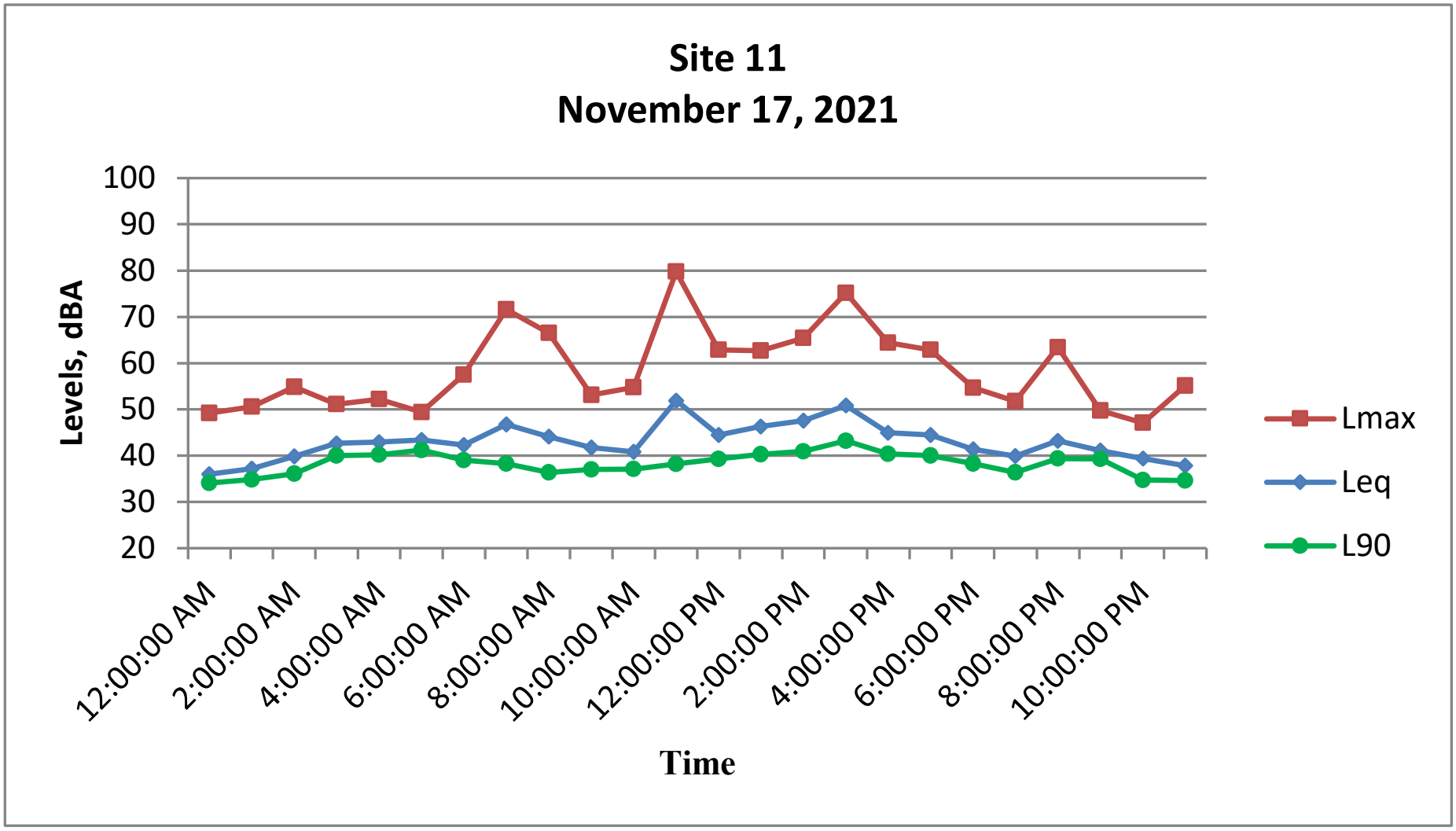
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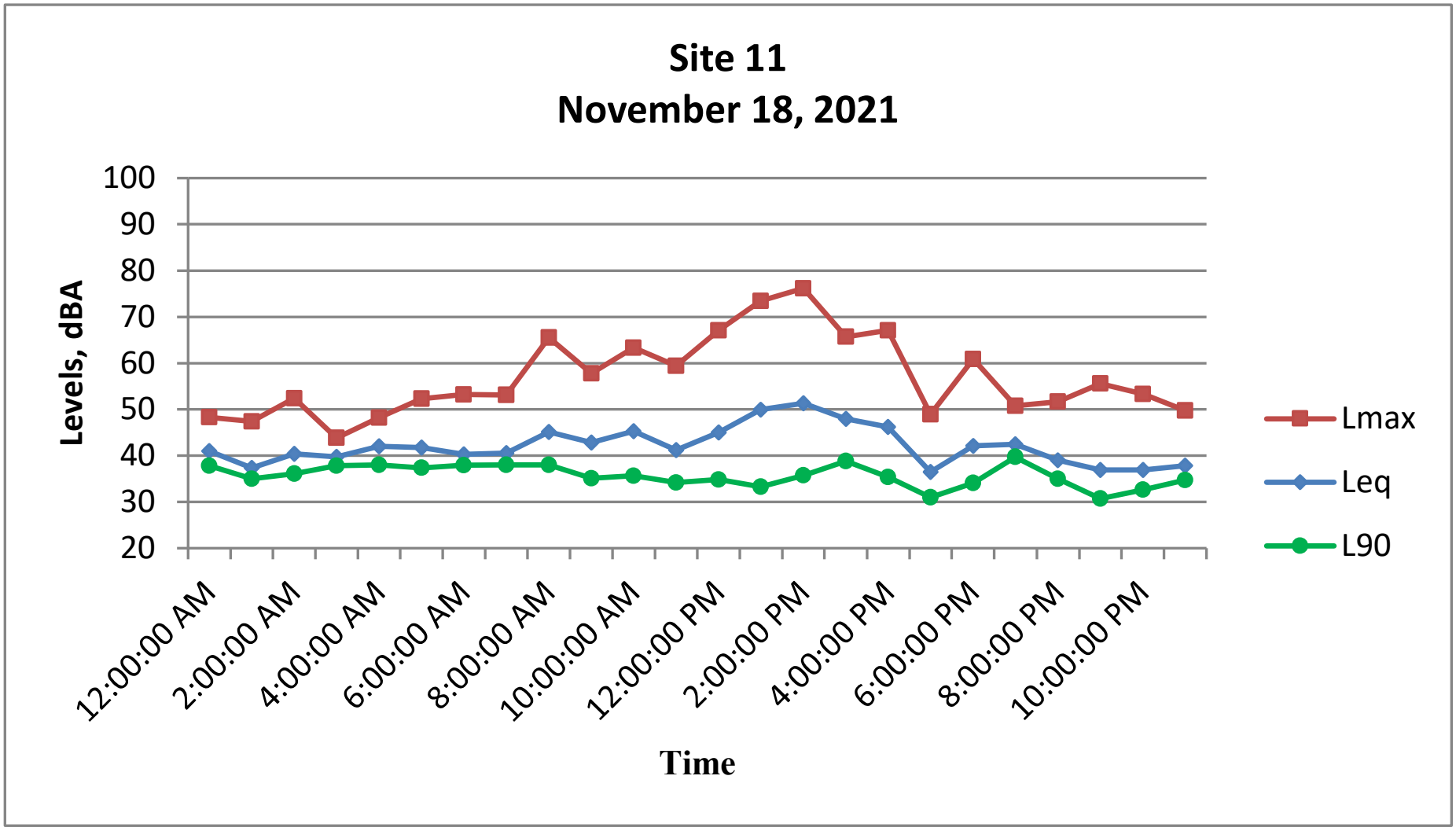
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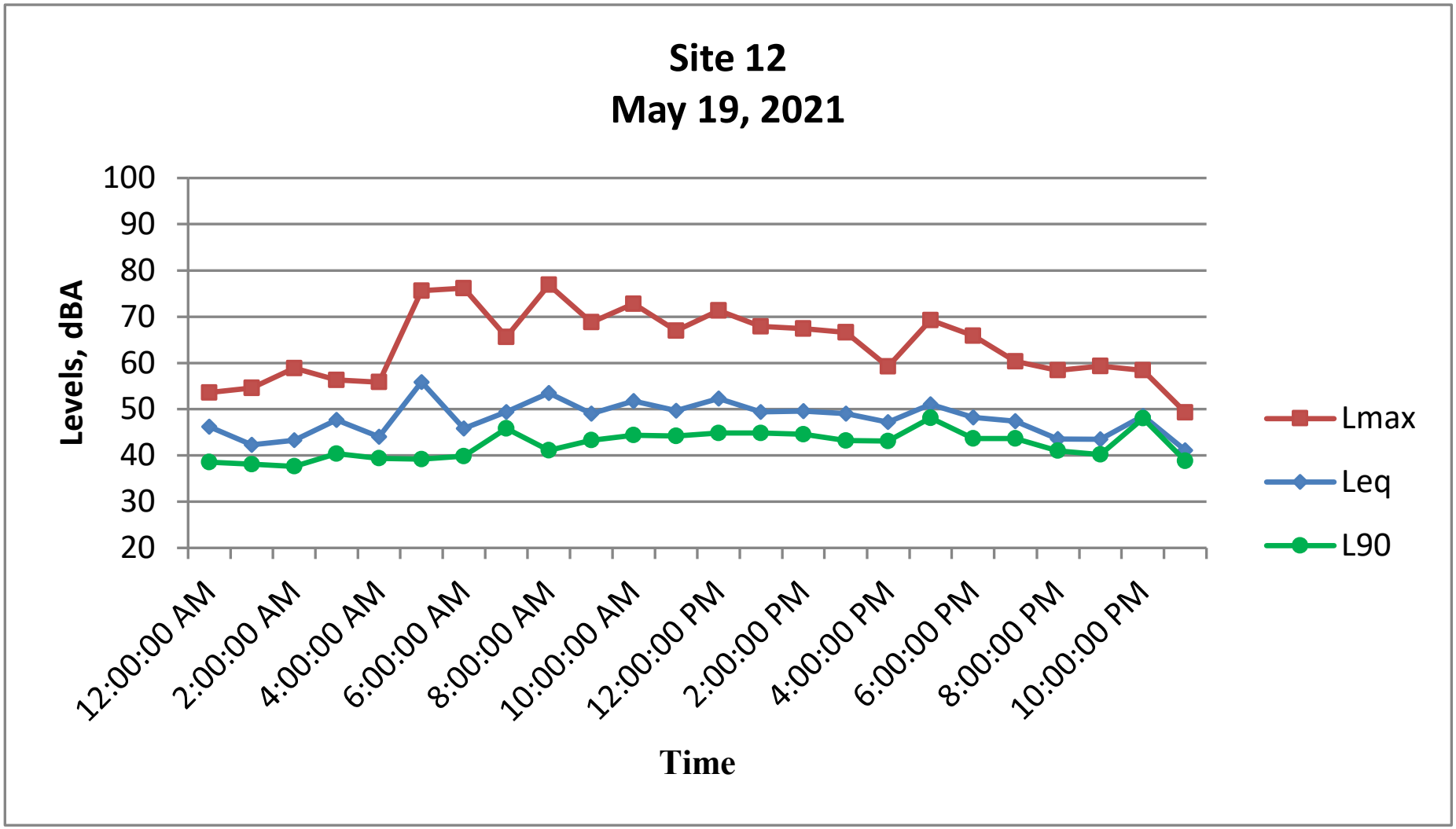
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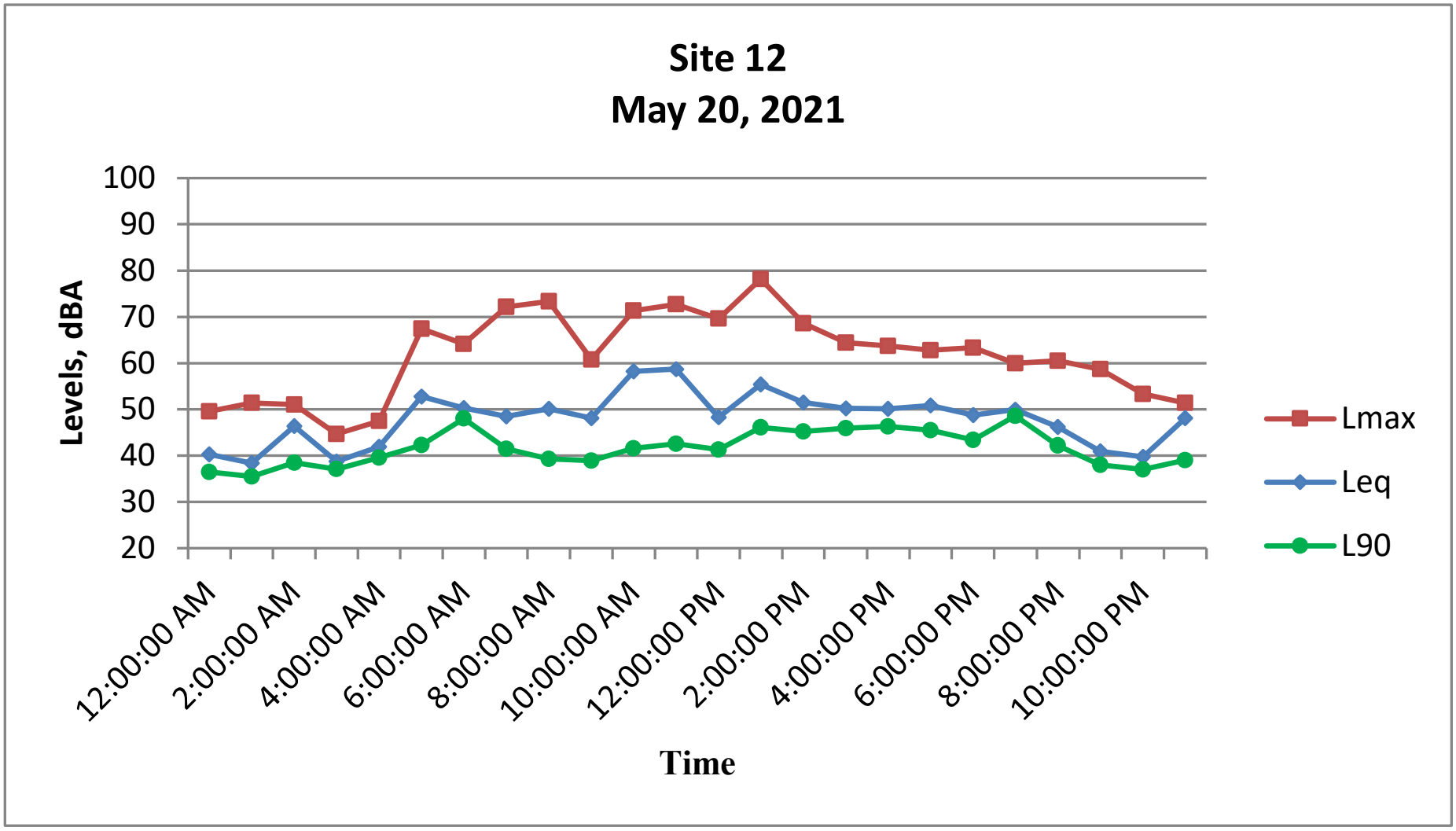
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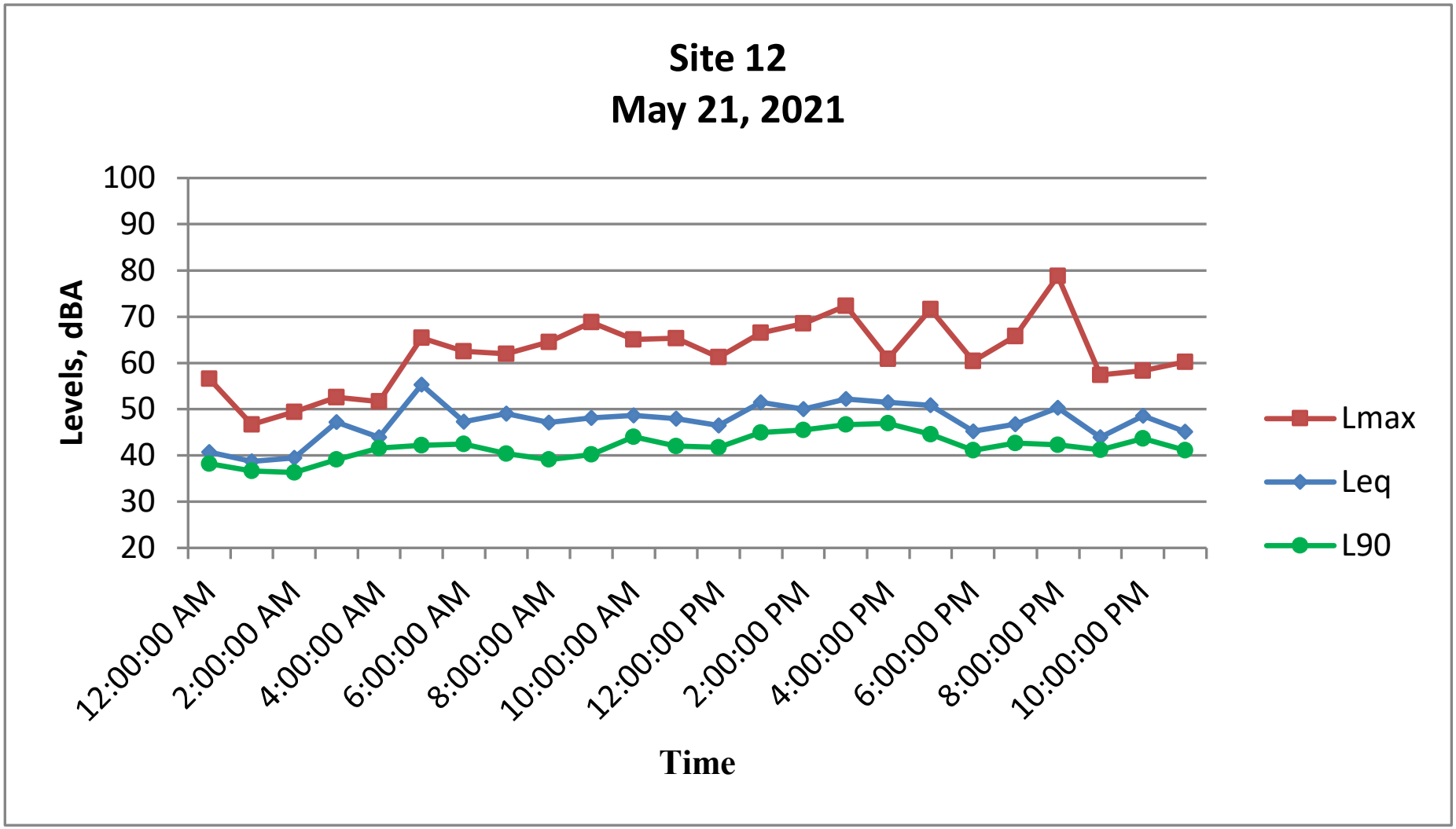
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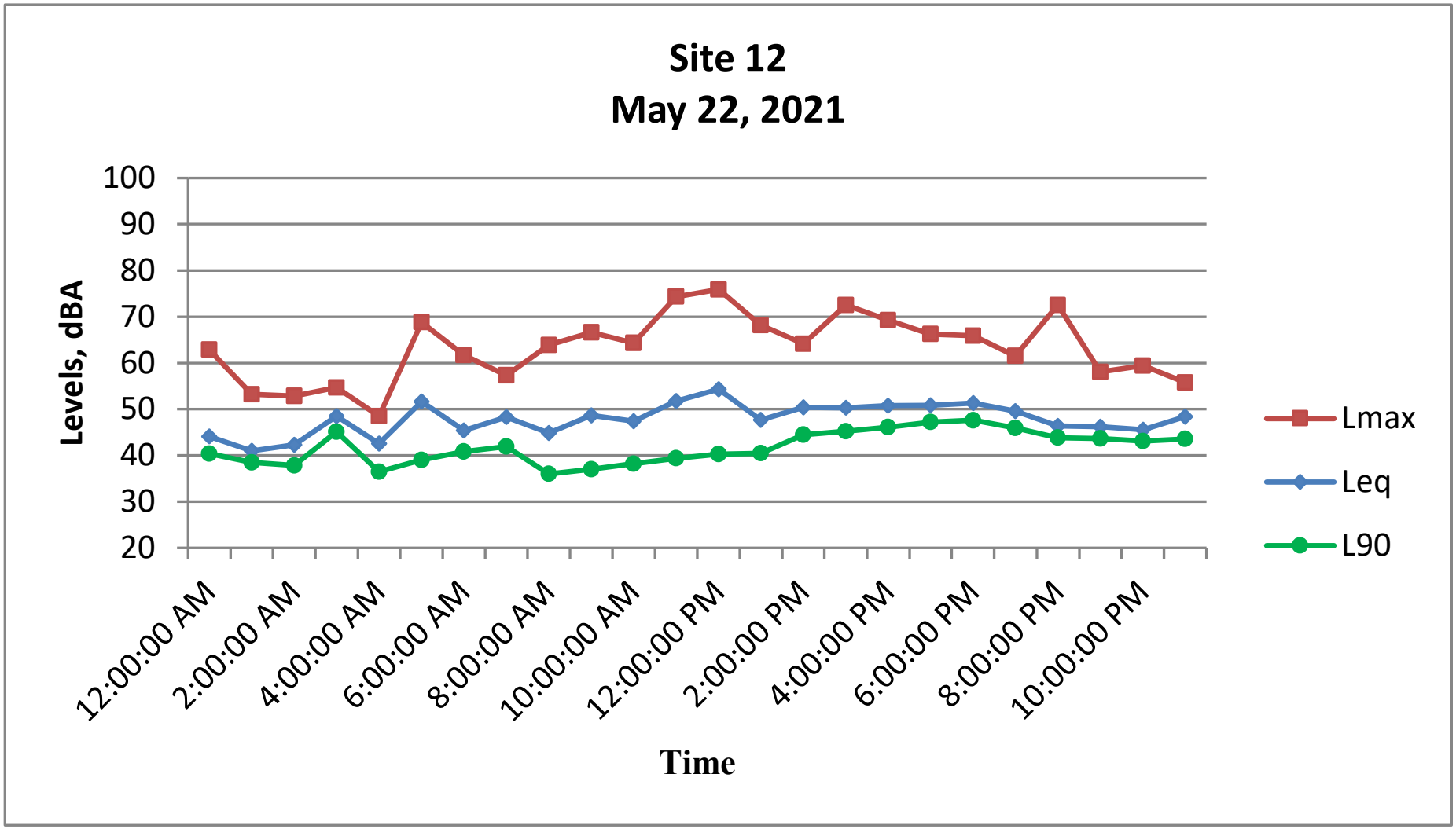
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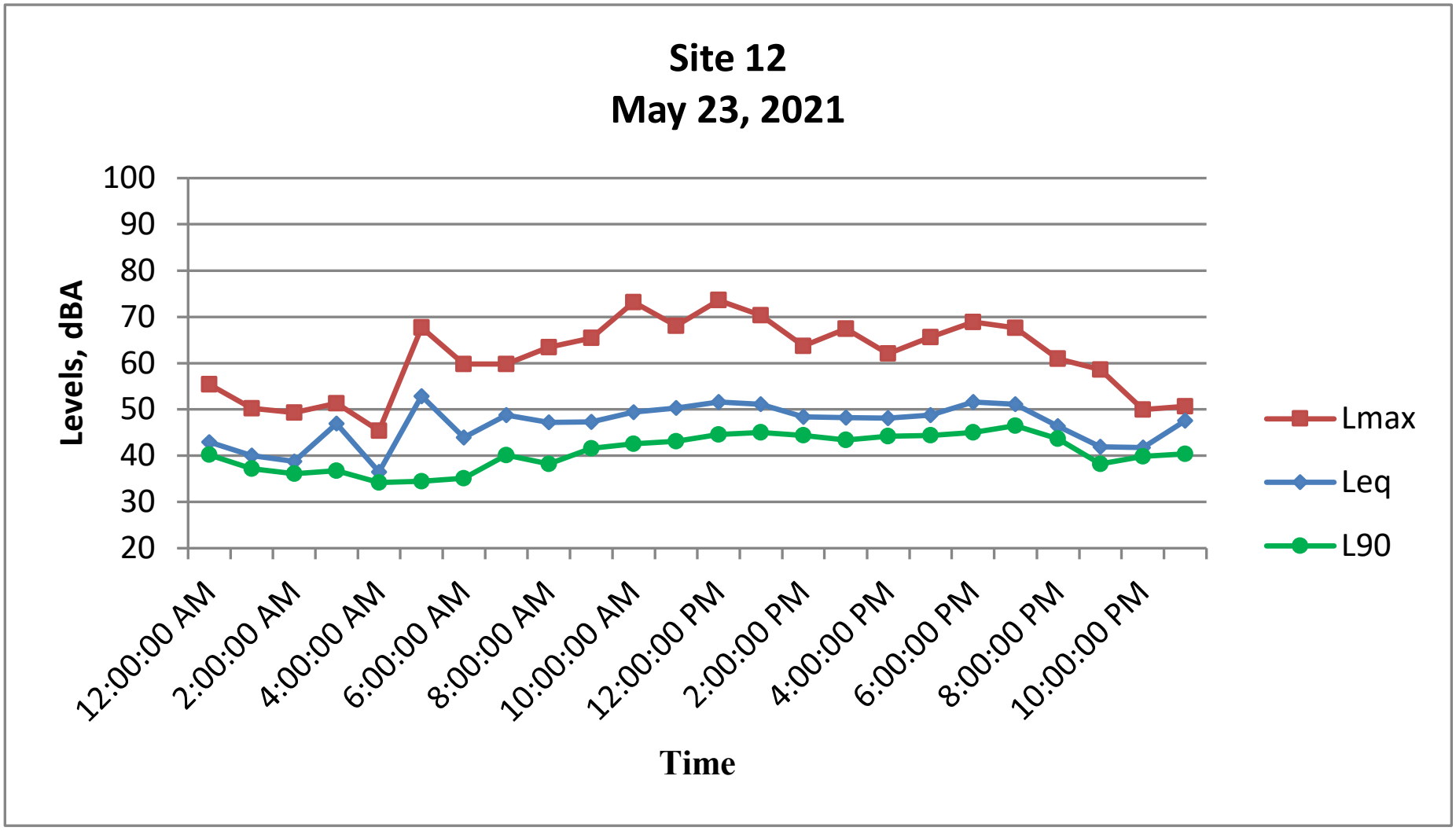
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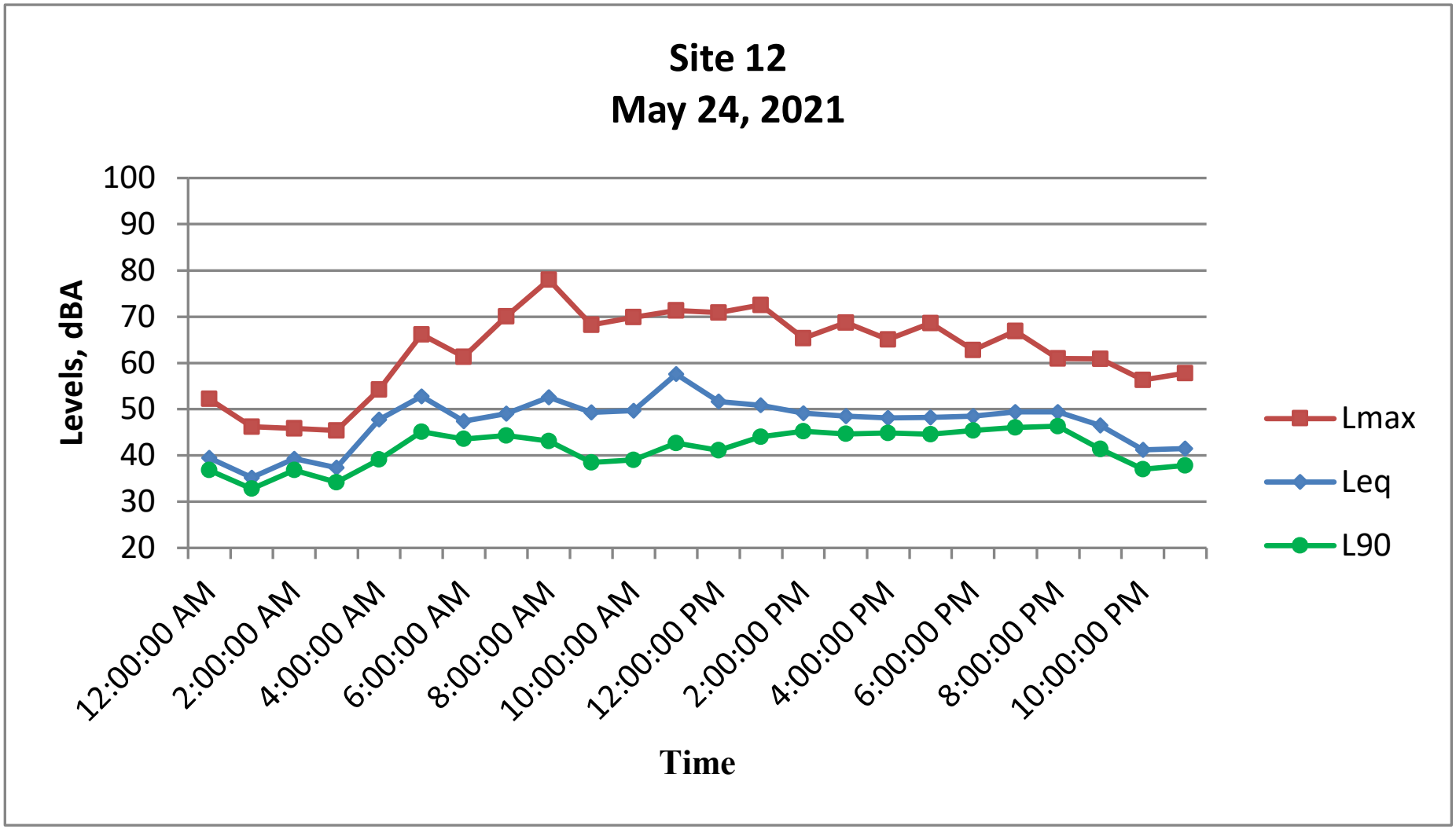
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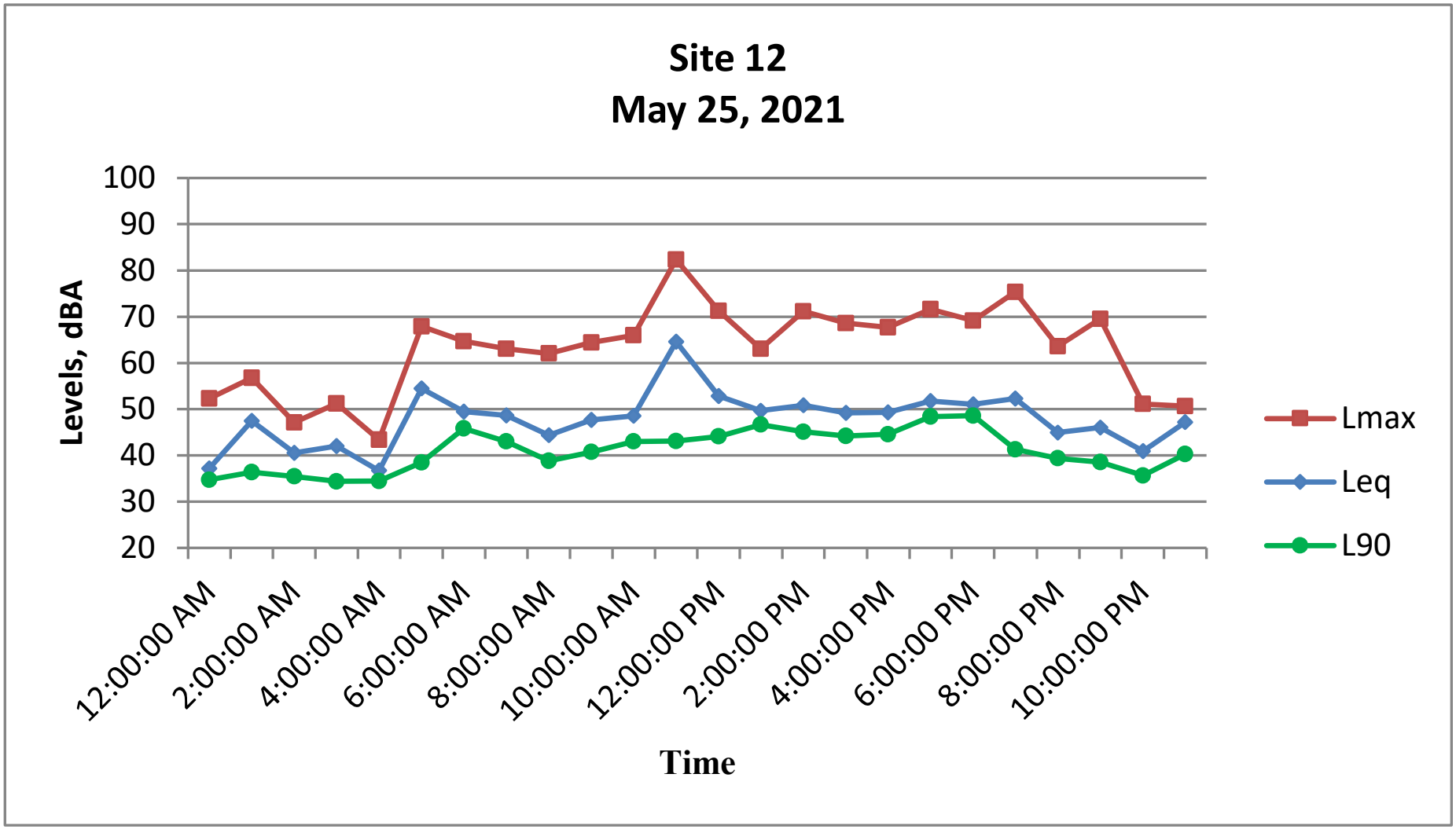
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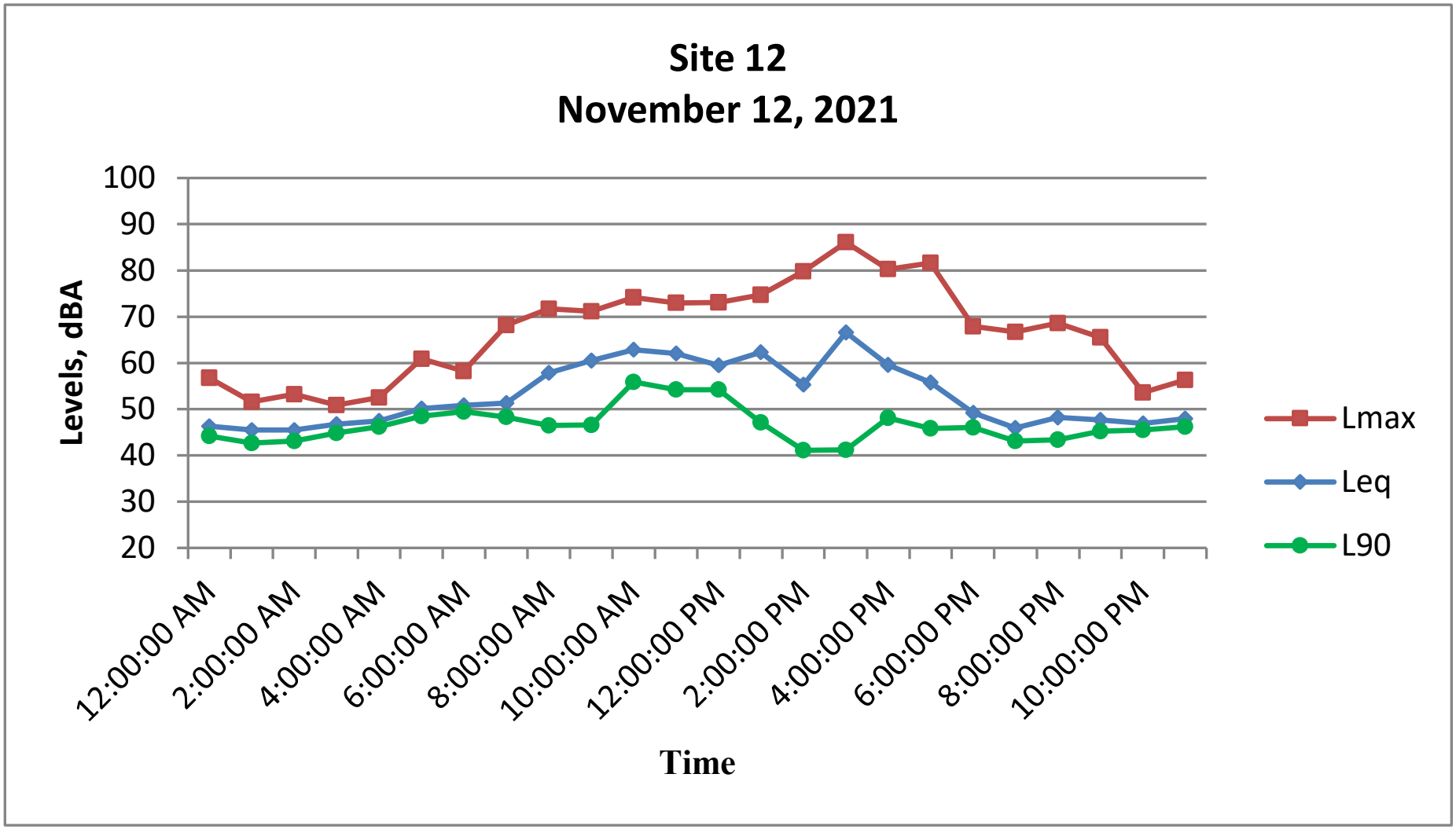
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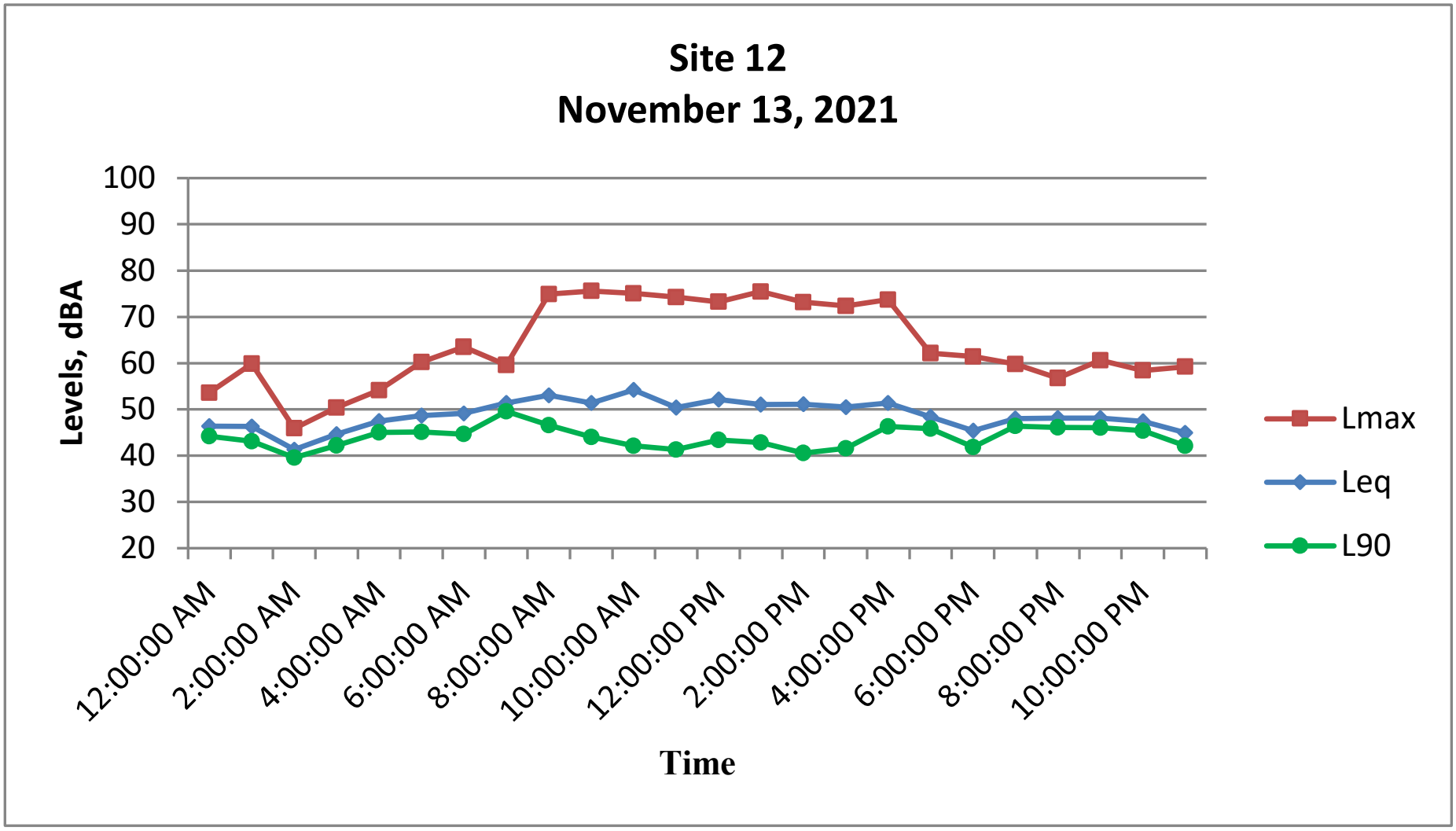
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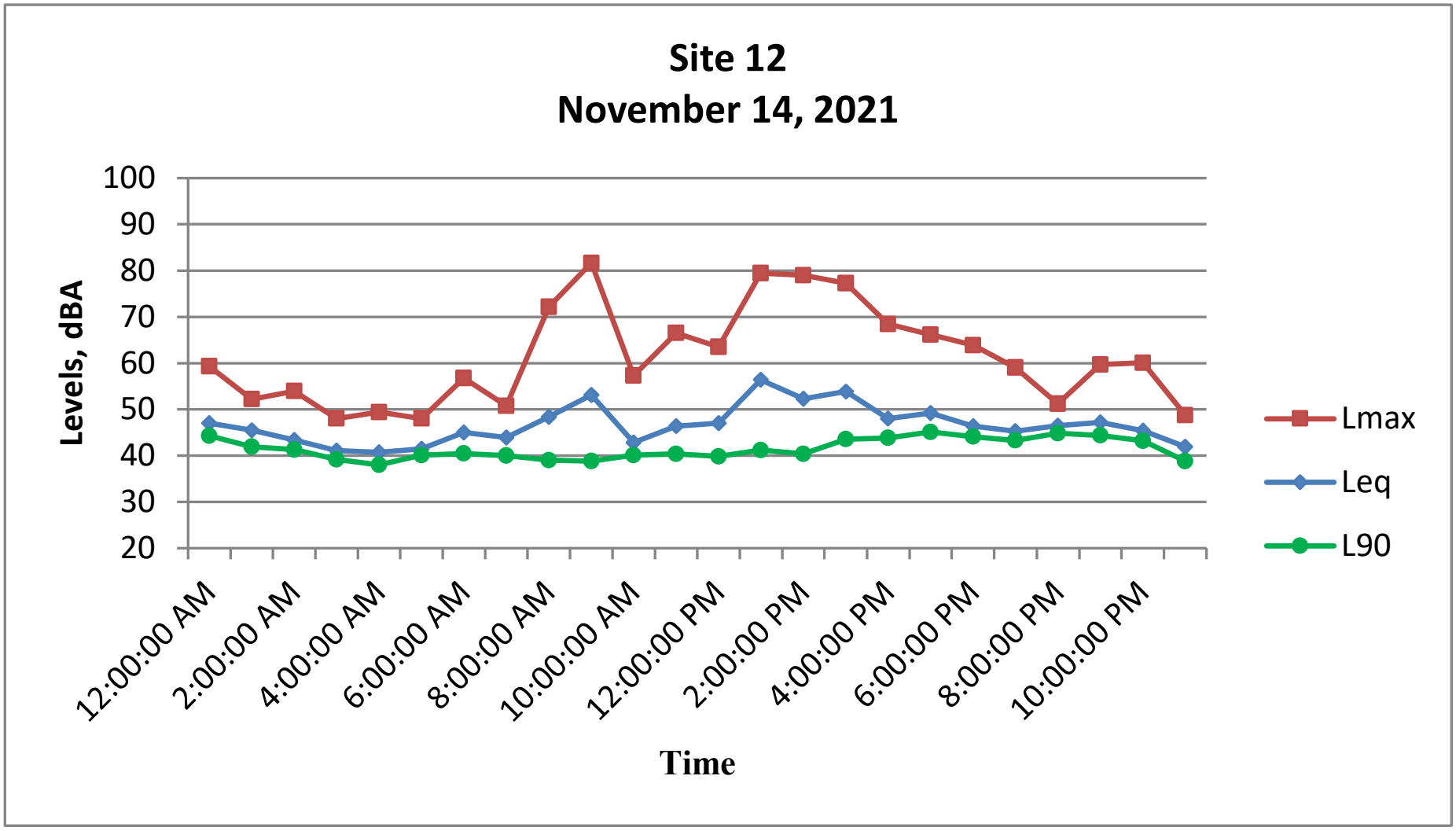
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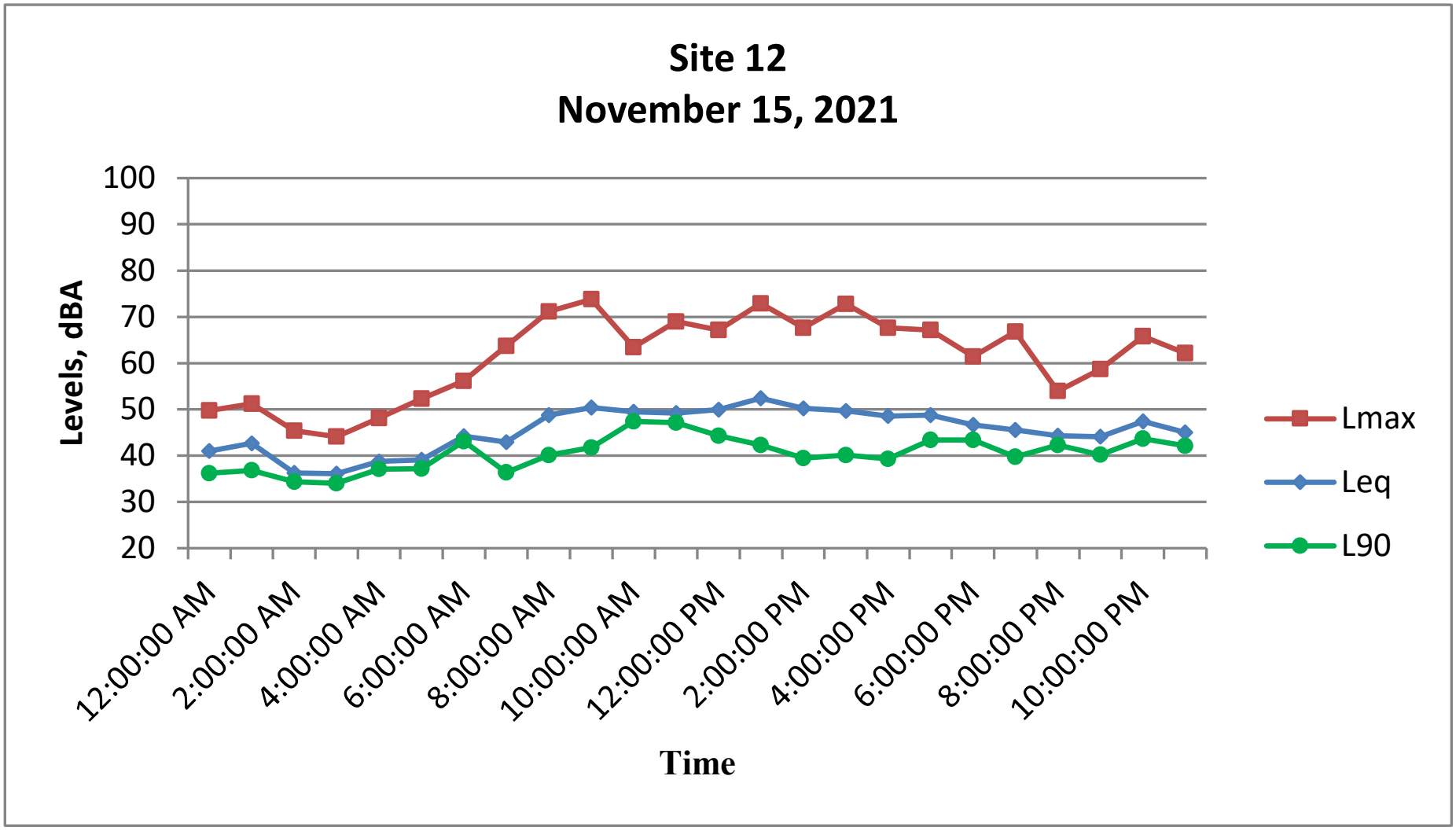
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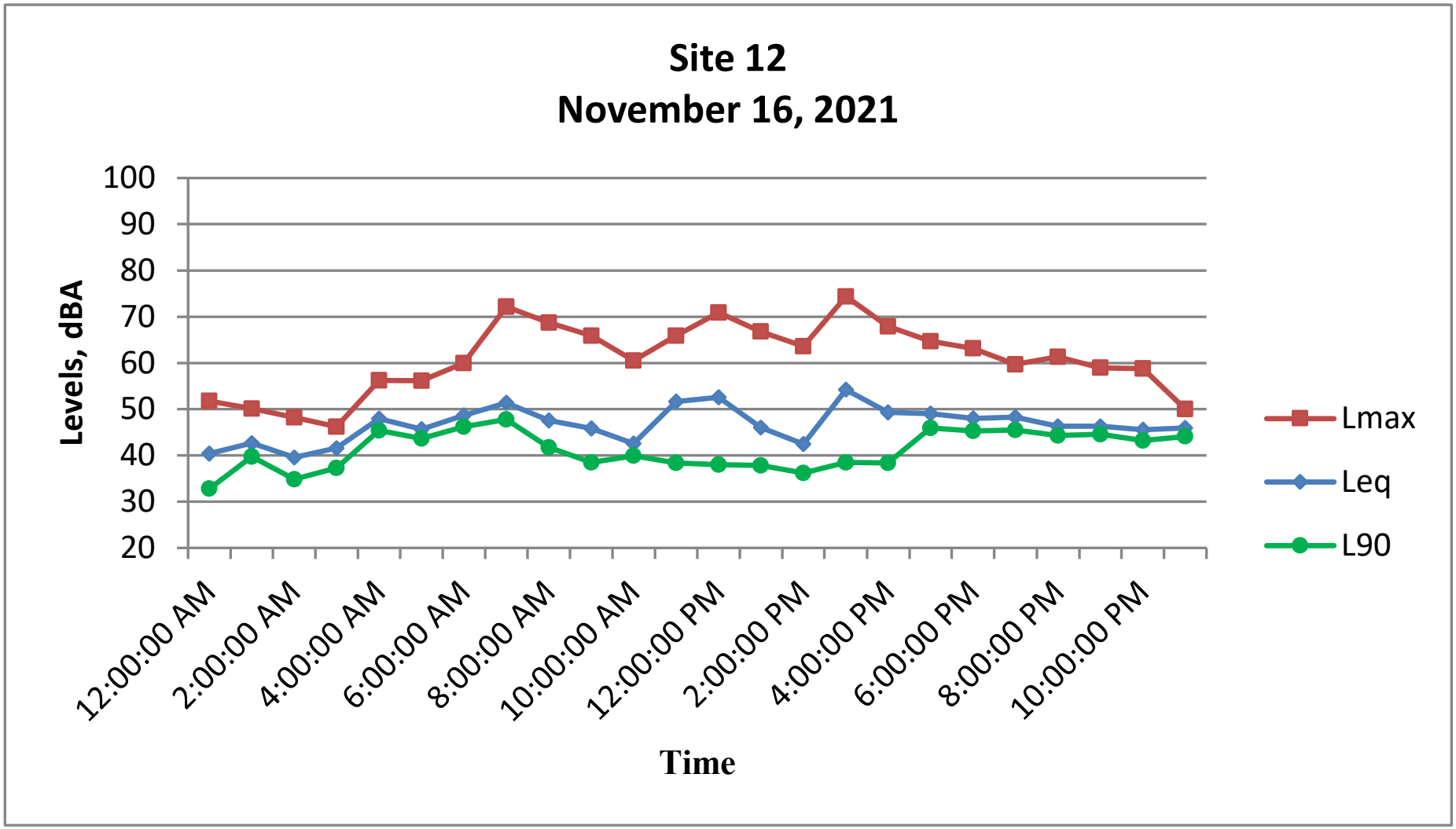
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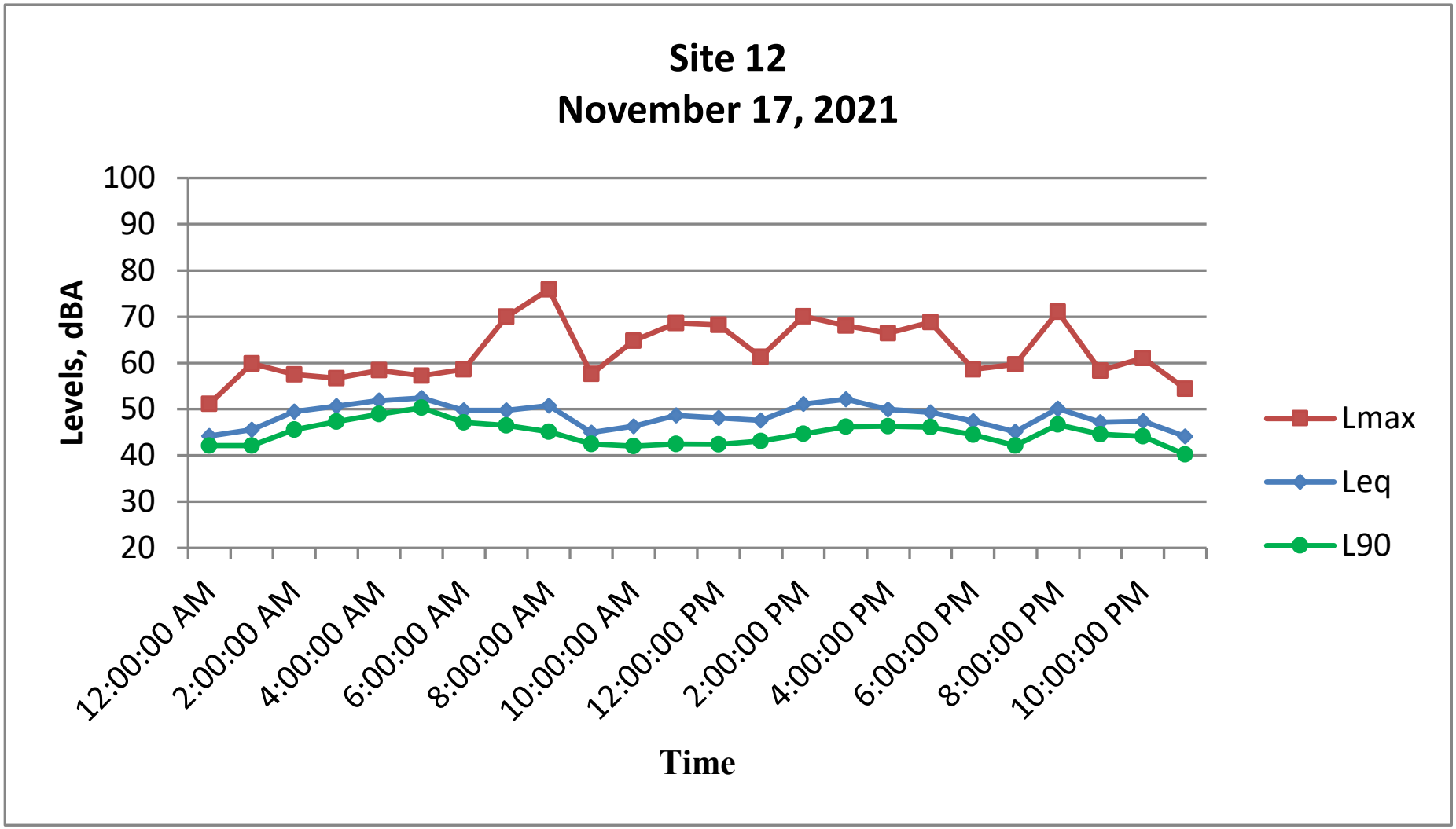
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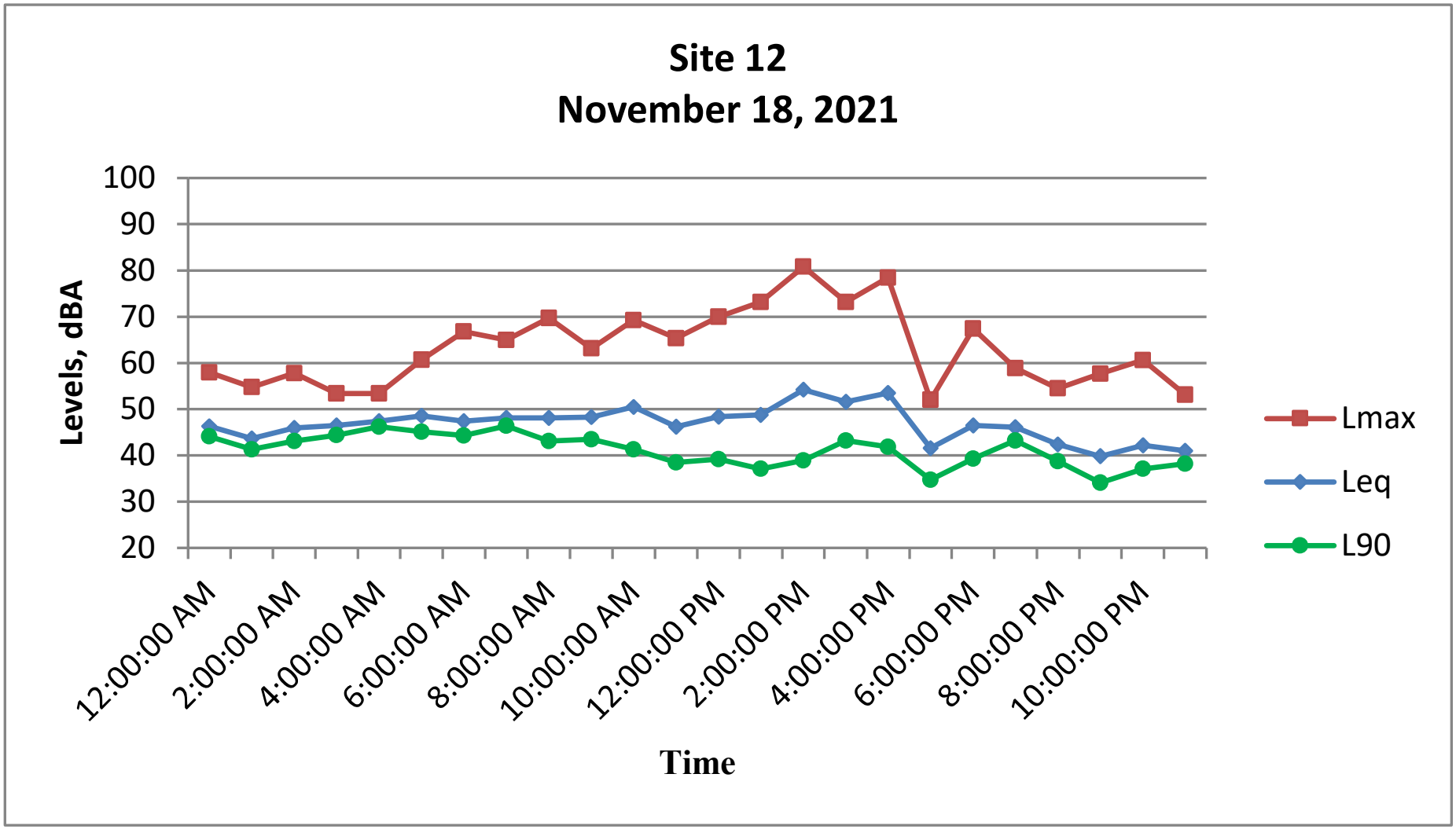
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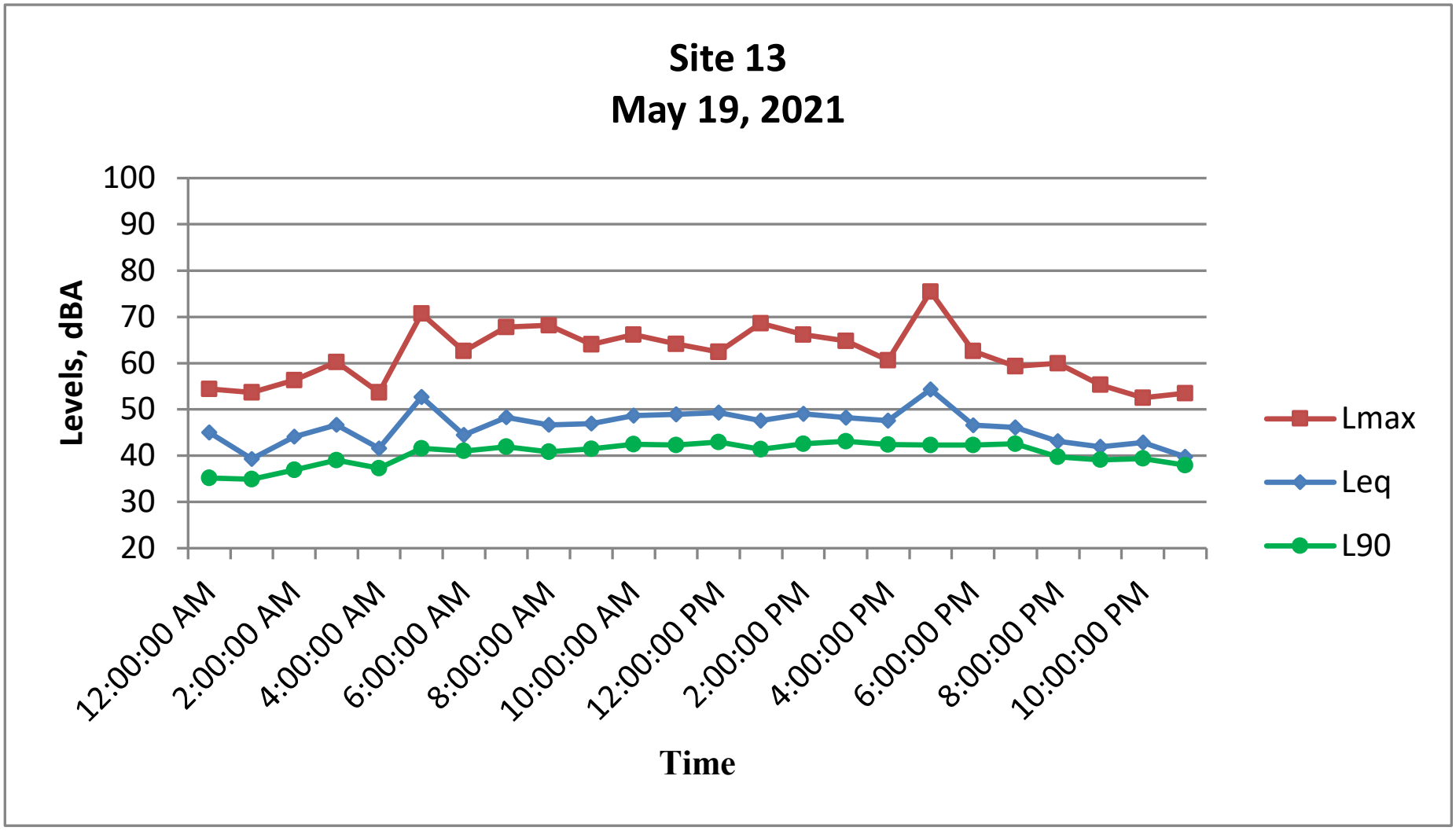
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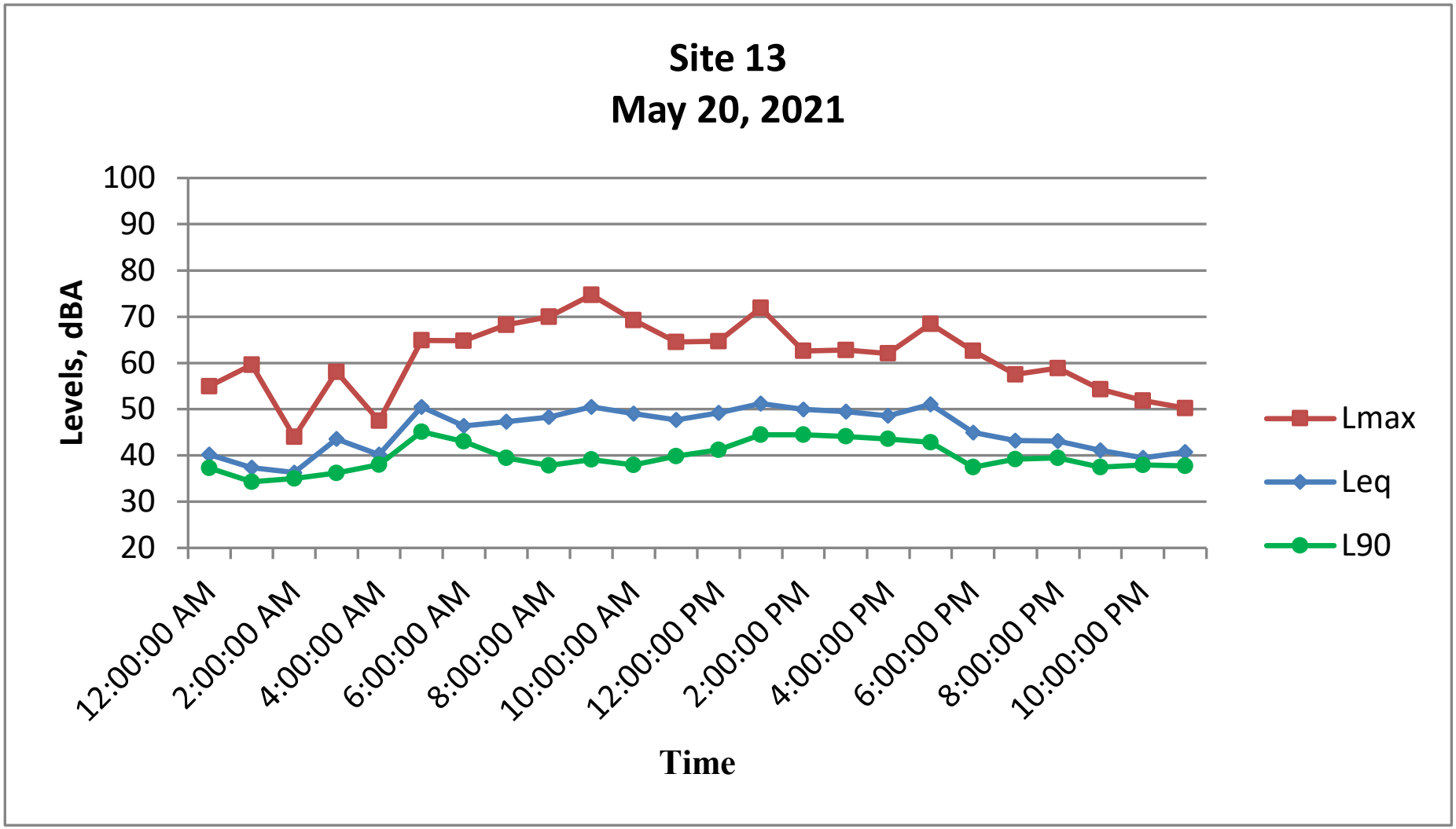
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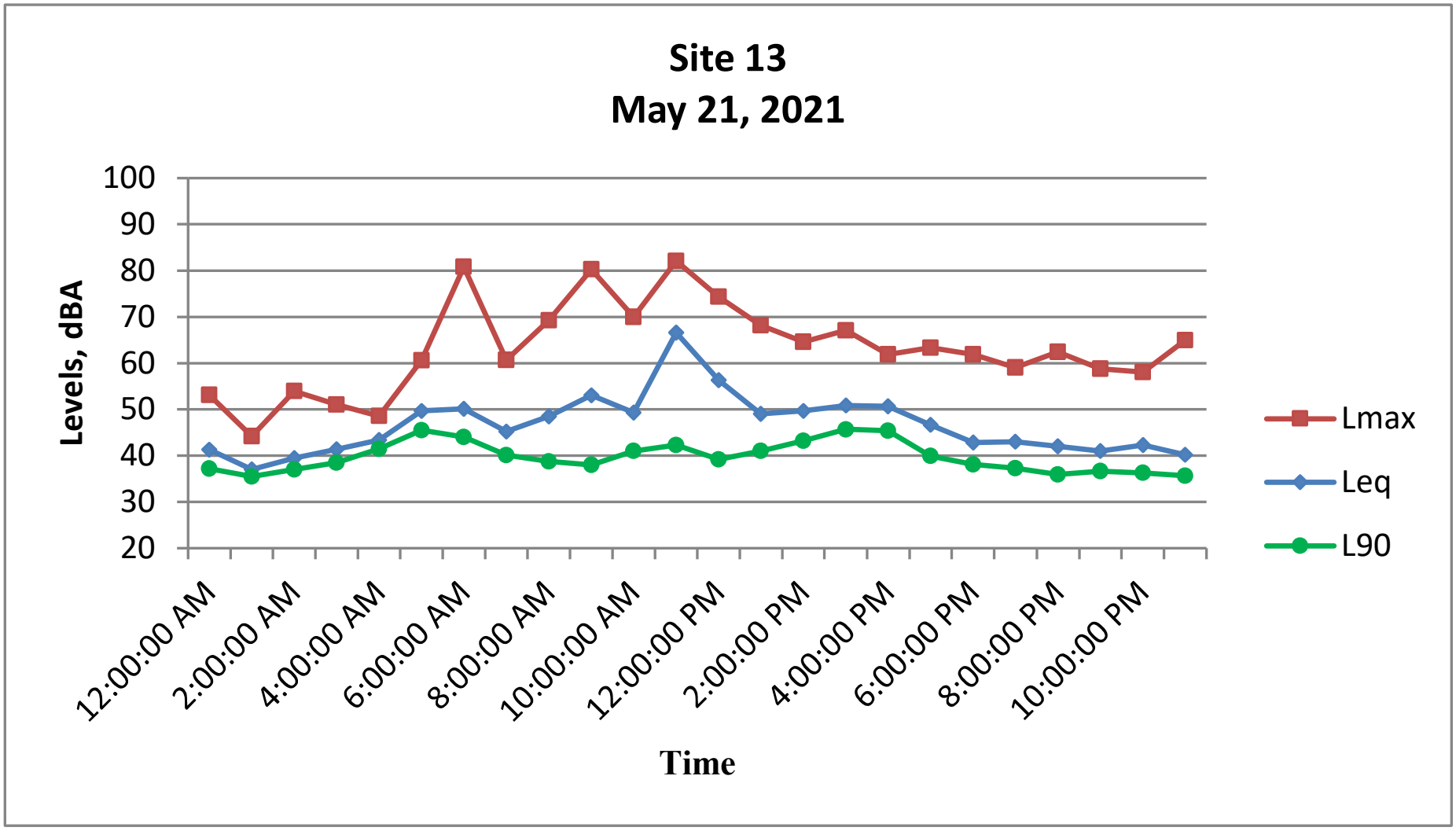
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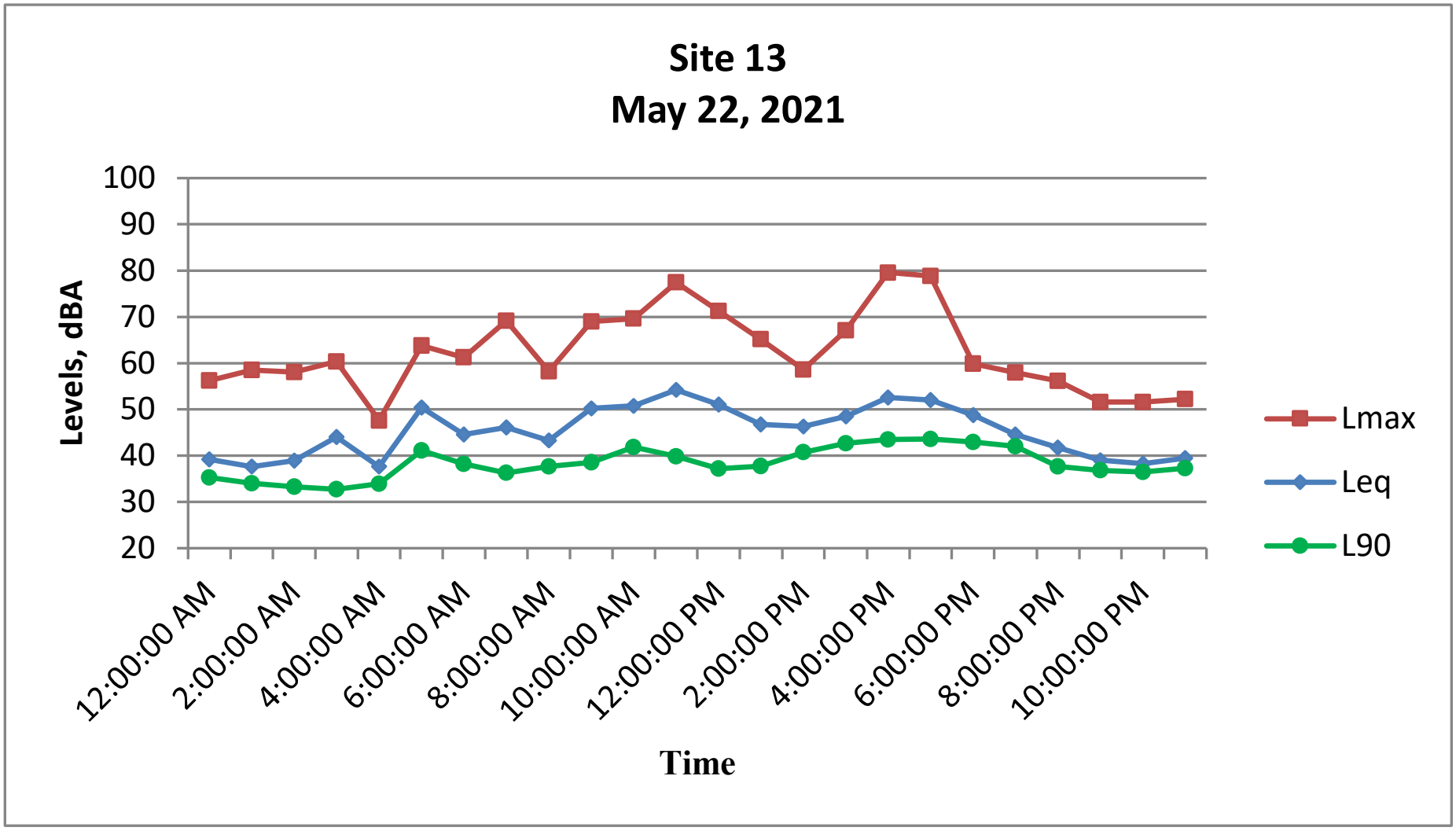
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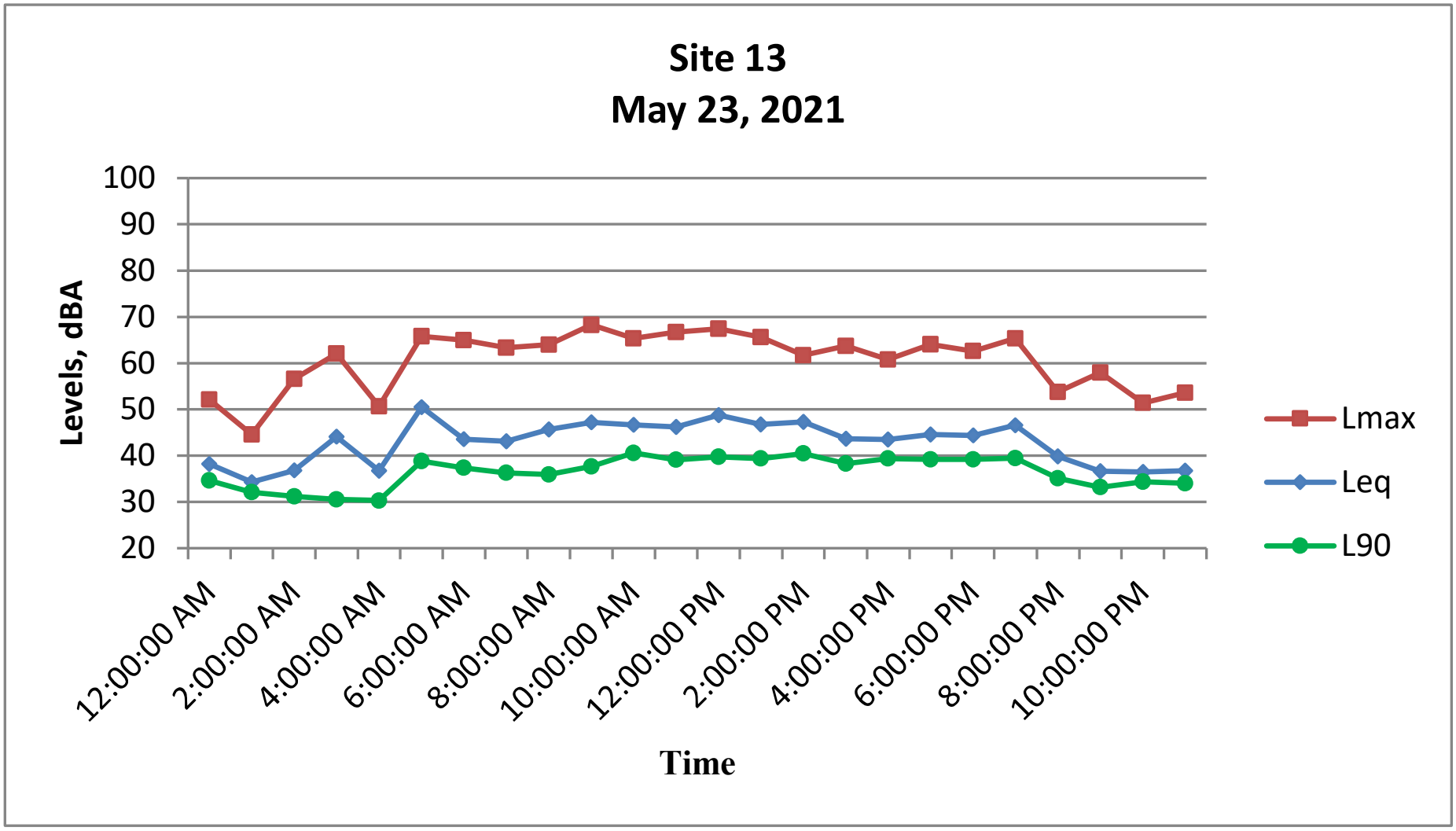
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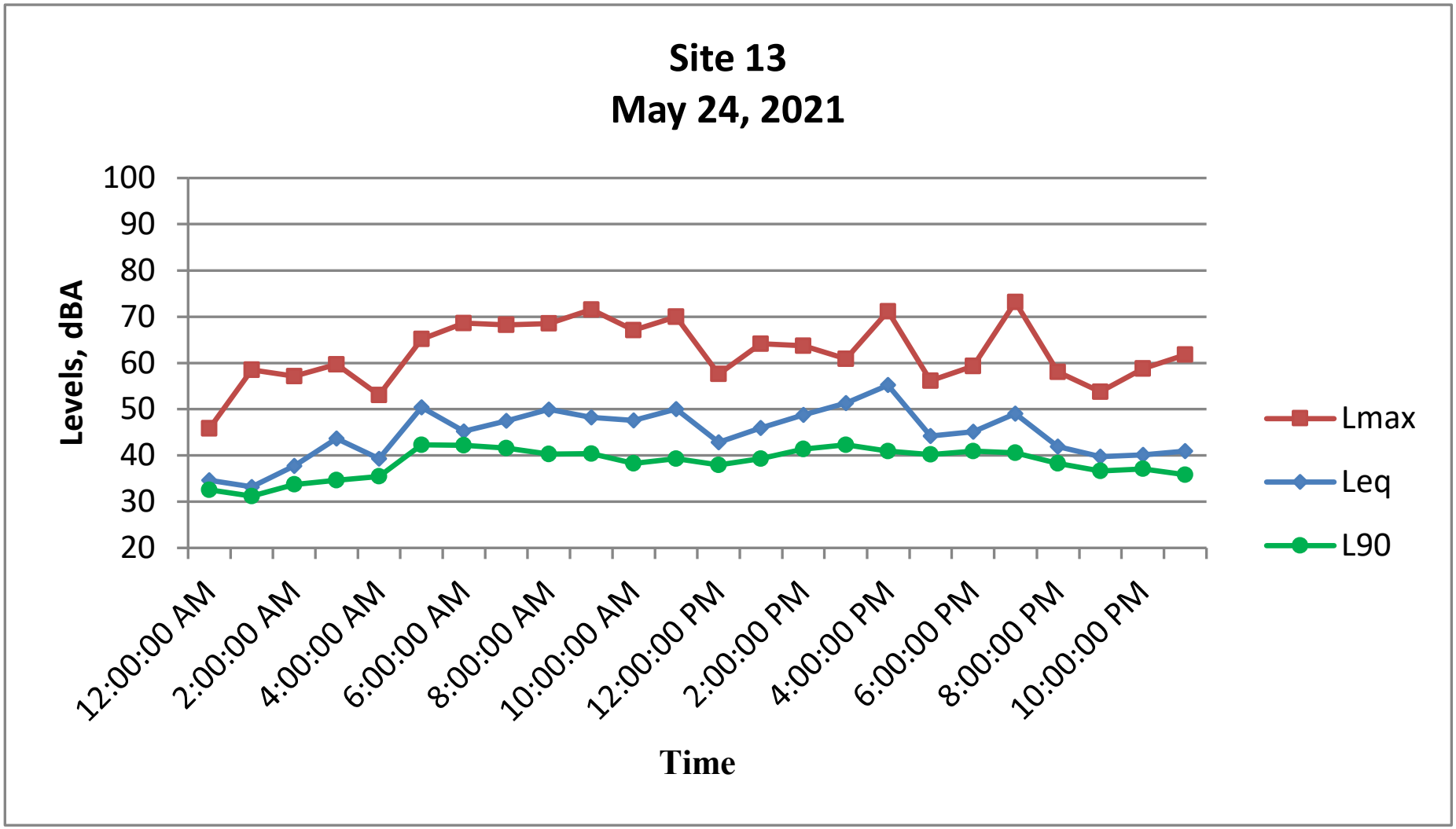
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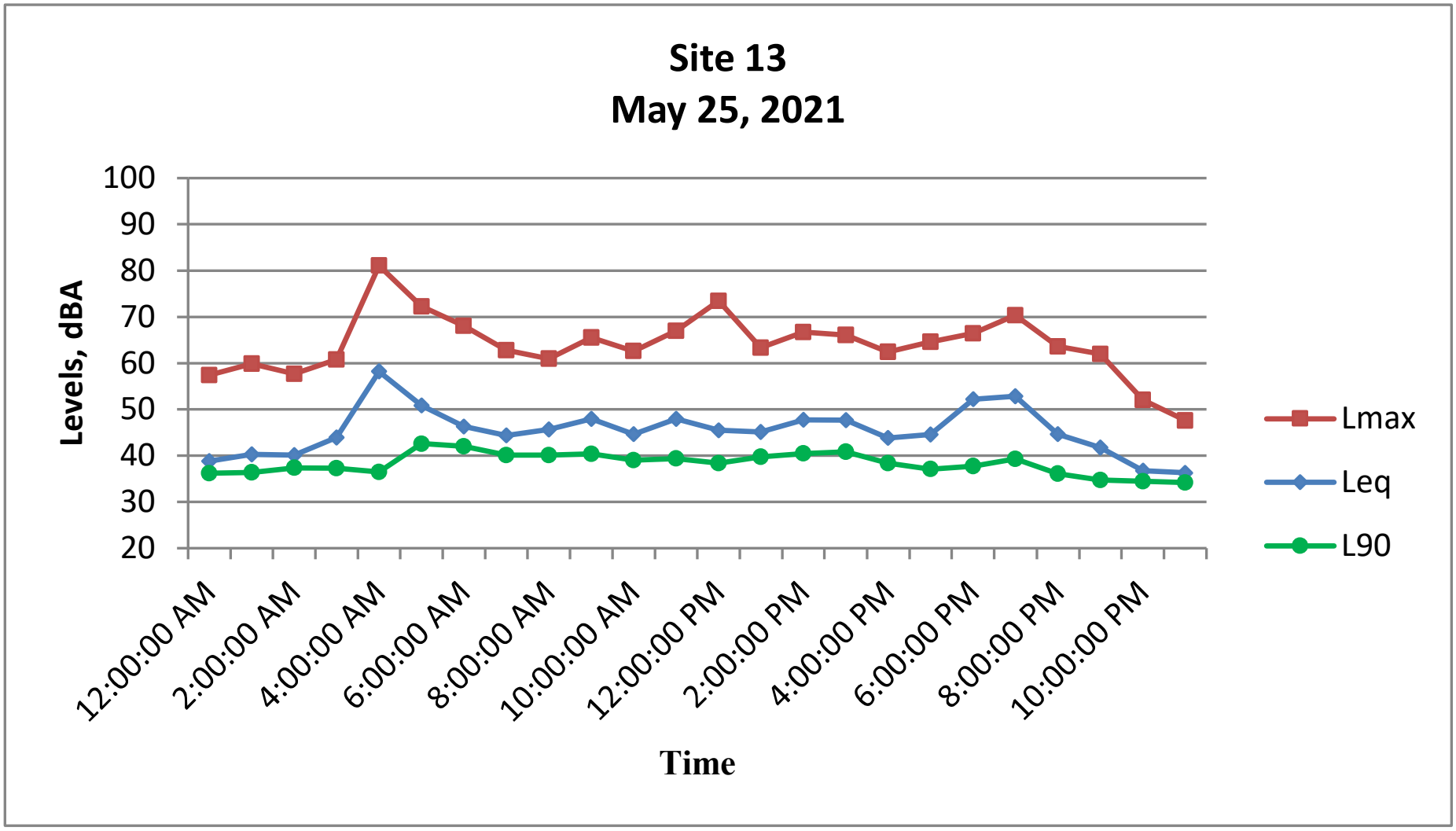
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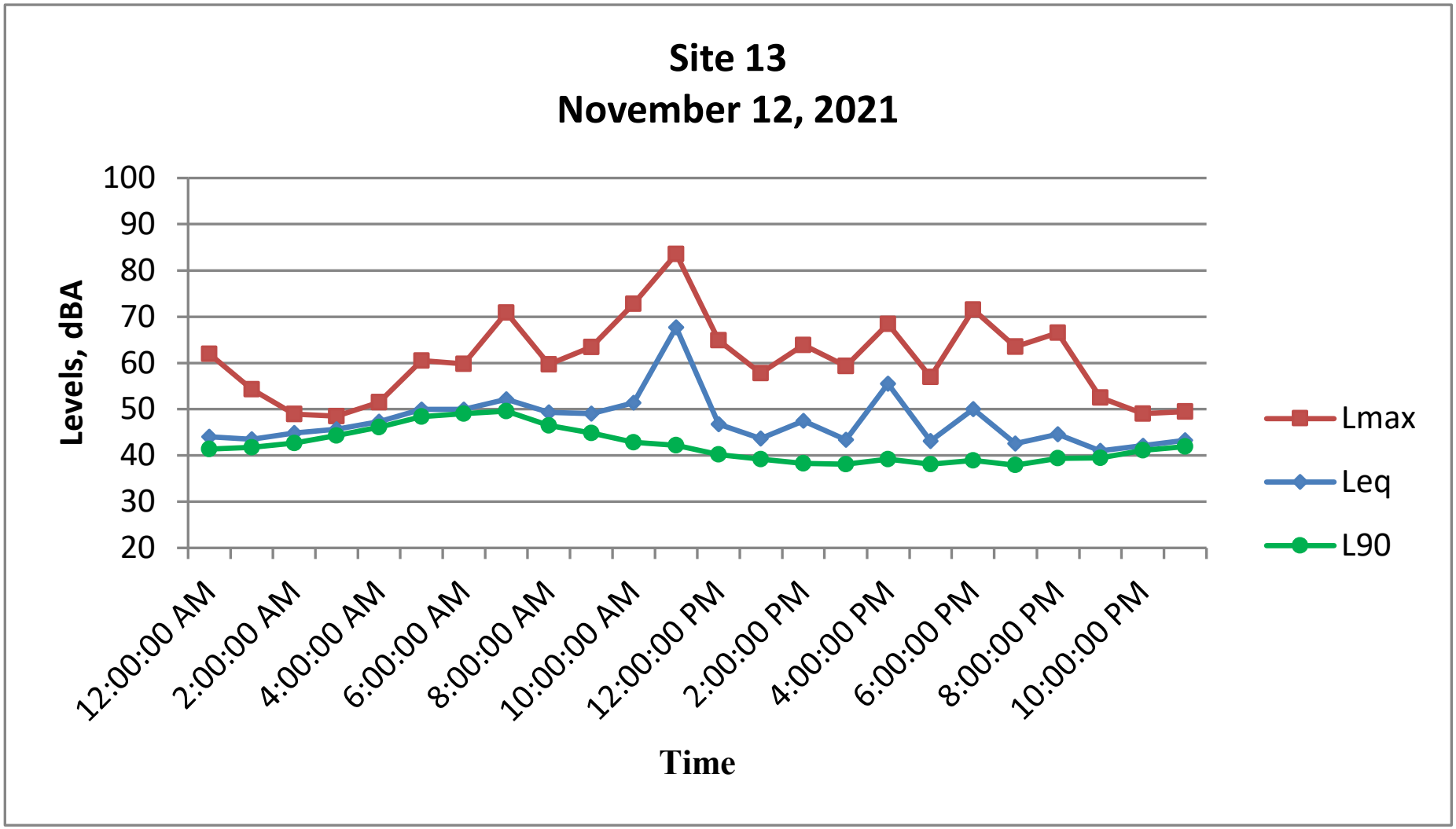
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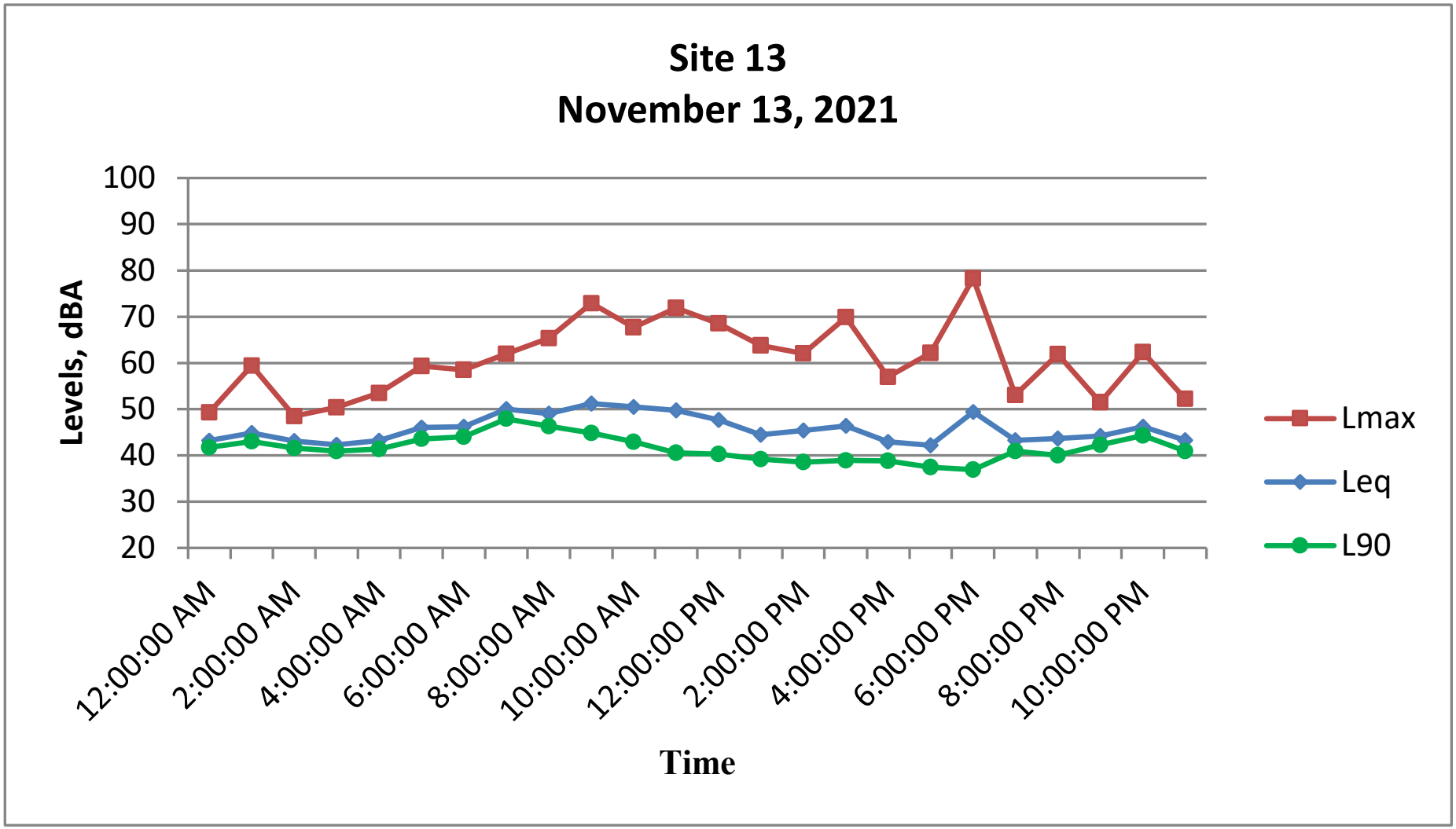
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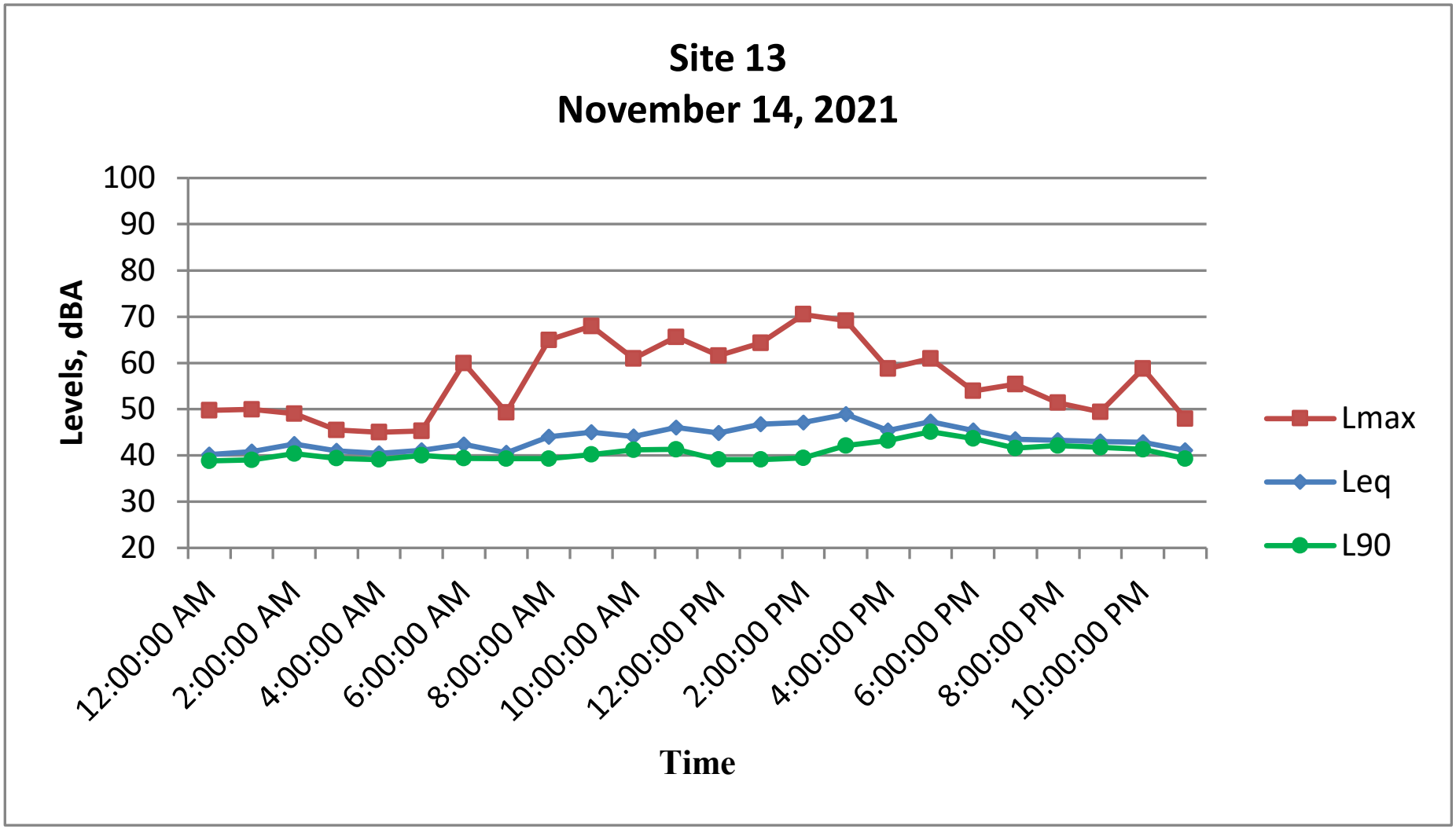
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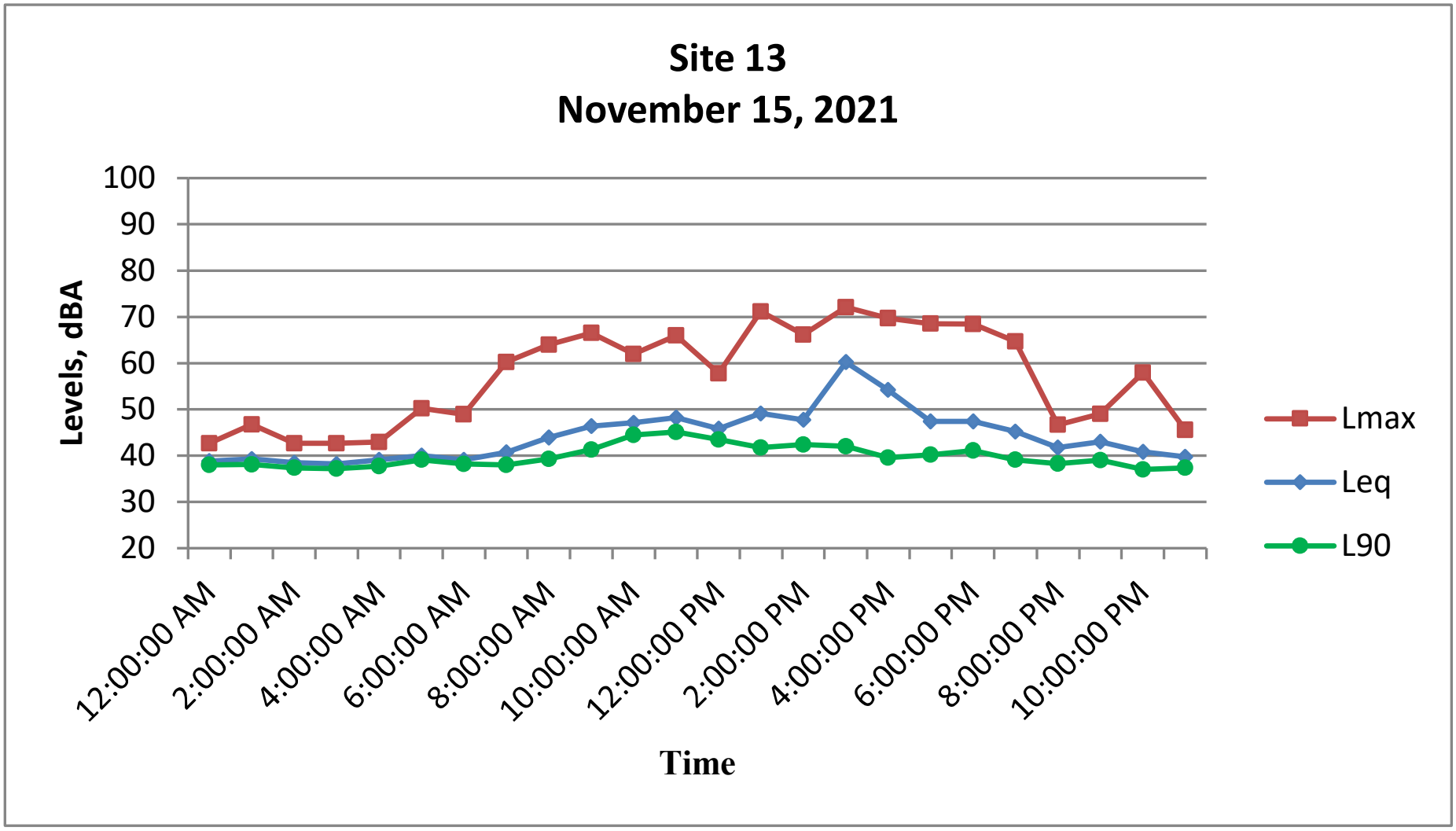
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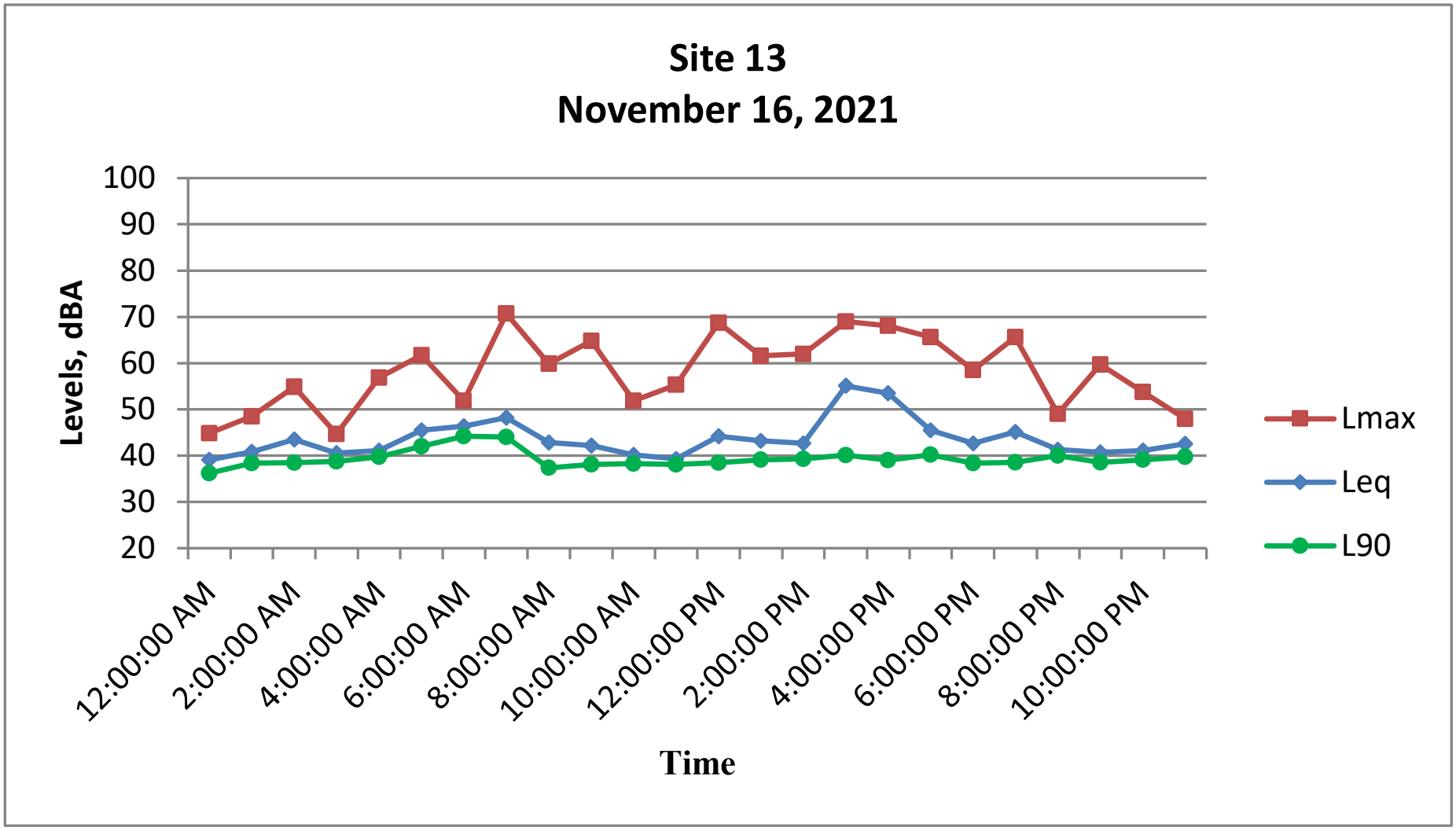
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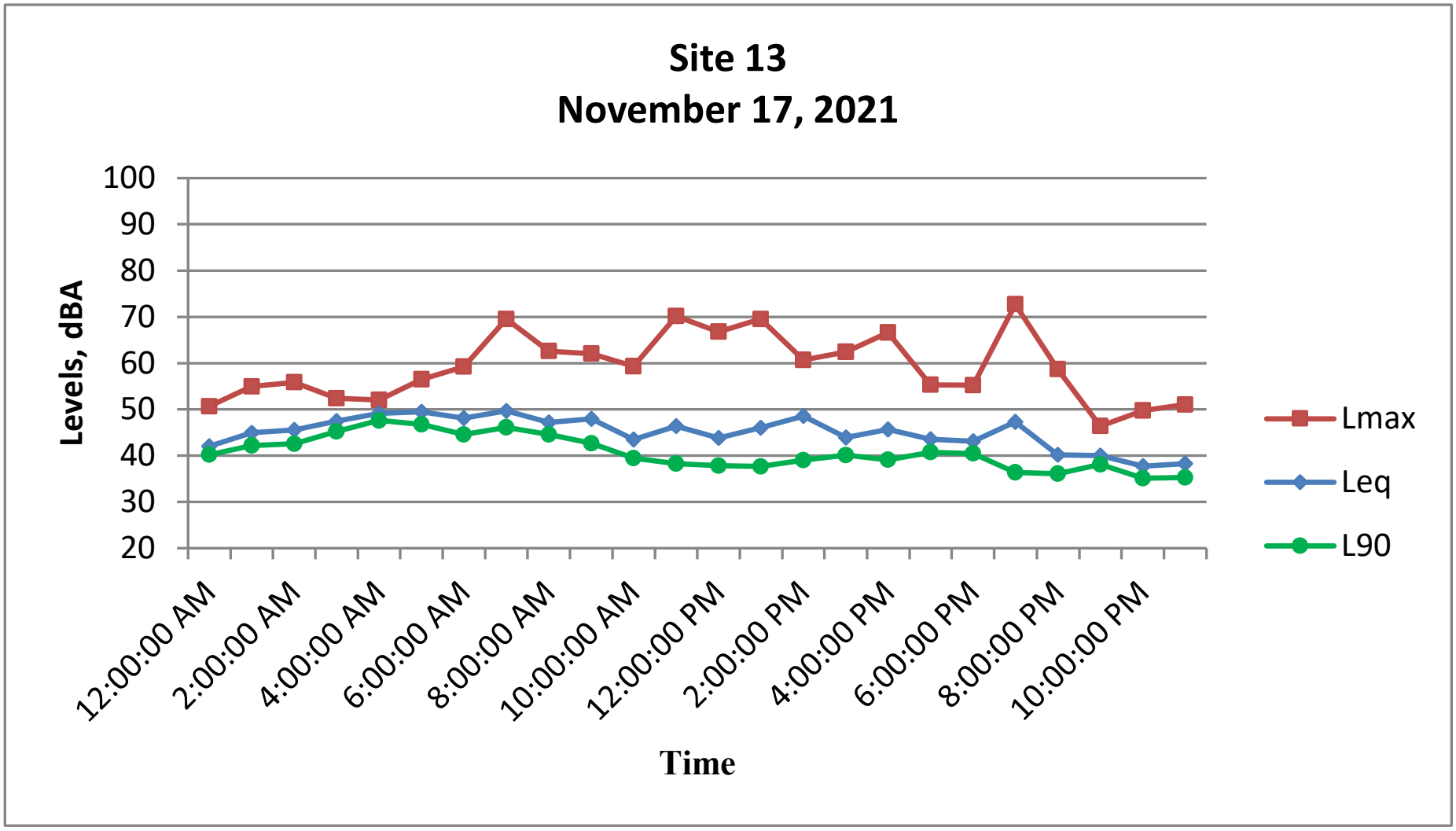
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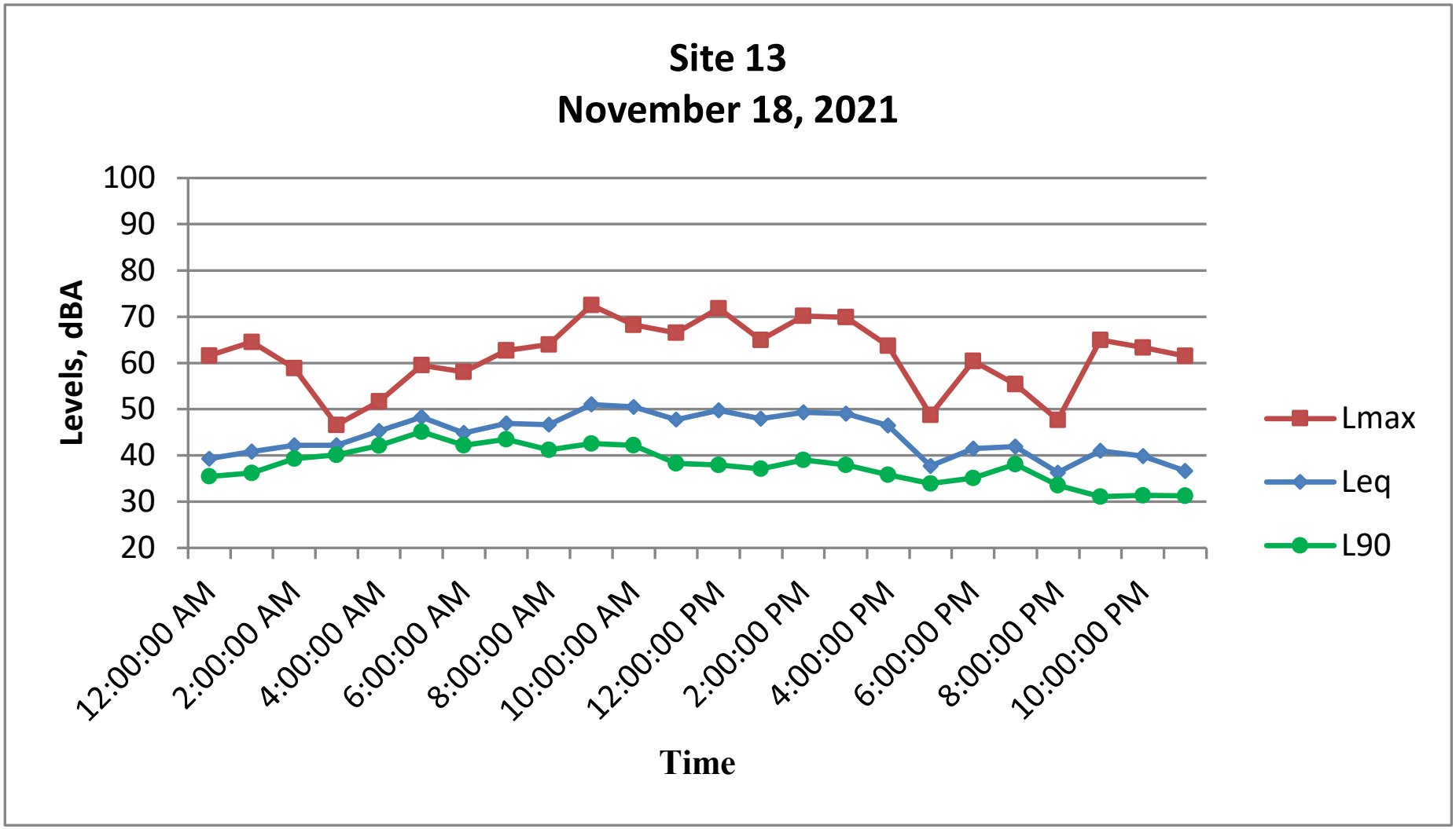
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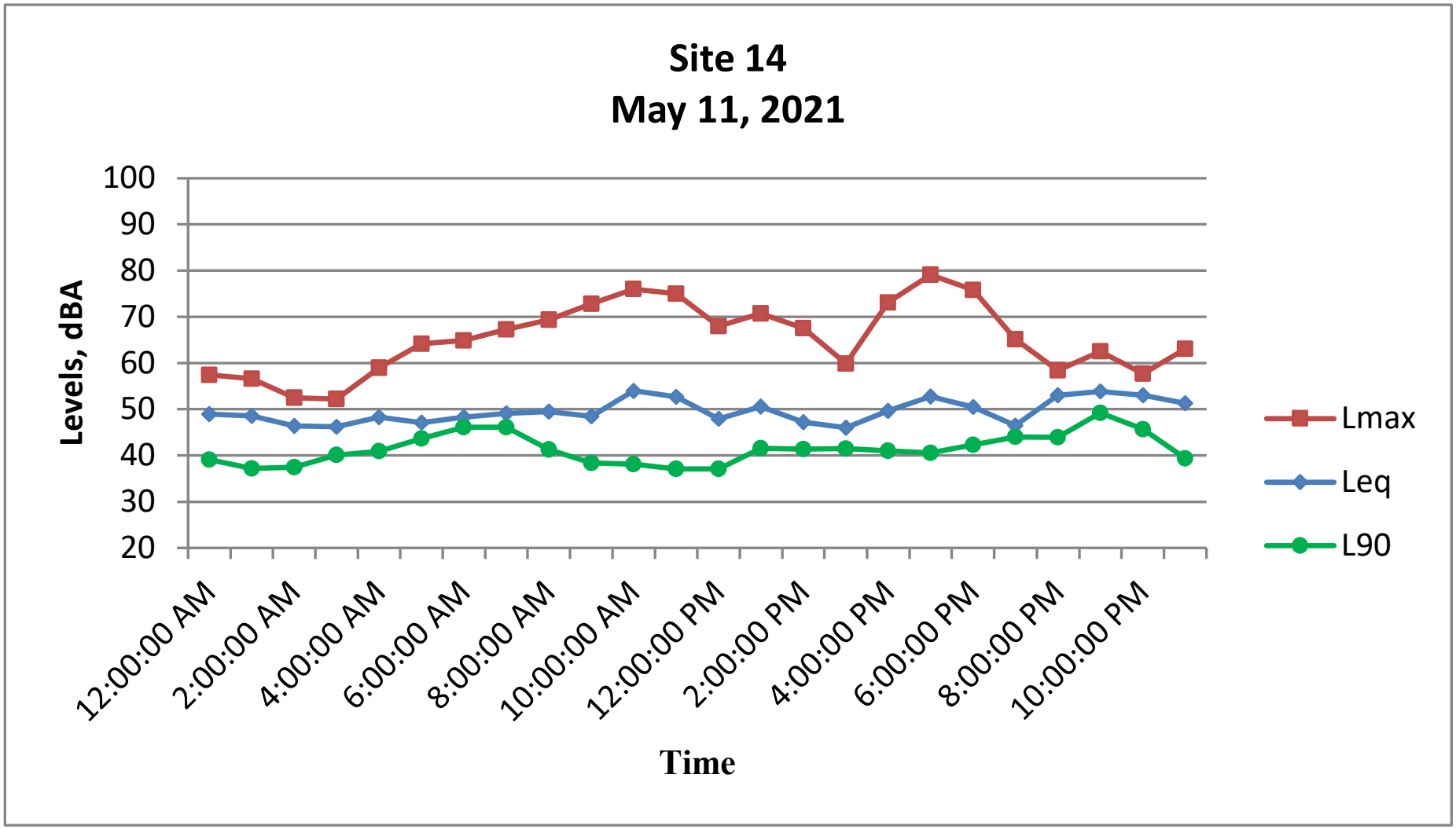
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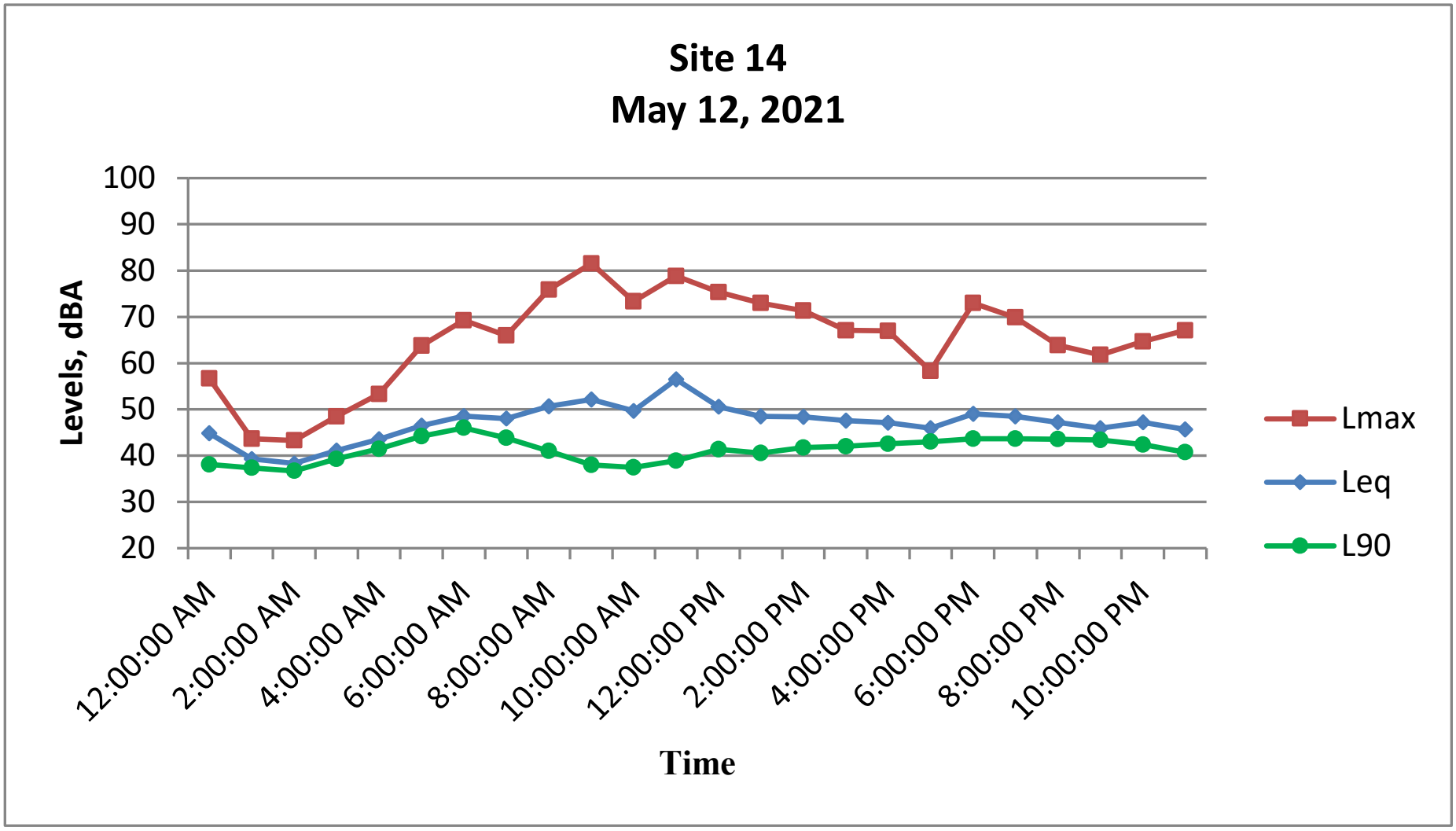
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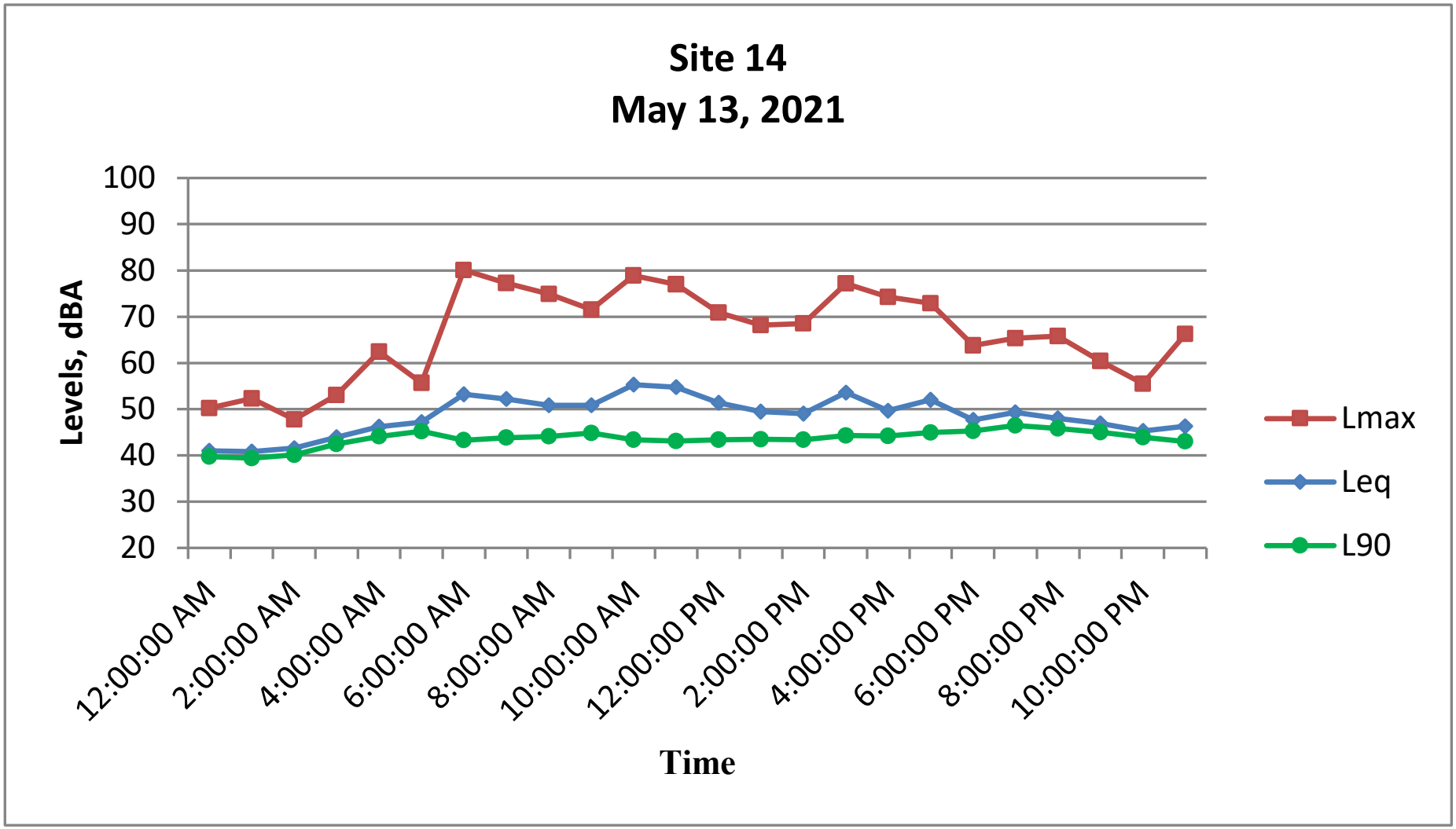
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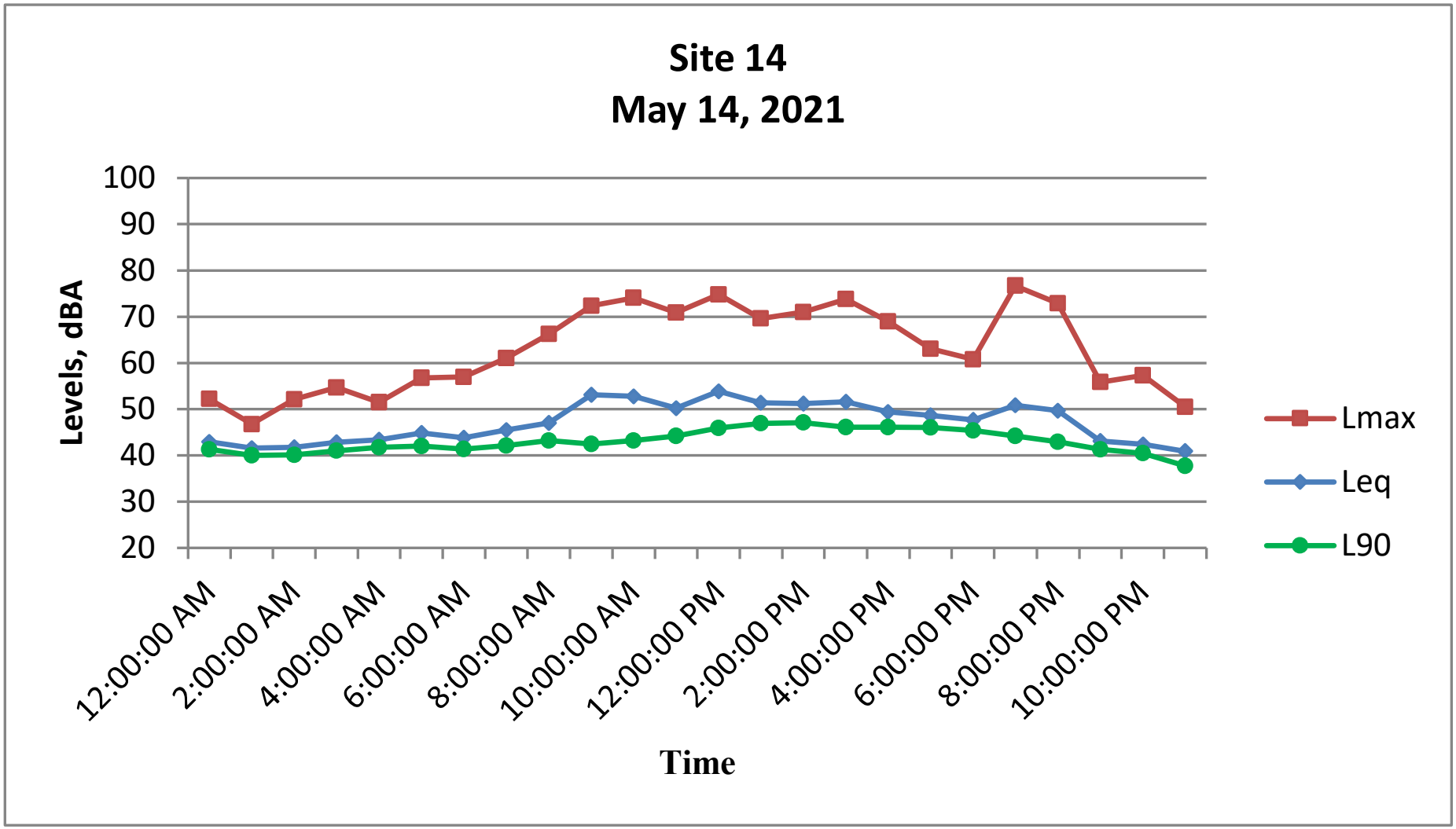
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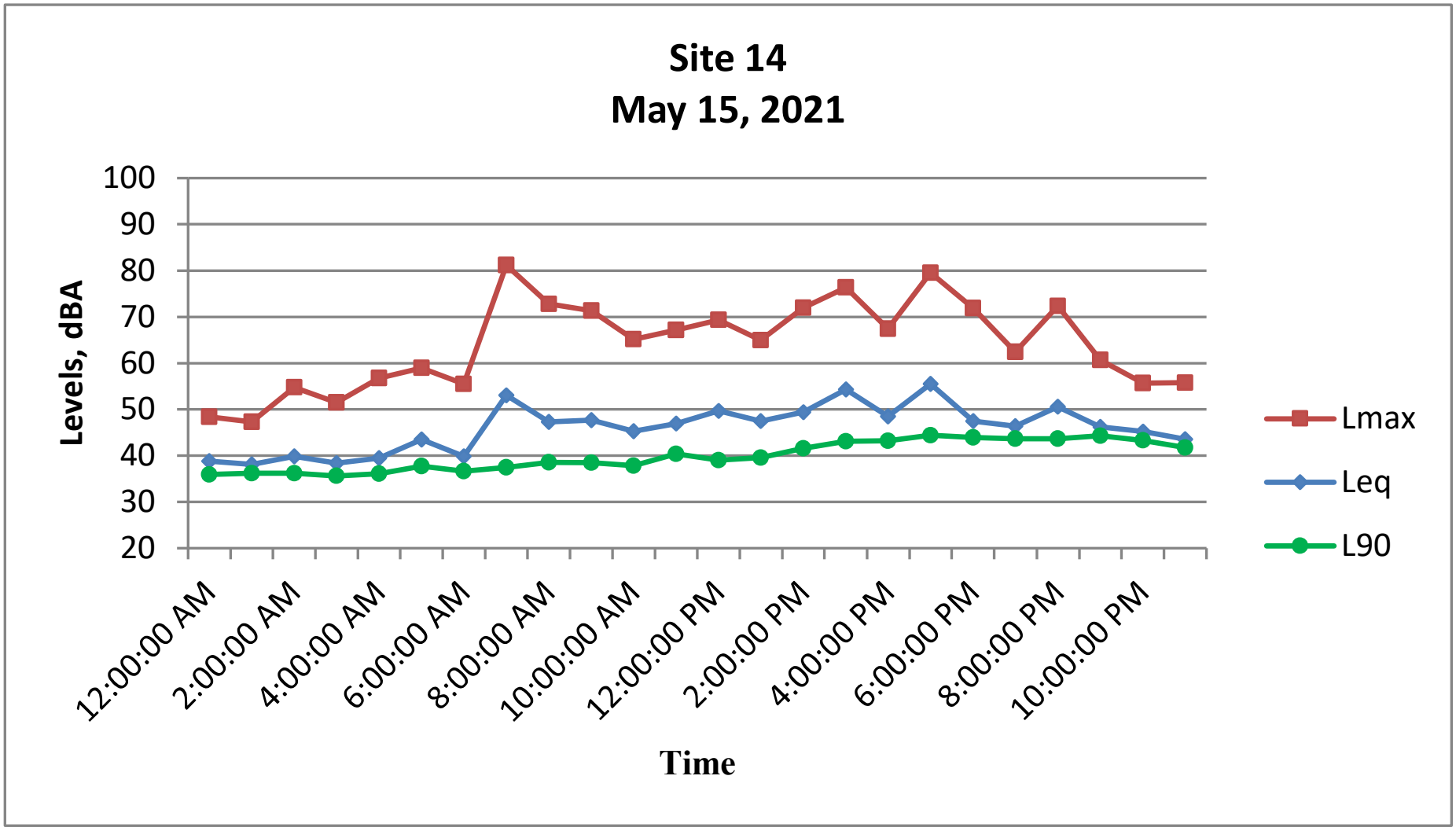
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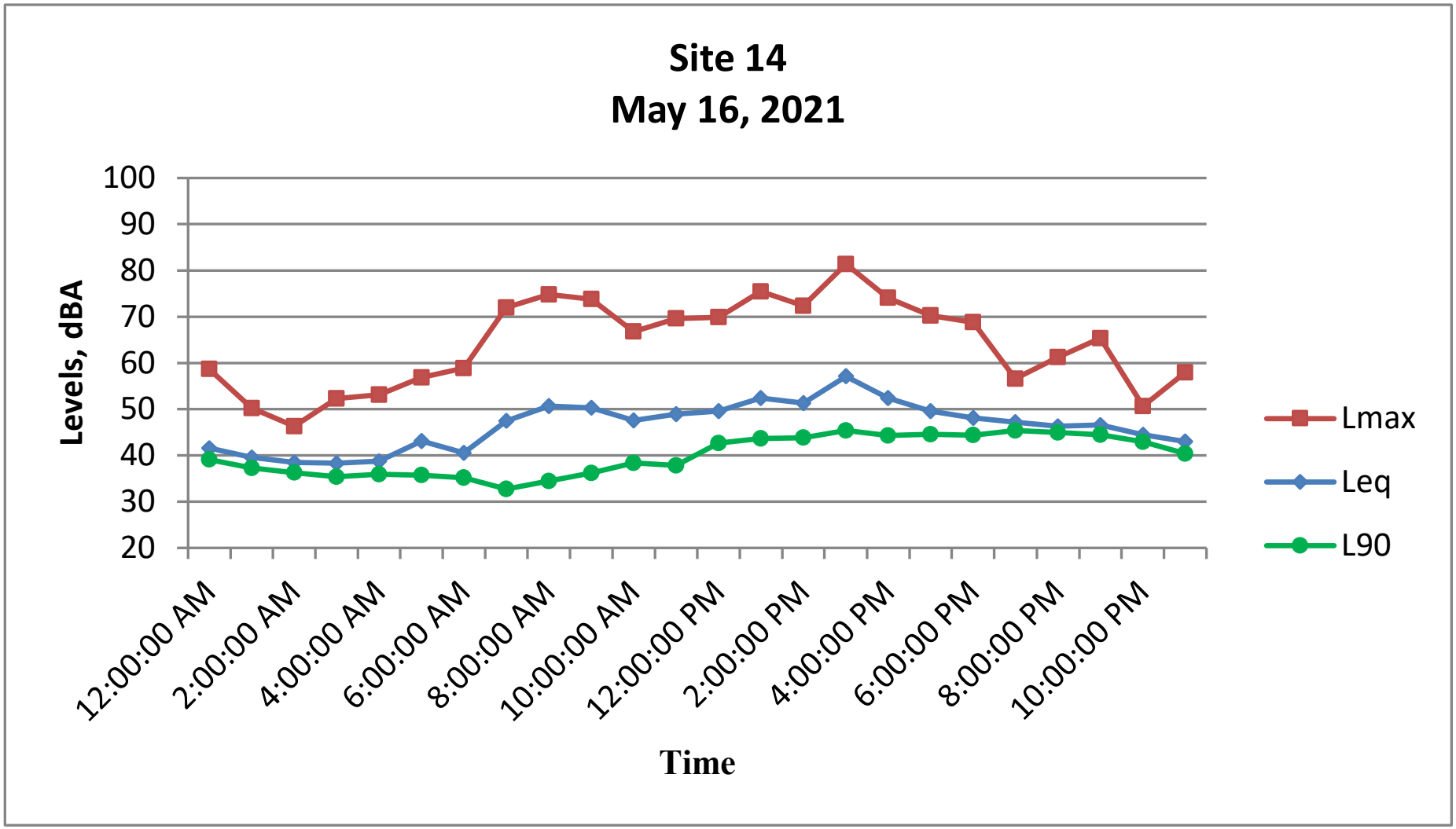
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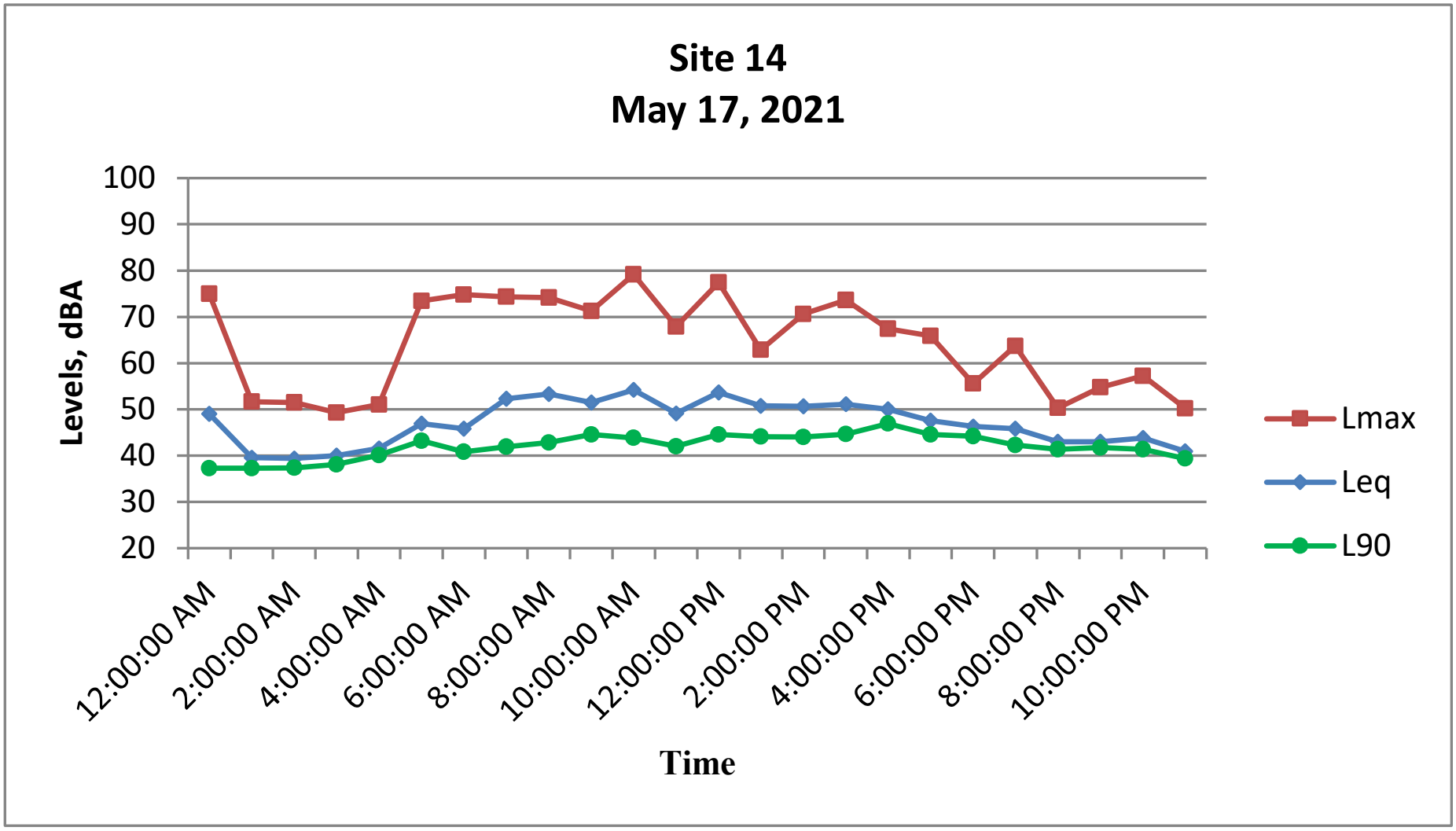
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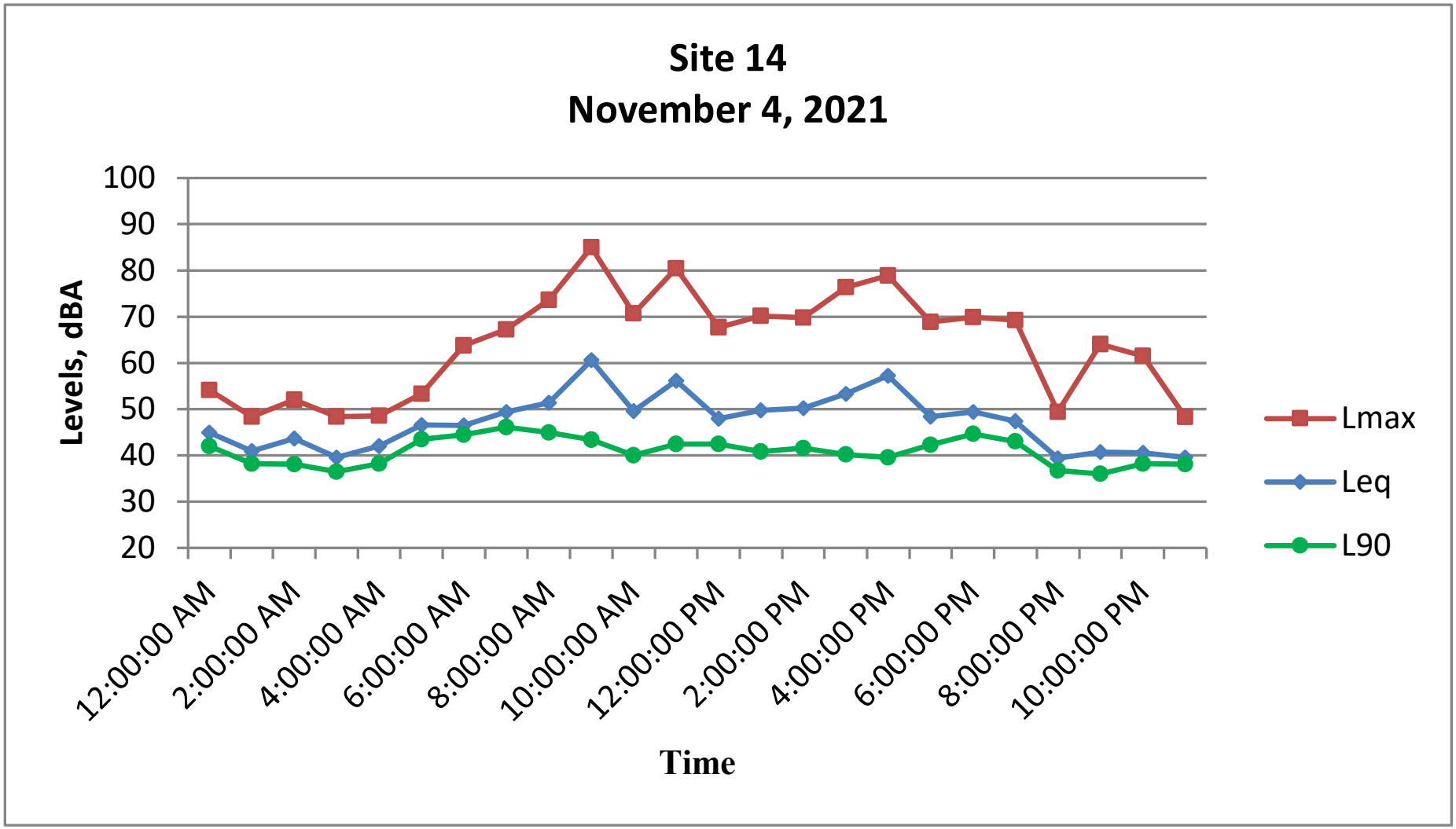
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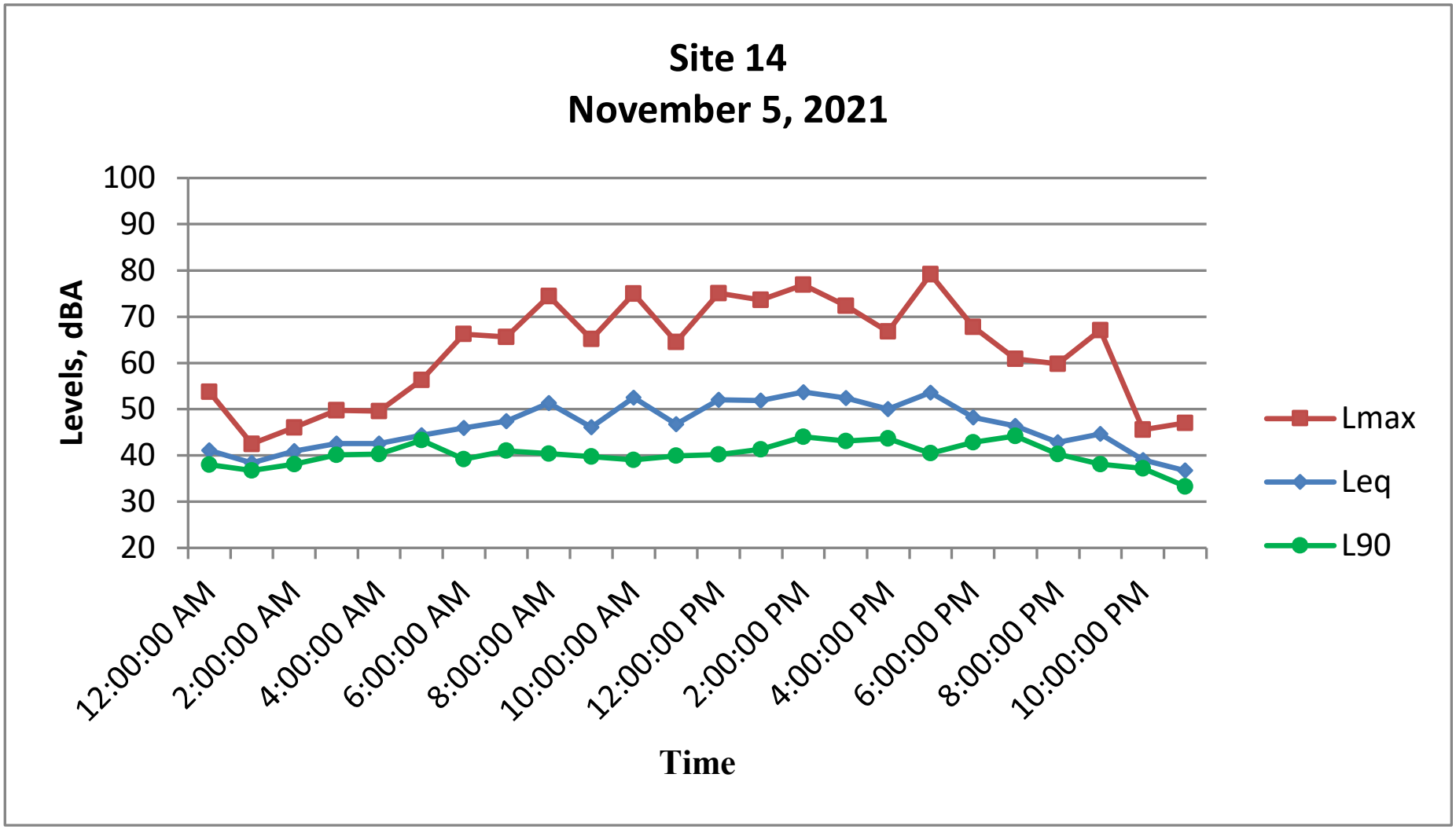
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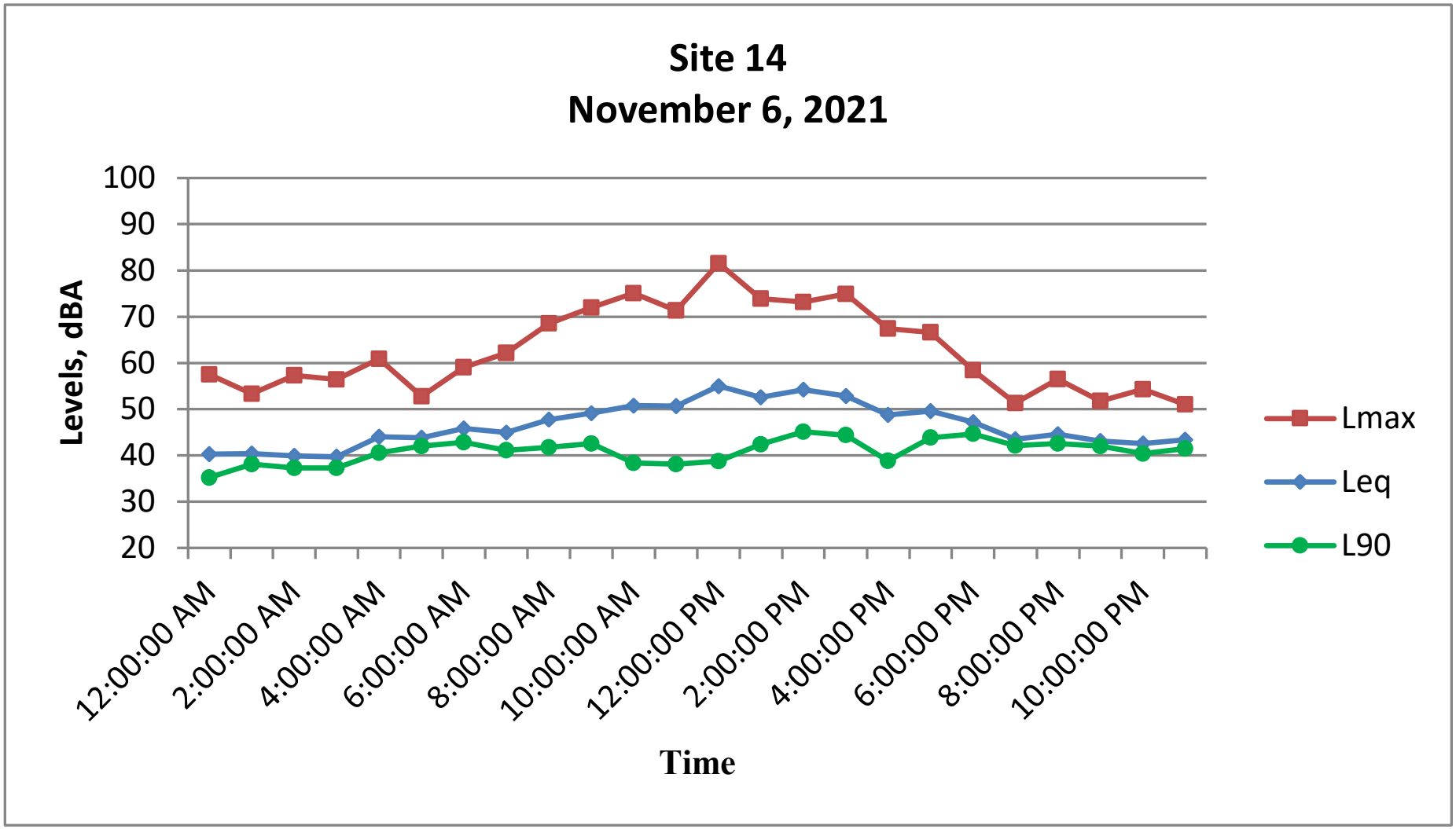
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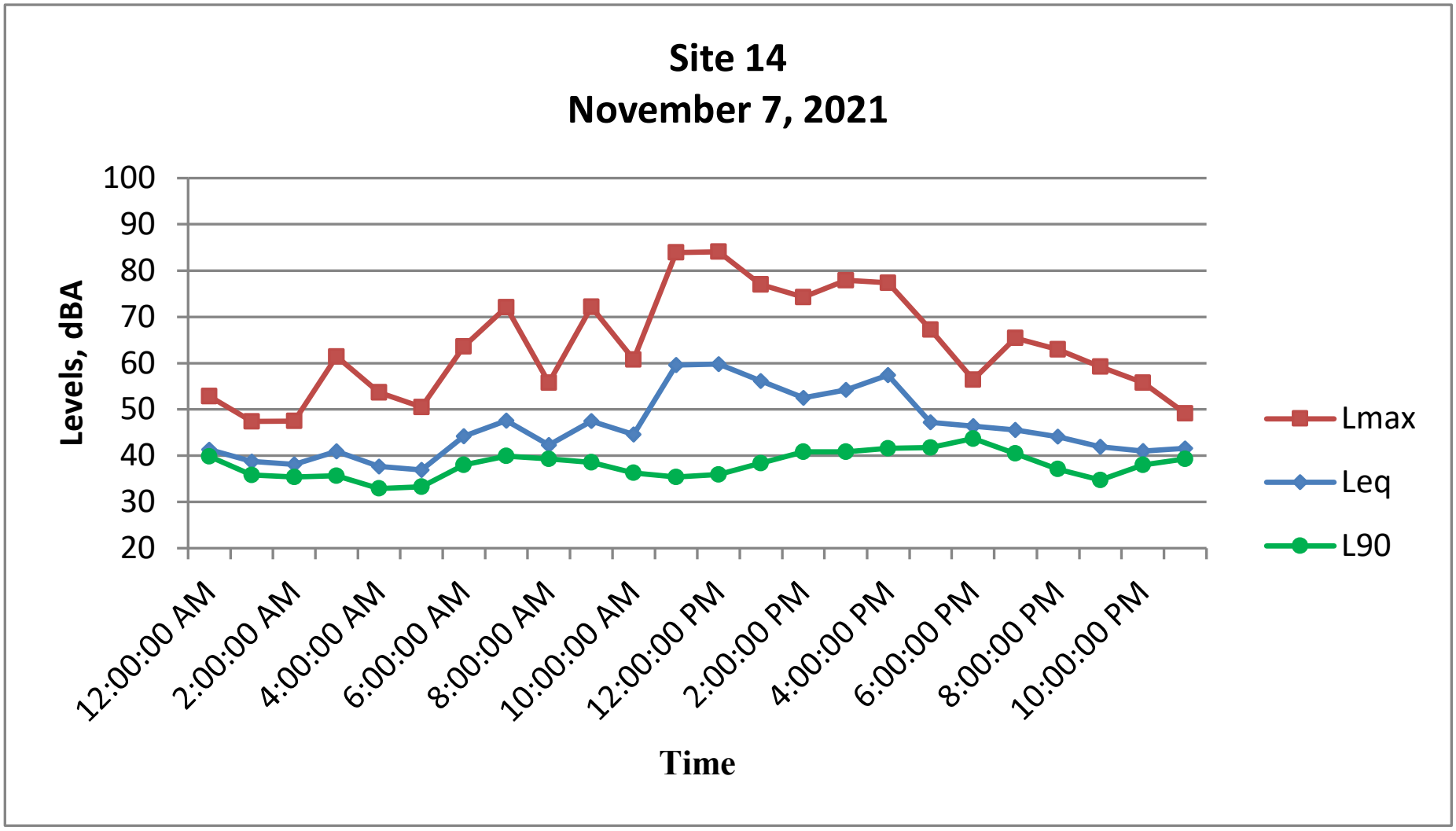
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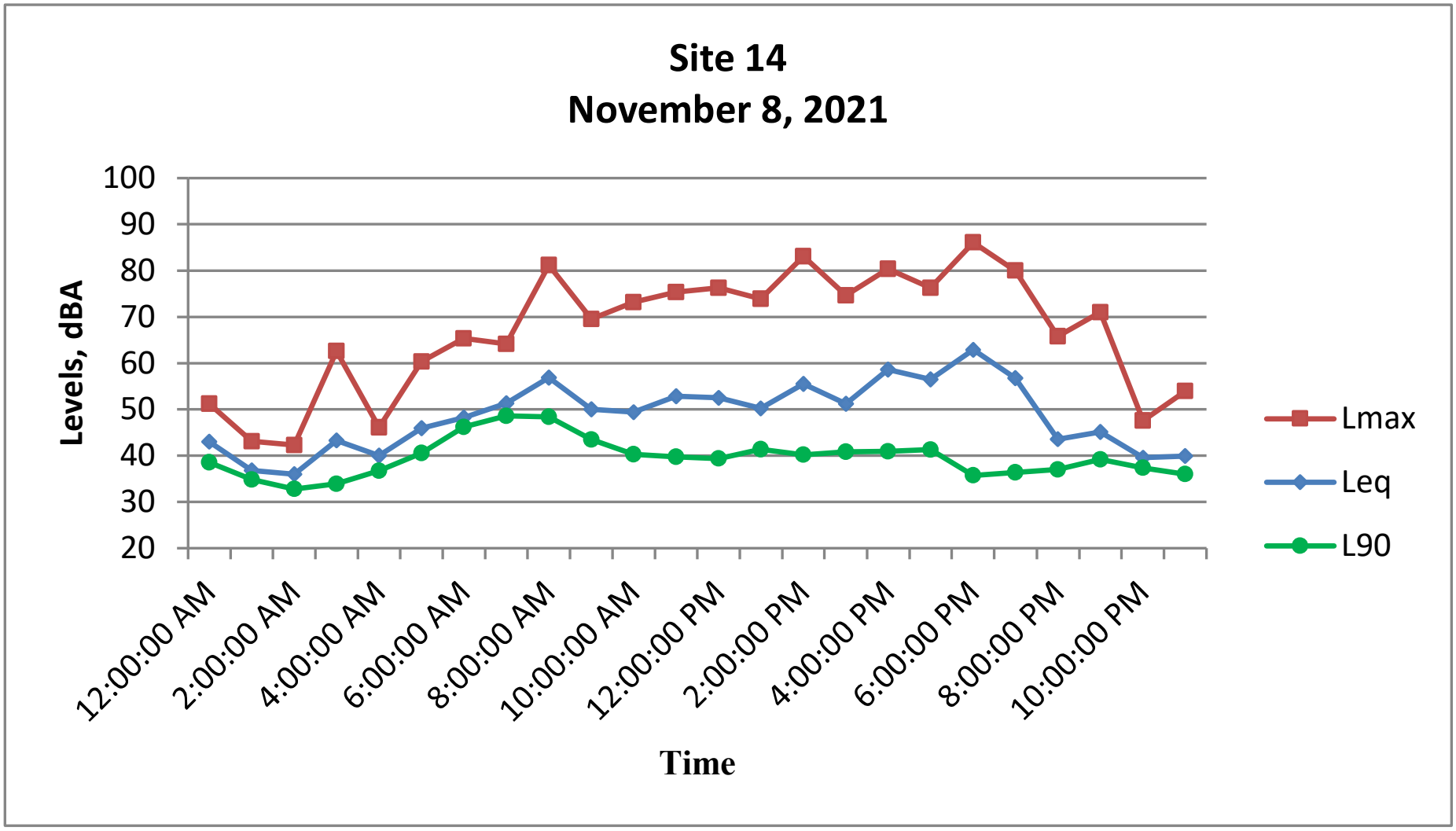
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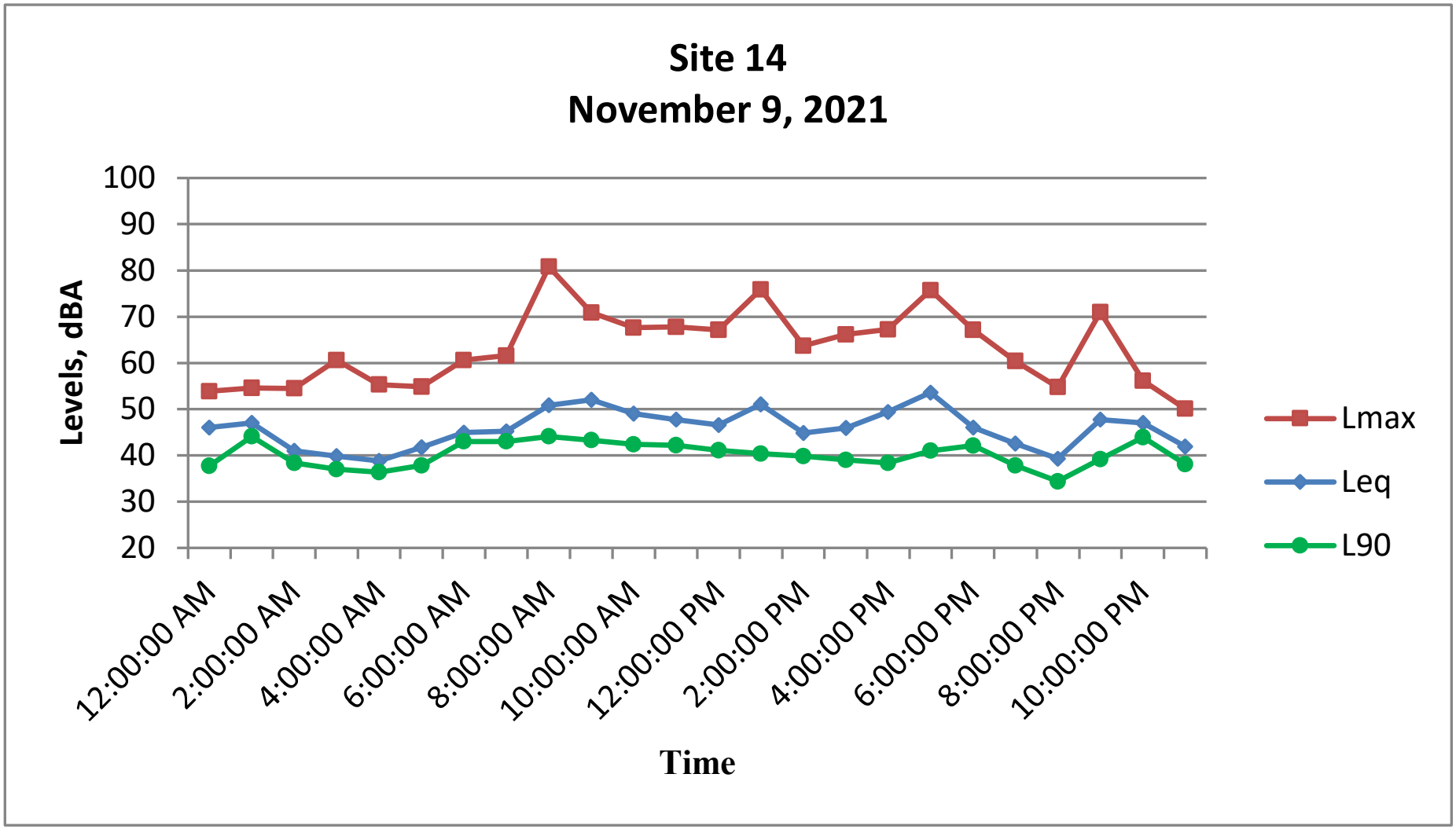
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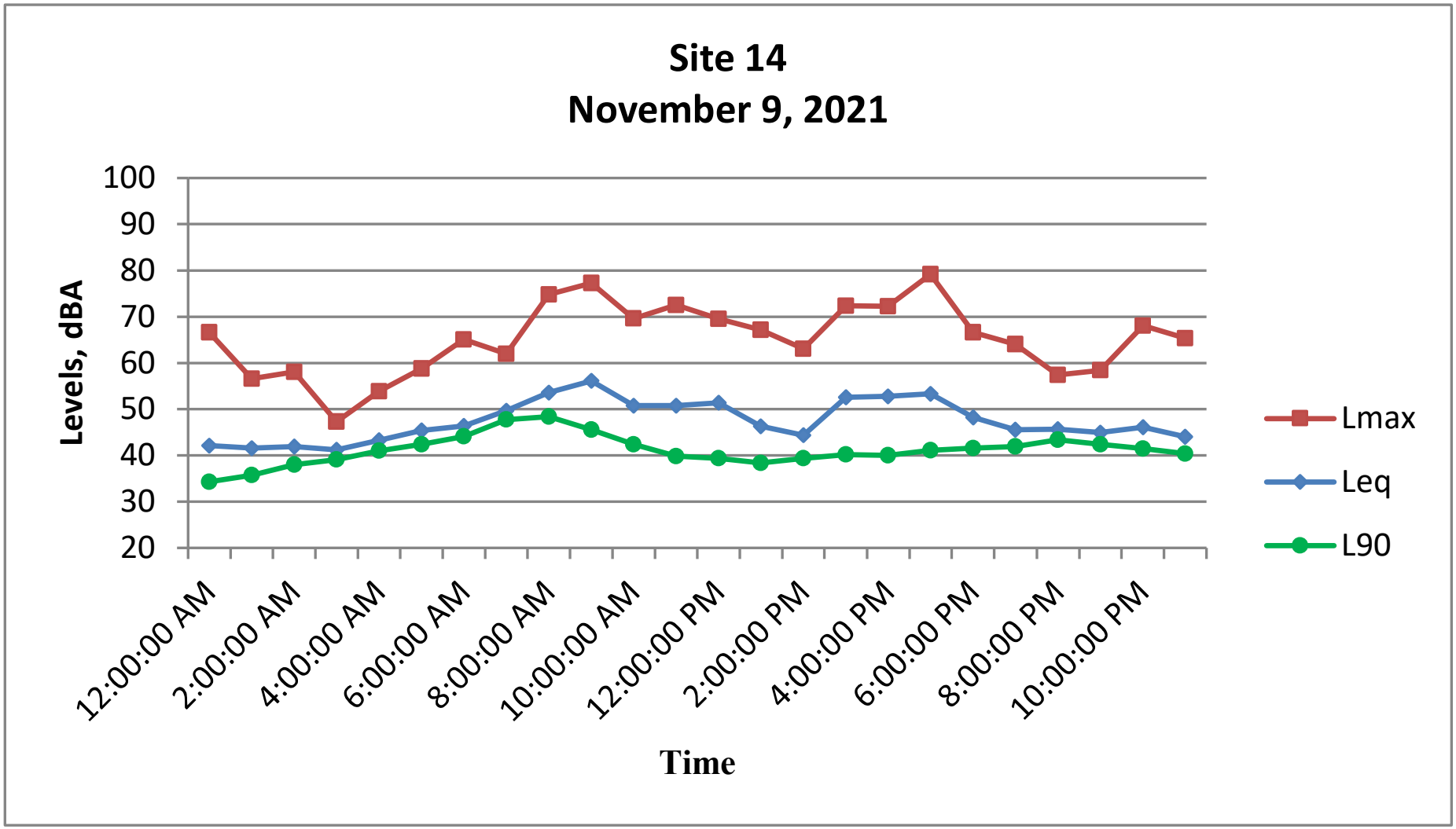
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