# AIRCRAFT NOISE MONITORING REPORT
# WATSONVILLE MUNICIPAL AIRPORT
## WATSONVILLE, CALIFORNIA

**WJVA Report No. 17-010**

**PREPARED FOR**

**THE CITY OF WATSONVILLE**
**WATSONVILLE MUNICIPAL AIRPORT**
**100 AVIATION WAY**
**WATSONVILLE, CALIFORNIA 95076**

**PREPARED BY**

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**AUGUST 29, 2018**

# I. INTRODUCTION

This report presents the findings of an aircraft noise monitoring study conducted by WJV Acoustics, Inc. (WJVA) for the Watsonville Municipal Airport in Watsonville, California. The study included aircraft noise monitoring over two individual week-long periods. The Spring noise monitoring study occurred in April of 2017 and the Fall noise monitoring study occurred in October of 2017. The objectives of the studies were to document existing levels of noise from aircraft and other sources at representative locations in the vicinity of Watsonville Municipal Airport and to compare measured noise levels to the results of previous noise monitoring studies. This report also includes the preparation of aircraft noise exposure maps for existing (2016) and forecast future (2036) conditions using the Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT2d). Aircraft operations data utilized for noise modeling was provided by the findings of the Watsonville Municipal Airport Operations Study (American Aviation Professionals, Inc.).

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.

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.

# II. AIRCRAFT NOISE MEASUREMENT PROGRAM

Continuous measurements of noise from aircraft and other sources were conducted during the seven-day period of April 19-25, 2017 (Spring aircraft noise survey) and October 17-23, 2017 (Fall aircraft noise survey) at eight (8) locations using automated noise monitoring equipment. The noise monitoring sites were selected by WJVA and the City of Watsonville to represent areas of the community potentially impacted by aircraft noise or where noise complaints have been received. Four (4) of the monitoring sites were previously utilized during the 2015 noise monitoring period (Sites 1, 2, 3 and 5), and four (4) additional site (Sites 4, 6, 7 and 8) were included in the current monitoring periods. Short-term measurements of aircraft single event noise levels were also conducted at each of the eight sites.

Weather conditions during the Spring noise measurement period consisted of mostly overcast skies in the morning hours, often becoming clear and sunny in the afternoon hours. The second part of the week saw numerous cloudy and overcast days conditions throughout the day. Temperatures generally ranged from approximately 55-60°F during the early morning hours to approximately 65-75°F during the mid-afternoon. Winds were light to moderate with speeds of 5-15 miles per hour during most of the monitoring period. Humidity was in the range of 20-100%.

Weather conditions during the Fall noise measurement period consisted of mostly overcast skies during the first portion of the week and clear skies toward the second portion of the week. Temperatures generally ranged from approximately 45-50°F during the early morning hours to approximately 55-80°F during the mid-afternoon, with a maximum of 93°F during the afternoon of October 23rd. Small amounts of precipitation occurred during the early portion of the week. Winds were light to moderate with speeds of 5-10 miles per hour during most of the monitoring period. Humidity was in the range of 50-100%.

## Noise Monitoring Locations:

Noise monitoring sites are described below. Site locations relative to the airport are shown in Figure 1.

Site 1 - This site was located in the backyard of a residence at 46 Buena Vista Drive, north of the airport. The site is exposed to aircraft noise from arrivals on Runway 20 and departures on Runway 02. The site is also exposed to vehicular traffic noise from Buena Vista Drive and Freedom Boulevard.

Site 2 - This site was located within a city-owned water tank property adjacent to the airport boundary. The site was located north of the approach to Runway 27. The site is exposed to noise from aircraft arrivals and departures on Runway 27 and aircraft making a downwind approach to Runway 20.

Site 3 - This site was located at a city-owned driving range south of the airport, and is surrounded by agricultural uses and open space. The site is exposed to noise from aircraft departures on Runway 20 and aircraft arrivals on Runway 02. The site is also exposed to noise from driving range maintenance activities, including pumping equipment near where the monitor was located.

Site 4 - This site was located south of the airport in land currently developed as agricultural. The site is exposed to noise from aircraft departures on Runway 20 and aircraft arrivals on Runway 02, and to periodic aircraft and helicopter over-flights.

Site 5 - This site was located in the backyard of the residence at 23 Magnolia Court, southeast of the airport. The site is exposed to aircraft over-flights and noise associated with touch-and-go operations on Runway 20. The site is also exposed to vehicular traffic on South Green Valley Road.

Site 6 - This site was located in the backyard of the residence at 119 B Roach Road, east of the airport. The site is exposed to noise from aircraft departures on runway 09 and aircraft arrivals on runway 27. Additionally, the site is exposed aircraft over-flights from arrival approach on runway 20.

Site 7 - This site was located in the backyard of the residence at 250 Fuchsia Drive, east of the airport. The site is exposed to noise from aircraft departures on runway 09 and aircraft arrivals on runway 27. Additionally, the site is exposed aircraft over-flights from arrival approach on runway 20.

Site 8 - This site was located in the backyard of the residence at 14 North Drive, west of the airport. The site is exposed to noise from aircraft arrivals on runway 09 and aircraft departures on runway 27. Additionally, the site is exposed aircraft noise from departures on runway 20 and aircraft overflights.

## Noise Monitoring Equipment:

Noise monitoring equipment 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 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 are programmed to distinguish between aircraft noise and noise from other sources using sound level and event duration thresholds. Typical noise measurement threshold settings for this study were 55-65 dBA for a minimum of 5 seconds. This means that the noise level had to equal or exceed the selected noise level threshold 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 the noise monitoring sites as defined by the CNEL metric. Shown by Table I is the energy average aircraft CNEL values for the entire Spring 2017 noise monitoring period and the range of daily CNEL values measured during the monitoring period. Shown by Table II is the energy average aircraft CNEL values for the entire Fall 2017 noise monitoring period and the range of daily CNEL values measured during the monitoring period.

The aircraft noise exposure values reported by Table I and Table II 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 to remove noise level data that were clearly not aircraft-related. This procedure may be relied upon to define aircraft noise exposure at locations 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 and Appendix D contain bar charts showing the *aircraft* and *community* (non-aircraft) CNEL values for each measurement day at the noise monitoring sites, for the Spring and Fall monitoring periods. Also shown by the bar charts are the *total* CNEL values for the measurement days. Community noise levels are determined by subtracting the aircraft CNEL from the total CNEL for a particular noise measurement day. This resulted in a relatively large difference between daily community and aircraft CNEL values at that site.

## TABLE I

## SUMMARY OF MEASURED AIRCRAFT CNEL VALUES
## WATSONVILLE MUNICIPAL AIRPORT
## SPRING 2017

| Site | Description | Dates | Measured Aircraft CNEL, dB[1] | |
|---|---|---|---|---|
| | | | Range | Mean |
| 1 | 46 Buena Vista Drive | 4/19/17-4/25/17 | 45.2-53.4 | 50.2 |
| 2 | City-owned water tank property | 4/19/17-4/25/17 | 36.9-50.6 | 43.9 |
| 3 | City-owned driving range | 4/19/17-4/25/17 | 54.9-60.8 | 58.3 |
| 4 | Agricultural Land | 4/19/17-4/25/17 | 50.8-56.8 | 52.4 |
| 5 | 24 Magnolia Court | 4/19/17-4/25/17 | 39.9-52.8 | 45.0 |
| 6 | 119 B Roach Road | 4/19/17-4/25/17 | 36.3-51.1 | 44.1 |
| 7 | 250 Fuchsia Drive | 4/19/17-4/25/17 | 41.7-50.1 | 46.2 |
| 8 | 14 North Drive | 4/19/17-4/25/17 | 37.4-45.3 | 42.3 |

[1]Shown are the range of daily aircraft CNEL values and the average aircraft CNEL for the entire noise measurement period.

Source: WJV Acoustics, Inc.

## TABLE II

## SUMMARY OF MEASURED AIRCRAFT CNEL VALUES
## WATSONVILLE MUNICIPAL AIRPORT
## FALL 2017

| Site | Description | Dates | Measured Aircraft CNEL, dB[1] | |
|---|---|---|---|---|
| | | | Range | Mean |
| 1 | 46 Buena Vista Drive | 10/17/17-10/23/17 | 41.4-57.2 | 49.2 |
| 2 | City-owned water tank property | 10/17/17-10/23/17 | 42.3-51.2 | 46.5 |
| 3 | City-owned driving range | 10/17/17-10/23/17 | 56.4-57.7 | 57.0 |
| 4 | Agricultural Land | 10/17/17-10/23/17 | 47.2-53.4 | 49.4 |
| 5 | 24 Magnolia Court | 10/17/17-10/23/17 | 41.1-47.3 | 44.9 |
| 6 | 119 B Roach Road | 10/17/17-10/23/17 | 38.9-57.7 | 44.9 |
| 7 | 250 Fuchsia Drive | 10/17/17-10/23/17 | 37.0-45.2 | 42.0 |
| 8 | 14 North Drive | 10/17/17-10/23/17 | 40.4-48.5 | 44.3 |

[1]Shown are the range of daily aircraft CNEL values and the average aircraft CNEL for the entire noise measurement period.

Source: WJV Acoustics, Inc.

## Single Event Noise Level Measurements:

Appendix E (Spring) and Appendix F (Fall) summarize the results of detailed single event noise level measurements at the noise monitoring sites. Detailed single event monitoring consisted of placing a trained observer at each site for approximately four (4) hours to record the type of aircraft, type of operation (arrival, departure or overflight), runway used, maximum noise level ($L_{max}$), sound exposure level (SEL) and azimuth for each observed flight. The azimuth is the angle between the aircraft flight path and the microphone at the point where the aircraft is closest to the microphone. An azimuth of 90º means the aircraft passed directly over the microphone.

The mean ($L_{max}$) values shown in Appendix E and Appendix F 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 number than the ($L_{max}$) for the same event because the SEL consolidates the energy of the entire noise event into a reference duration of one second. The SEL is not "heard", but is a derived value used for calculation of cumulative aircraft noise exposure as defined by the CNEL.

# III. PREPARATION OF CNEL CONTOURS

Aircraft noise exposure contours were prepared for the Watsonville Municipal Airport using the FAA Aviation Environmental Design Tool (AEDT2d) and aircraft operations data provided by the findings of the Watsonville Municipal Airport Operations Study (American Aviation Professionals, Inc.). As required by the State of California, contours were prepared in terms of the annual average CNEL. CNEL contours were prepared for existing (2016) and forecast future (2036) conditions.

## The Aviation Environmental Design Tool:

The AEDT was developed for the FAA and represents the federally sanctioned and required method for quantifying aircraft noise exposure for noise compatibility planning purposes. Version 2d is the current version of the AEDT.

The AEDT calculates aircraft noise exposure by mathematically combining aircraft noise levels and airport operations factors at a series of points within a cartesian coordinate system which defines the locations of airport runways and generalized aircraft flight tracks. The model then interpolates between points to plot contours of equal noise exposure. User inputs to the AEDT include the following:

- Runway configuration
- Aircraft flight track definitions
- Distribution of aircraft to flight tracks
- Aircraft traffic volume and fleet mix
- Temporal distribution of flights (day, evening or night)

The AEDT database includes aircraft performance parameters and noise level data that may be used to model noise from operations by most of the civilian fixed-wing aircraft and helicopters presently in service at U.S. airports. When a user specifies an aircraft type from the AEDT database, the model provides the necessary inputs concerning aircraft power settings, speed, departure profiles and noise levels. In its present form, the AEDT accounts for changes in the distance from a receptor to an aircraft noise source (slant range distance) due to variations in local terrain. The AEDT does *not* take into account reflections from nearby buildings or acoustical shielding caused by buildings or vegetation that may surround an airport.

## Noise Modeling Assumptions:

Airport operations data were obtained from a study performed on behalf of the City of Watsonville by American Aviation Professionals, Inc. (AAP) that counted aircraft operations using specialized cameras at strategic locations on the airfield. The study, entitled *Watsonville Municipal Airport Aircraft Operations Data, February 1, 2013-January 31, 2018*, included counts

of aircraft operations by type of aircraft, runway used and time of day. Total annual aircraft operations counts over the study period ranged from 41,000 in 2016-17 to 58,564 in 2015-2016. WJVA selected the highest aircraft operations count during the 5-year study period to represent existing conditions at the airport. The period of time selected was the 12-month period ending January 31, 2016.

Table III summarizes the airport operations data utilized to prepare CNEL contours for existing (2016) and forecast future (2036) conditions and the aircraft types selected by WJVA from the AEDT Version 2d database. Forecast future aircraft operations were estimated from the expected 20-year increase in aviation activity at the airport as summarized in the Airport Master Plan. The AEDT aircraft types selected for noise modeling include the GASEPV and GASEPF (for variable- and fixed-pitch single propeller aircraft, respectively), BEC58P (for twin propeller-driven aircraft), DHC6 (for twin turboprop aircraft), the CNA55B and LEAR35 (for jet aircraft), and the R22 (for helicopters).

**TABLE III**

**ASSUMED ANNUAL AIRCRAFT OPERATIONS**
**WATSONVILLE MUNICIPAL AIRPORT**

| Aircraft Category | AEDT Aircraft Designation | Year | |
|---|---|---|---|
| | | 2016 | 2036 |
| Single engine propeller | GASEPF/GASEPV | 47,120 | 53,527 |
| Multi-engine propeller | BEC58P | 1510 | 1764 |
| Helicopter | R22 | 6284 | 8358 |
| Turboprop | DCH6/CNA208 | 2054 | 3451 |
| Turbine (Jet) | CNA55B/LEAR35 | 1596 | 3416 |
| **Totals** | | **58,564** | **70,516** |

Sources: City of Watsonville
AAP, Inc.
WJV Acoustics, Inc.

Annual average runway use is summarized in Table IV. On an annual average basis, most flights take off and land in a southerly direction on Runway 20. The crosswind runway (09-27) is used only by smaller propeller-driven aircraft.

**TABLE IV**

**ANNUAL AVERAGE RUNWAY USE ASSUMPTIONS**
**WATSONVILLE MUNICIPAL AIRPORT**

| | Takeoffs | | Landings | | Touch-and-Go |
|---|---|---|---|---|---|
| Runway | Jet/ Turboprop | Propeller/ Helicopters | Jet/ Turboprop | Propeller/ Helicopters | Single-Eng. Prop. |
| 02 | 10% | 8.0% | 10% | 8.0% | -0- |
| 20 | 90% | 85.9% | 90% | 85.9% | 90% |
| 09 | -0- | 1.7% | -0- | 1.7% | -0- |
| 27 | -0- | 4.4% | -0- | 4.4% | 10% |

Sources: City of Watsonville
AAP, Inc.
WJV Acoustics, Inc.

The temporal distribution of aircraft operations assumed for noise modeling is summarized in Table V. The temporal distribution of flights is an important factor in the determination of the CNEL since evening and nighttime flights are weighted to account for increased sensitivity to noise during those hours of the day.

**TABLE V**

**TEMPORAL DISTRIBUTION OF FLIGHTS**
**WATSONVILLE MUNICIPAL AIRPORT**

| Aircraft Type | Time of Day | | |
|---|---|---|---|
| | Day (7a-7p) | Evening (7p-10p) | Night (10p-7a) |
| Fixed-wing aircraft (except touch-and-go) | 94% | 4% | 2% |
| Touch-and-go | 95% | 5% | 0 |
| Helicopter | 95% | 5% | 0 |

Sources: City of Watsonville
AAP, Inc.
WJV Acoustics, Inc.

Generalized aircraft flight tracks were developed by WJVA for noise modeling purposes based upon field observations and information provided by airport staff. Figure 2 shows generalized departure tracks and Figure 3 shows generalized arrival and touch-and-go tracks. Generalized flight tracks do not represent all areas around the airport where over-flights could occur but rather the areas with the highest concentrations of aircraft over-flights.

## CNEL Contours:

The operations data summarized above were used to calculate the location of annual average CNEL contours using the AEDT. Figure 4 shows CNEL contours of 60-75 dB for existing aircraft operations. Figure 5 depicts CNEL contours of 60-75 dB for aircraft operations forecast for the year 2036. CNEL contour areas are summarized in Table VI. The 60 dB CNEL contour is reported for informational purposes. The State of California and the FAA consider areas outside the CNEL 65 dB contour to have an acceptable aircraft noise exposure under normal conditions for noise compatibility planning purposes. However, areas within the 60 dB CNEL contour are exposed to aircraft over-flights and single event noise that may be clearly audible above other sources of ambient noise.

**TABLE VI**

**CNEL CONTOUR AREAS (SQUARE MILES/ACRES)**
**WATSONVILLE MUNICIPAL AIRPORT**

| Contour | 2016 | 2036 |
|---|---|---|
| CNEL 60 | 0.335/214 | 0.417/267 |
| CNEL 65 | 0.155/99 | 0.191/122 |
| CNEL 70 | 0.063/40 | 0.080/51 |
| CNEL 75 | 0.020/13 | 0.026/17 |

Source: WJV Acoustics, Inc.

# IV. COMPARISON OF PRESENT AND PREVIOUS AIRCRAFT NOISE STUDIES

Table VII compares measured aircraft CNEL values from the May 2013 and May 2015 noise monitoring period to those obtained during the April 2017 and October 2017 noise monitoring periods. It should be noted that a new location was selected for Site 4 during the 2017 noise monitoring periods, therefore a comparison of Site 4 data to previous (May 2013 and May 2015) noise monitoring periods is not provided.

Reference to Table VII indicates that aircraft noise levels at Site 2 during the April 2017 measurement period were 3-6 dB lower than noise levels measured during the previous measurement periods as well as the October 2017 measurement period. Noise levels at Site 1 have fluctuated within a range of approximately 3 dB, at Site 2 within a range of approximately 6 dB and at Site 3 within a range of less than 2 db, and at Site 5 by approximately 2 dB over the four monitoring periods. In general, aircraft noise levels have remained somewhat comparable between 2013 and 2017. At all 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 VII**

**COMPARISON OF MEASURED AIRCRAFT CNEL VALUES**
**2013, 2015 and 2017**
**WATSONVILLE MUNICIPAL AIRPORT**

| Site | Measured Aircraft CNEL, dB | | | | |
|---|---|---|---|---|---|
| | Location | May 2013 Mean (Range) | May 2015 Mean (Range) | April 2017 Mean (Range) | October 2017 Mean (Range) |
| 1 | 46 Buena Vista Drive | 52.5 (49.2-57.6) | 50.0 (45.9-52.2) | 50.2 (45.2-53.4) | 49.2 (41.4-57.2) |
| 2 | City-owned water tank property | 49.7 (42.1-55.1) | 46.6 (40.8-53.4) | 43.9 (36.9-50.6) | 46.5 (42.3-51.2) |
| 3 | City-owned driving range | 57.1 (53.9-59.2) | 56.5 (55.5-57.7) | 58.3 (54.9-60.8) | 57.0 (56.4-57.7) |
| 4 | Agricultural Land | -- | -- | 52.4 (50.8-56.8) | 49.4 (47.2-53.4) |
| 5 | 24 Magnolia Court | -- | 42.9 (41.1-46.4) | 45.0 (39.9-52.8) | 44.9 (41.1-47.3) |
| 6 | 119 B Roach Road | -- | -- | 44.1 (36.3-51.1) | 44.9 (38.9-57.7) |
| 7 | 250 Fuchsia Drive | -- | -- | 46.2 (41.7-50.1) | 42.0 (37.0-45.2) |
| 8 | 14 North Drive | -- | -- | 42.3 (37.4-45.3) | 44.3 (40.4-48.5) |

Source: WJV Acoustics, Inc.

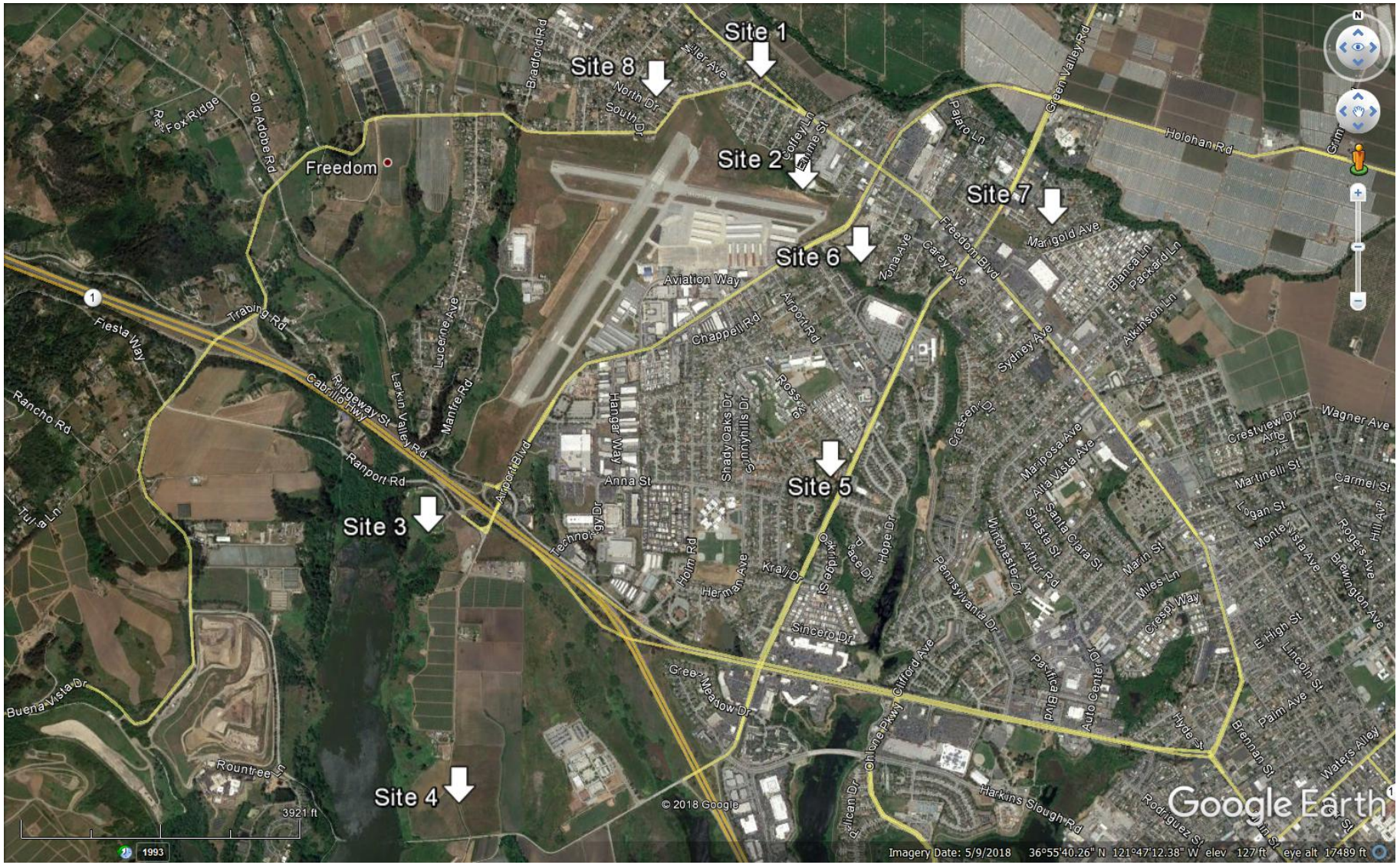
Changes in aircraft noise exposure may be expected over time due to fluctuations in the volume of aircraft operations, the aircraft fleet mix and runway use. Also, aircraft operators have introduced newer technology aircraft and older-technology aircraft have been retired, resulting in a generally quieter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

# V. DAILY FLUCTUATIONS IN AIRCRAFT AND COMMUNITY NOISE

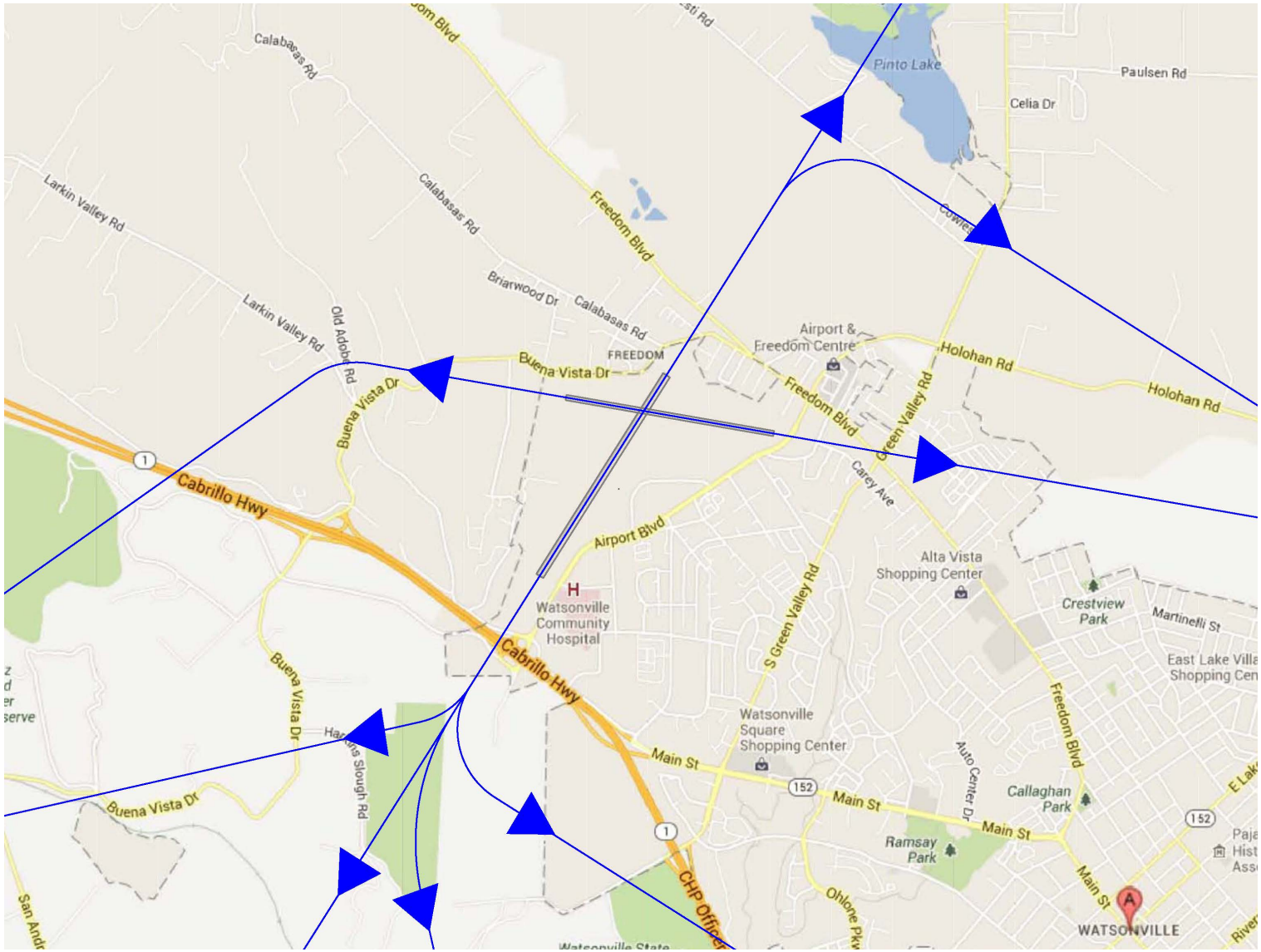
Appendix G provides measured hourly noise levels for each of the eight monitoring sites over each day of the monitoring periods. For each full 24-hour measurement period, Appendix G provides measurement day and hourly maximum ($L_{max}$), energy average ($L_{eq}$), and selected ($L_n$) values. $L_n$ values are statistical descriptors used to define noise levels exceeded "n" percent of the time during each hourly noise measurement period. For example, the $L_{50}$ defines the noise level exceeded 50 percent of the time during each one-hour period (i.e. 30 minutes). The $L_{90}$ describes the noise level exceeded 90 percent of the time during each hour, which is generally considered to represent the residual (or background) noise level in the absence of identifiable single noise events from traffic, aircraft and other local noise sources.

Data provided in Appendix G indicates that existing background (ambient) noise levels at Site 1, Site 3 and Site 5 are typically around 50 dB during the daytime hours, while background noise levels at Site 2, Site 4, Site 6, Site 7 and Site 8 are typically around 40 dB during daytime hours. Site 1, Site 3 and Site 5 are exposed to vehicle traffic noise on local roadways, resulting in generally higher background noise levels that remaining sites, which are not exposed to ongoing local roadway traffic noise.

## FIGURE 1: AIRCRAFT NOISE MONITORING SITES



## FIGURE 2: GENERALIZED DEPARTURE TRACKS



## FIGURE 3: GENERALIZED ARRIVAL TRACKS

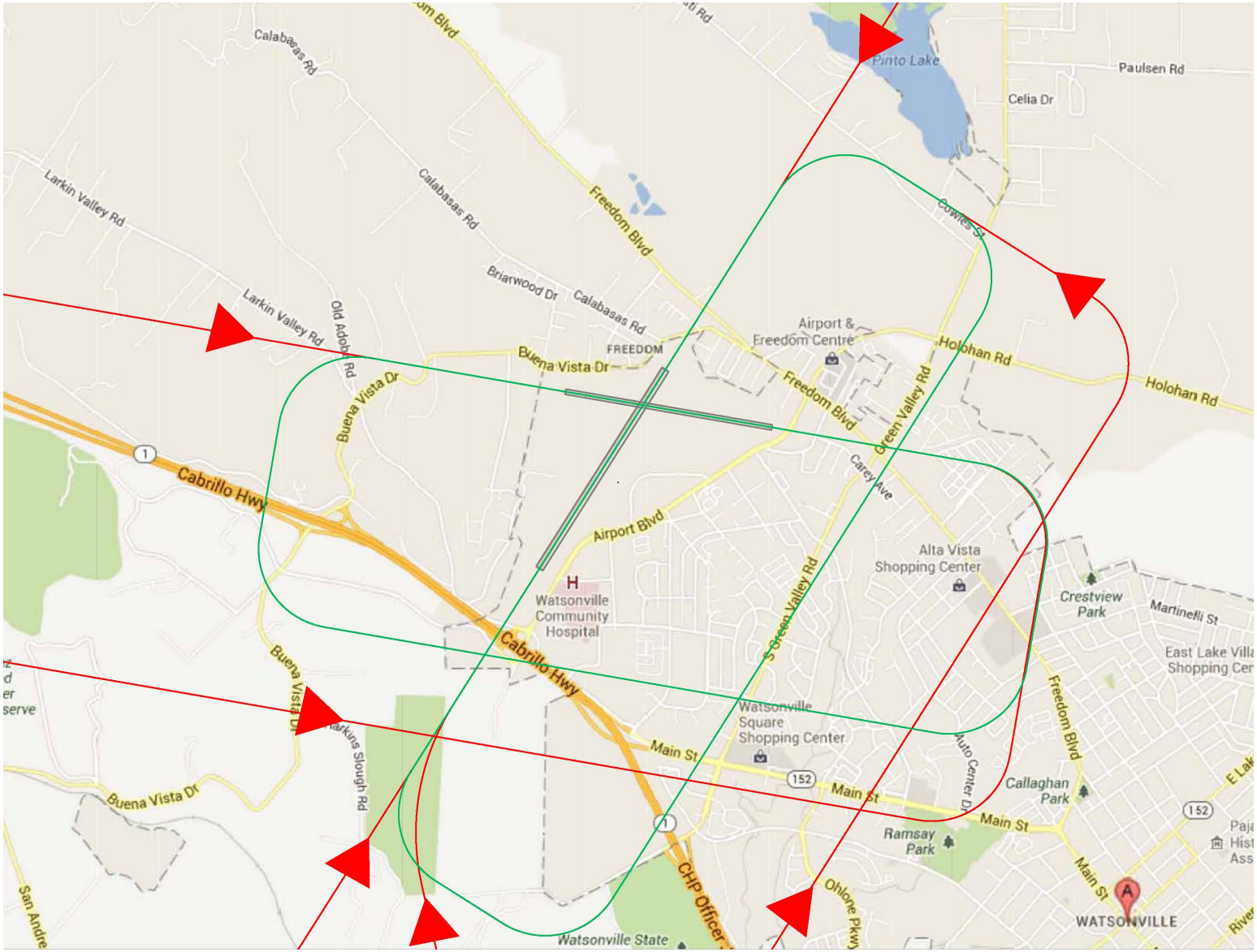


**FIGURE 3: 2016 CNEL CONTOURS**

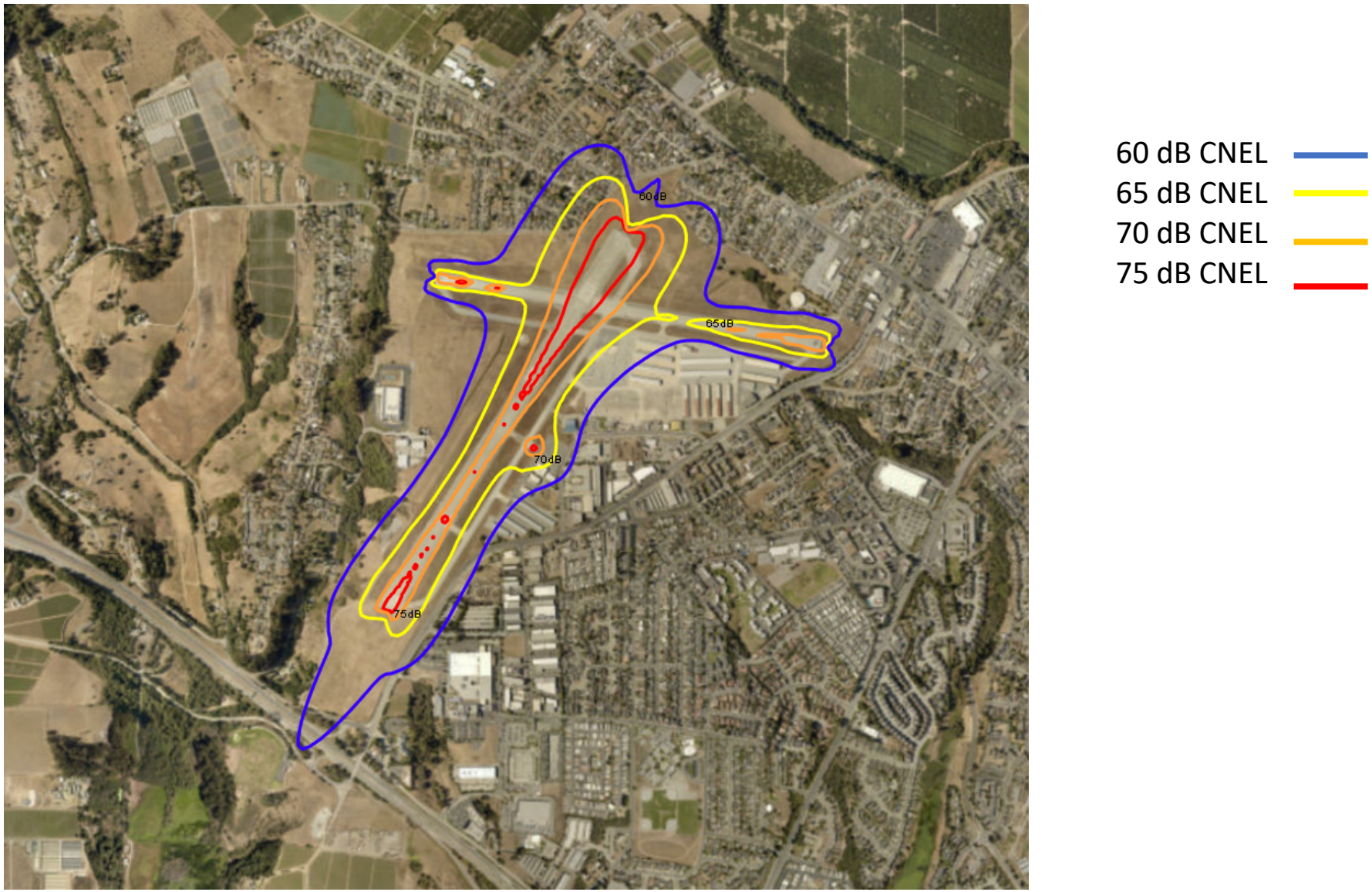
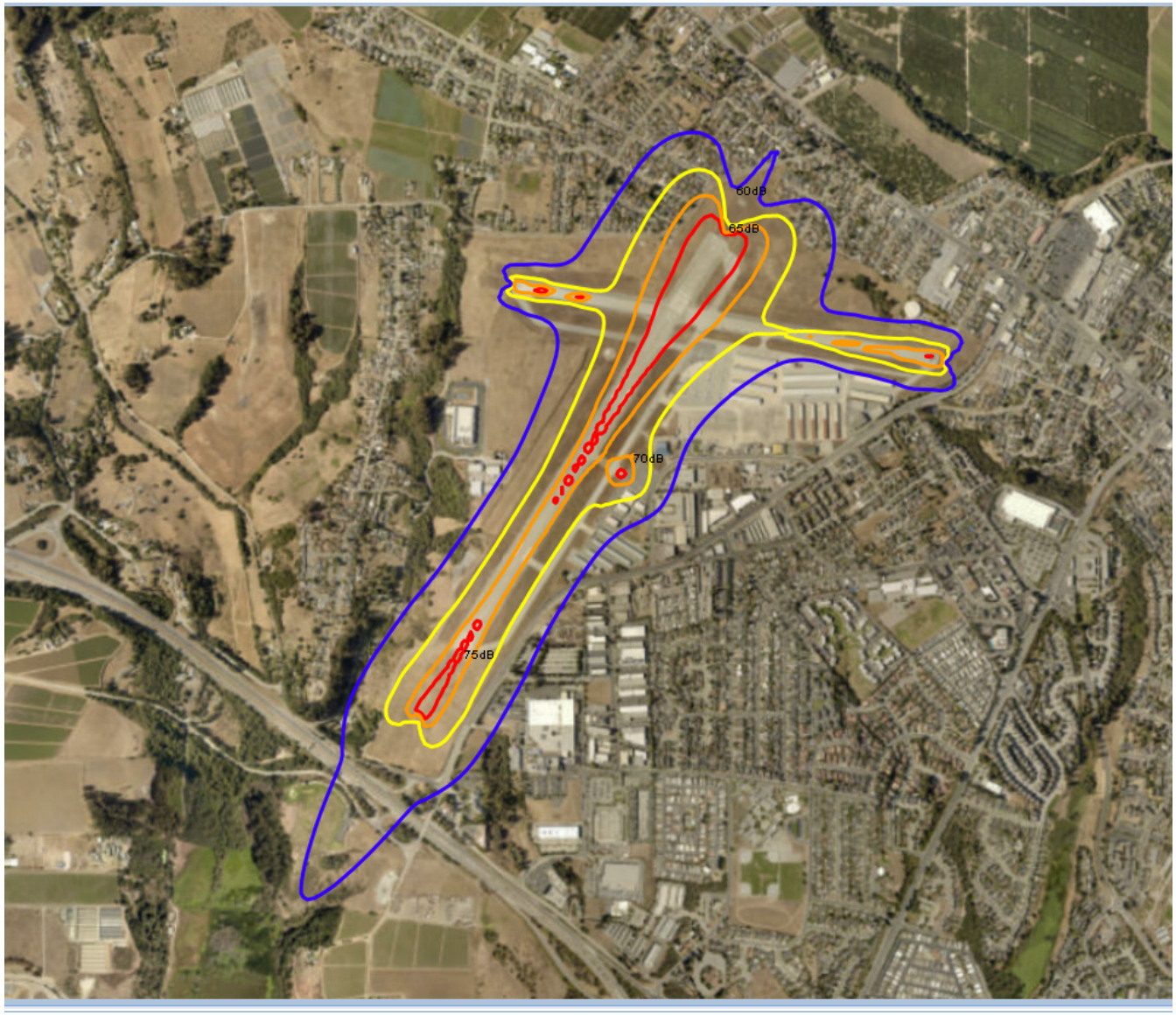


**FIGURE 4: 2036 CNEL CONTOURS**



# APPENDIX A

# ACOUSTICAL TERMINOLOGY

## APPENDIX A-1

## ACOUSTICAL TERMINOLOGY

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

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

**CNEL:** Community Noise Equivalent Level. The average equivalent sound level during a 24-hour day, obtained after addition of 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 from 10:00 p.m. to 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 represents daily levels of noise exposure averaged on an annual basis, while the $L_{eq}$ represents the average noise exposure for a shorter time period, typically one hour.*

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

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

**NOISE EXPOSURE CONTOURS:** Lines drawn about a noise source indicating equal levels of noise exposure. CNEL contours are frequently utilized to describe community exposure to noise for noise compatibility planning.

## APPENDIX A-2

## ACOUSTICAL TERMINOLOGY

**SEL or SENEL:** Sound Exposure Level or Single Event Noise Exposure Level. The level of noise accumulated during a single noise event, such as an aircraft 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.

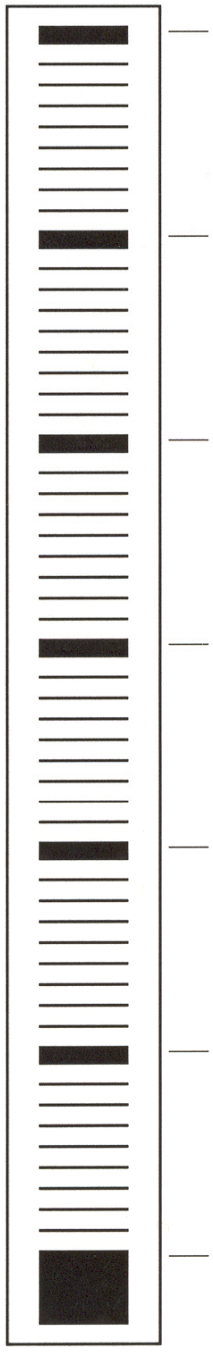
**SOUND LEVEL:** The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation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

# APPENDIX B

# EXAMPLES OF SOUND LEVELS

# APPENDIX B
## EXAMPLES OF SOUND LEVELS

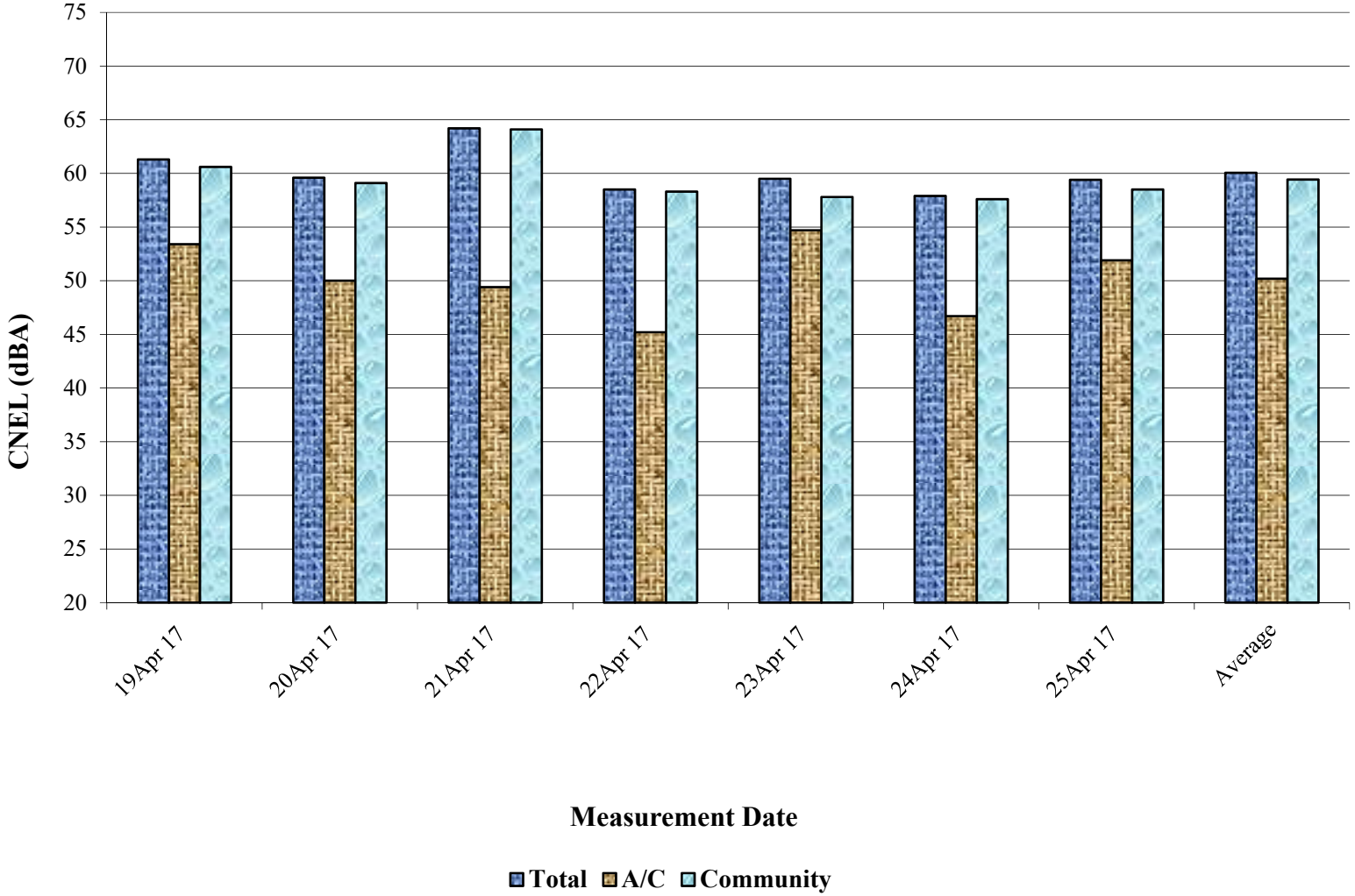
| NOISE SOURCE | SOUND LEVEL | SUBJECTIVE DESCRIPTION |
|---|---|---|
| AMPLIFIED ROCK 'N ROLL ▸ | 120 dB | |
| JET TAKEOFF @ 200 FT ▸ | | DEAFENING |
| | 100 dB | |
| BUSY URBAN STREET ▸ | | VERY LOUD |
| | 80 dB | |
| FREEWAY TRAFFIC @ 50 FT ▸ | | LOUD |
| CONVERSATION @ 6 FT ▸ | 60 dB | |
| TYPICAL OFFICE INTERIOR ▸ | | MODERATE |
| SOFT RADIO MUSIC ▸ | 40 dB | |
| RESIDENTIAL INTERIOR ▸ | | FAINT |
| WHISPER @ 6 FT ▸ | 20 dB | |
| HUMAN BREATHING ▸ | | VERY FAINT |
| | 0 dB | |



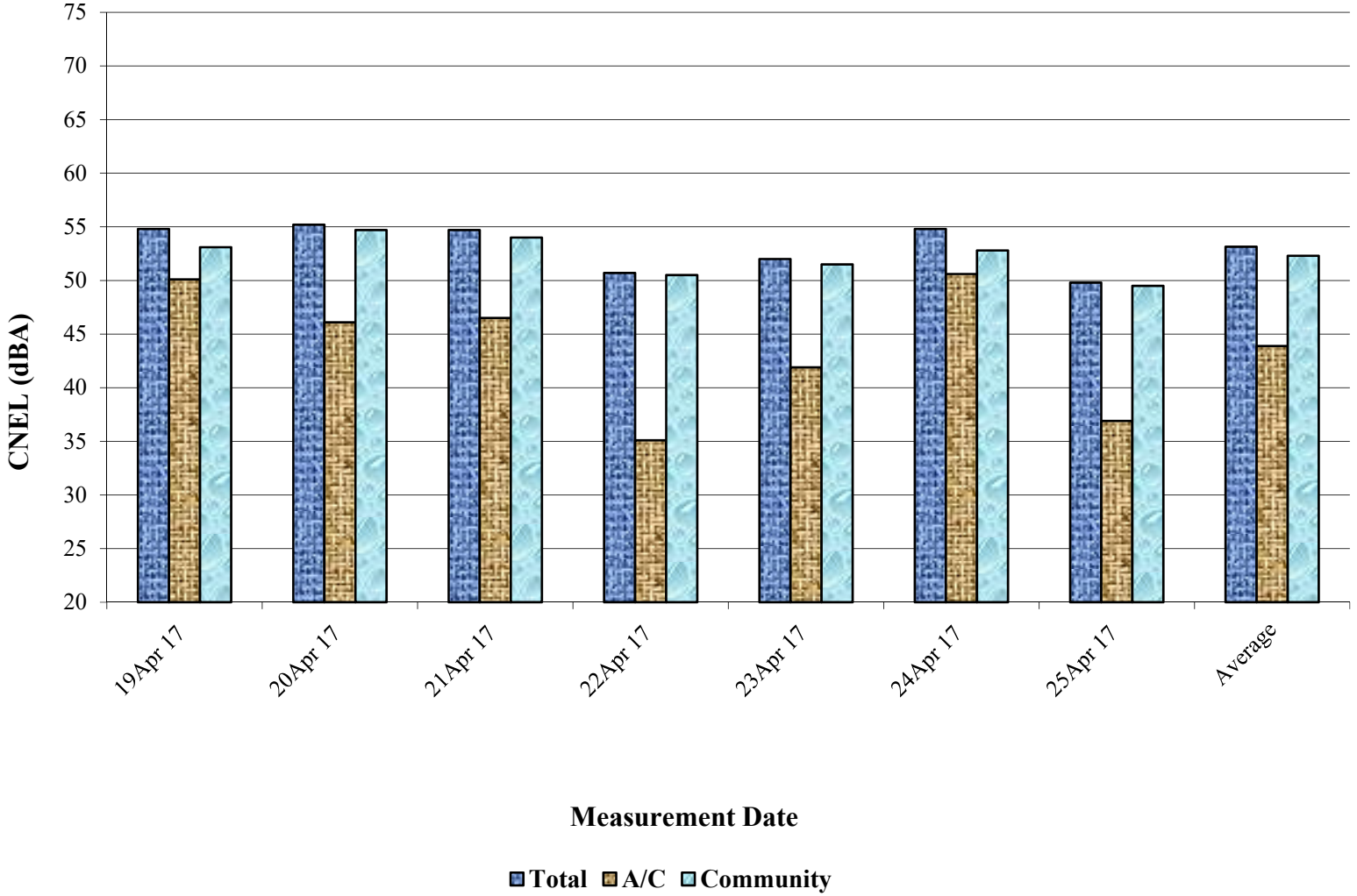
# APPENDIX C

# DAILY MEASURED CNEL VALUES
# APRIL 19-25, 2017

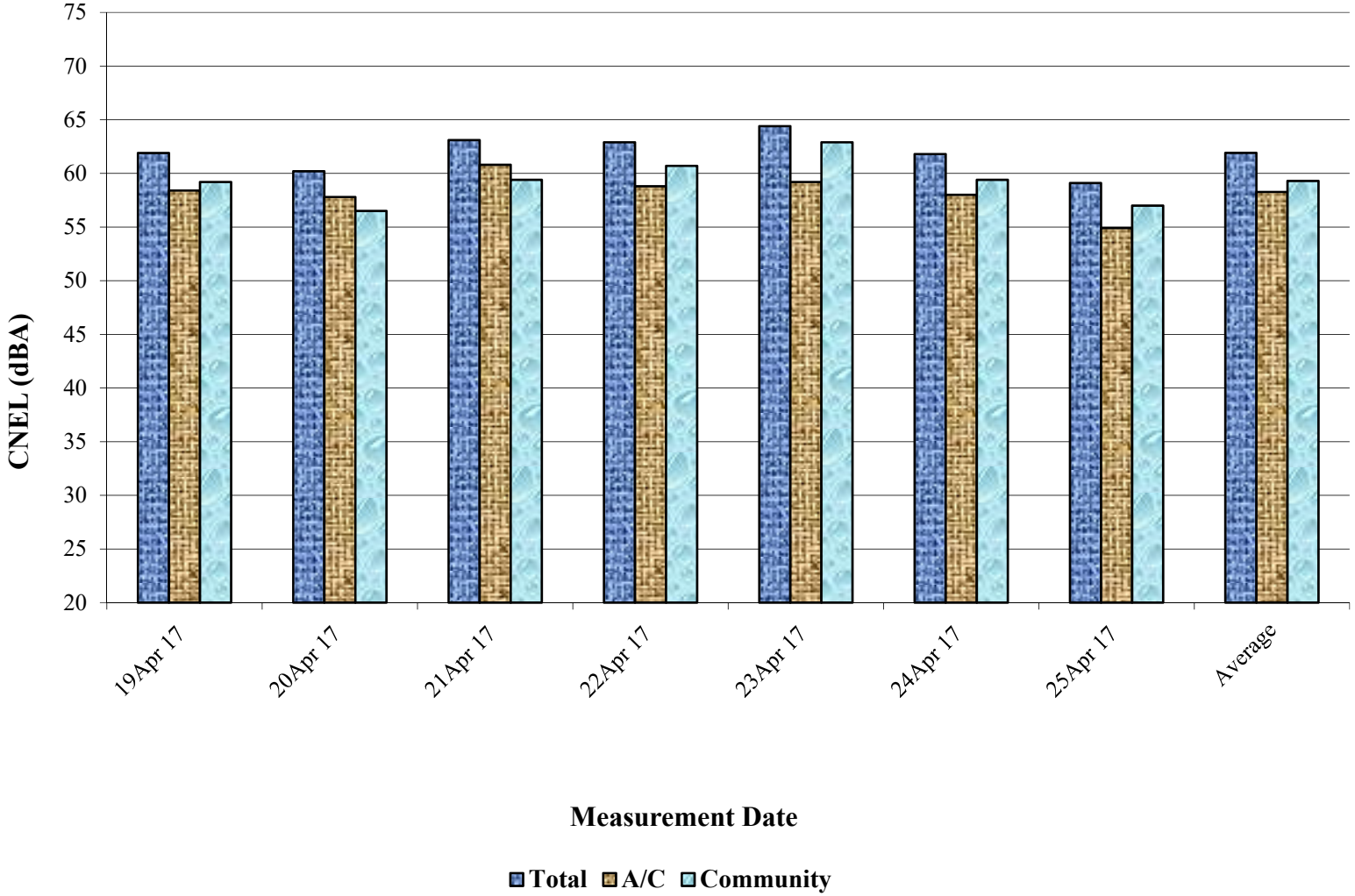
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 1: April 2017**



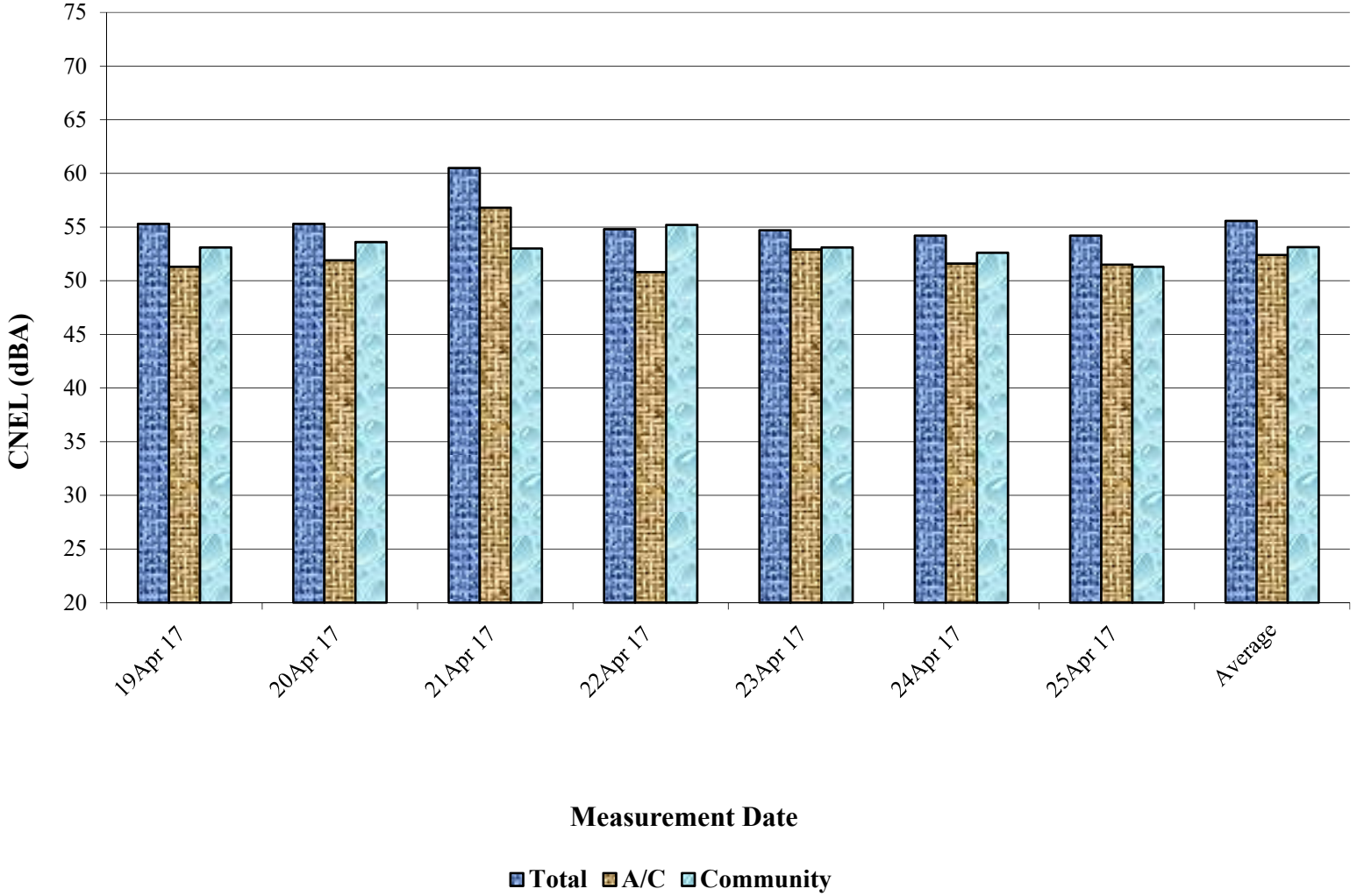
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 2: April 2017**



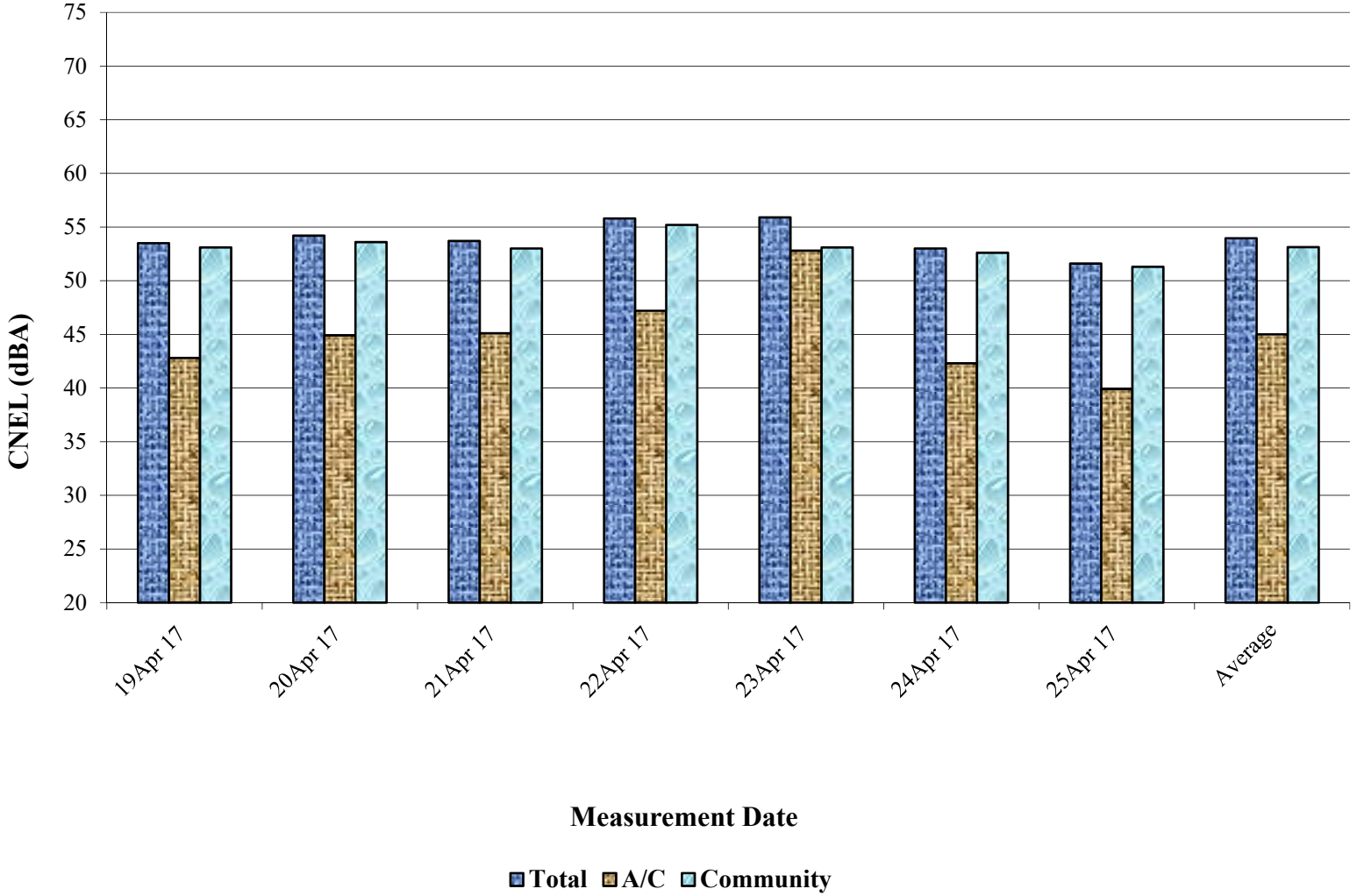
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 3: April 2017**



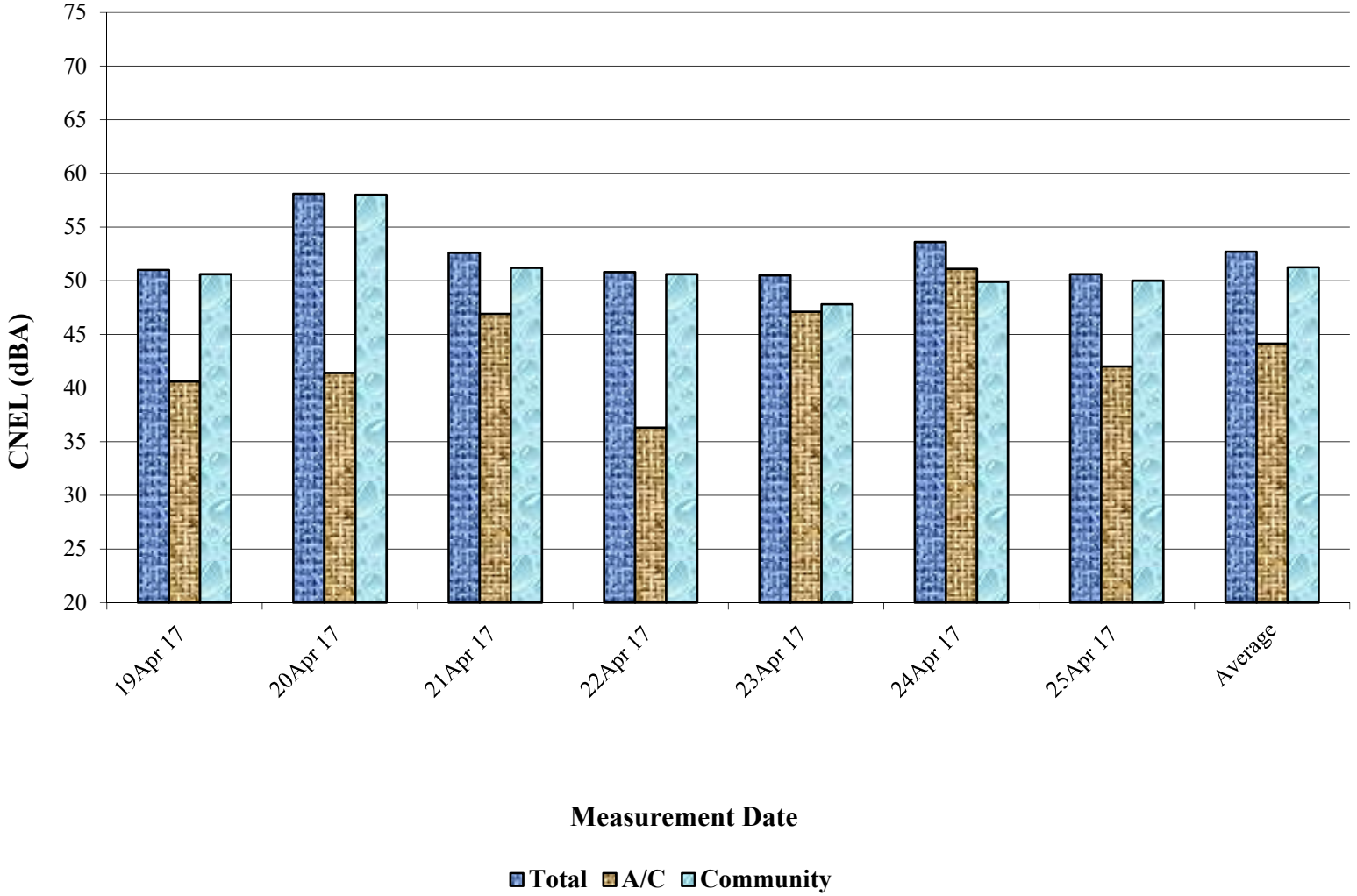
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 4: April 2017**



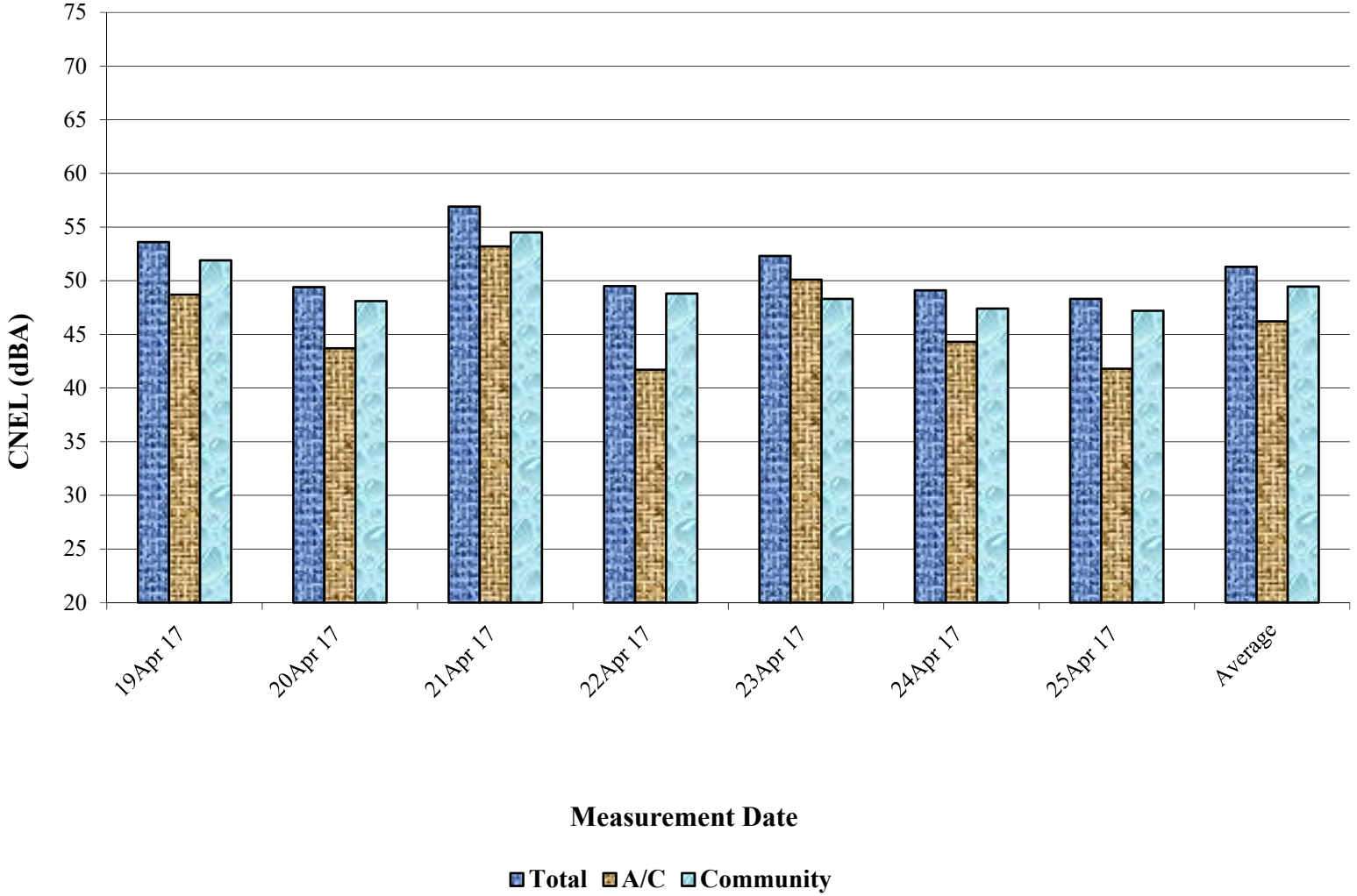
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 5: April 2017**



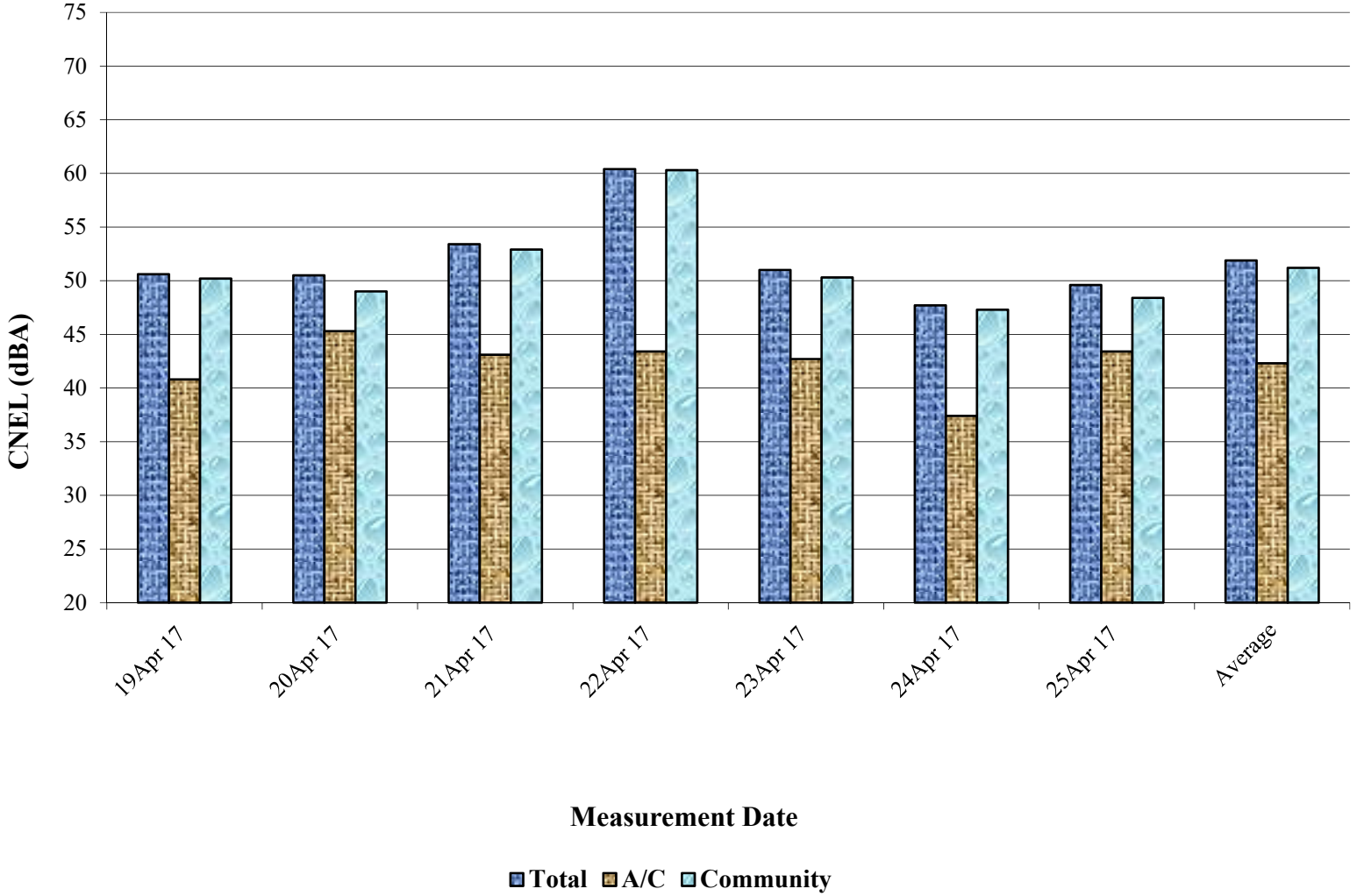
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 6: April 2017**



**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 7: April 2017**



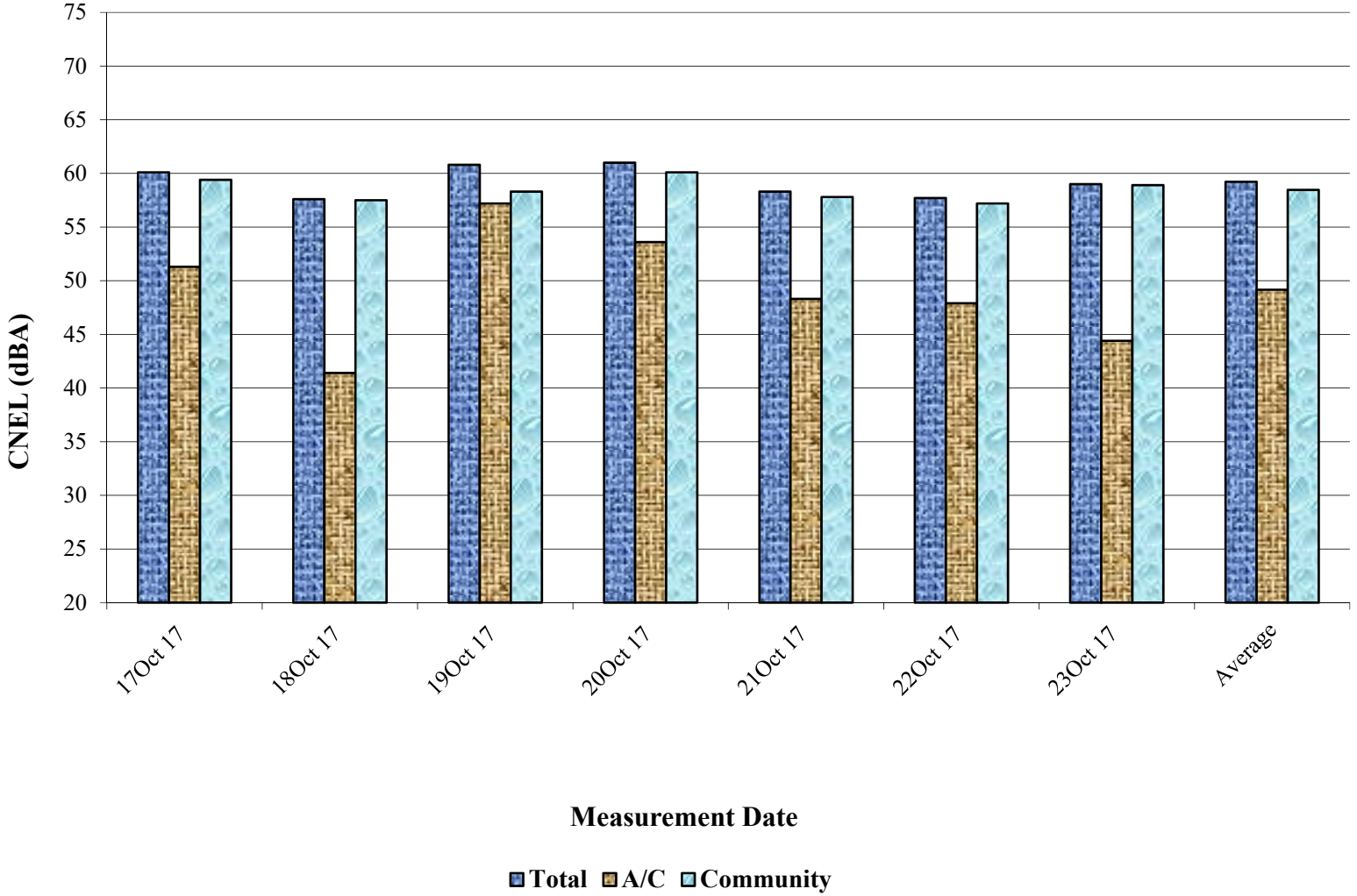
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 8: April 2017**



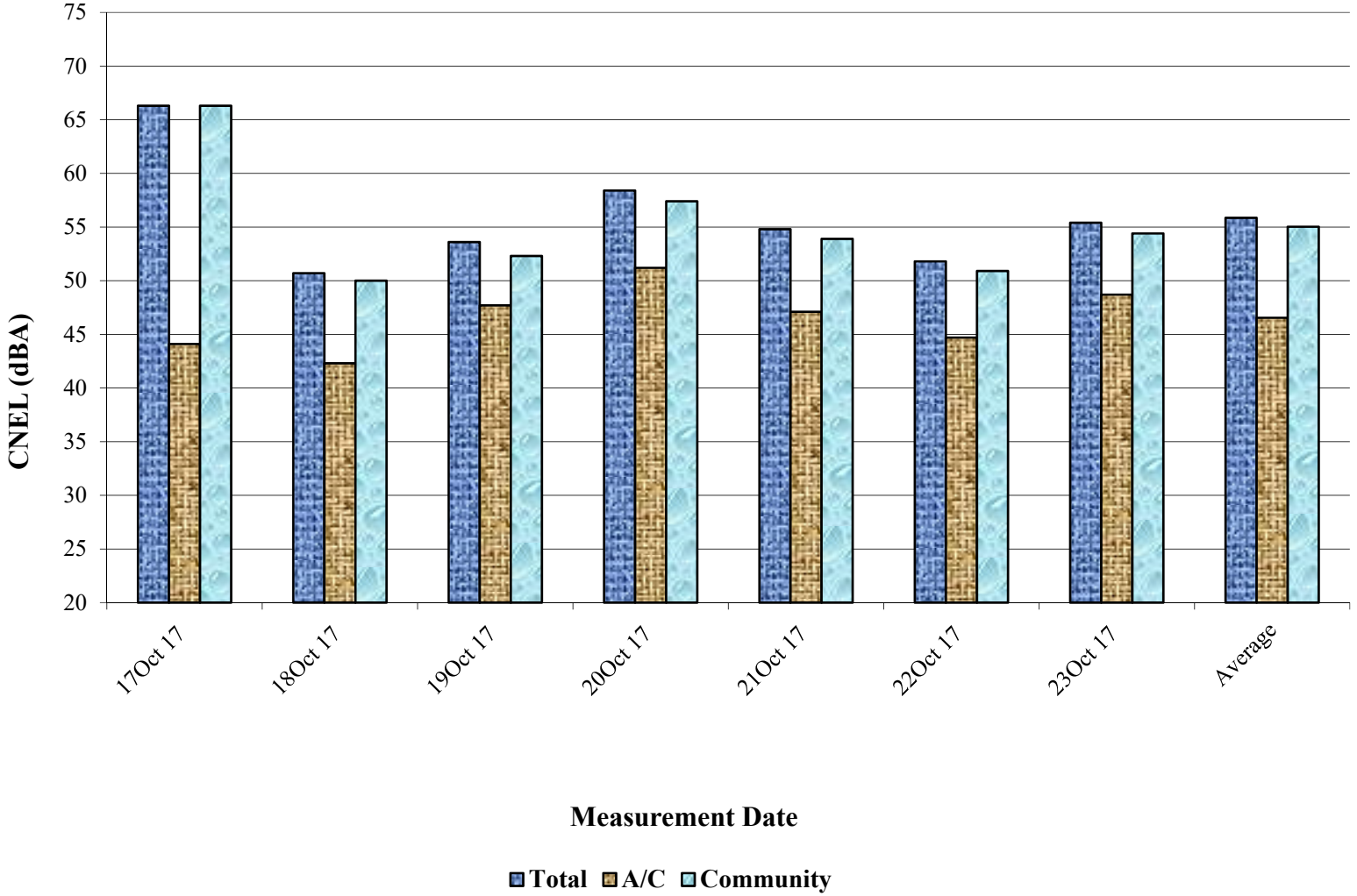
# APPENDIX D

# DAILY MEASURED CNEL VALUES
# OCTOBER 17-23, 2017

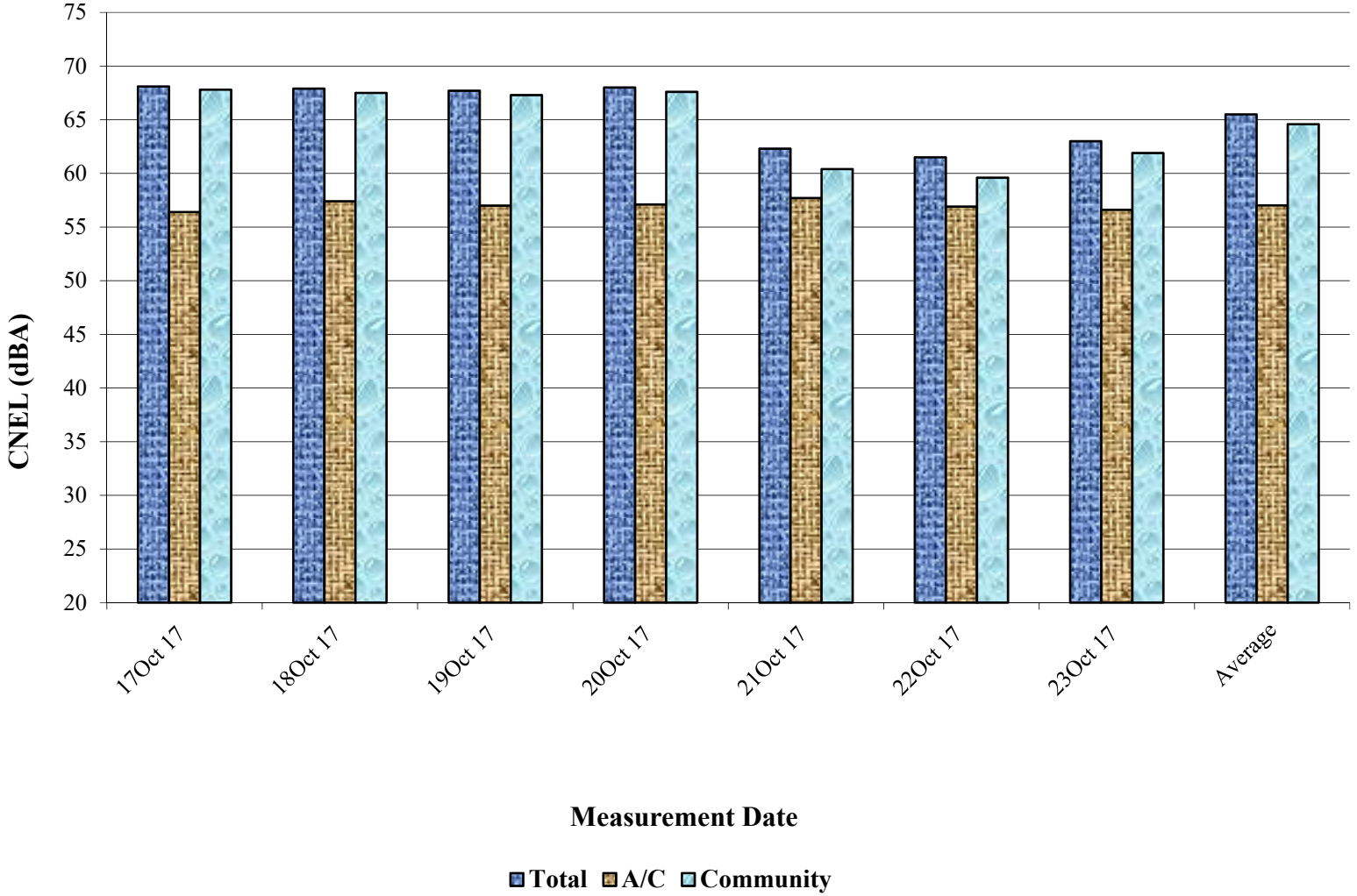
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 1: October 2017**



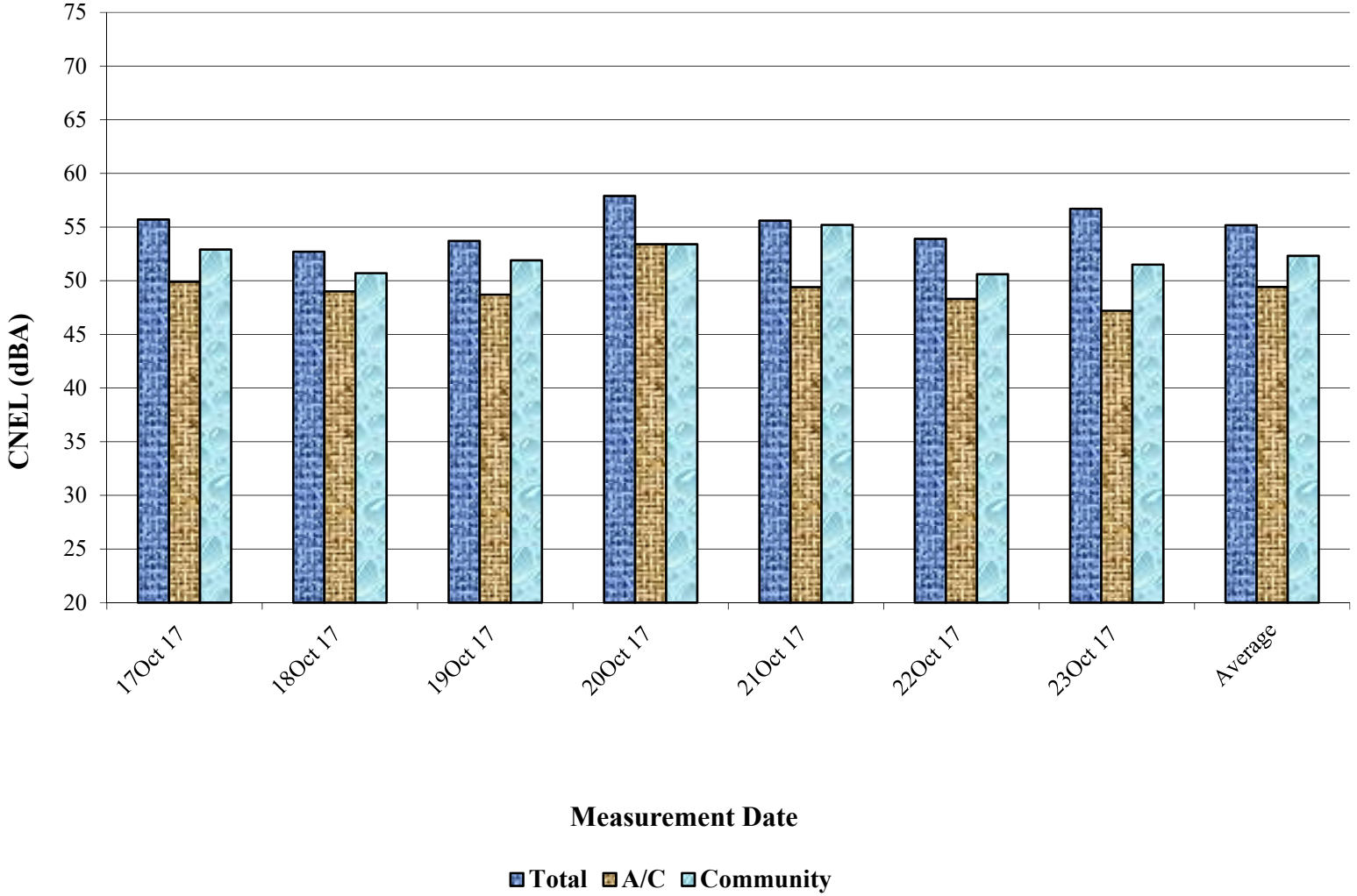
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 2: October 2017**



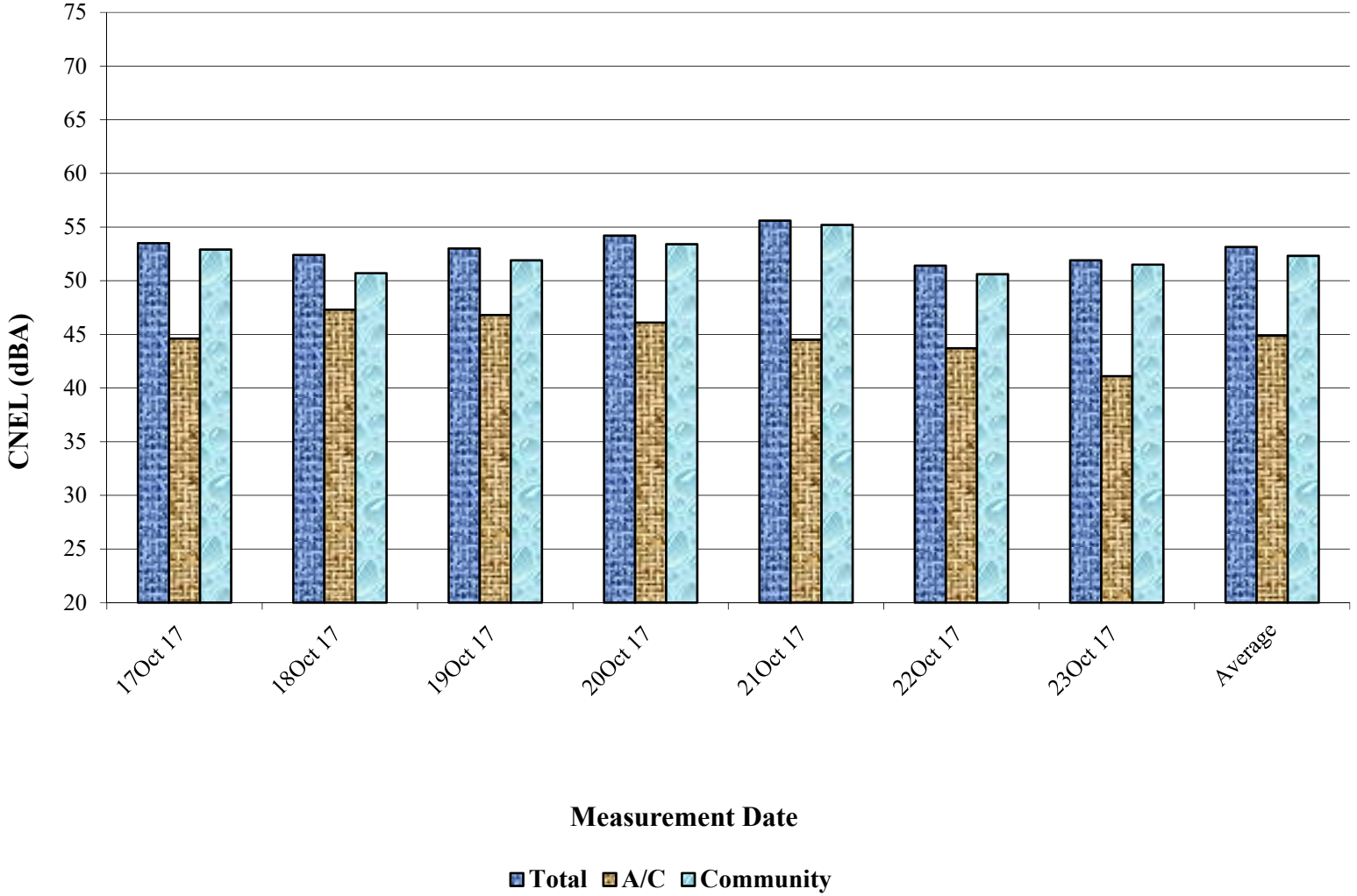
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 3: October 2017**



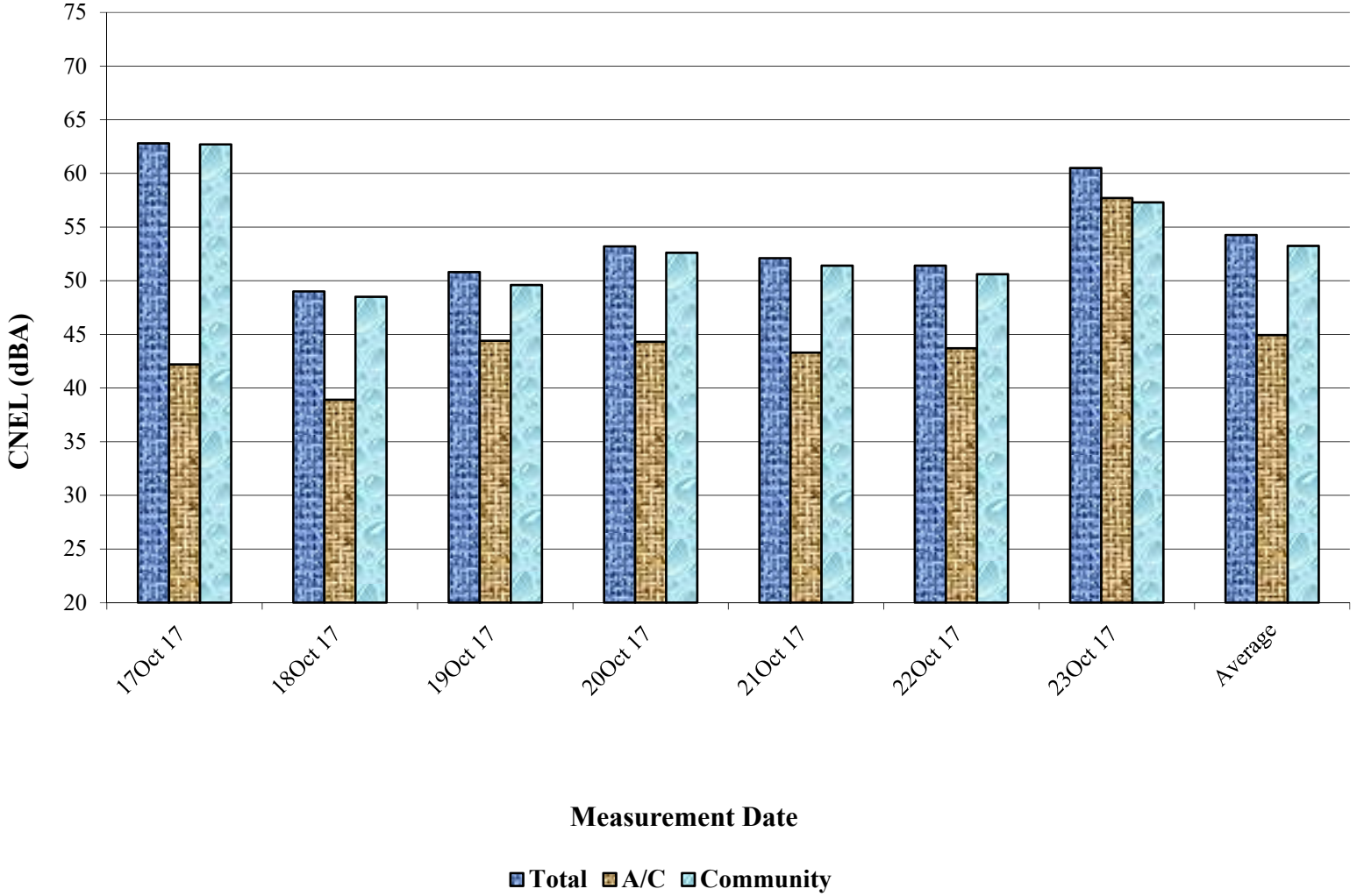
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 4: October 2017**



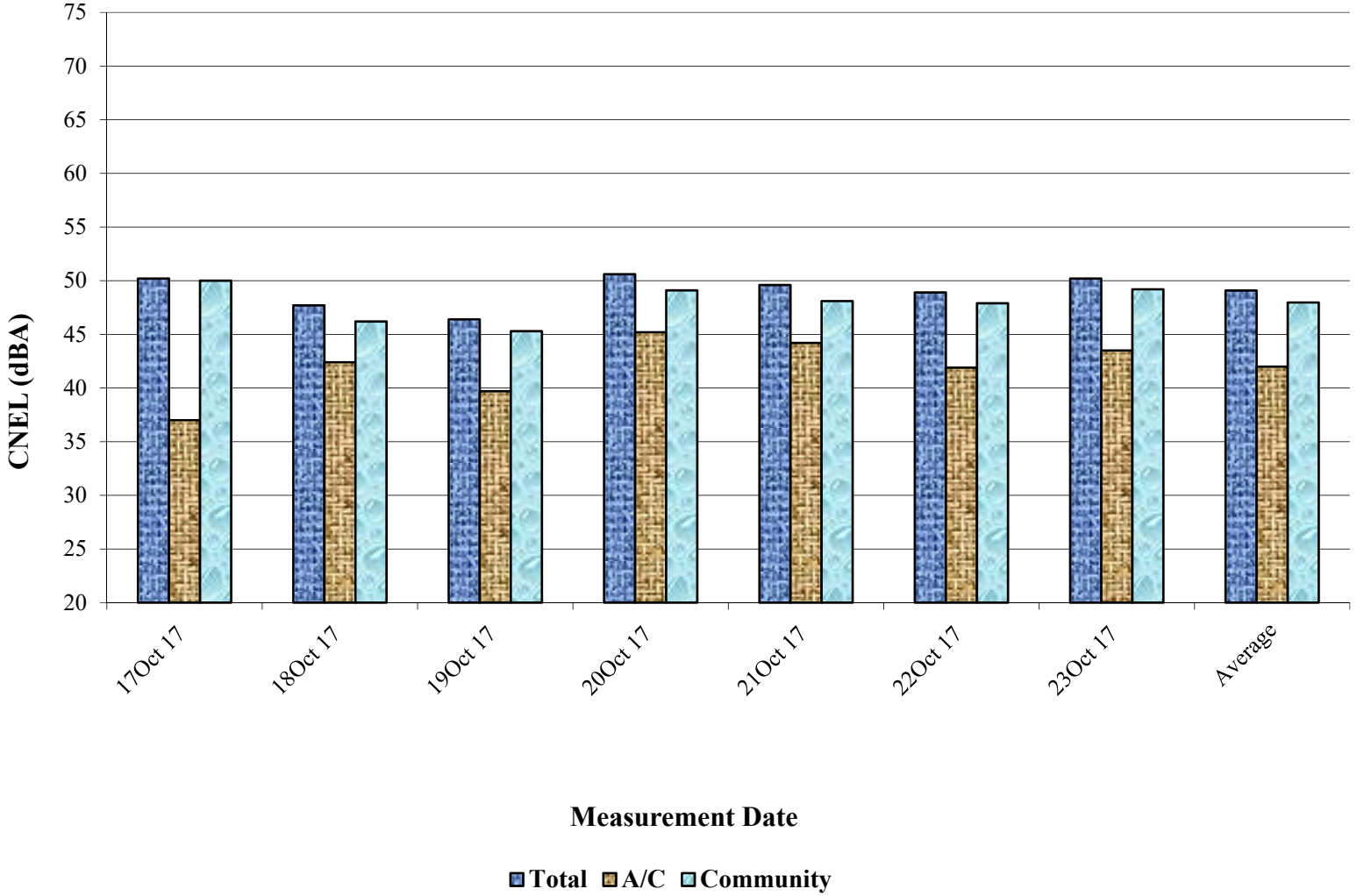
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 5: October 2017**



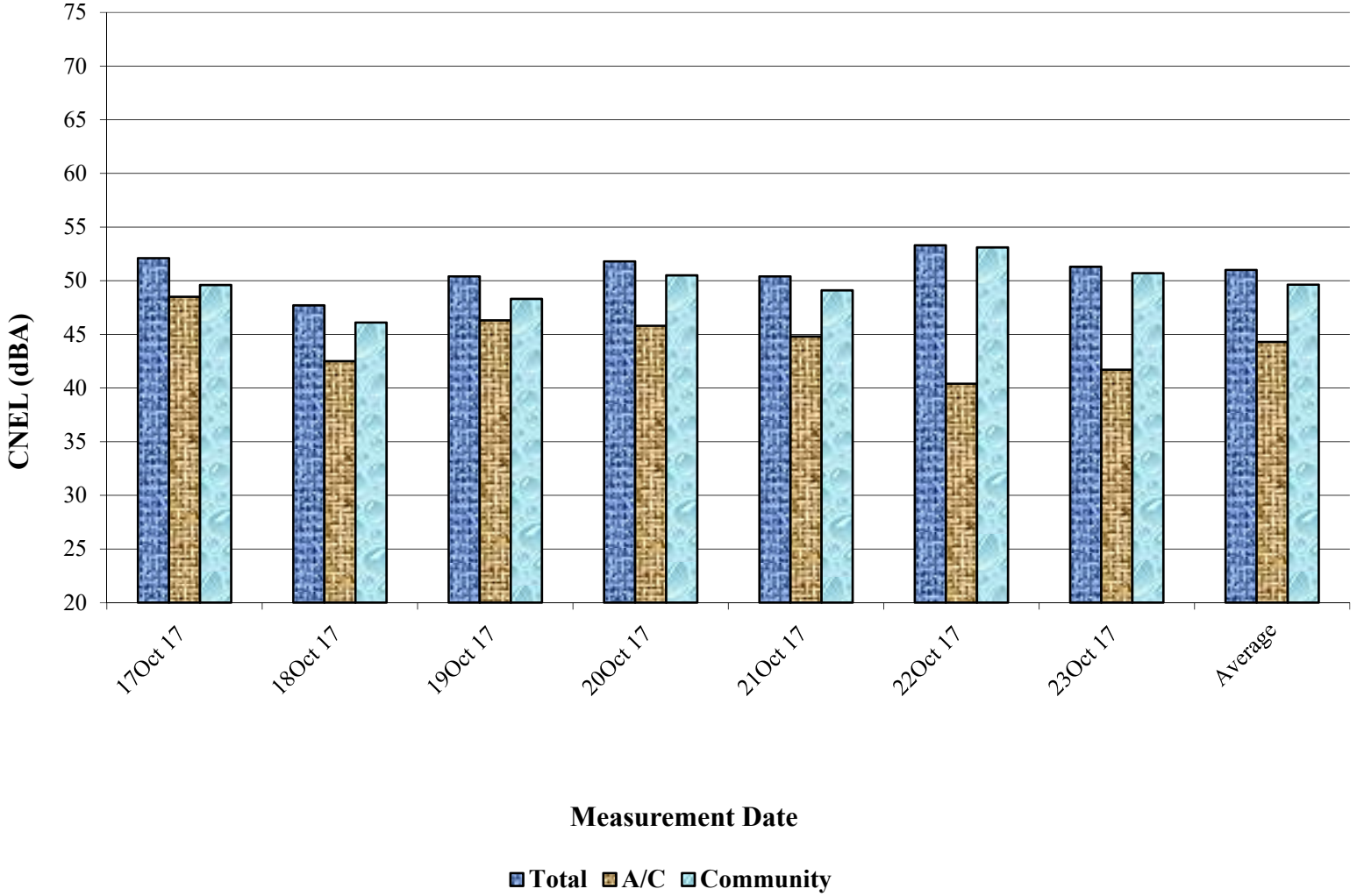
**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 6: October 2017**



**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 7: October 2017**



**Daily Measured CNEL Values**
**Watsonville Municipal Airport**
**Site 8: October 2017**



# APPENDIX E

# SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS
# APRIL 2017

**APPENDIX E**

**SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS**
**WATSONVILLE MUNICIPAL AIRPORT**
**APRIL 2017**

| Aircraft Type | Number Sampled | SEL, dBA Mean (Range) | Lmax, dBA Mean (Range) | Azimuth |
|---|---|---|---|---|
| **Site 1 - Arrivals on Runway 20 (4/26/17)** | | | | |
| Single Engine Prop. | 9 | 72.1 (64.9-76.1) | 61.8 (55.3-69.4) | 30°NW-45°NW |
| **Site 1 - Departures on Runway 02 (4/26/17)** | | | | |
| Single Engine Prop. | 2 | 71.7 (70.9-72.9) | 63.2 (60.1-66.3) | 30°S-45°SW |
| **Site 1 - Overflights (4/26/17)** | | | | |
| Single Engine Prop. | 2 | 71.2 (67.1-73.3) | 59.8 (56.6-62.9) | 45°S-90° |
| Helicopter | 1 | 61.7 | 53.7 | 45°S |
| **Site 2 - Arrivals on Runway 20 (4/25/17)** | | | | |
| Single Engine Prop. | 1 | 55.6 | 47.5 | 30°NW |
| **Site 2 - Departures on Runway 20 (4/25/17)** | | | | |
| Single Engine Prop. | 2 | 65.9 (59.7-68.3) | 55.5 (52.1-58.8) | 0° |
| **Site 2 - Overflights (4/25/17)** | | | | |
| Helicopter | 1 | 67.8 | 58.6 | 60°NW |
| **Site 3 - Departures on Runway 20 (4/21/17)** | | | | |
| Helicopter | 2 | 78.7 (77.1-79.9) | 68.4 (67.4-69.4) | 45°E |
| Single Engine Prop. | 26 | 87.4 (73.-91.3) | 79.2 (65.7-87.6) | 90°-75°W |
| **Site 4 – Arrivals on 20 (4/24/17)** | | | | |
| Single Engine Prop. | 2 | 74.6 (72.7-75.9) | 66.9 (64.4-69.3) | 30°W-45°W |
| **Site 4 – Departures on 20 (4/24/17)** | | | | |
| Single Engine Prop. | 3 | 79.1 (60.8-82.2) | 64.0 (48.8-74.3) | 30°W-60°S |
| **Site 4 – Overflights (4/24/17)** | | | | |
| Single Engine Prop. | 1 | 71.6 | 59.7 | 45°N |
| **Site 5 – Overflights (4/21/17)** | | | | |
| Helicopter | 2 | 72.0 (70.9-72.8) | 62.5 (60.7-64.2) | 45°W-60°W |
| Single Engine Prop. | 32 | 70.8 (64.1-77.1) | 60.4 (55.3-67.2) | 30°S-45°N |
| **Site 6 – Arrivals on 20 (4/25/17)** | | | | |
| Single Engine Prop. | 12 | 70.7 (59.2-76.4) | 58.9 (49.4-67.0) | 45°W-75°E |
| **Site 6 – Overflights (4/25/17)** | | | | |
| Helicopter | 5 | 74.4 (67.6-76.6) | 62.1 (58.3-64.4) | 45°W-75°E |
| Source: WJV Acoustics, Inc. | | | | |

**APPENDIX E (Concluded)**

**SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS**
**WATSONVILLE MUNICIPAL AIRPORT**
**APRIL 2017**

| Aircraft Type | Number Sampled | SEL, dBA Mean (Range) | Lmax, dBA Mean (Range) | Azimuth |
|---|---|---|---|---|
| **Site 7 - Arrivals on Runway 20 (4/24/17)** | | | | |
| Single Engine Prop. | 13 | 68.2 (58.2-75.3) | 55.7 (49.0-63.3) | 90°-45°W |
| **Site 7 - Overflights (4/24/17)** | | | | |
| Single Engine Prop. | 4 | 59.9 (55.9-63.3) | 50.4 (47.8-52.8) | 90°S-60°E |
| **Site 8 – Arrivals on 20 (4/25/17)** | | | | |
| Single Engine Prop. | 3 | 61.4 (59.0-63.2) | 53.2 (52.1-55.1) | 15°E |
| **Site 8 – Departures on 20 (4/25/17)** | | | | |
| Bizjet | 1 | 73.9 | 64.8 | 0° |
| Single Engine Prop. | 6 | 70.9 (63.1-74.2) | 59.1 (55.8-65.9) | 0° |
| **Site 8 – Overflights (4/25/17)** | | | | |
| Helicopter | 3 | 78.0 (66.2-81.0) | 65.3 (58.2-70.2) | 15°E-45°E |
| Single Engine Prop. | 1 | 57.6 | 49.2 | 90° |
| **Site 8 – Engine Runups (4/25/17)** | | | | |
| Single Engine Prop. | 2 | 65.9 (65.2-66.5) | 54.0 (52.5-55.5) | 0° |

Source: WJV Acoustics, Inc.

# APPENDIX F

# SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS
# OCTOBER 2017

**APPENDIX F**

**SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS**
**WATSONVILLE MUNICIPAL AIRPORT**
**OCTOBER 2017**

| Aircraft Type | Number Sampled | SEL, dBA Mean (Range) | Lmax, dBA Mean (Range) | Azimuth |
|---|---|---|---|---|
| **Site 1 - Arrivals on Runway 20 (10/19/17)** | | | | |
| Single Engine Prop. | 4 | 68.3 (66.9-69.4) | 60.6 (59.8-61.4) | 45°NW |
| **Site 1 - Overflights (4/26/17)** | | | | |
| Single Engine Prop. | 3 | 63.2 (61.3-64.5) | 53.3 (52.9-53.7) | 45°E |
| **Site 2 - Departures on Runway 20 (10/19/17)** | | | | |
| Single Engine Prop. | 2 | 58.6 (57.8-59.3) | 50.3 (49.9-50.6 | 0° |
| **Site 3 - Arrivals on Runway 02 (10/24/17)** | | | | |
| Bizjet | 1 | 87.4 | 83.1 | 75°NW |
| **Site 3 – Departures on 20 (10/24/17)** | | | | |
| Bizjet | 1 | 92.3 | 87.2 | 75°NW |
| Single Engine Prop. | 28 | 84.1 (76.7-89.8) | 76.1 (66.2-84.8) | 45°NW-90° |
| **Site 4 – Departures on 20 (10/17/17)** | | | | |
| Single Engine Prop. | 22 | 76.4 (58.6-81.7) | 64.0 (50.3-73.2) | 30°W-90° |
| **Site 5 – Overflights (4/21/17)** | | | | |
| Helicopter | 3 | 70.9 (68.1-72.8) | 61.1 (60.0-62.2) | 45°W-60°W |
| Single Engine Prop. | 22 | 71.4 (63.0-78.2) | 62.2 (57.3-68.9) | 45°W-45°E |
| **Site 6 – Arrivals on 20 (10/17/17)** | | | | |
| Single Engine Prop. | 9 | 67.9 (58.9-75.1) | 55.8 (50.2-66.0) | 45°W-75°E |
| **Site 6 – Departures on 09 (10/17/17)** | | | | |
| Single Engine Prop. | 1 | 82.5 | 72.5 | 60°S |
| **Site 7 – Arrivals on 20 (10/18/17)** | | | | |
| Single Engine Prop. | 4 | 59.9 (55.9-63.3) | 50.4 (47.8-52.8) | 90°S-60°E |
| **Site 7 – Departures on 09 (10/24/17)** | | | | |
| Single Engine Prop. | 1 | 79.7 | 71.2 | 75°W |
| **Site 7– Overflights (10/18/17)** | | | | |
| Helicopter | 1 | 77.2 | 67.6 | 75°NW |
| **Site 8 – Departure on 09 (10/16/17)** | | | | |
| Single Engine Prop. | 3 | 70.2 (67.7-71.5) | 61.8 (59.1-64.0) | 0° |
| **Site 8 – Arrivals on 20 (10/16/17)** | | | | |

**APPENDIX F (Concluded)**

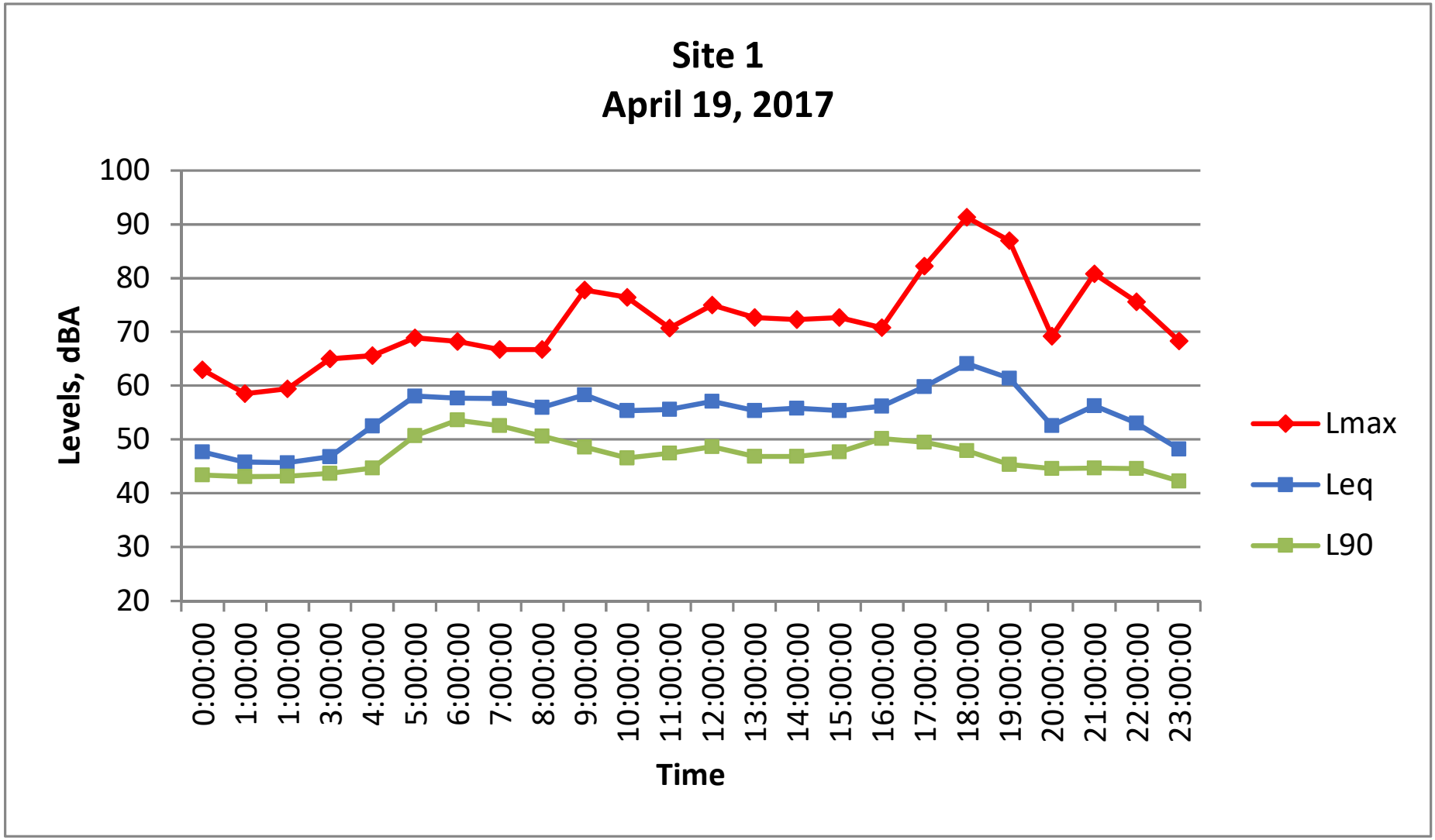
**SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS**
**WATSONVILLE MUNICIPAL AIRPORT**
**OCTOBER 2017**

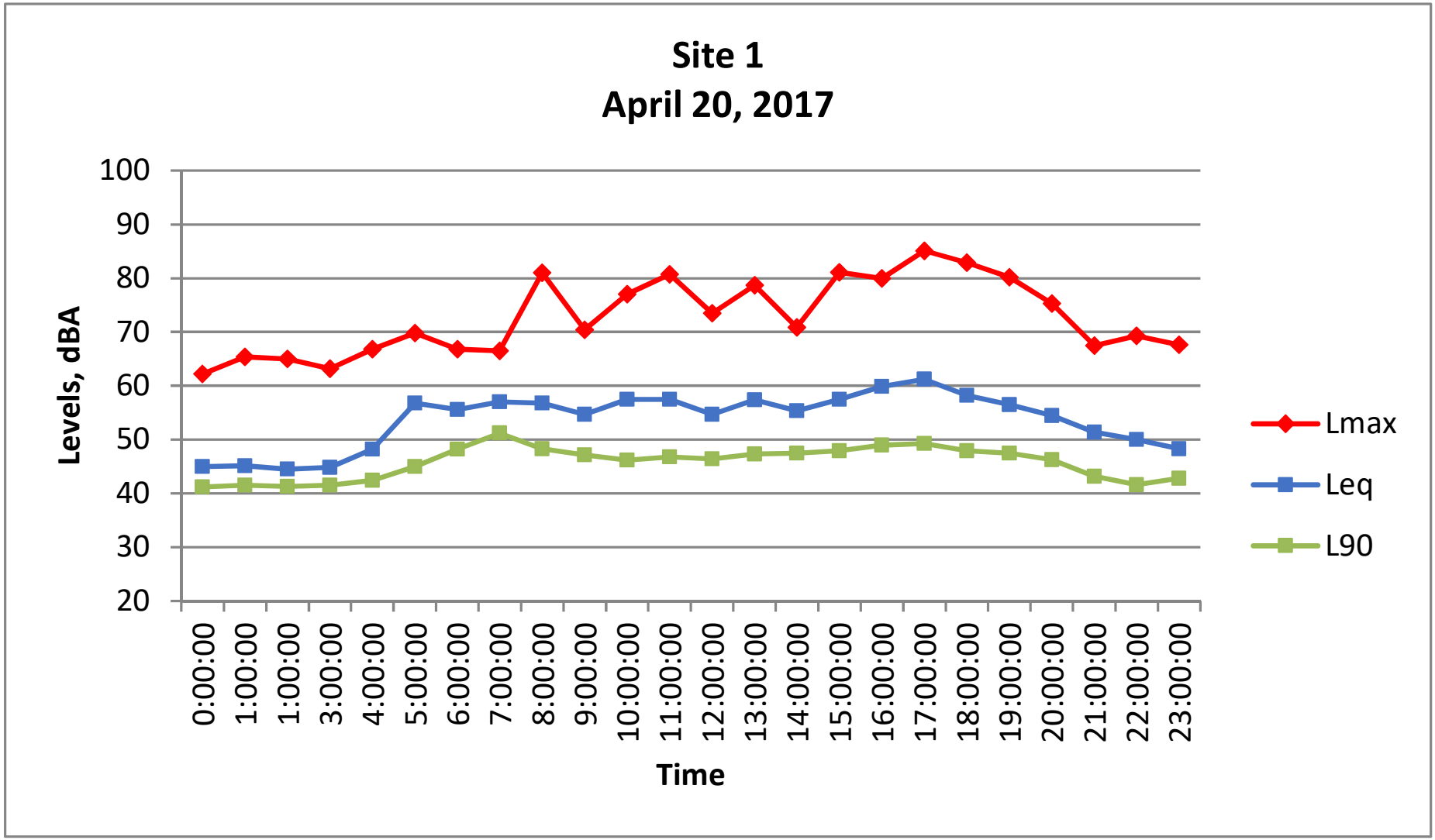
| Aircraft Type | Number Sampled | SEL, dBA Mean (Range) | Lmax, dBA Mean (Range) | Azimuth |
|---|---|---|---|---|
| Single Engine Prop. | 2 | 68.5 (65.8-70.2) | 62.2 (61.6-62.7) | 30°E |
| Twin Turboprop | 1 | 81.5 | 76.8 | 30°E |
| Source: WJV Acoustics, Inc. | | | | |

# APPENDIX G

# MEASURED HOURLY NOISE LEVELS
# WATSONVILLE MUNICIPAL AIRPORT

# APRIL & OCTOBER, 2017


Site 1
April 19, 2017
Levels, dBA
100
90
80
70
60
50
40
30
20
0:00:00
1:00:00
1:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
Time
Lmax
Leq
L90


Site 1
April 20, 2017
Levels, dBA
100
90
80
70
60
50
40
30
20
0:00:00
1:00:00
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3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
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15:00:00
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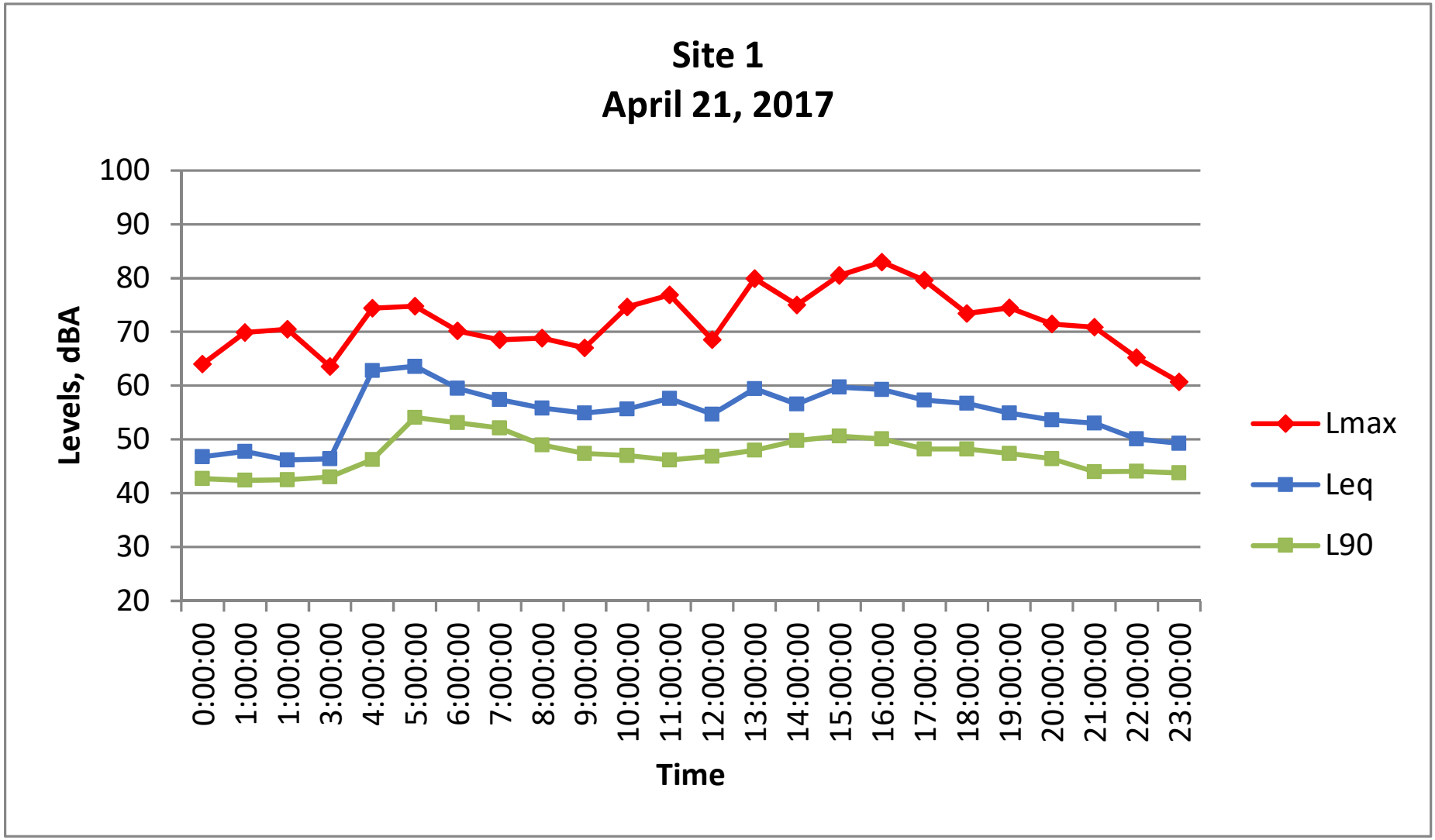
22:00:00
23:00:00
Time
Lmax
Leq
L90


Site 1
April 21, 2017
Levels, dBA
100
90
80
70
60
50
40
30
20
0:00:00
1:00:00
1:00:00
3:00:00
4:00:00
5:00:00
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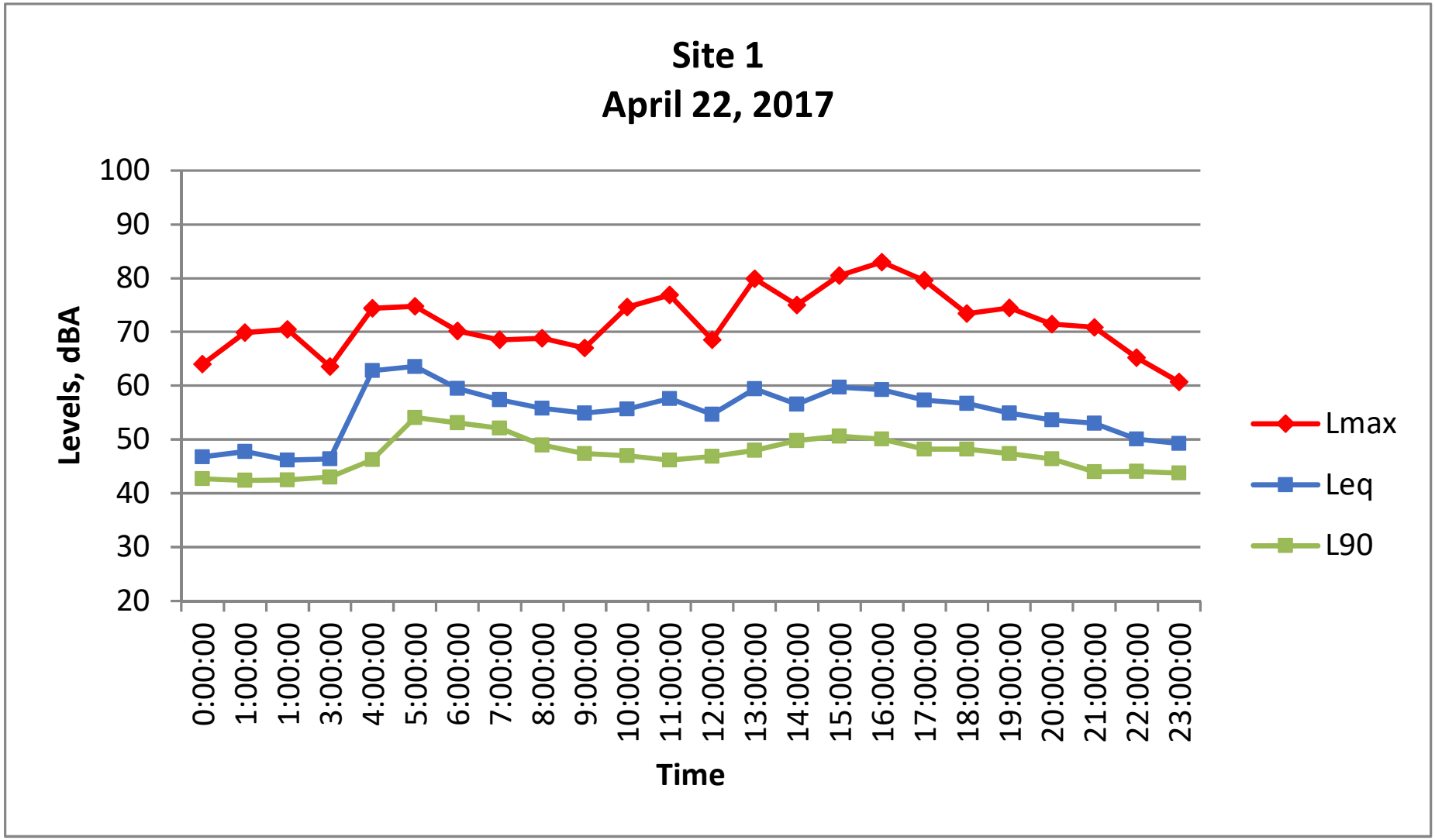
22:00:00
23:00:00
Time
Lmax
Leq
L90


Site 1
April 22, 2017
Levels, dBA
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90
80
70
60
50
40
30
20
0:00:00
1:00:00
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3:00:00
4:00:00
5:00:00
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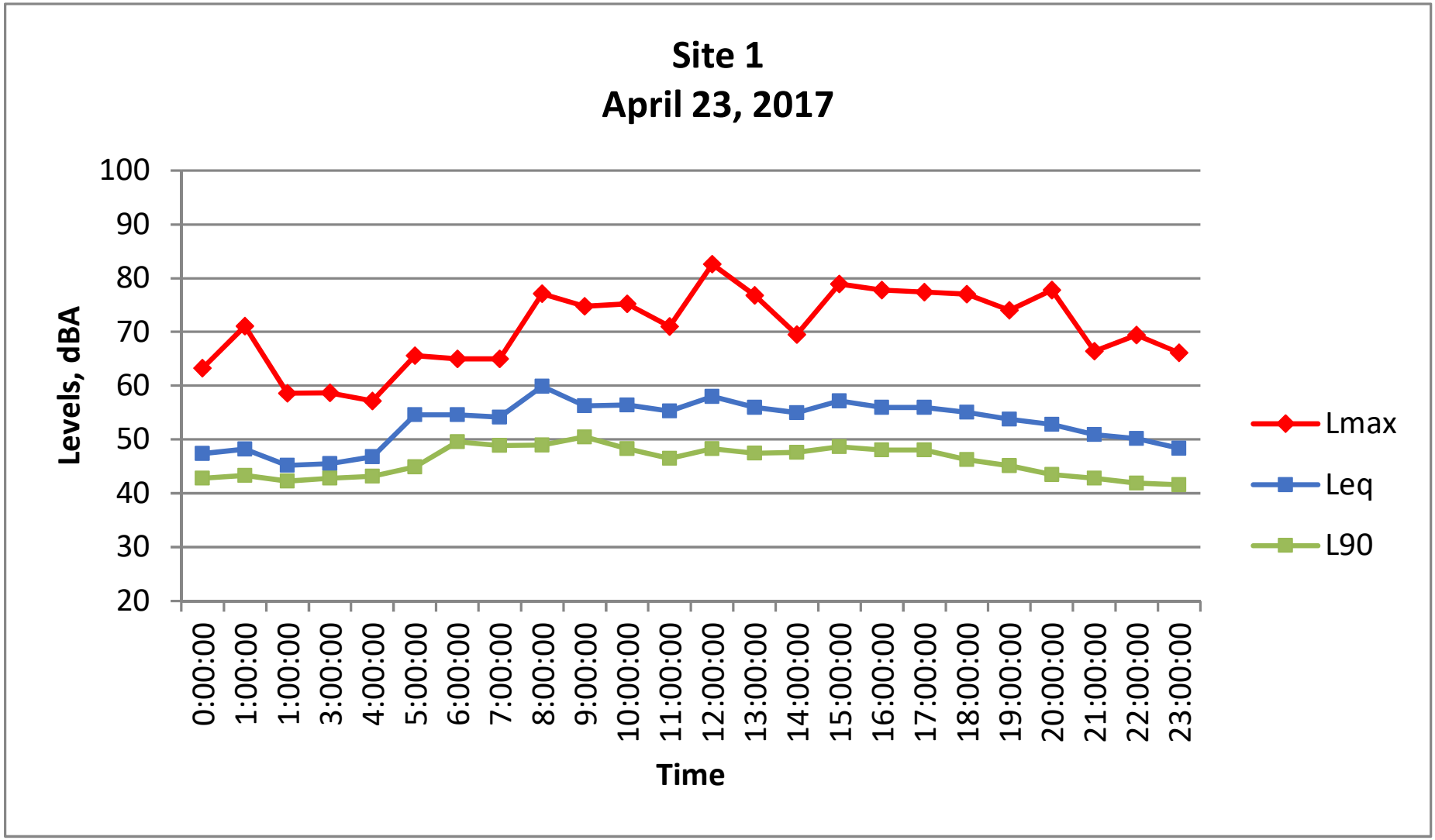
22:00:00
23:00:00
Time
Lmax
Leq
L90


Site 1
April 23, 2017
Levels, dBA
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90
80
70
60
50
40
30
20
0:00:00
1:00:00
1:00:00
3:00:00
4:00:00
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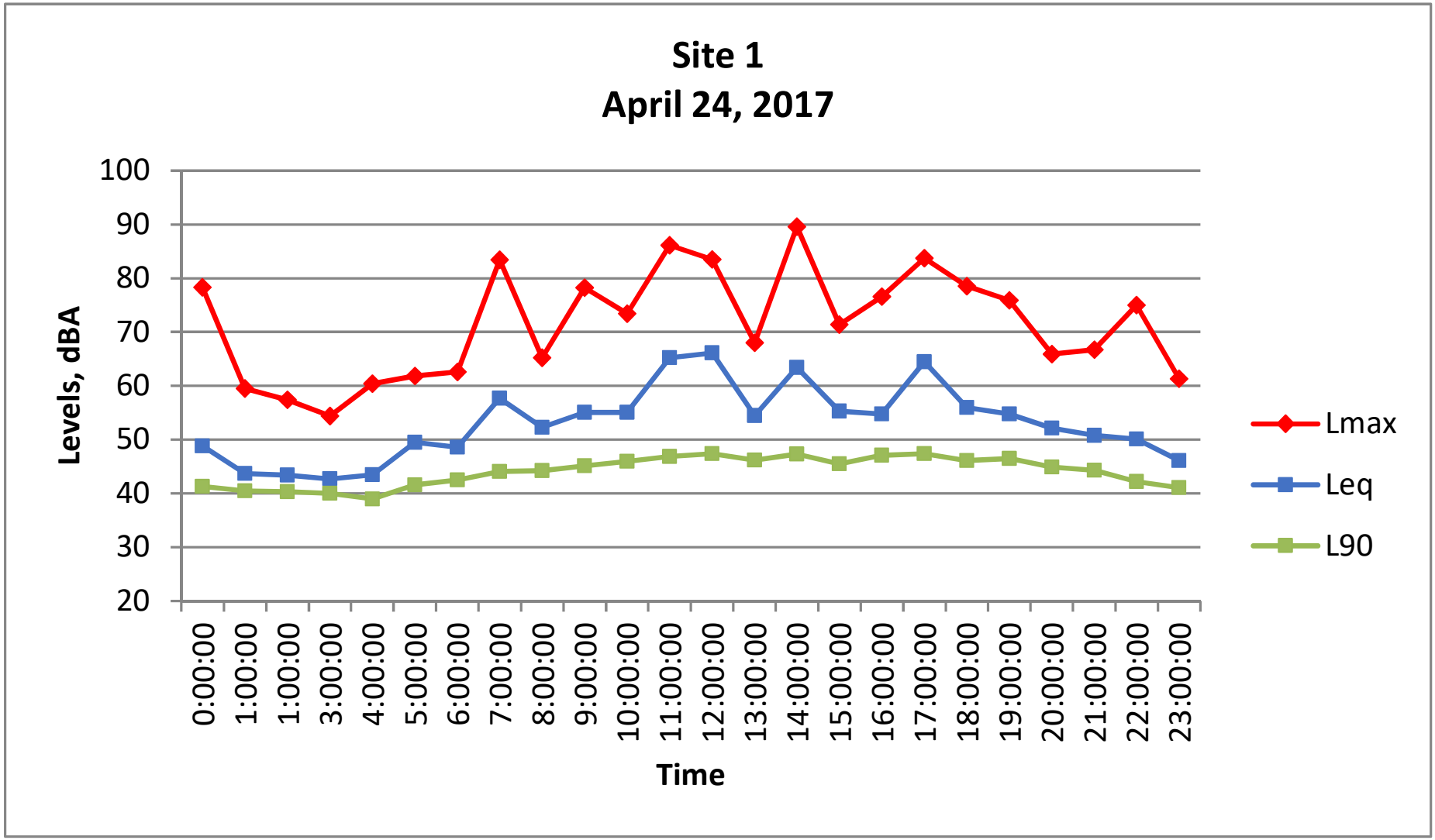
22:00:00
23:00:00
Time
Lmax
Leq
L90


Site 1
April 24, 2017
Levels, dBA
100
90
80
70
60
50
40
30
20
0:00:00
1:00:00
1:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
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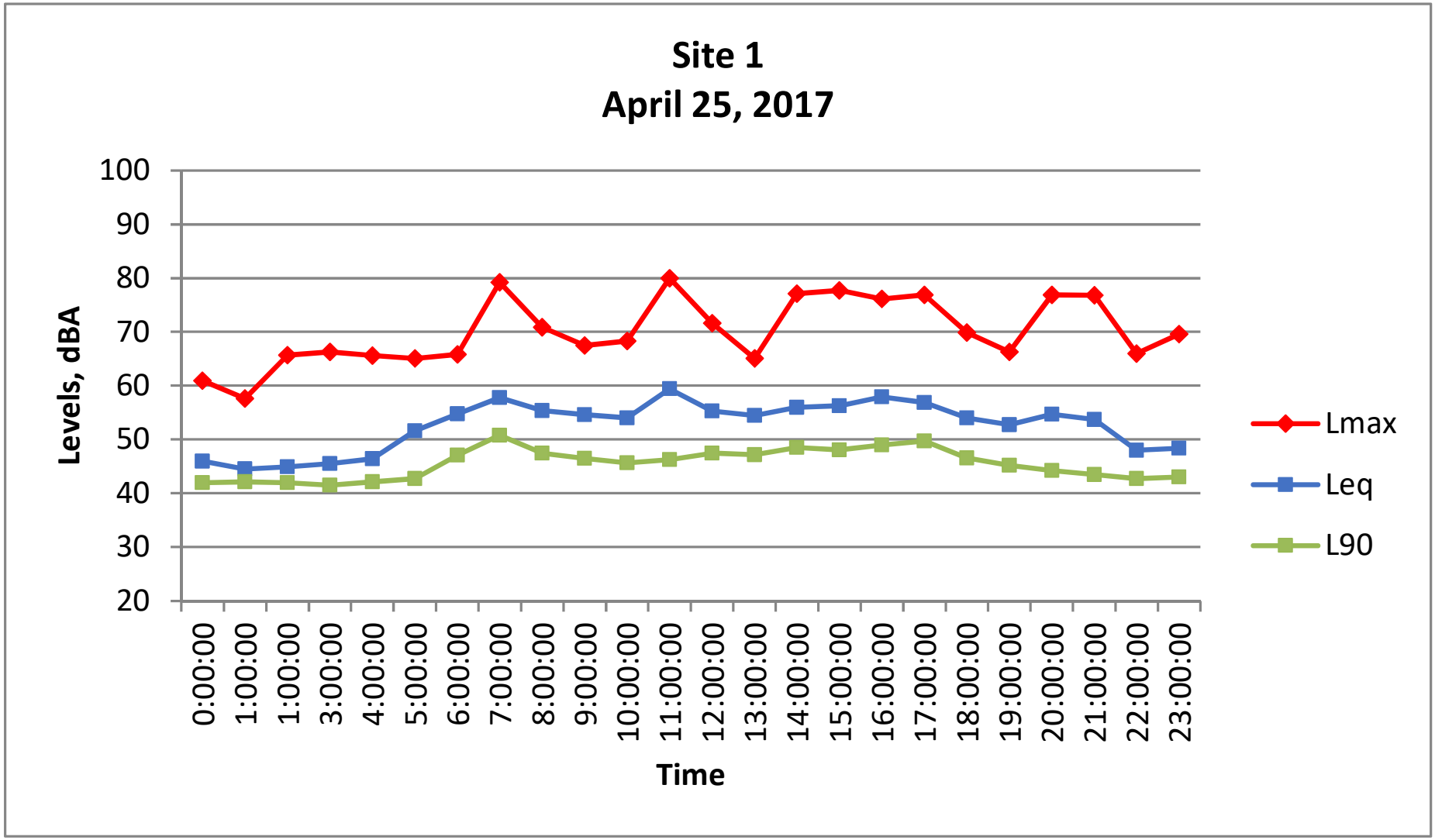
22:00:00
23:00:00
Time
Lmax
Leq
L90


Site 1
April 25, 2017
Levels, dBA
100
90
80
70
60
50
40
30
20
0:00:00
1:00:00
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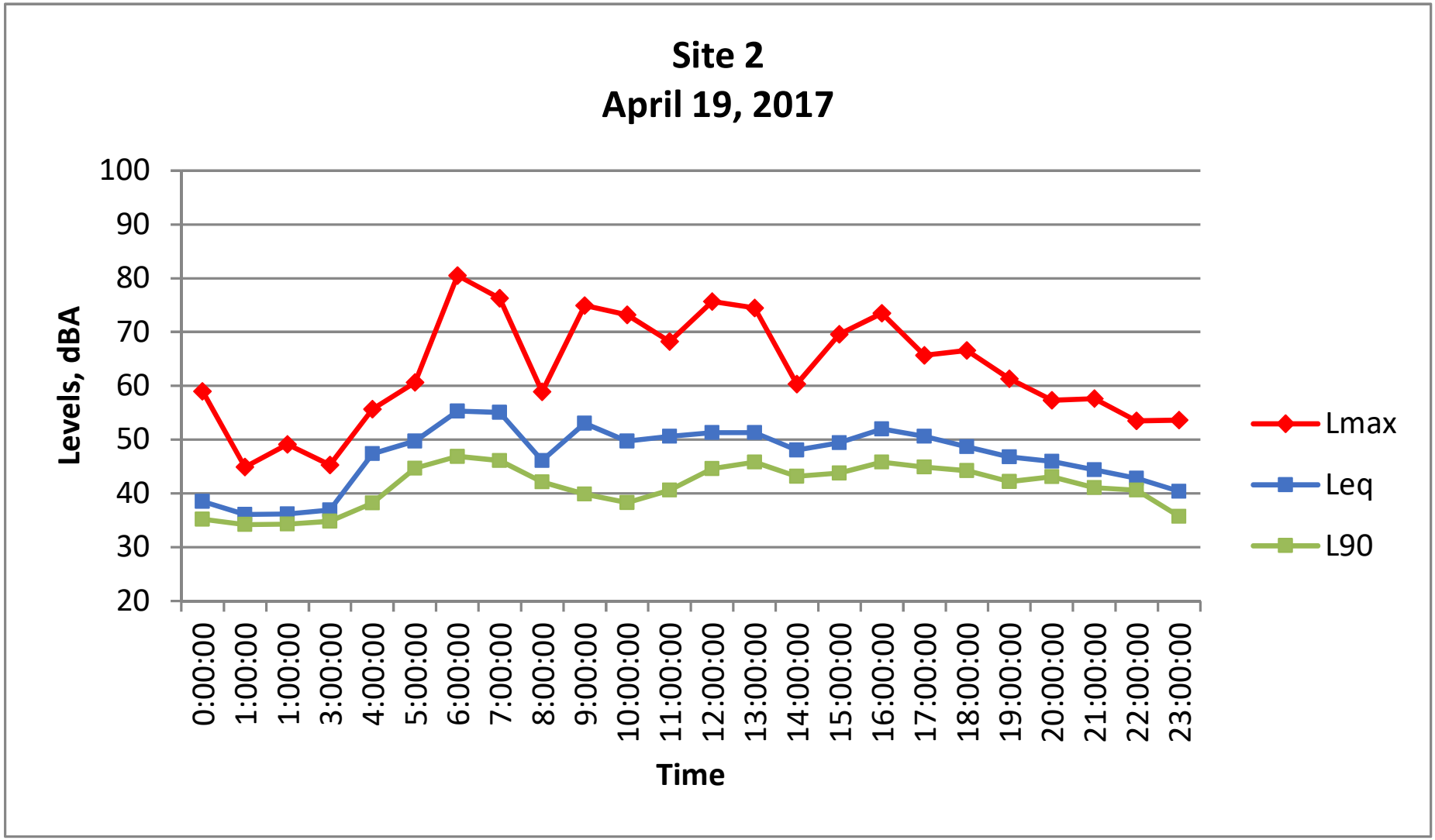
Time
Lmax
Leq
L90


Site 2
April 19, 2017
Levels, dBA
100
90
80
70
60
50
40
30
20
0:00:00
1:00:00
1:00:00
3:00:00
4:00:00
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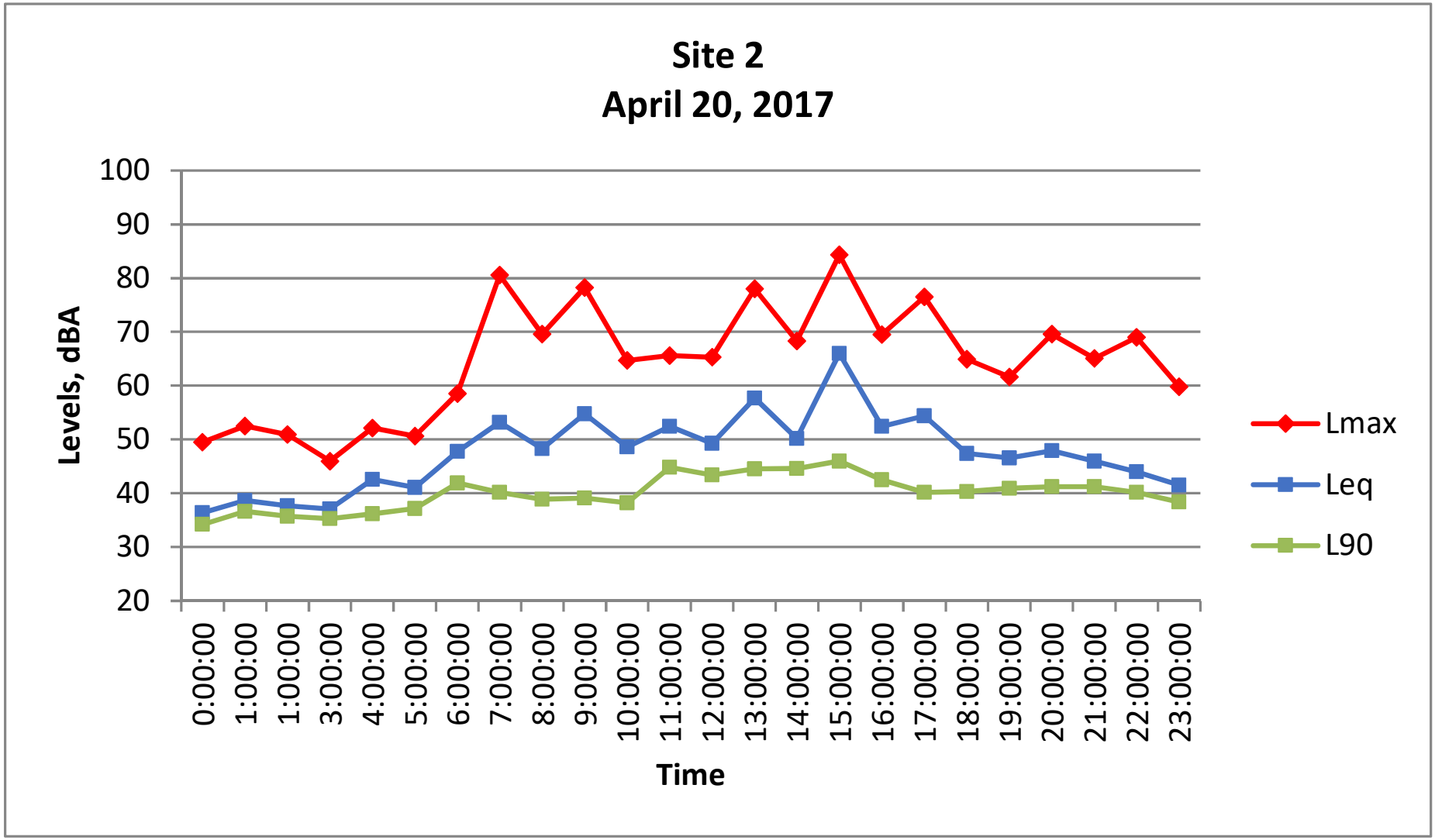
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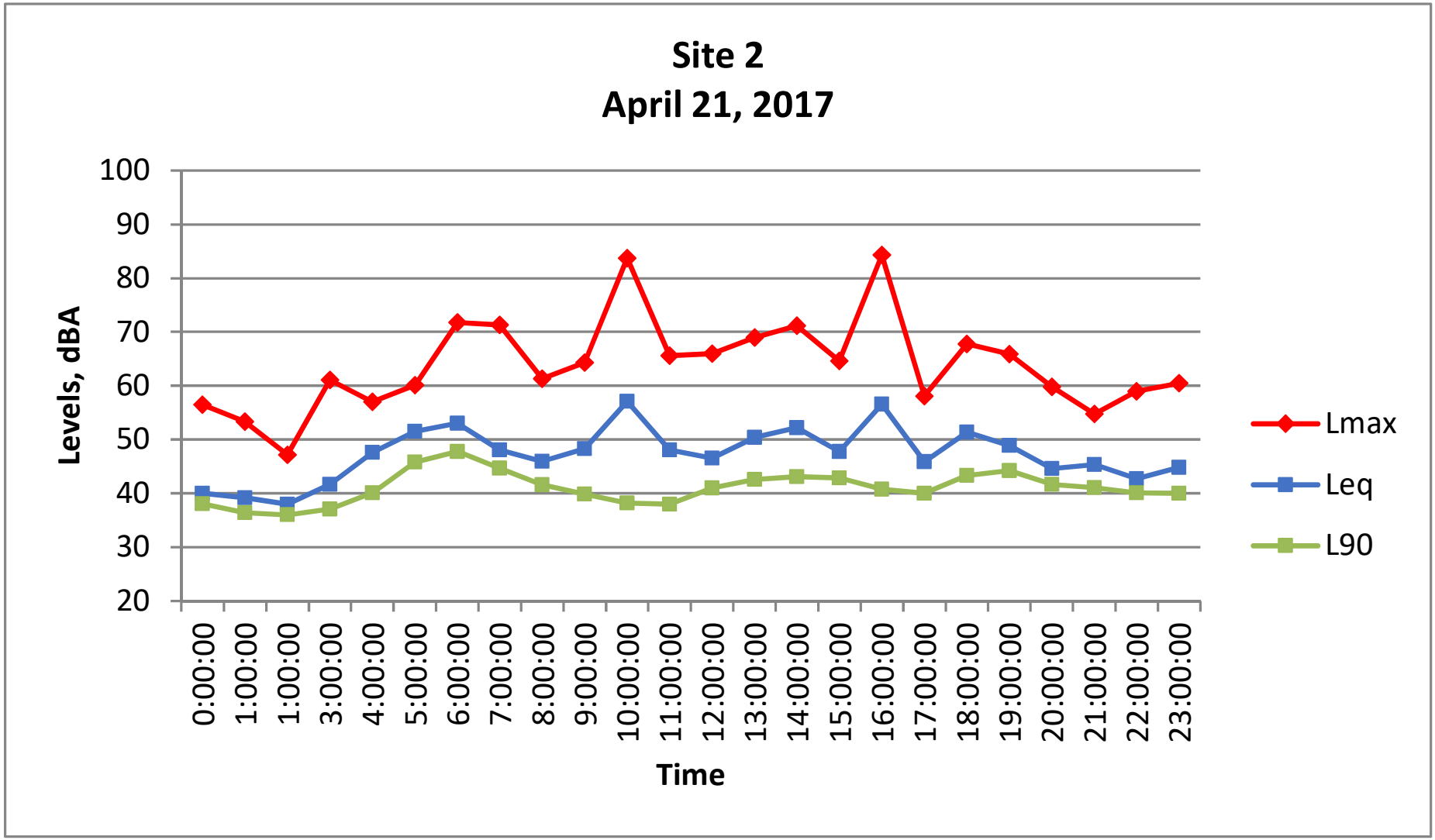
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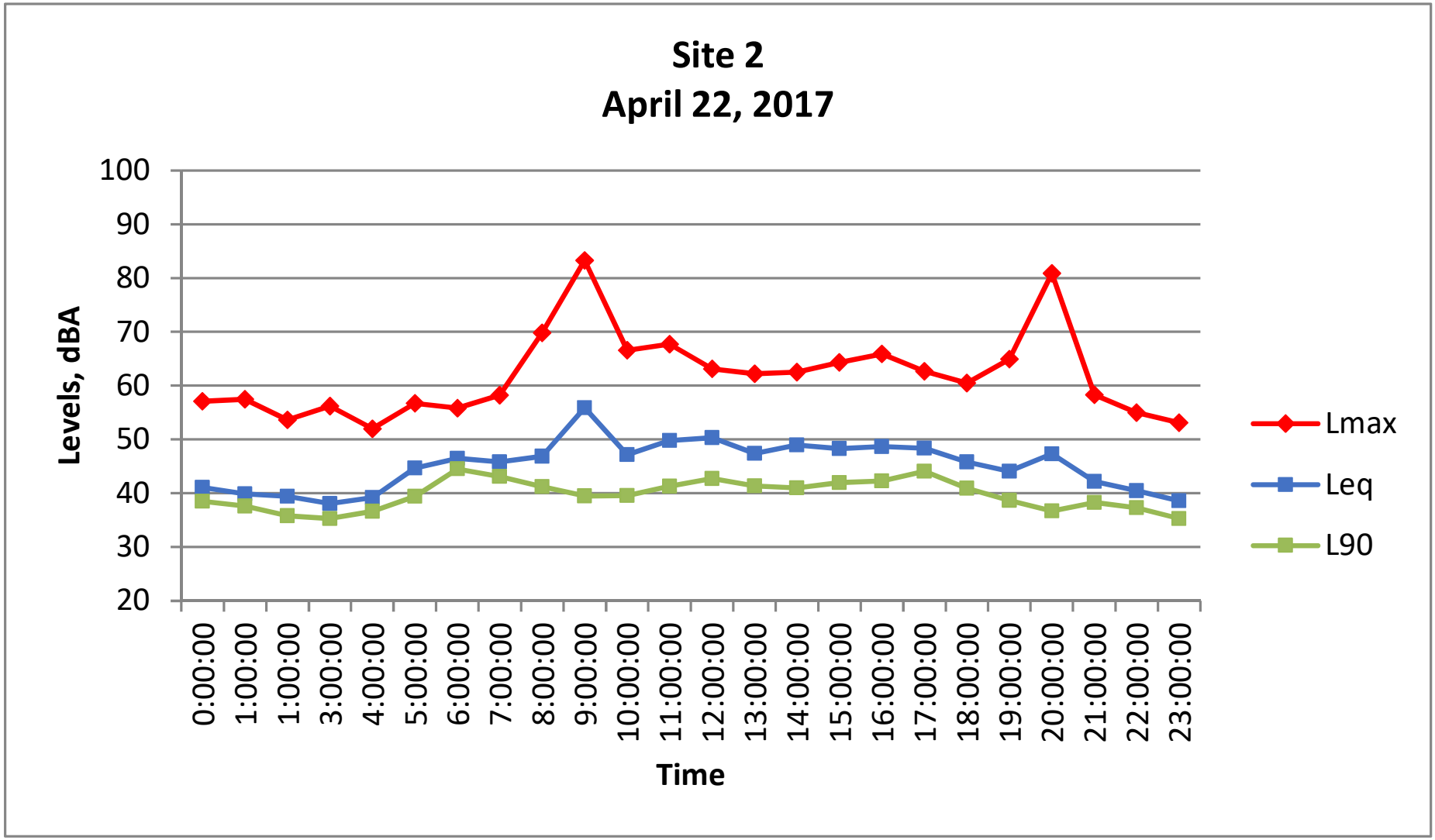
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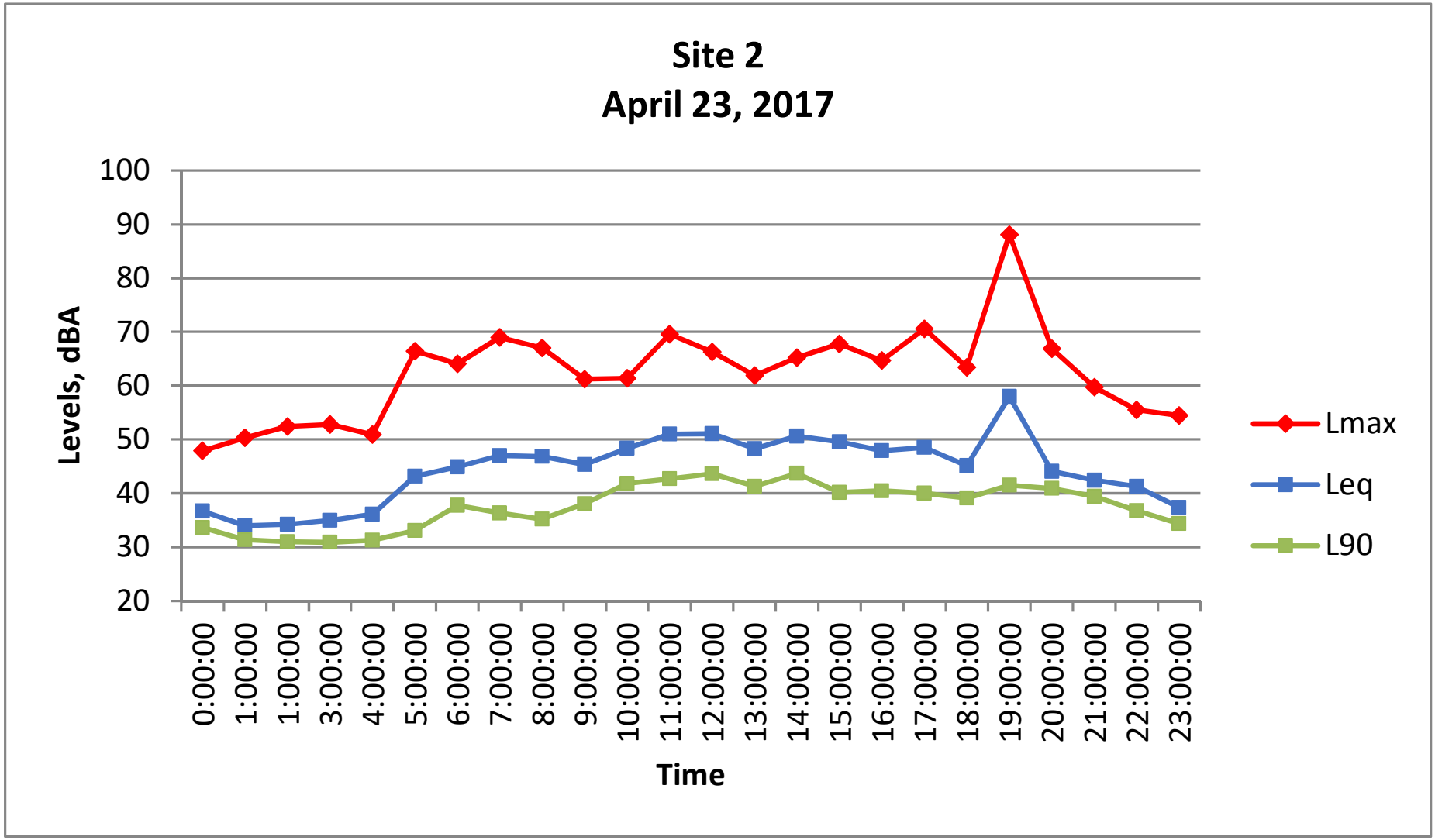
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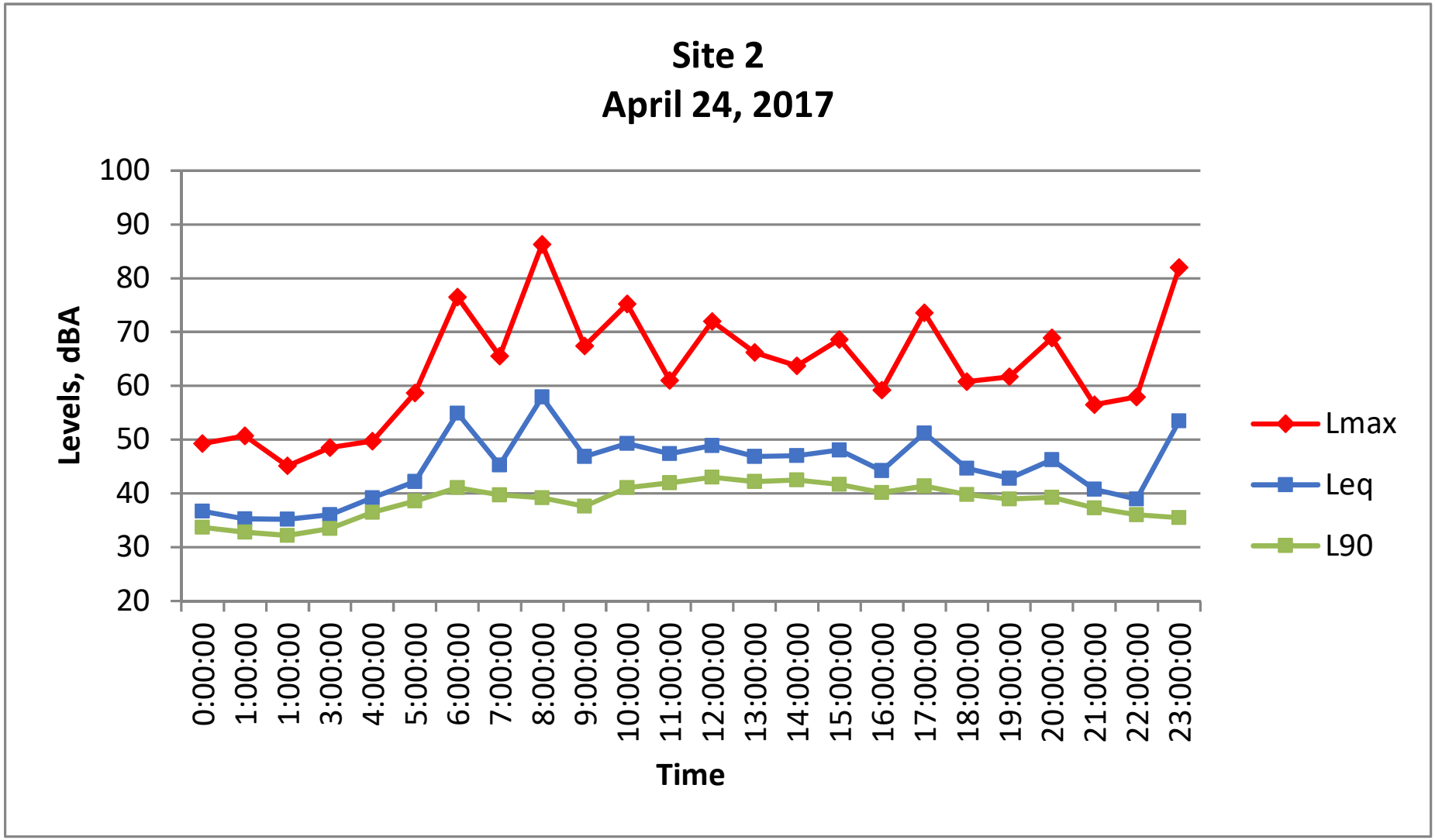
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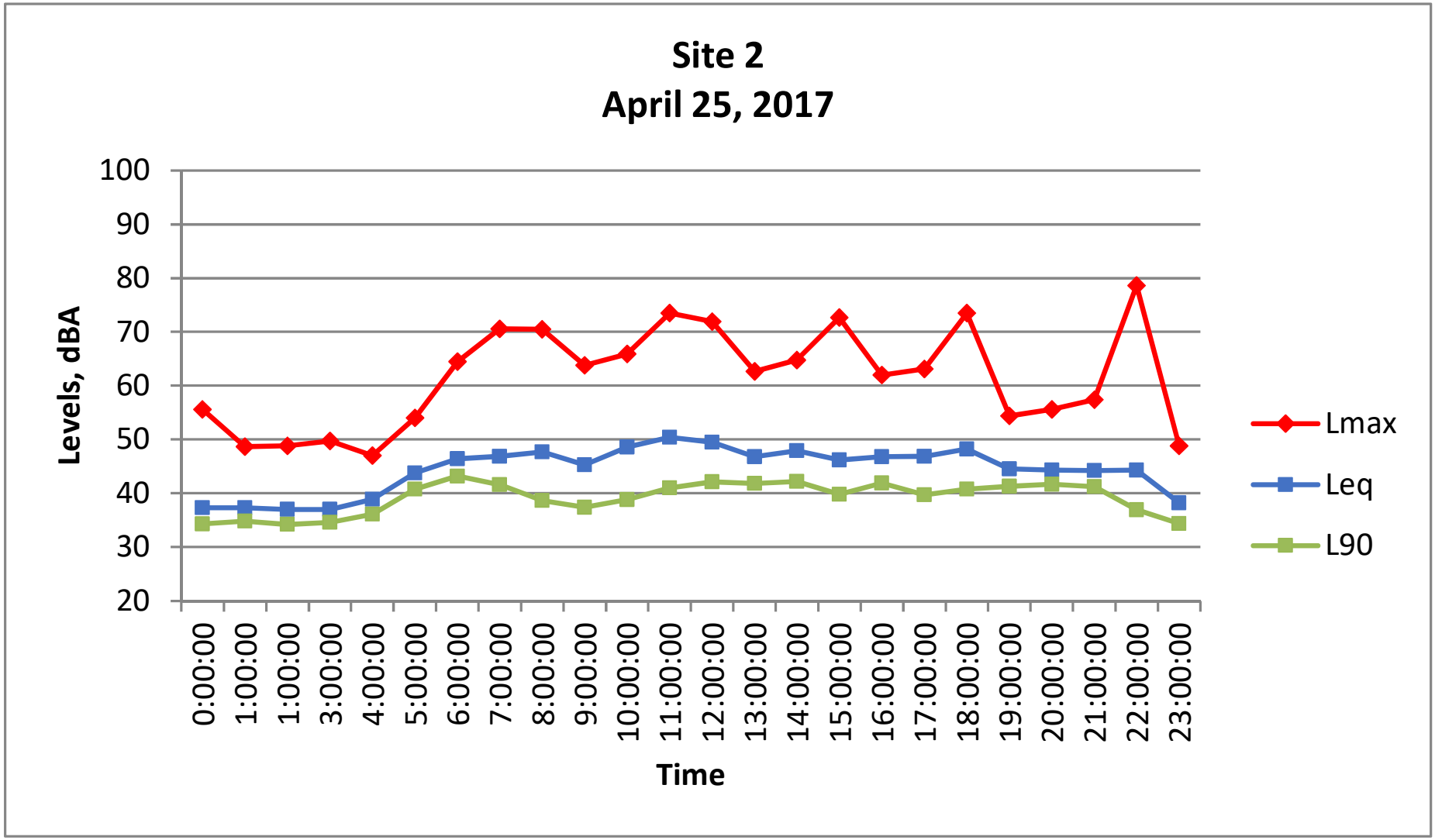
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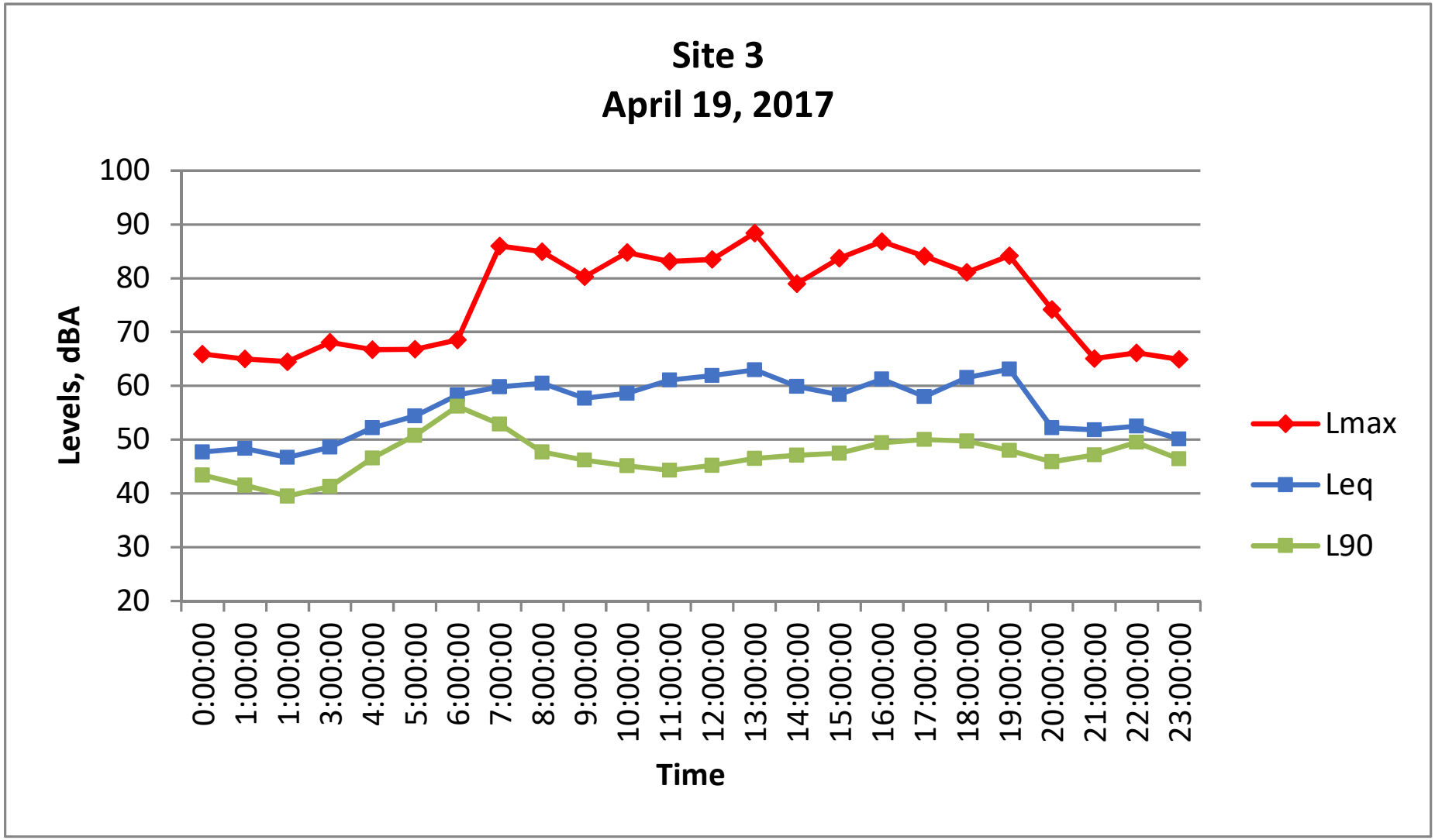
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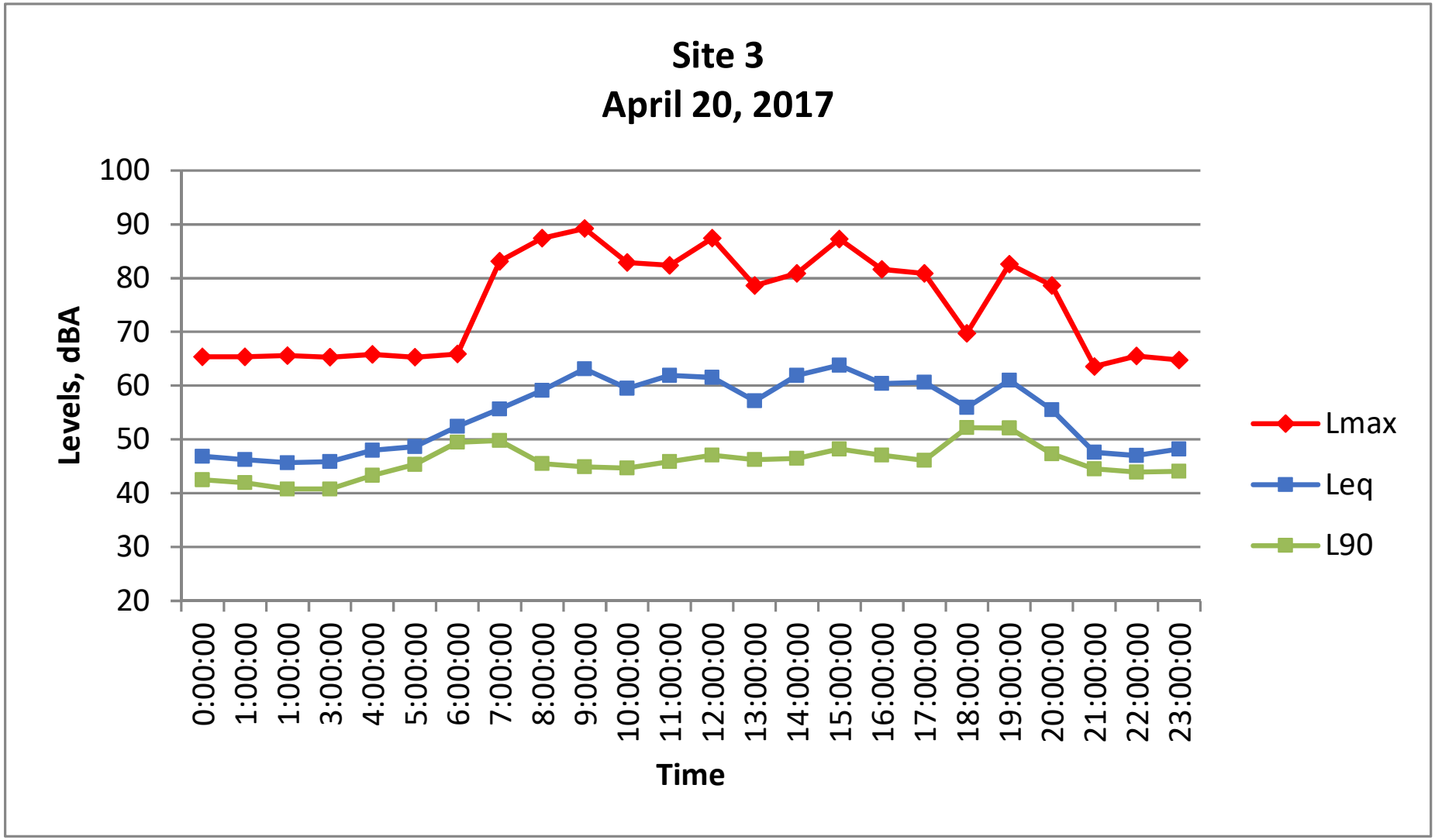
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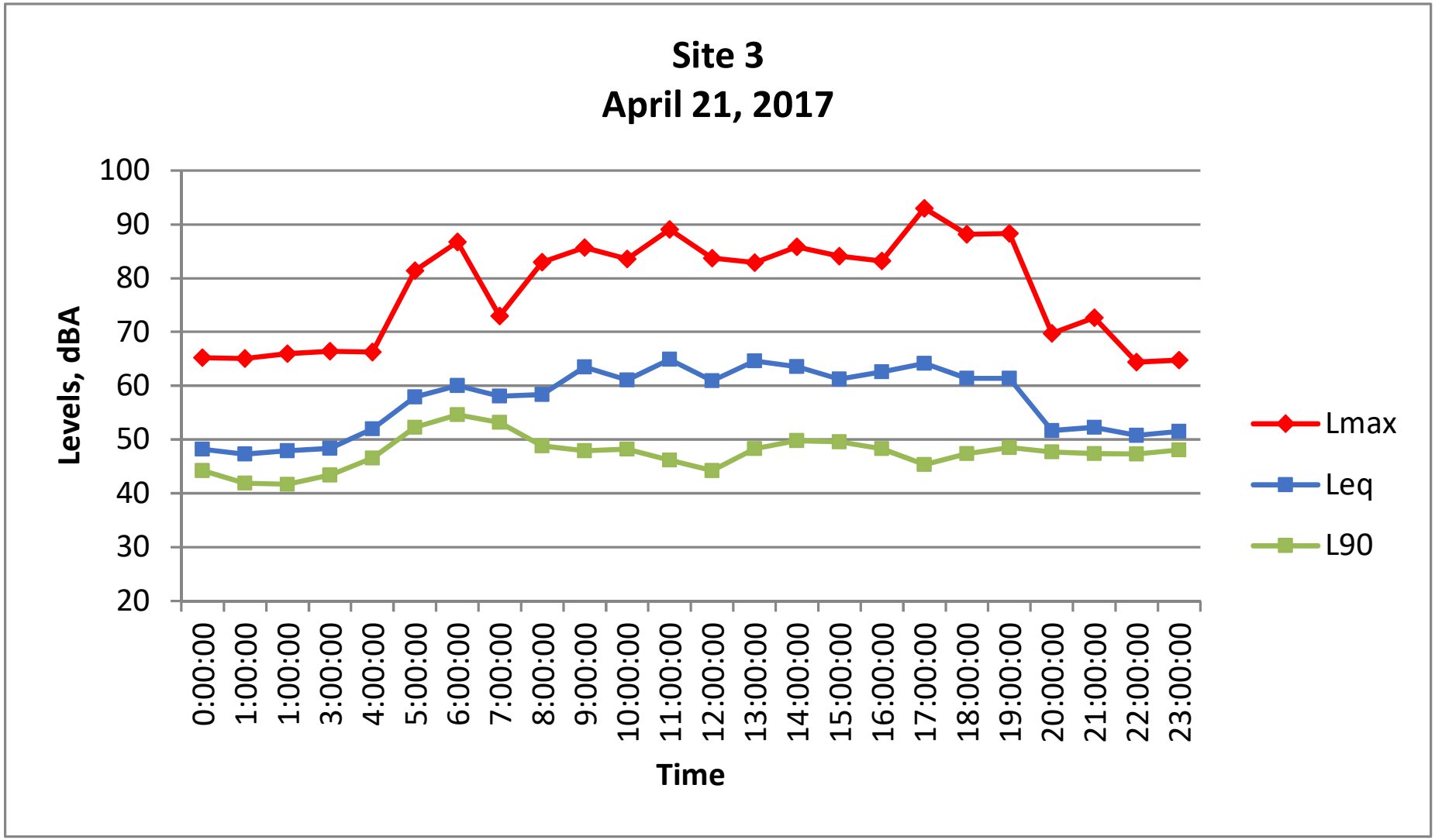
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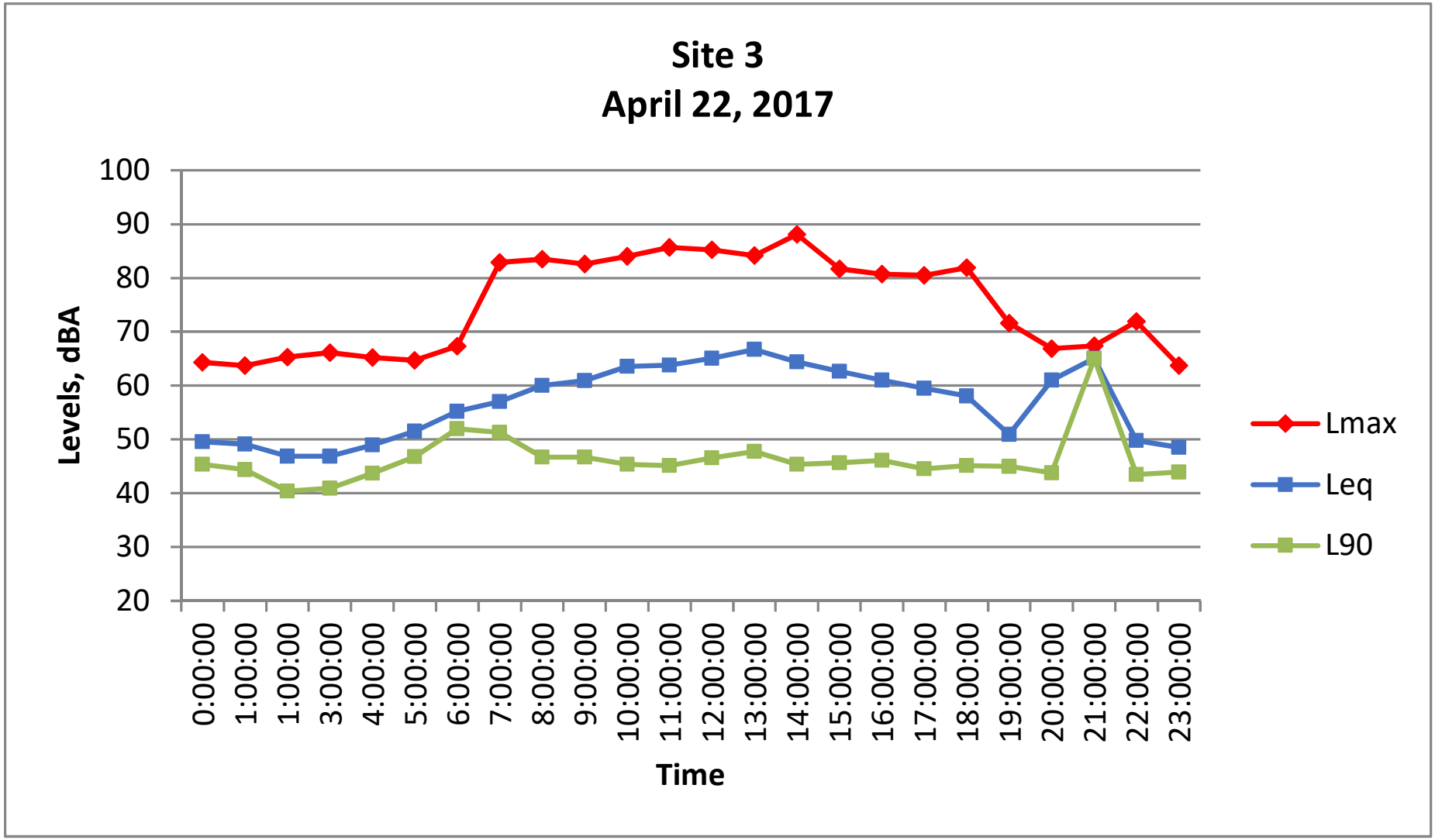
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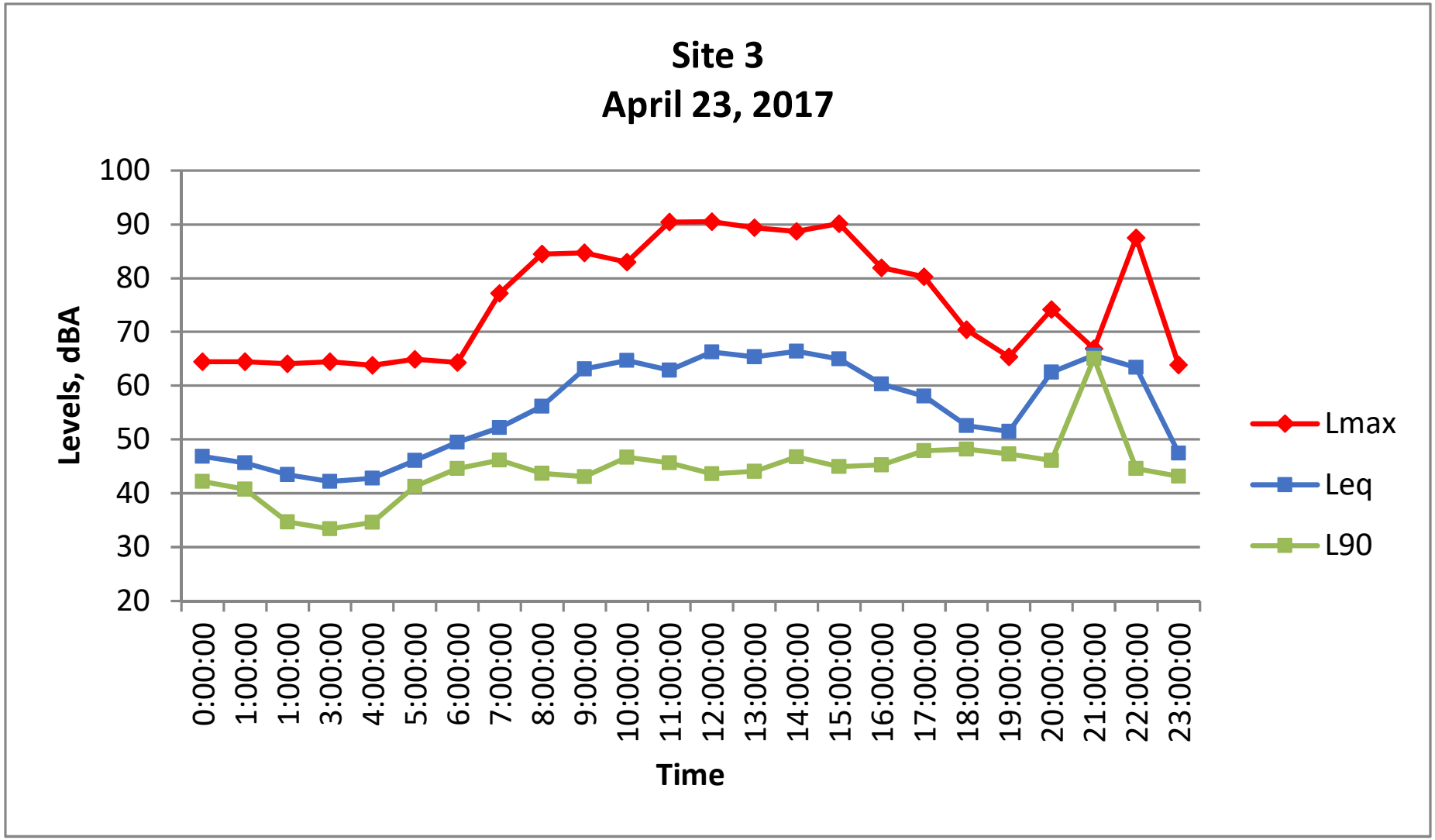
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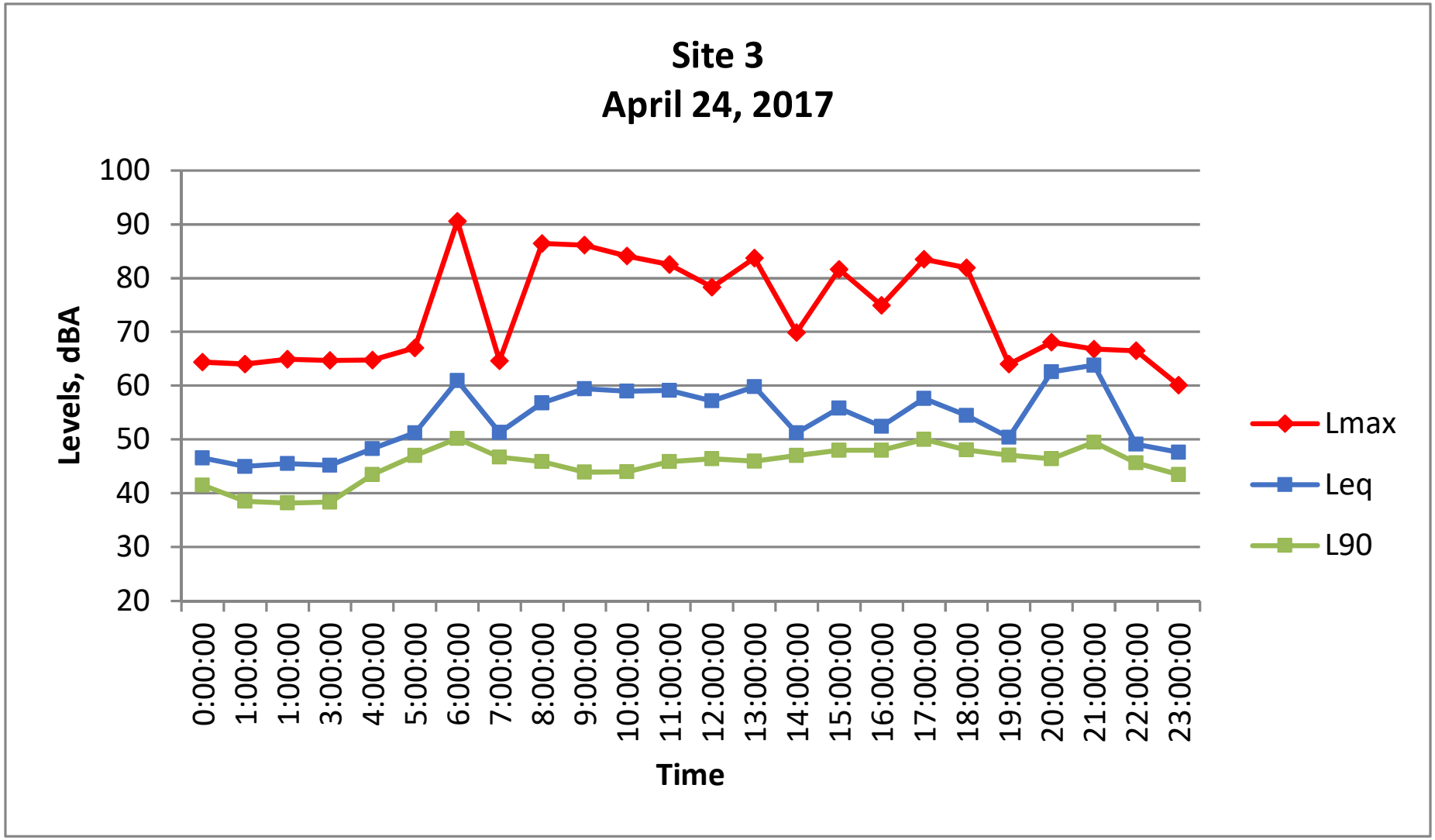
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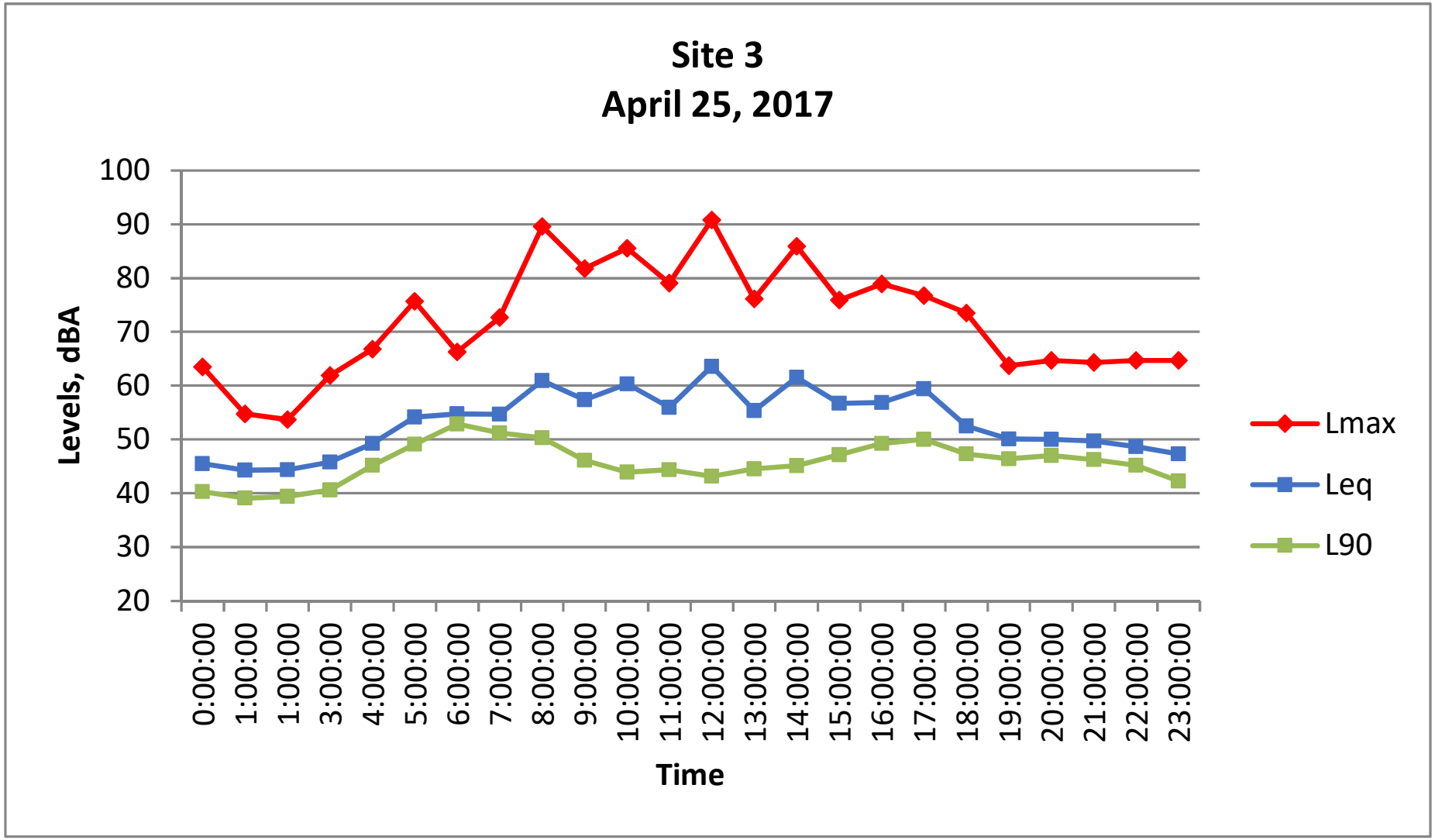
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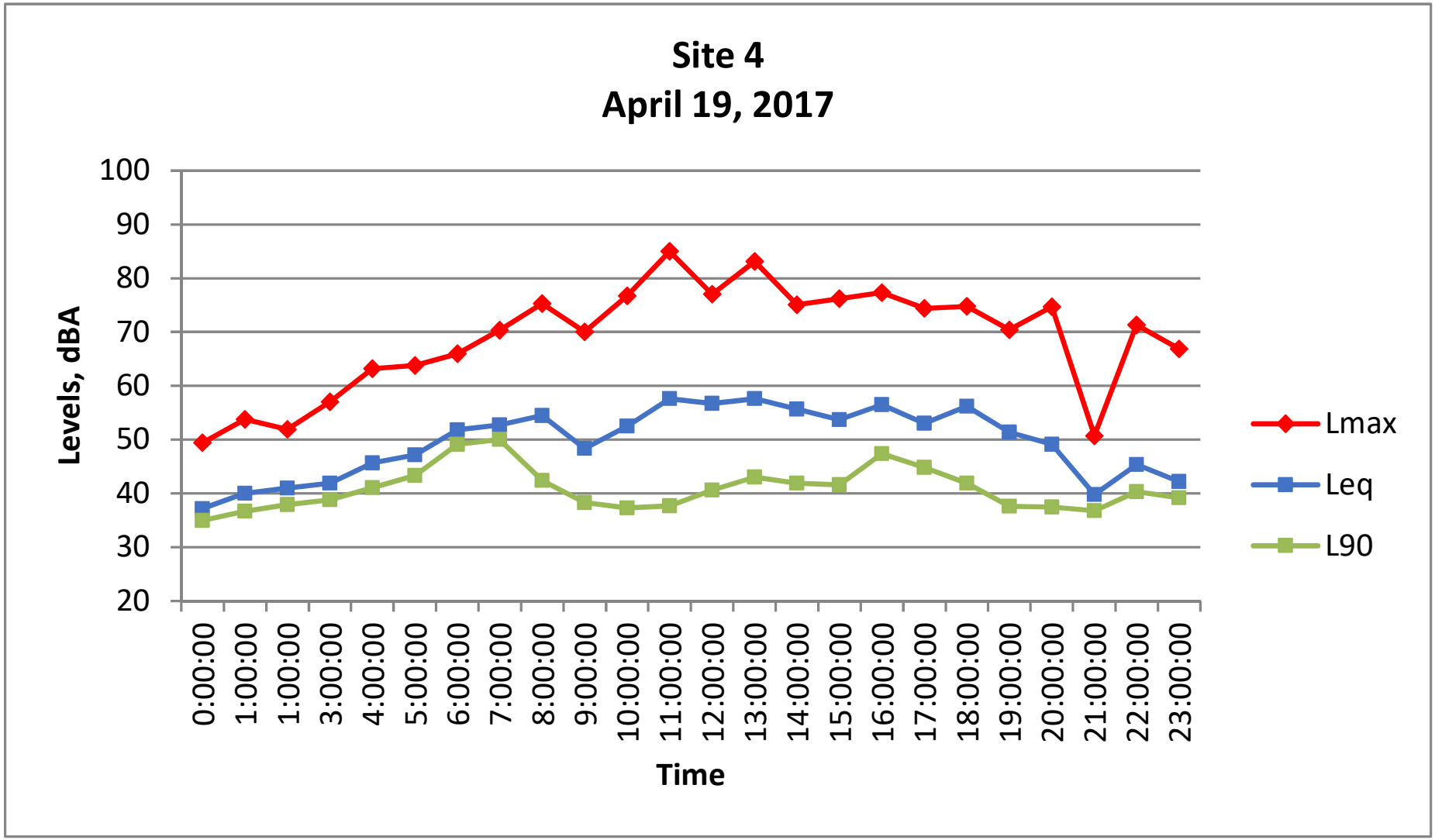
Site 4
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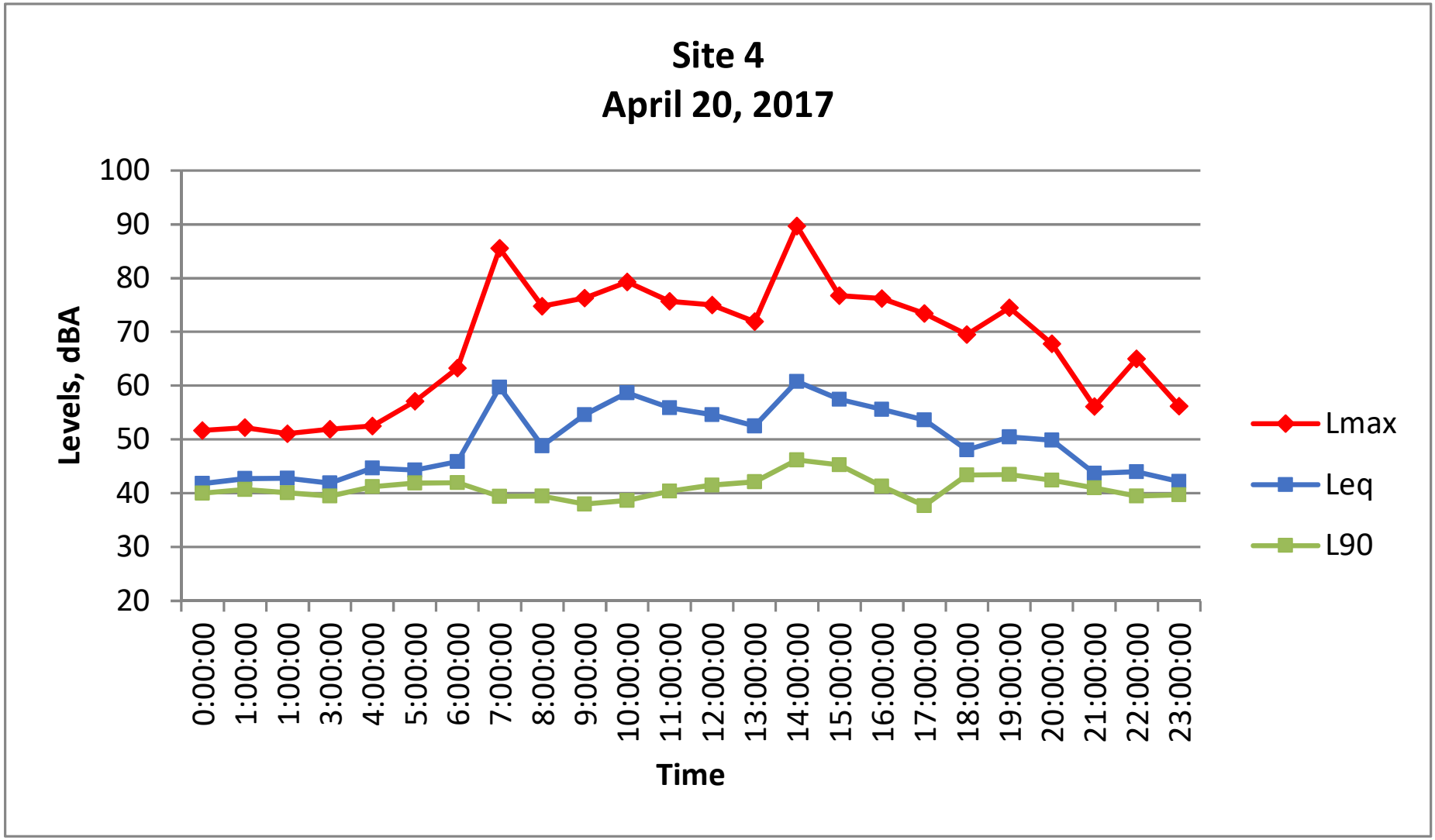
Site 4
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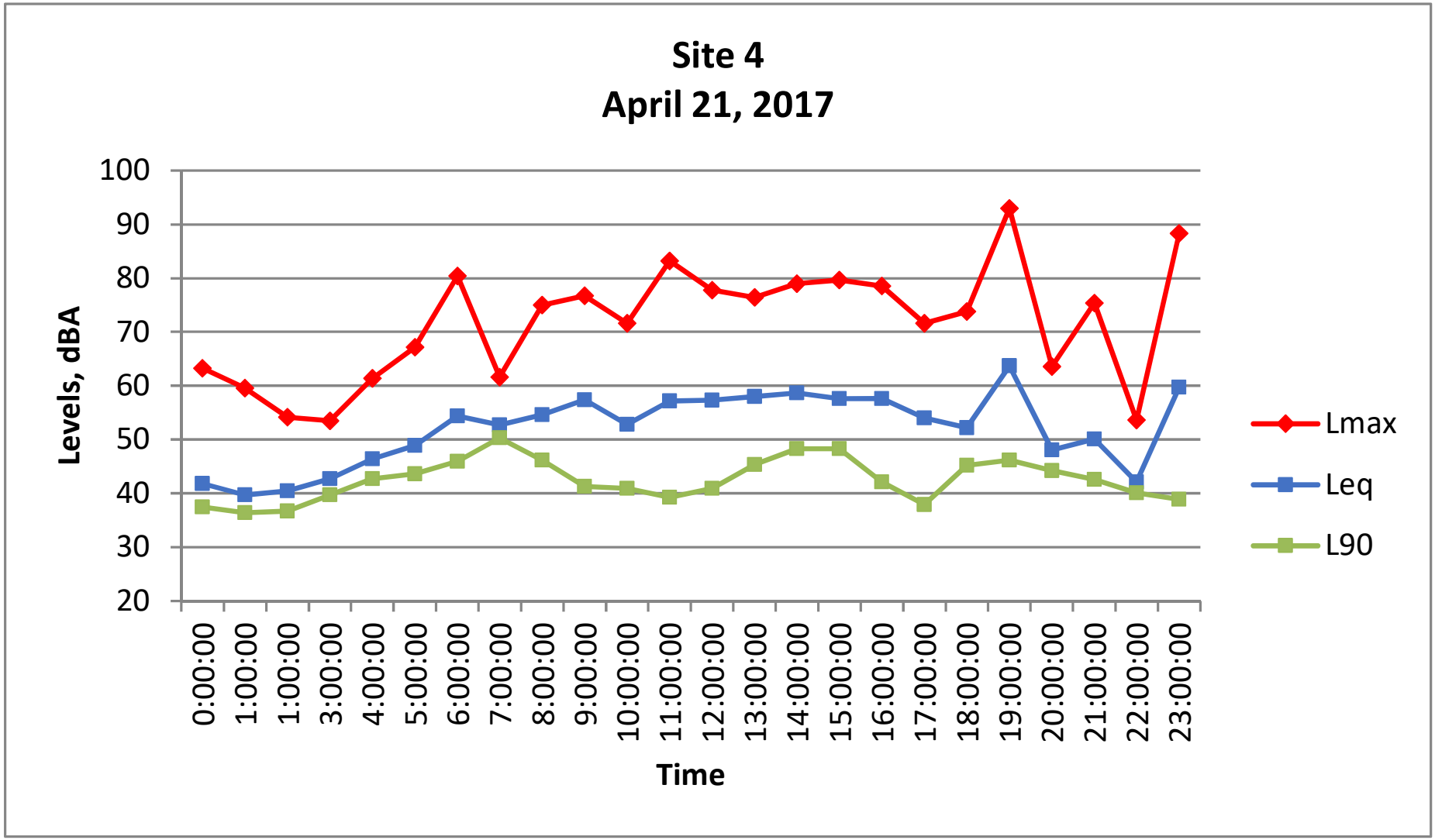
Site 4
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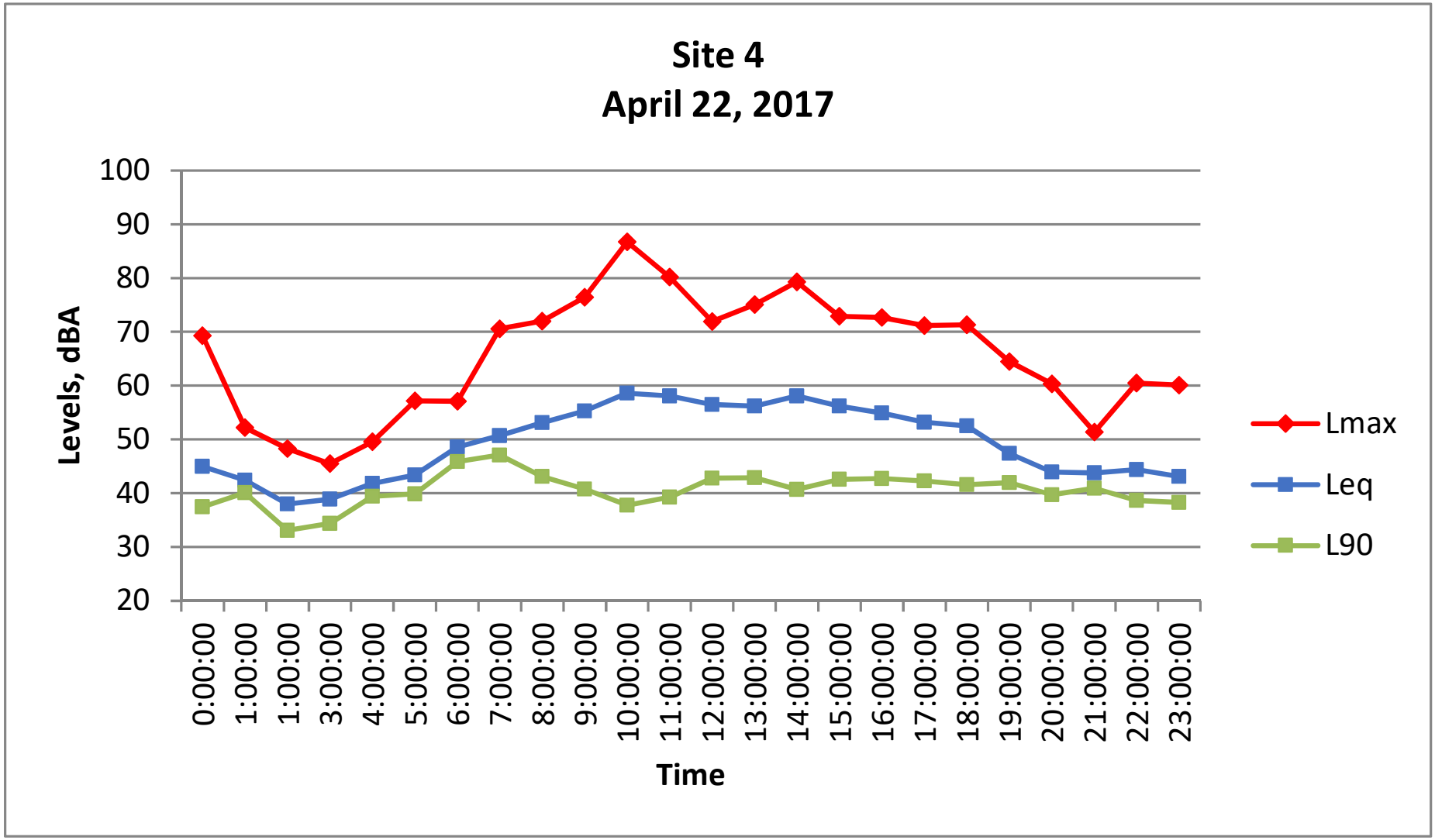
Site 4
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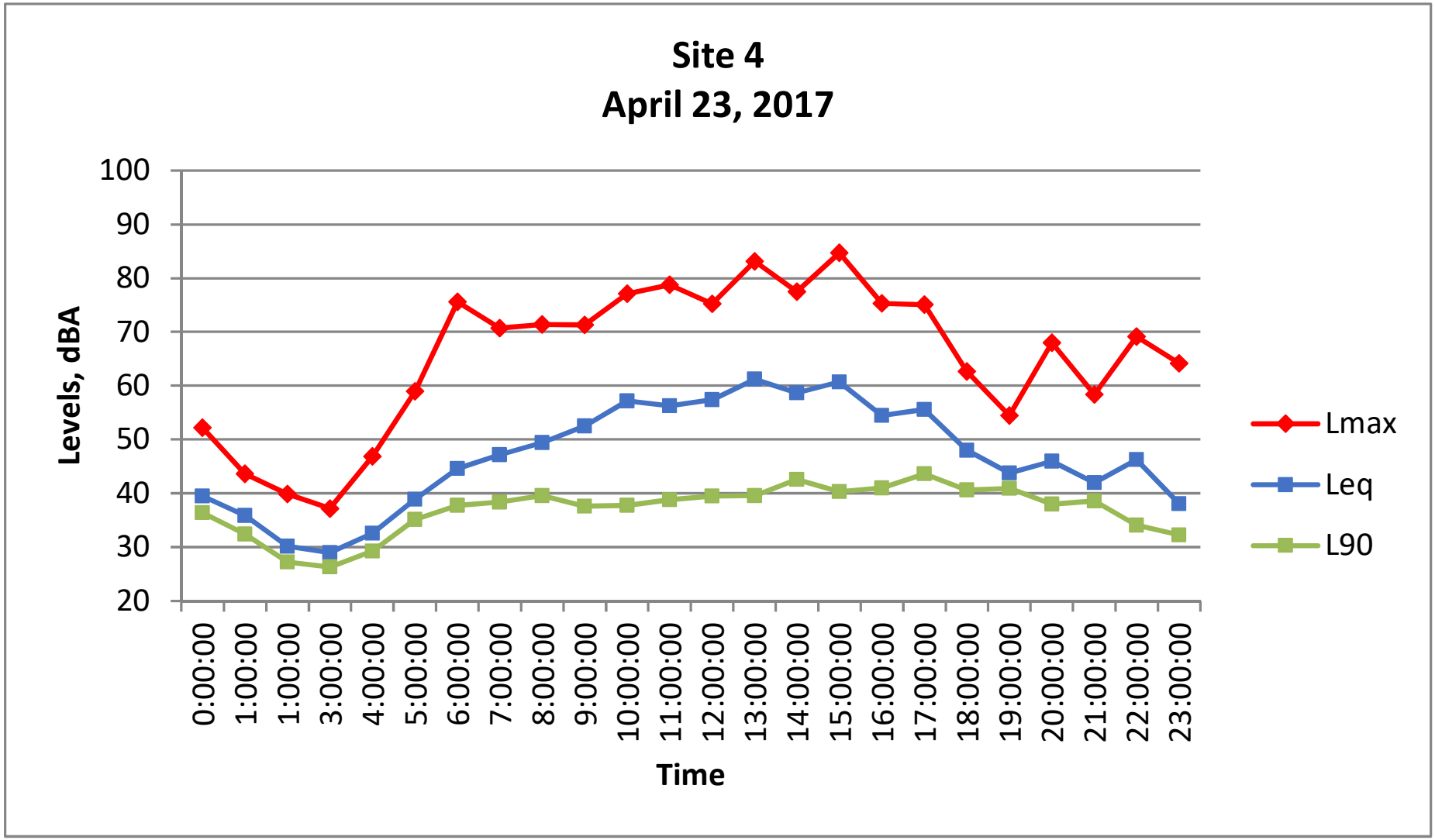
Site 4
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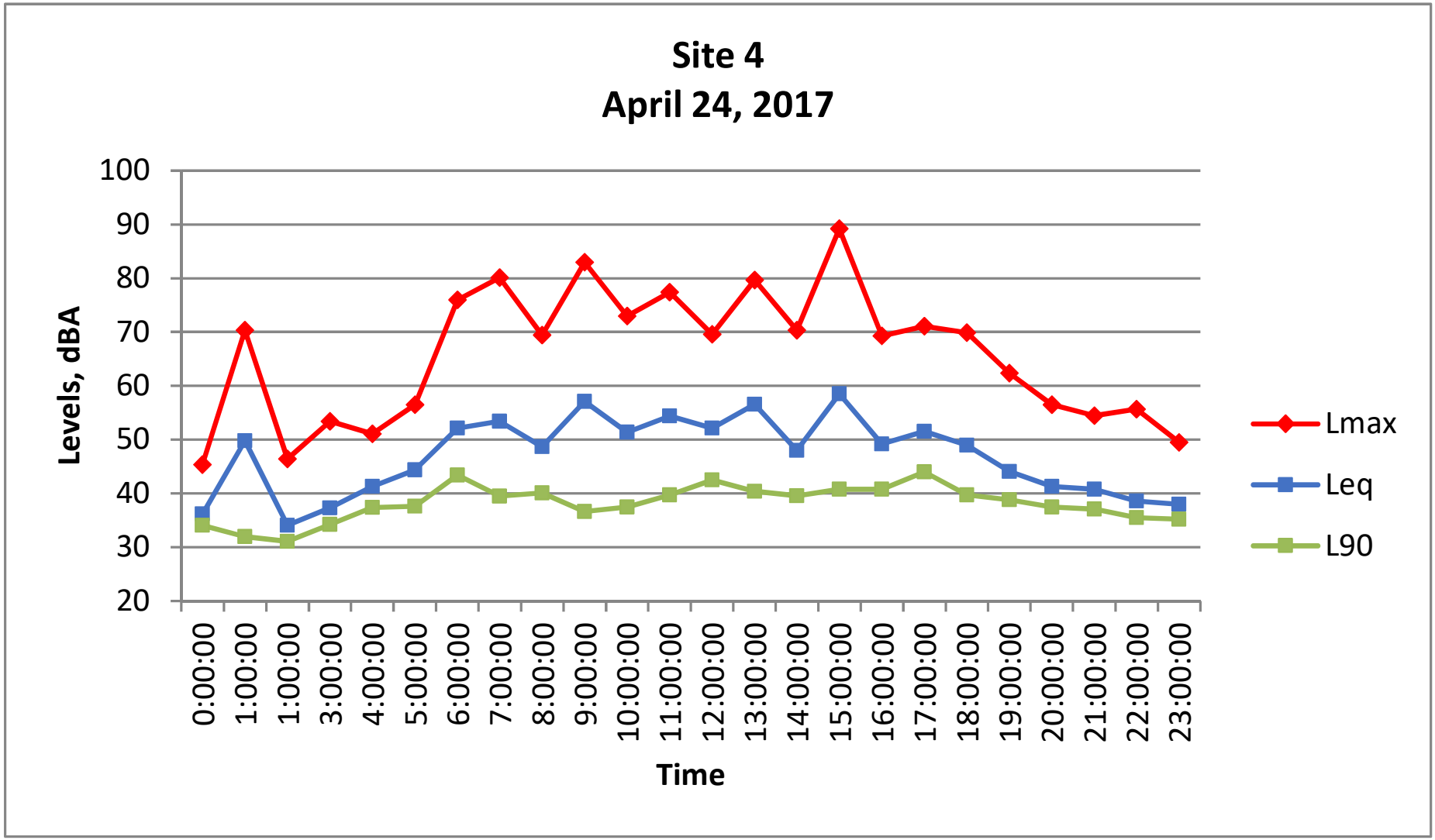
Site 4
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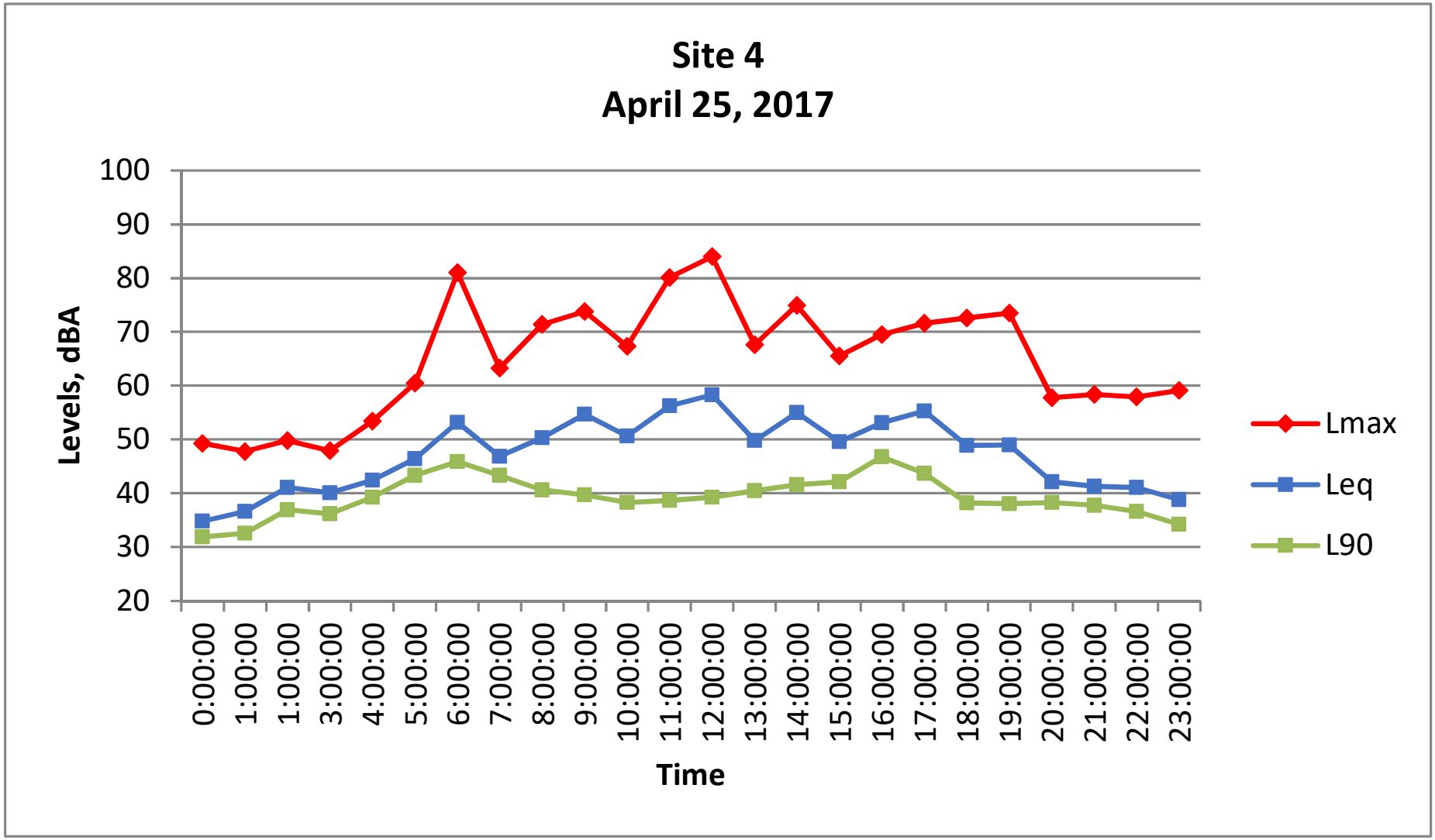
Site 4
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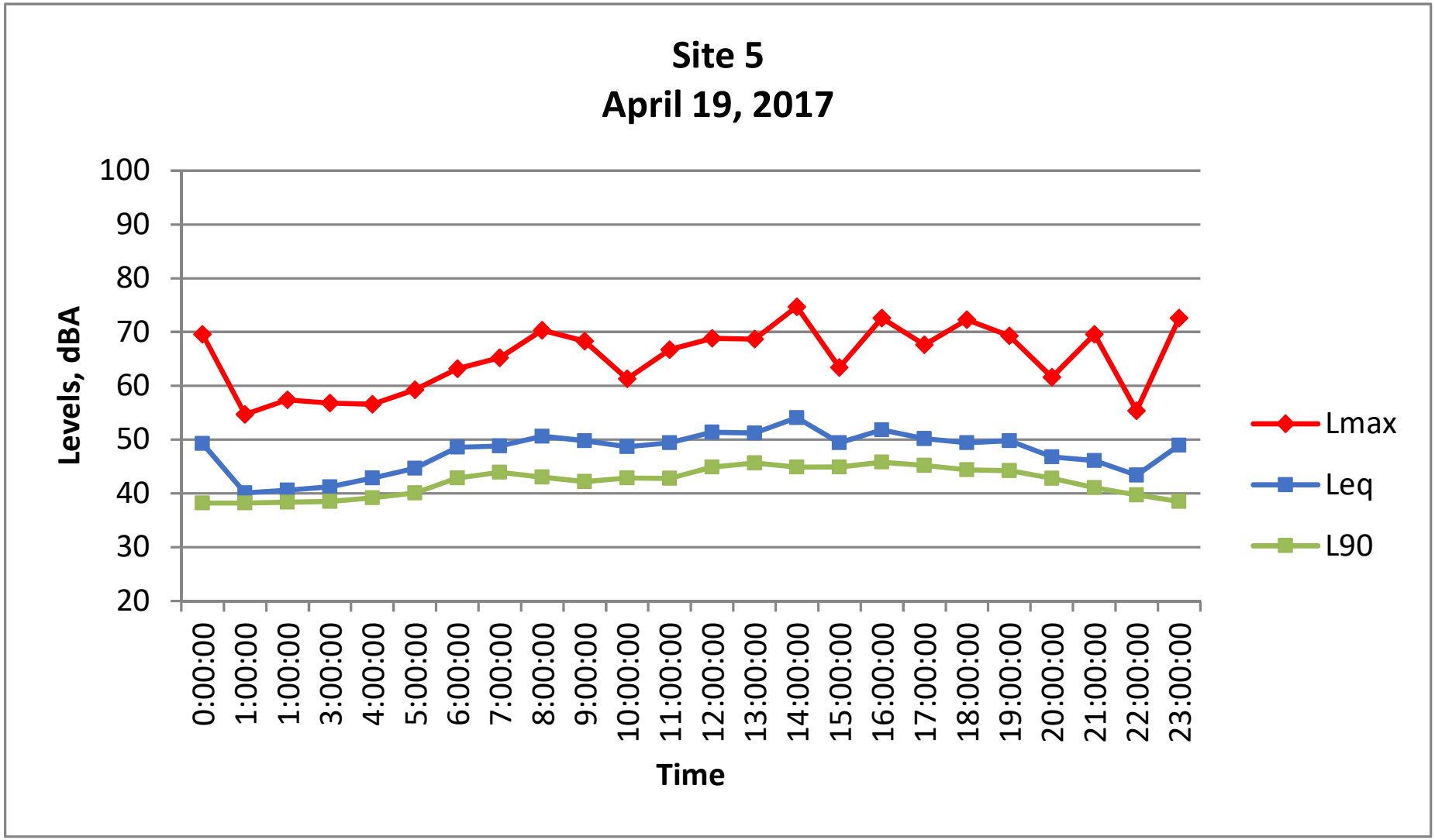
Site 5
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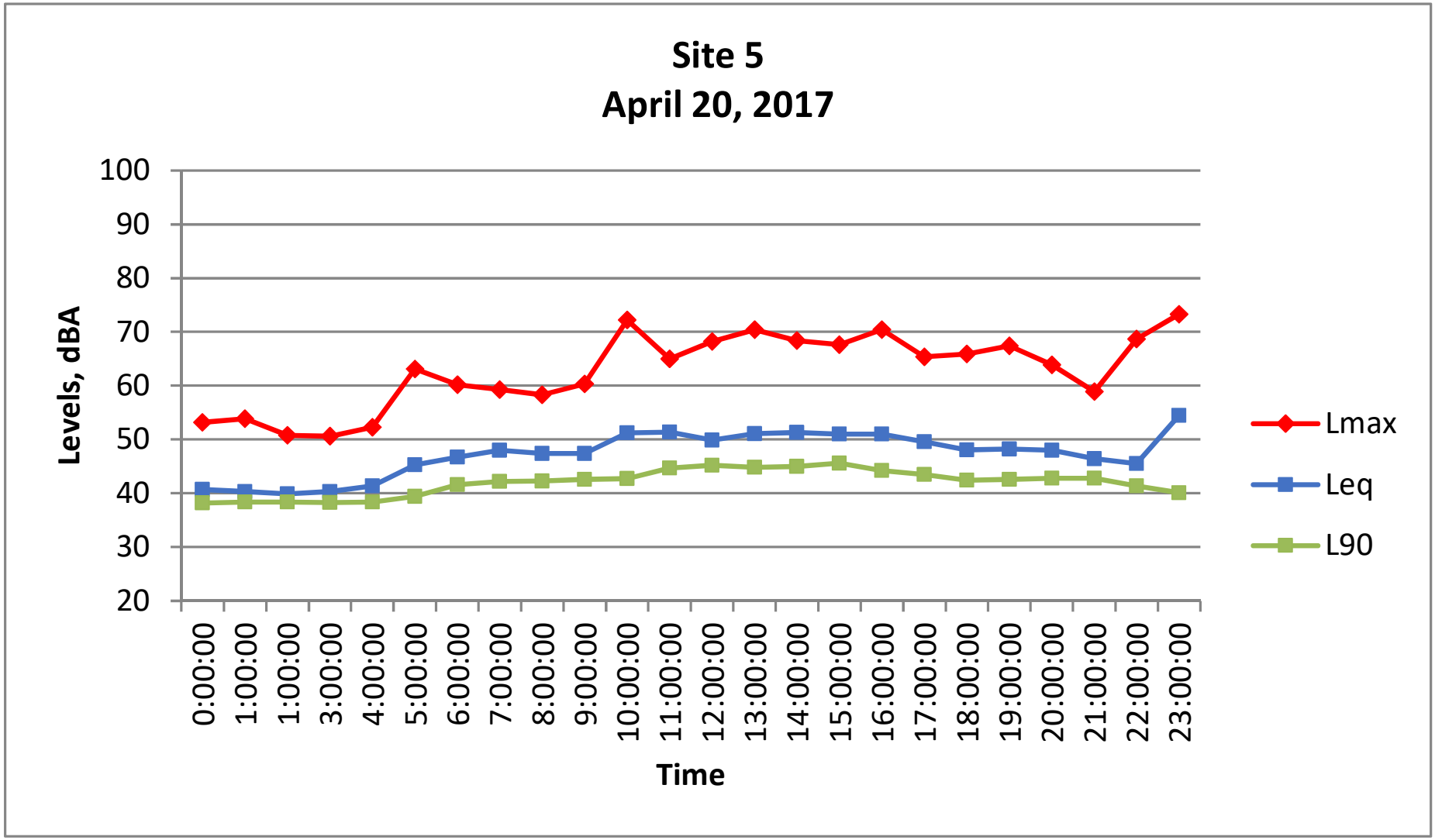
Site 5
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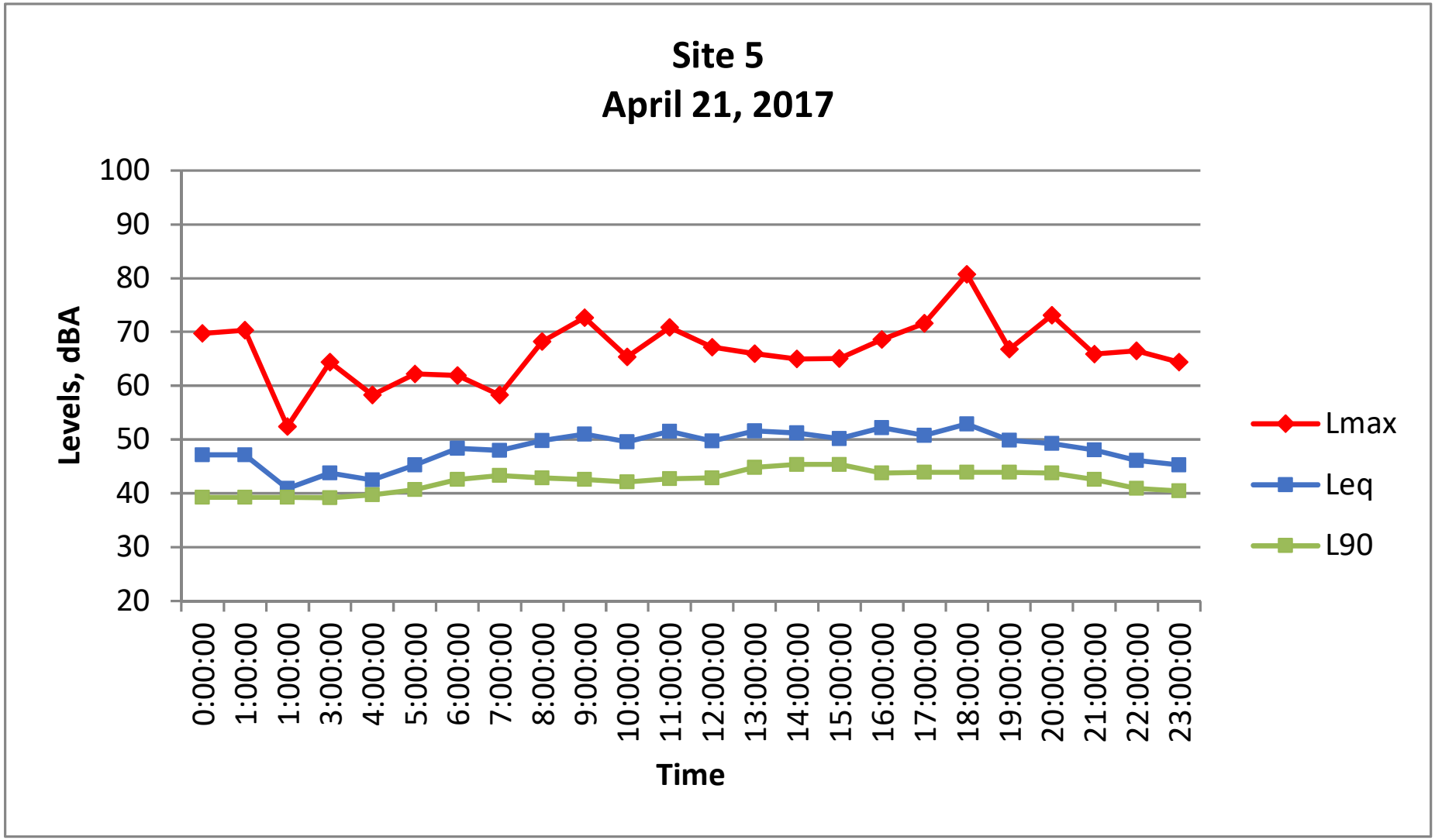
Site 5
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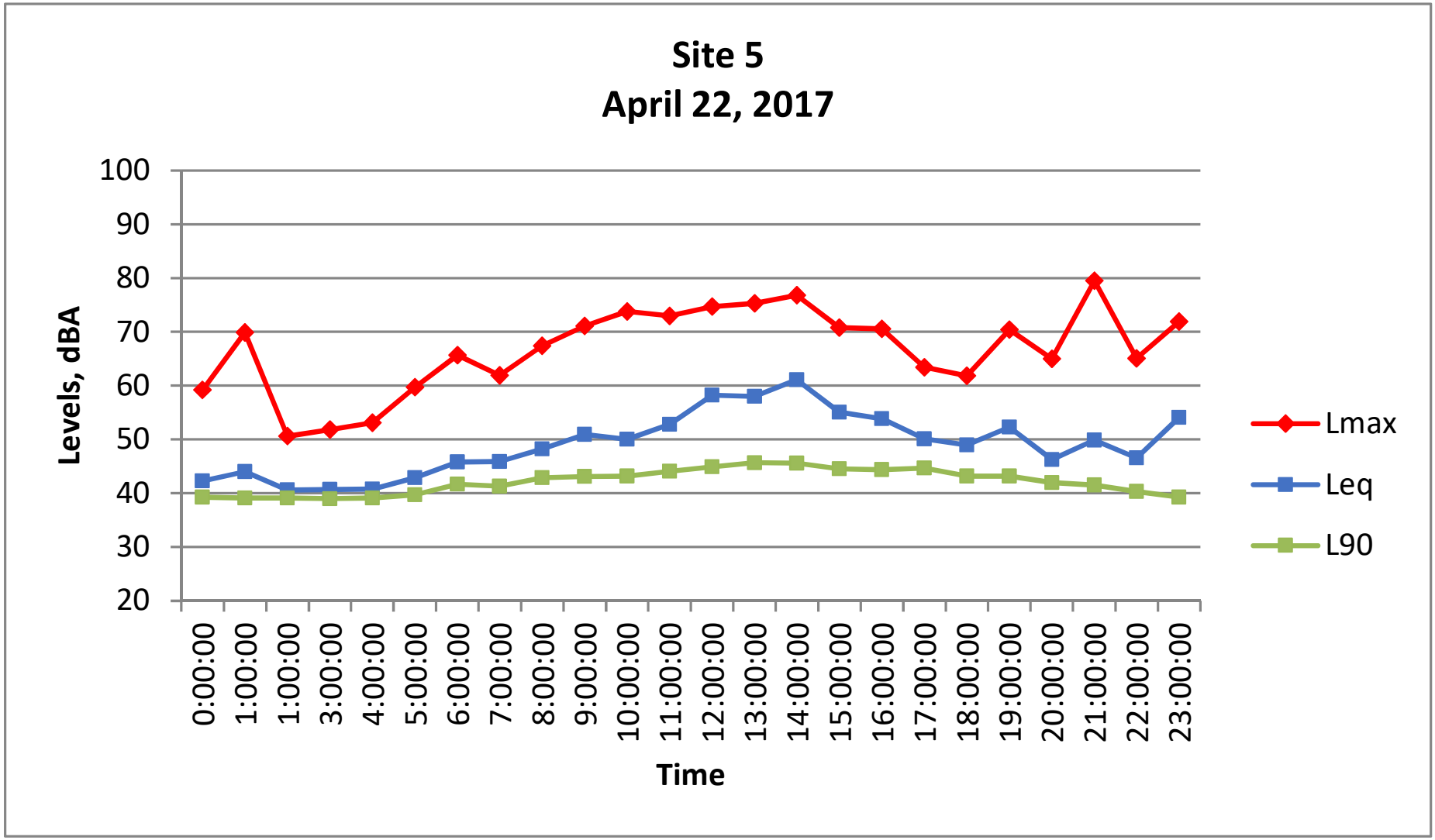
Site 5
April 22, 2017
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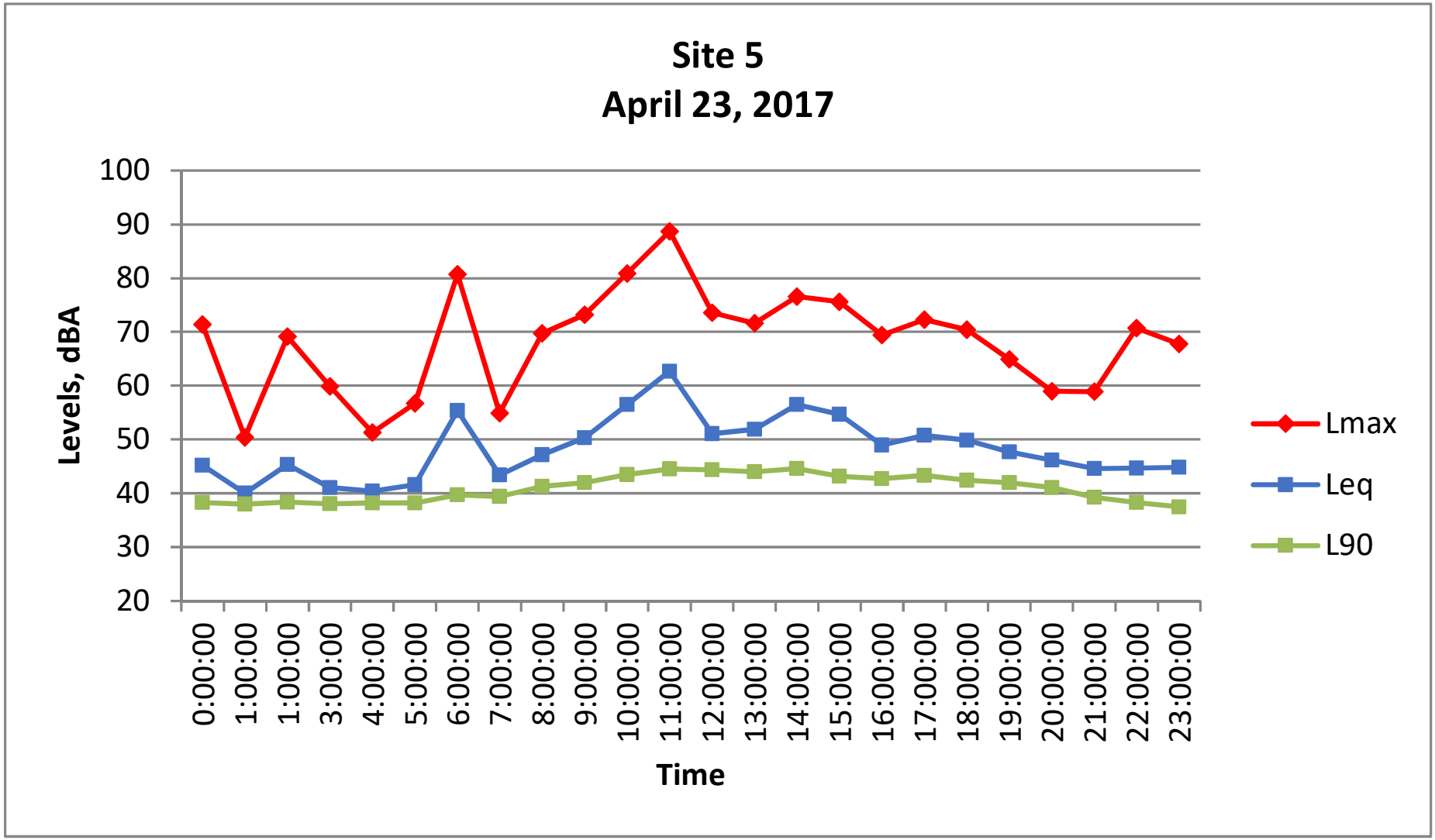
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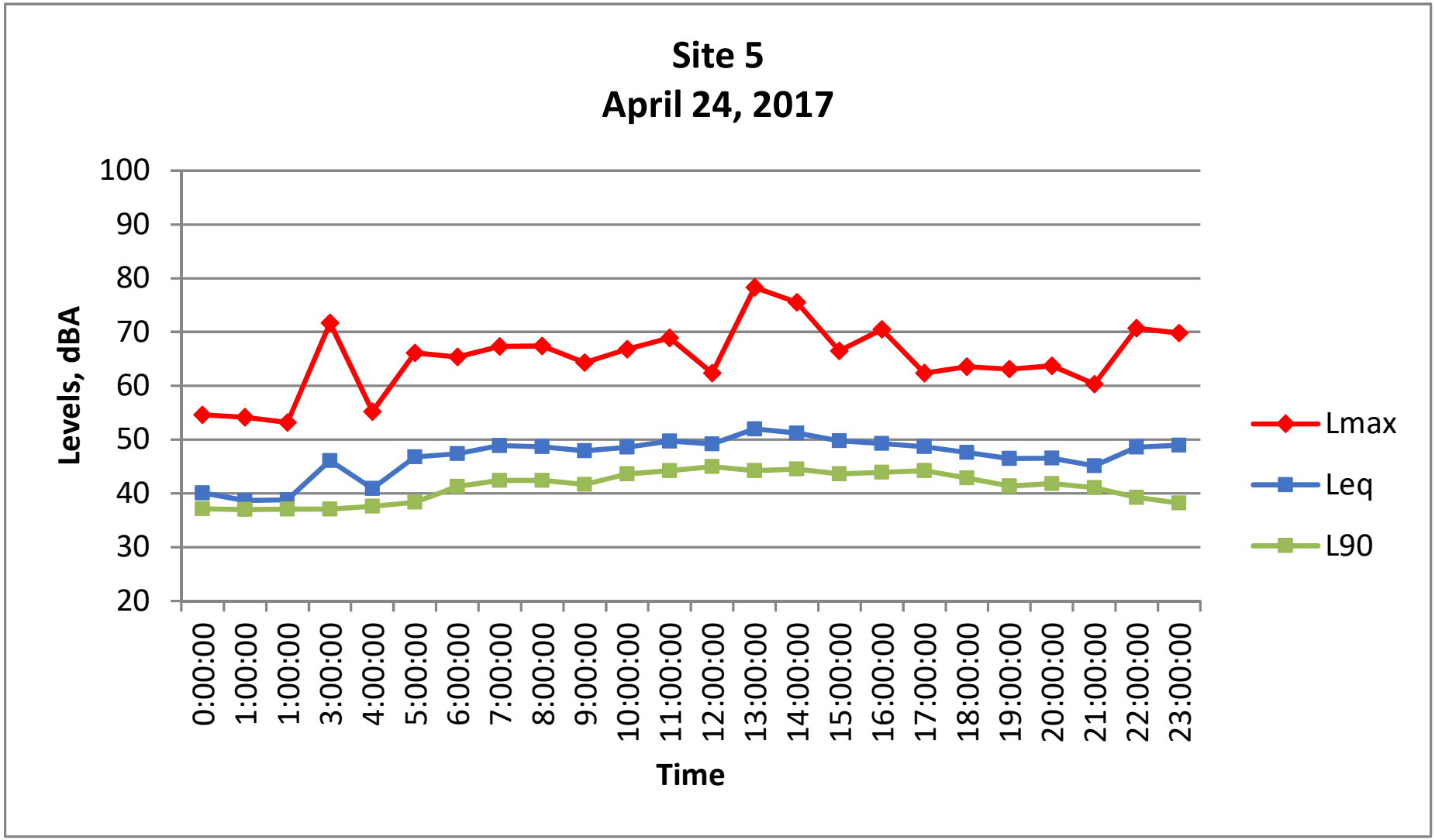
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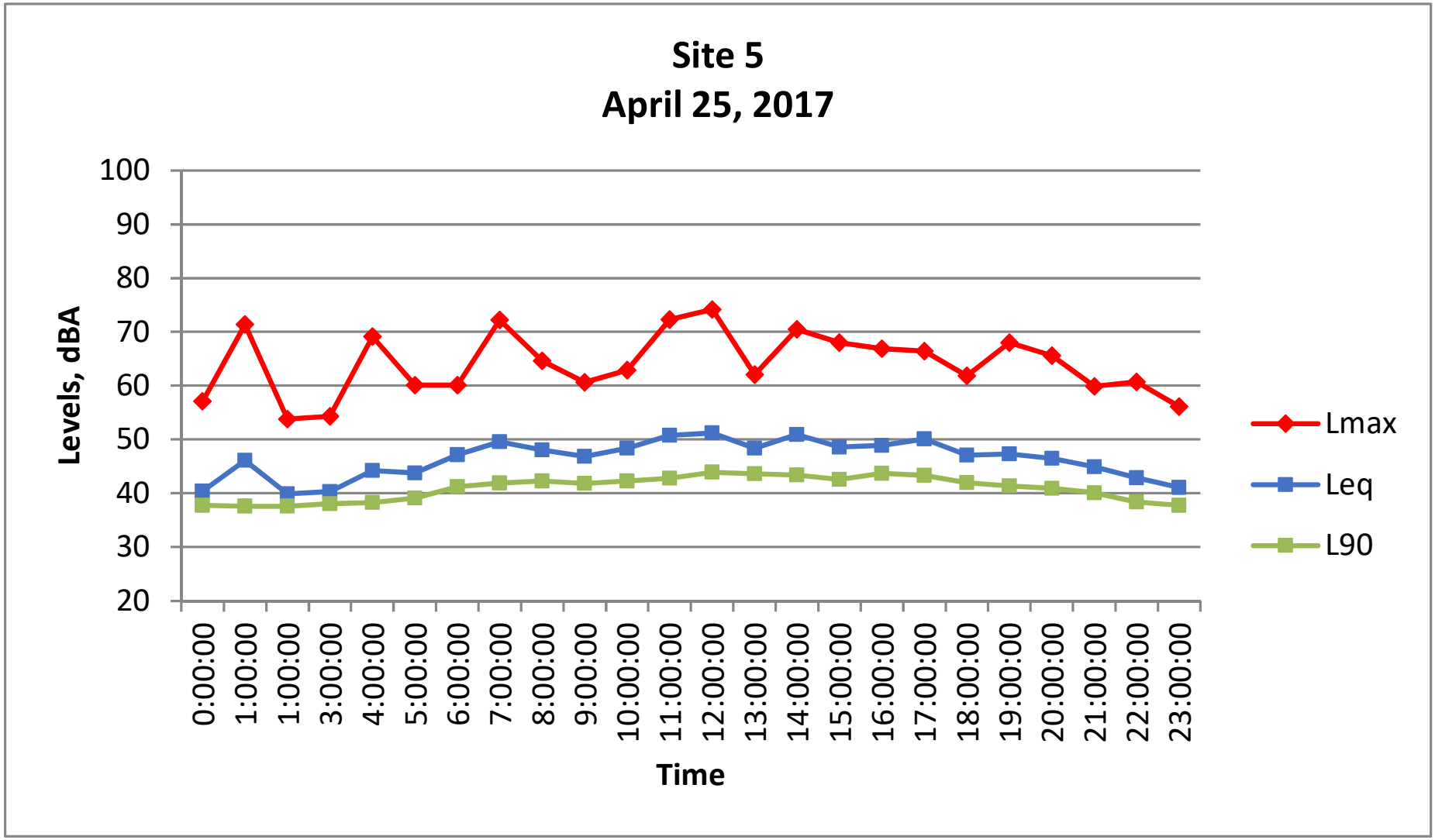
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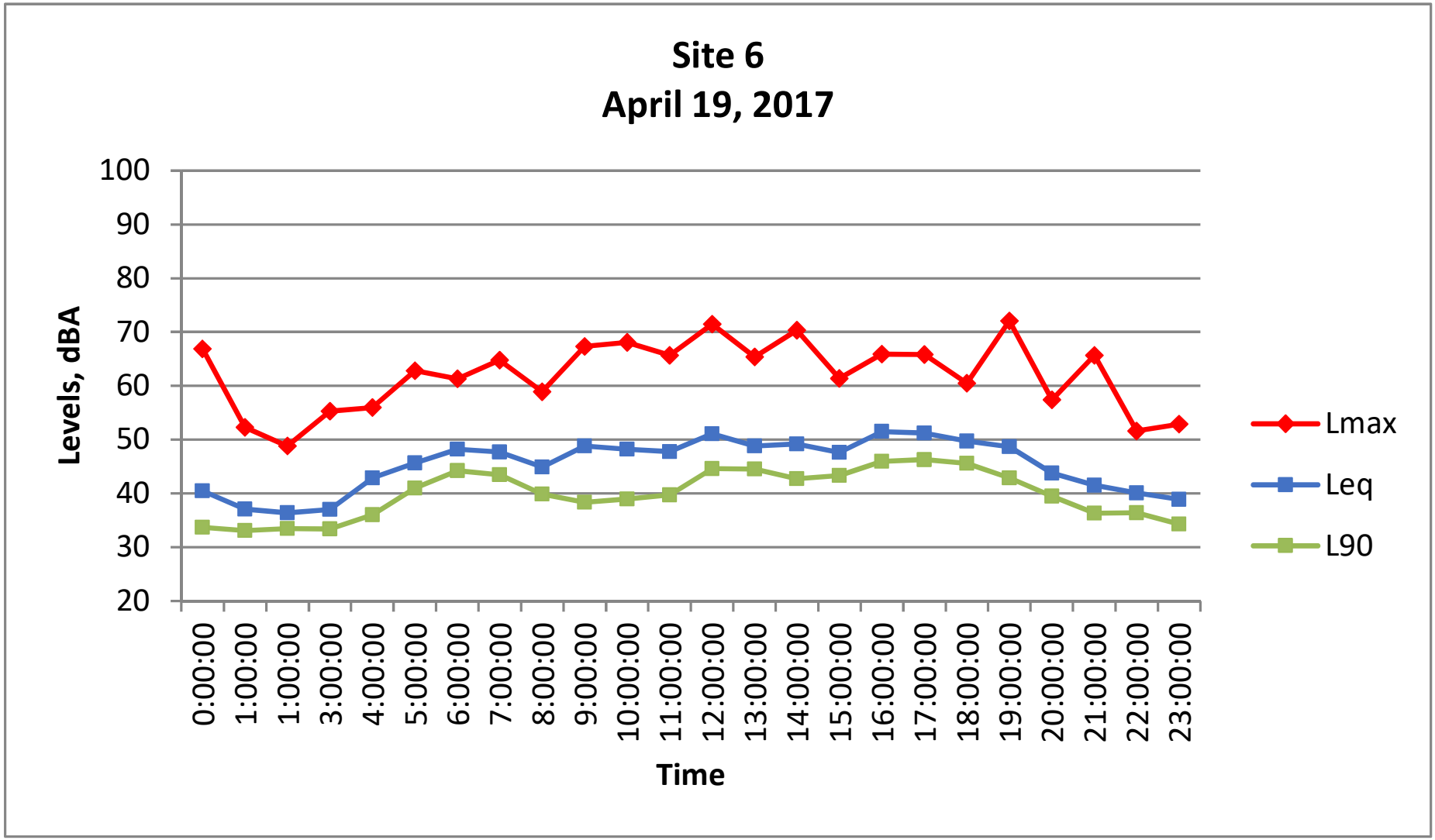
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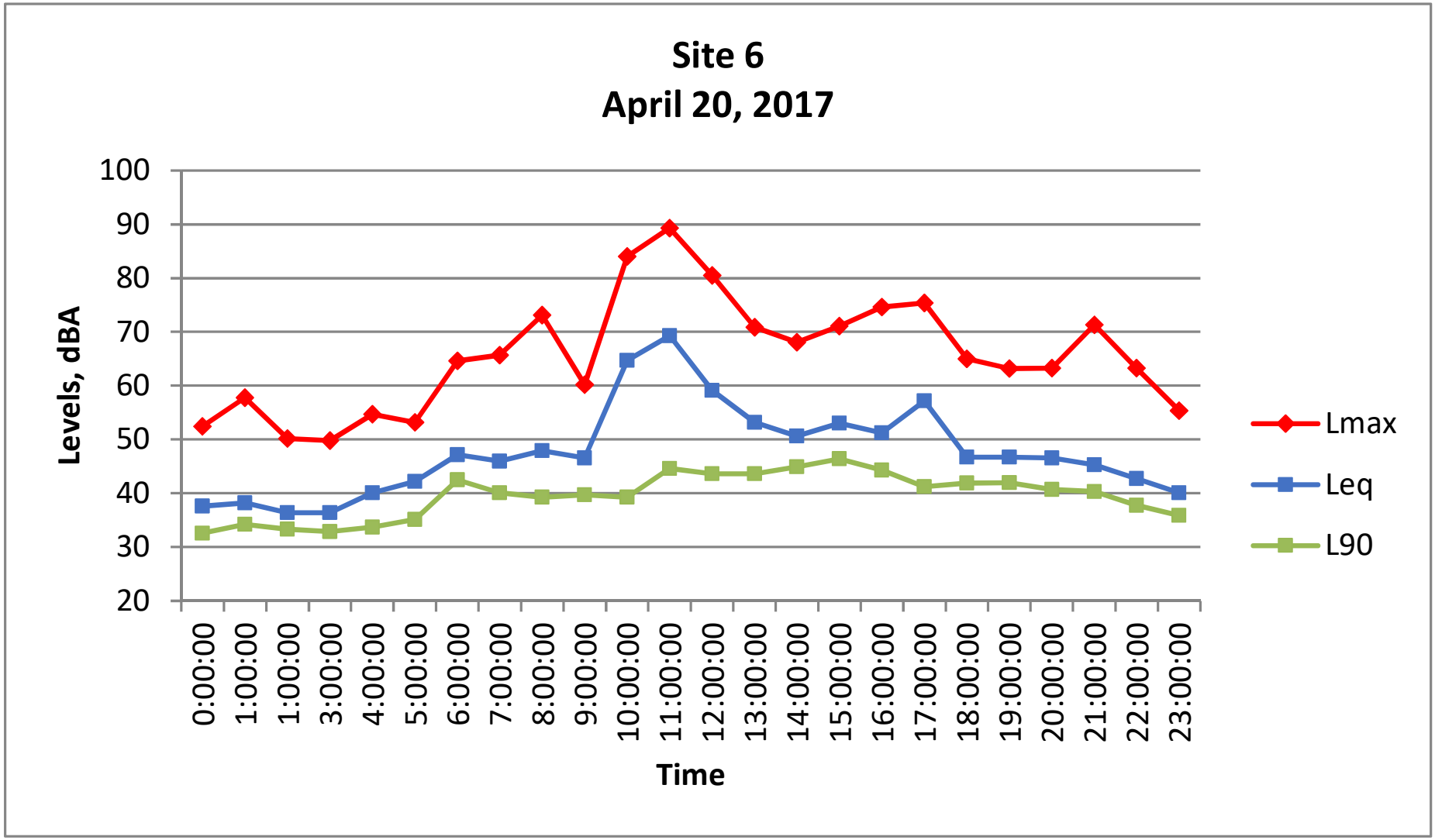
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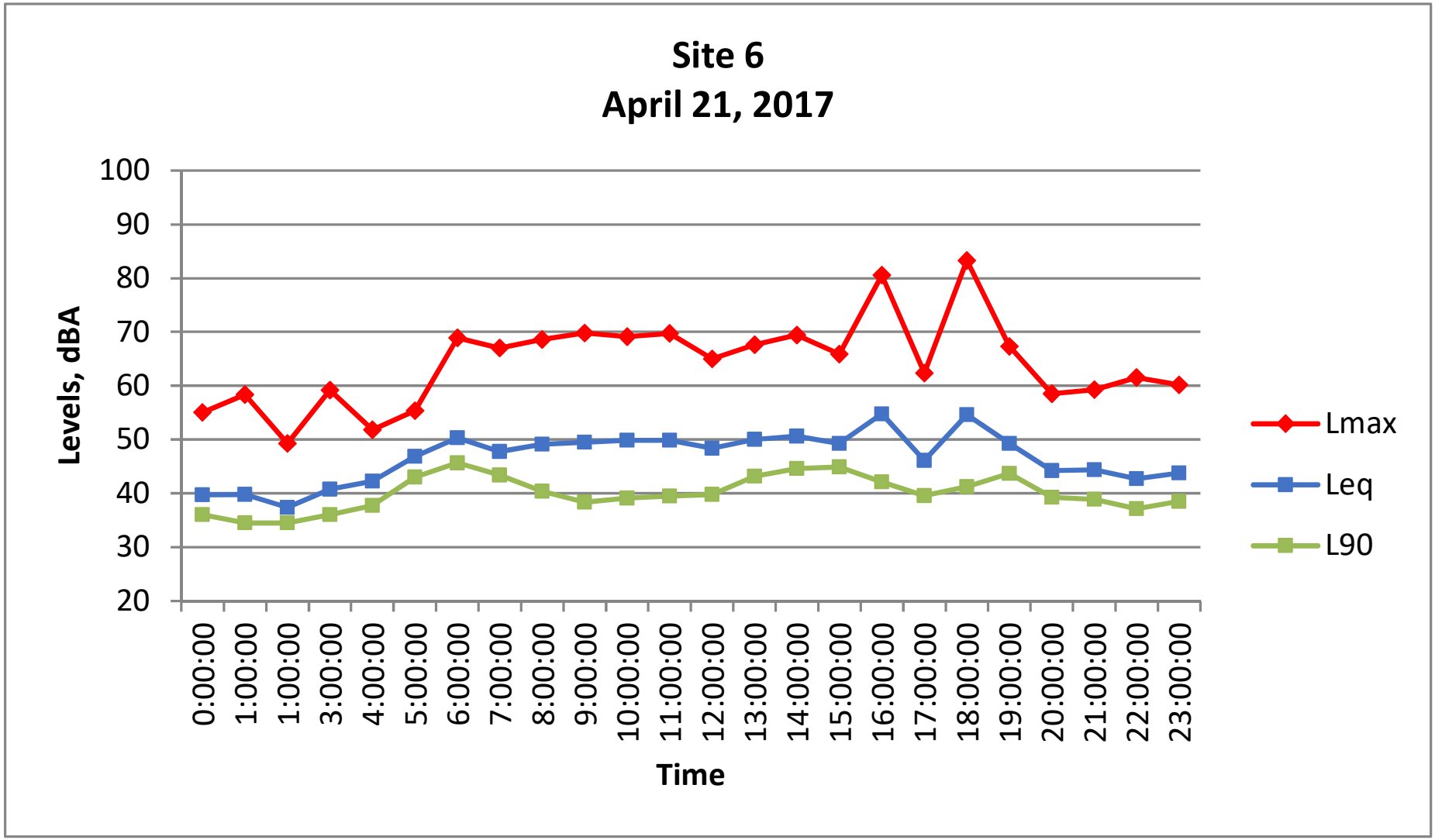
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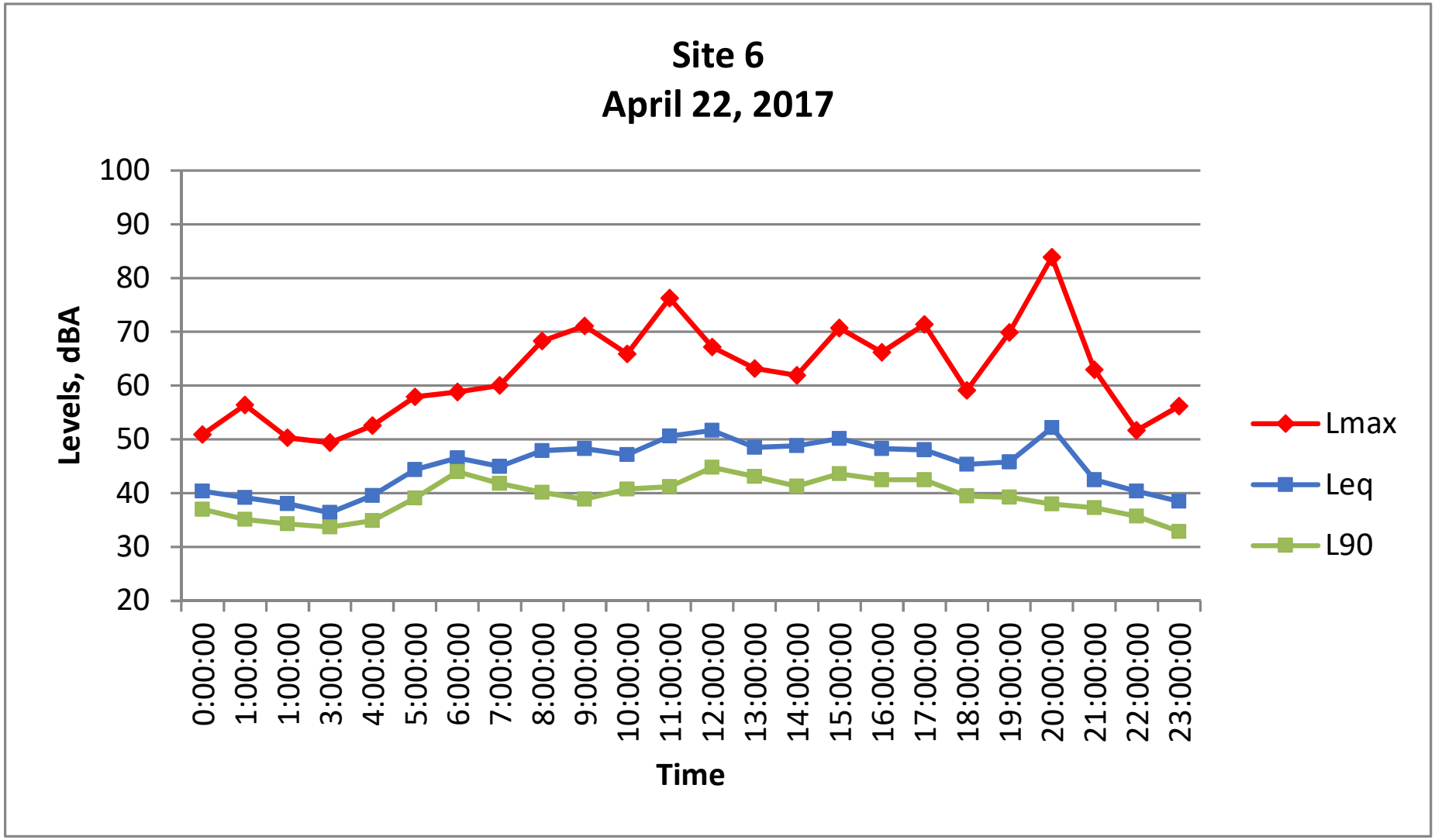
Site 6
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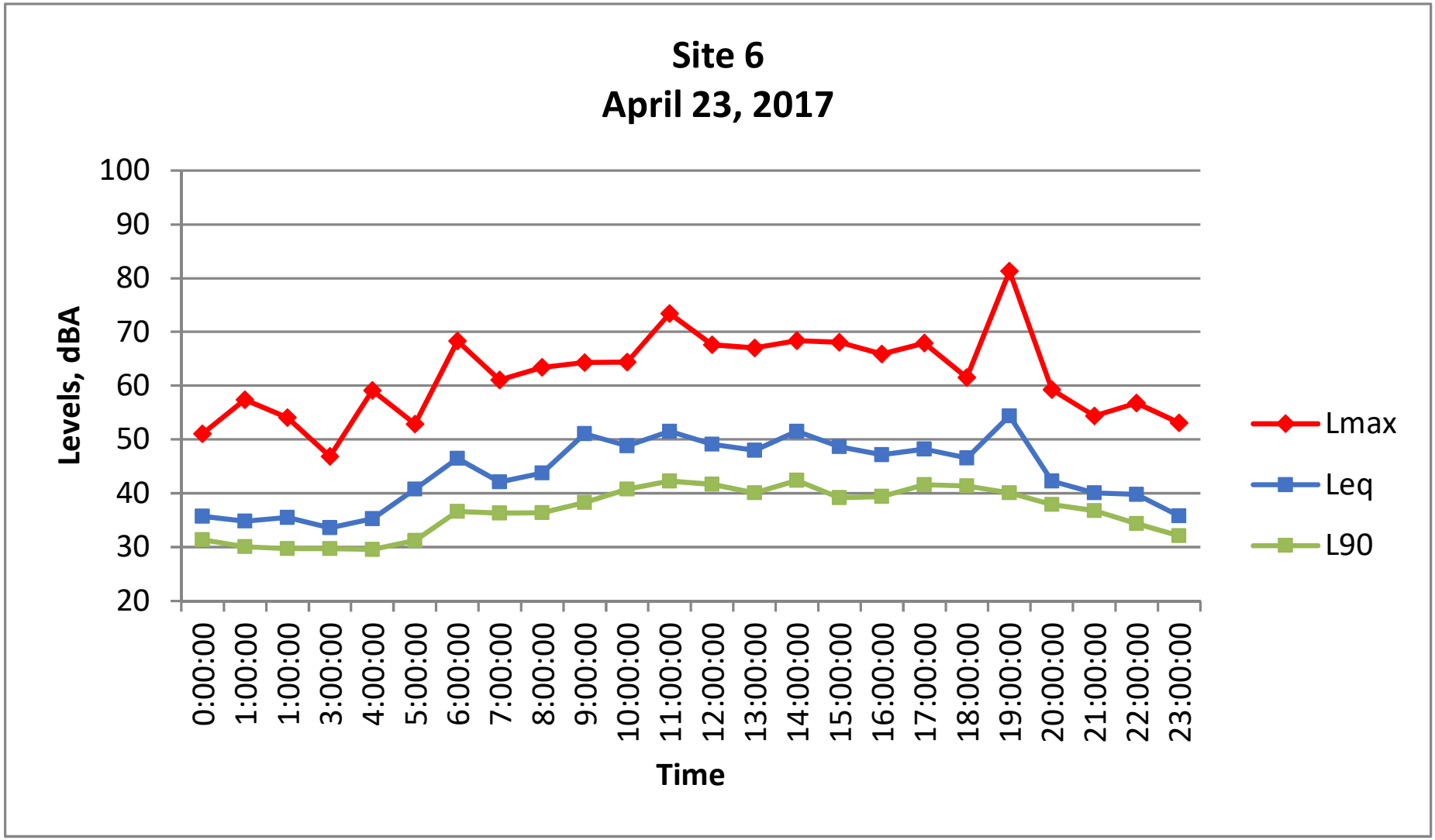
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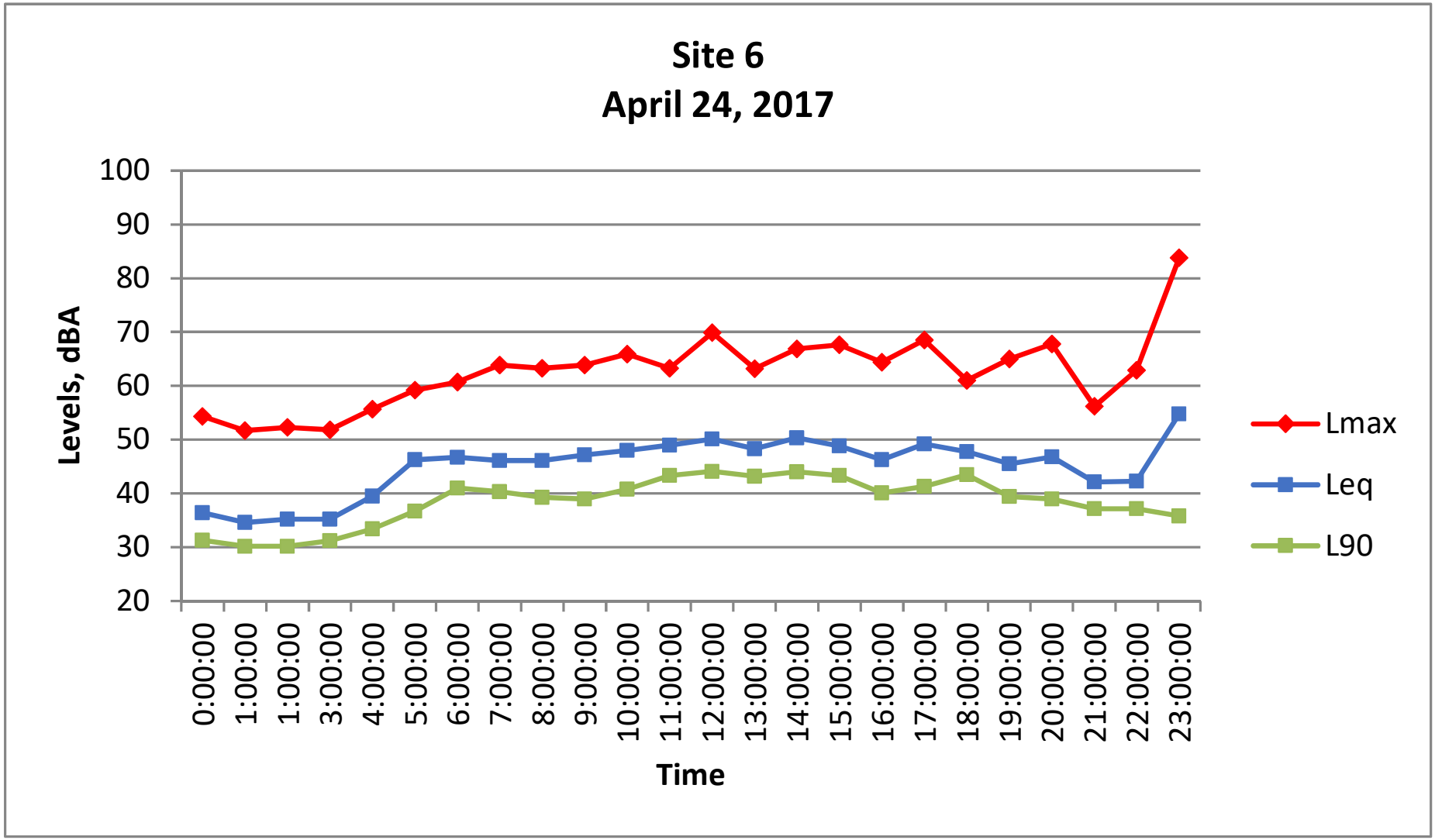
Site 6
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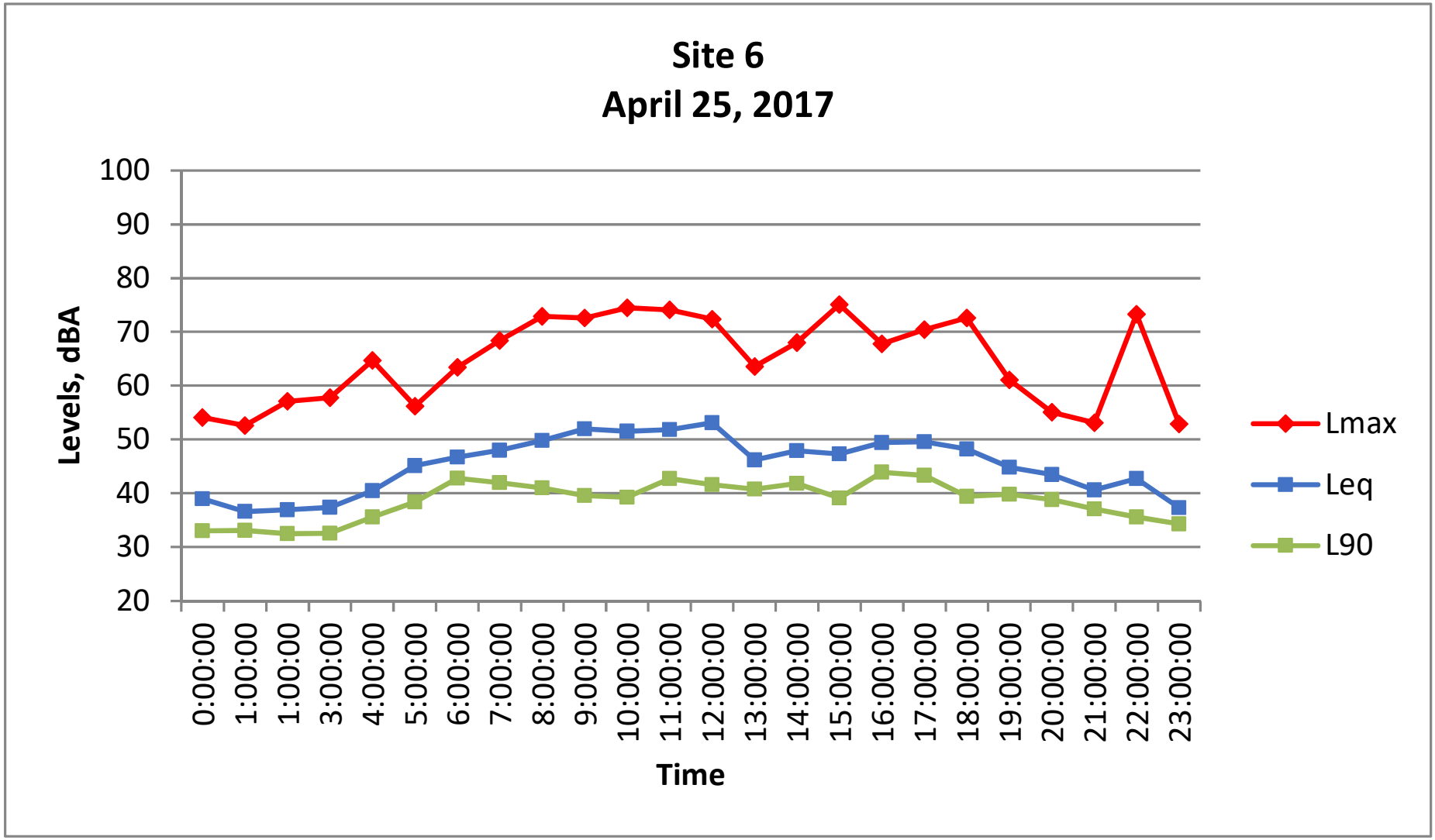
Site 6
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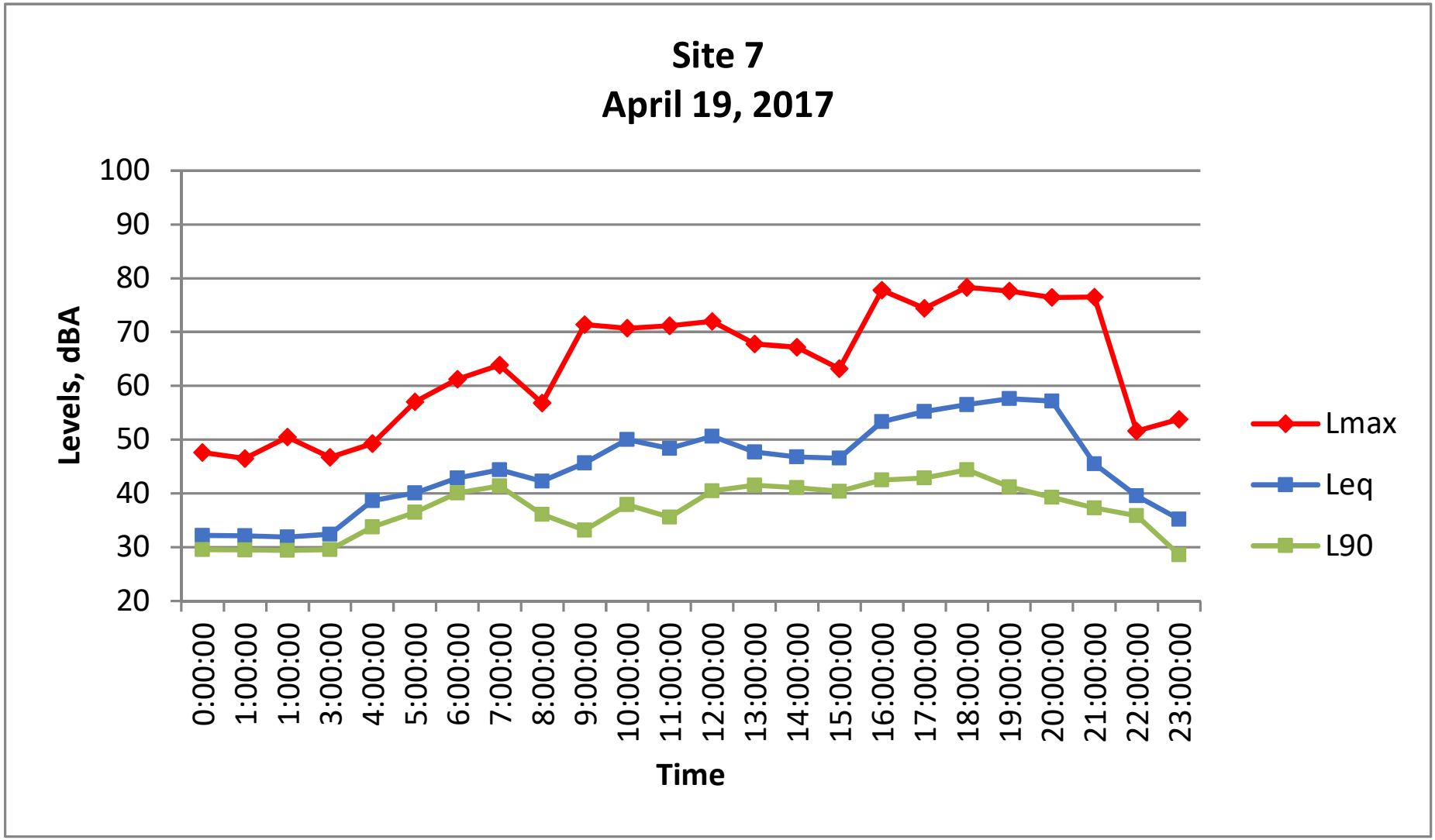
Site 7
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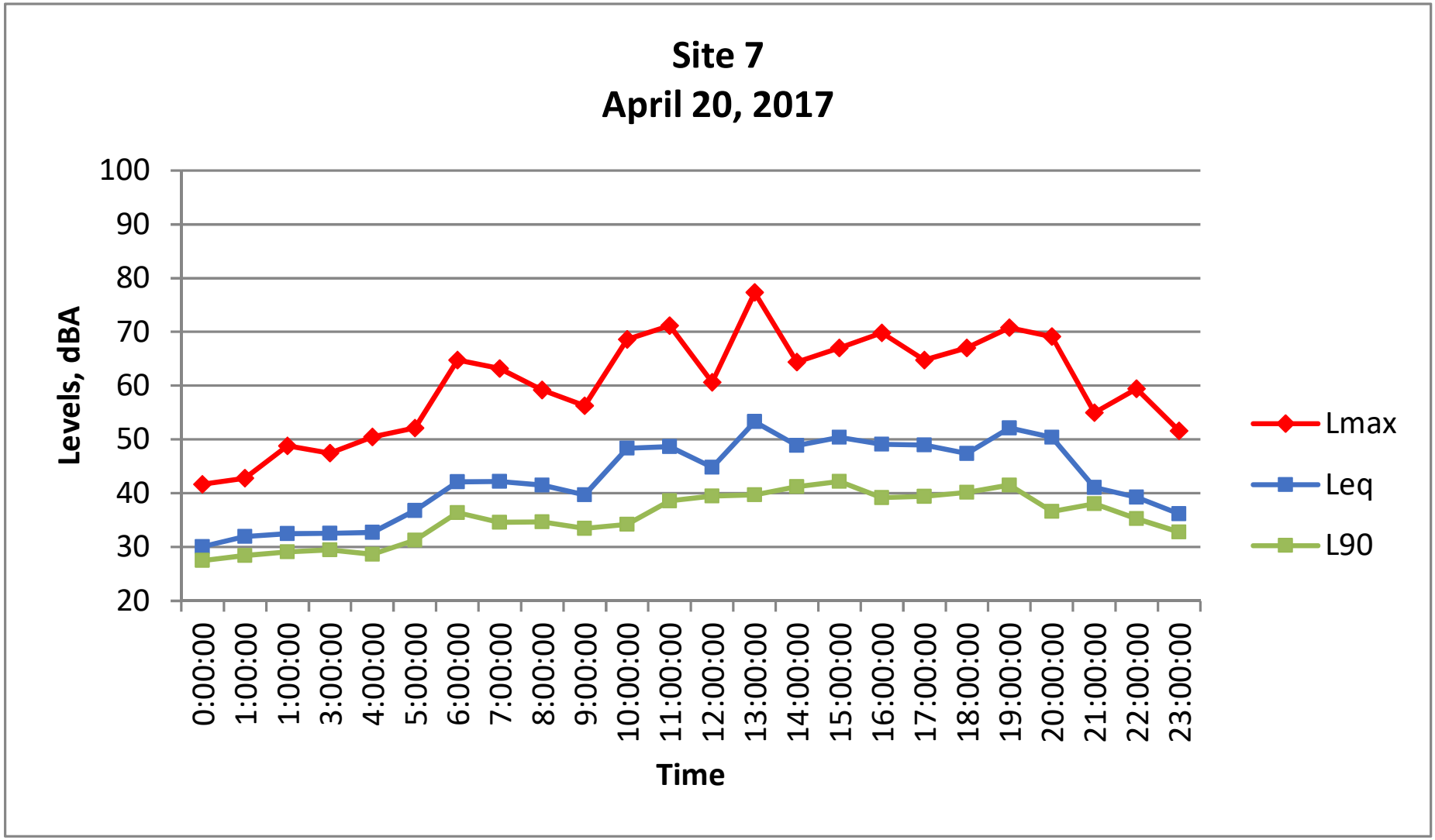
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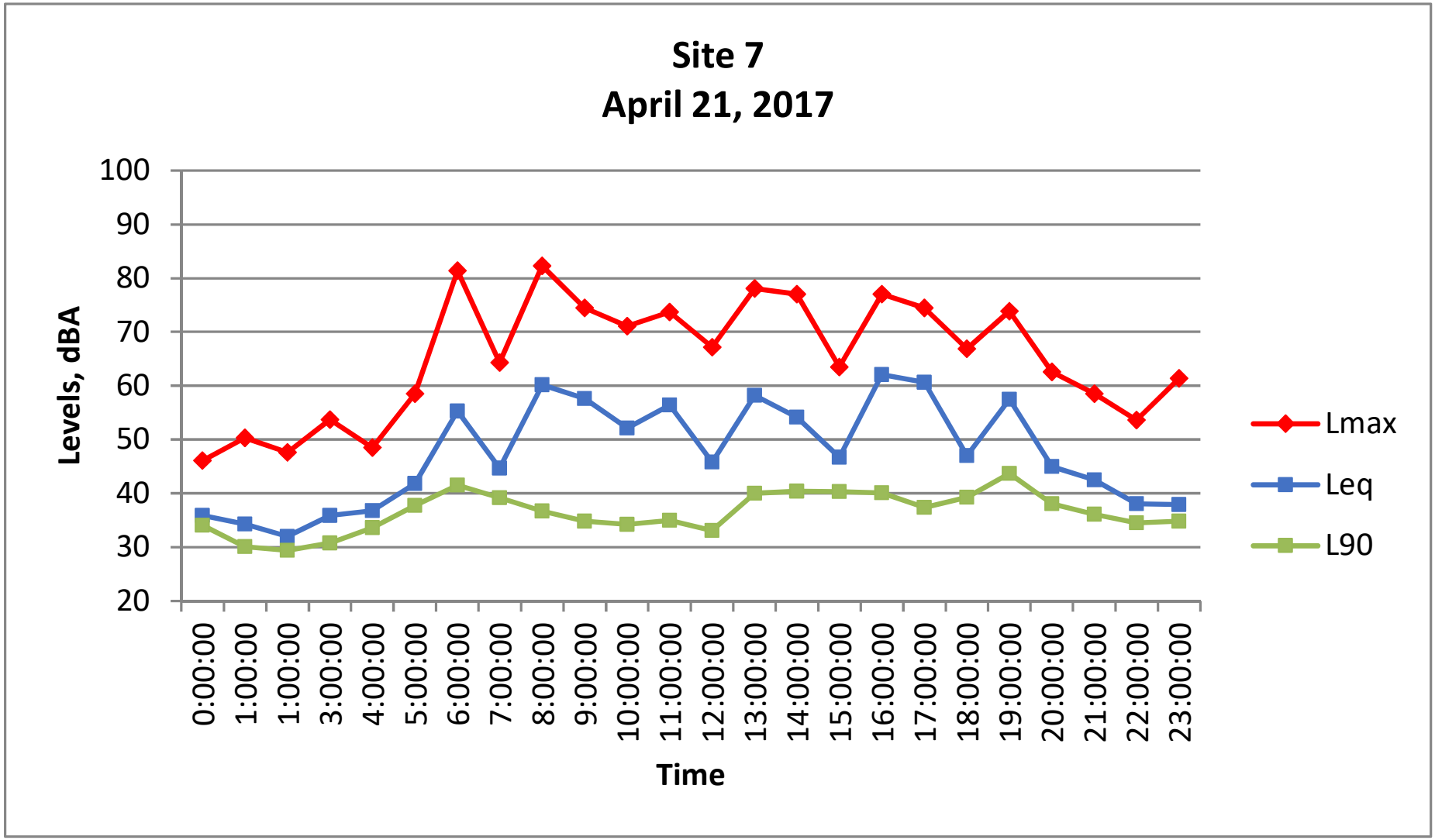
Site 7
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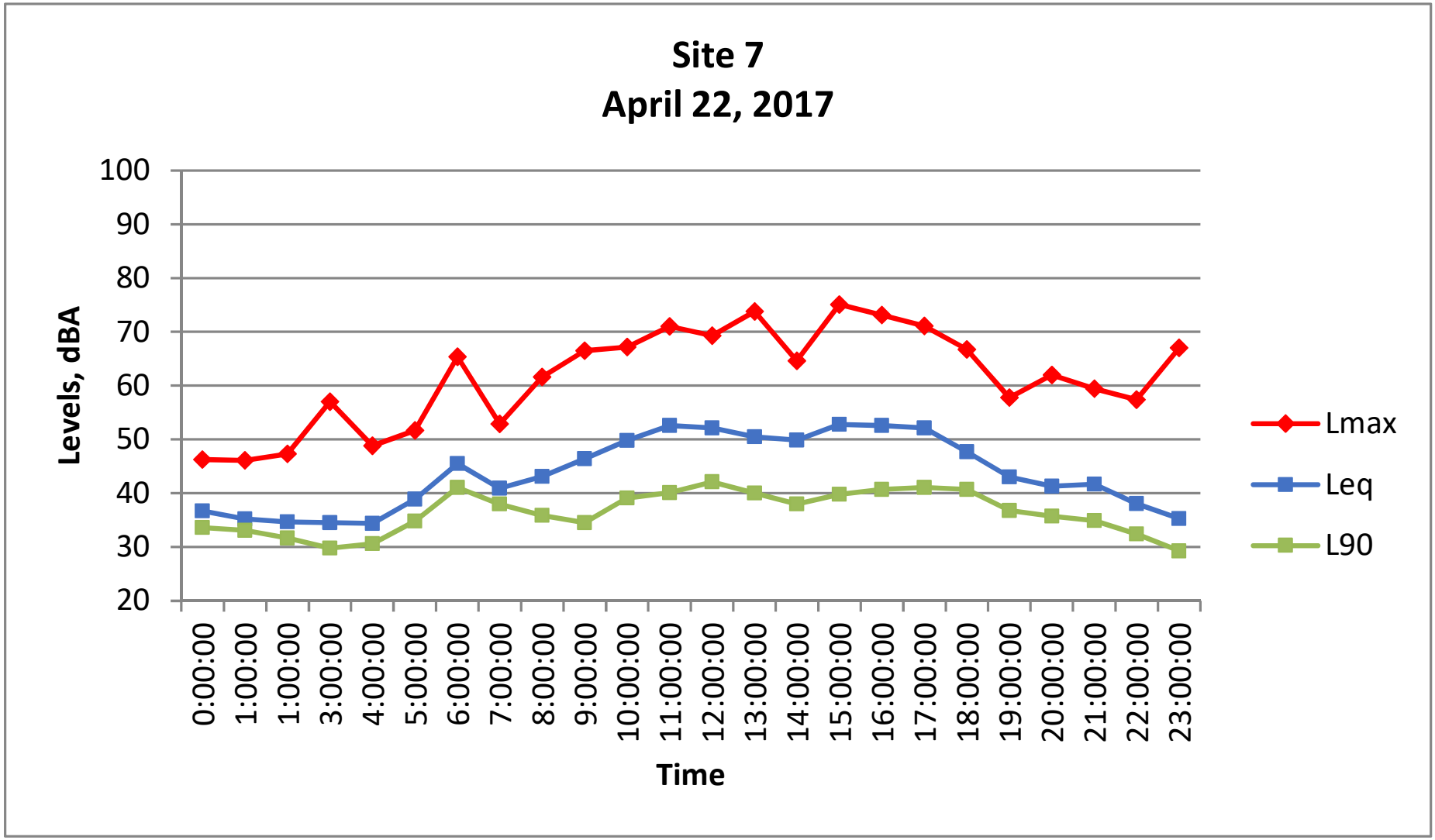
Site 7
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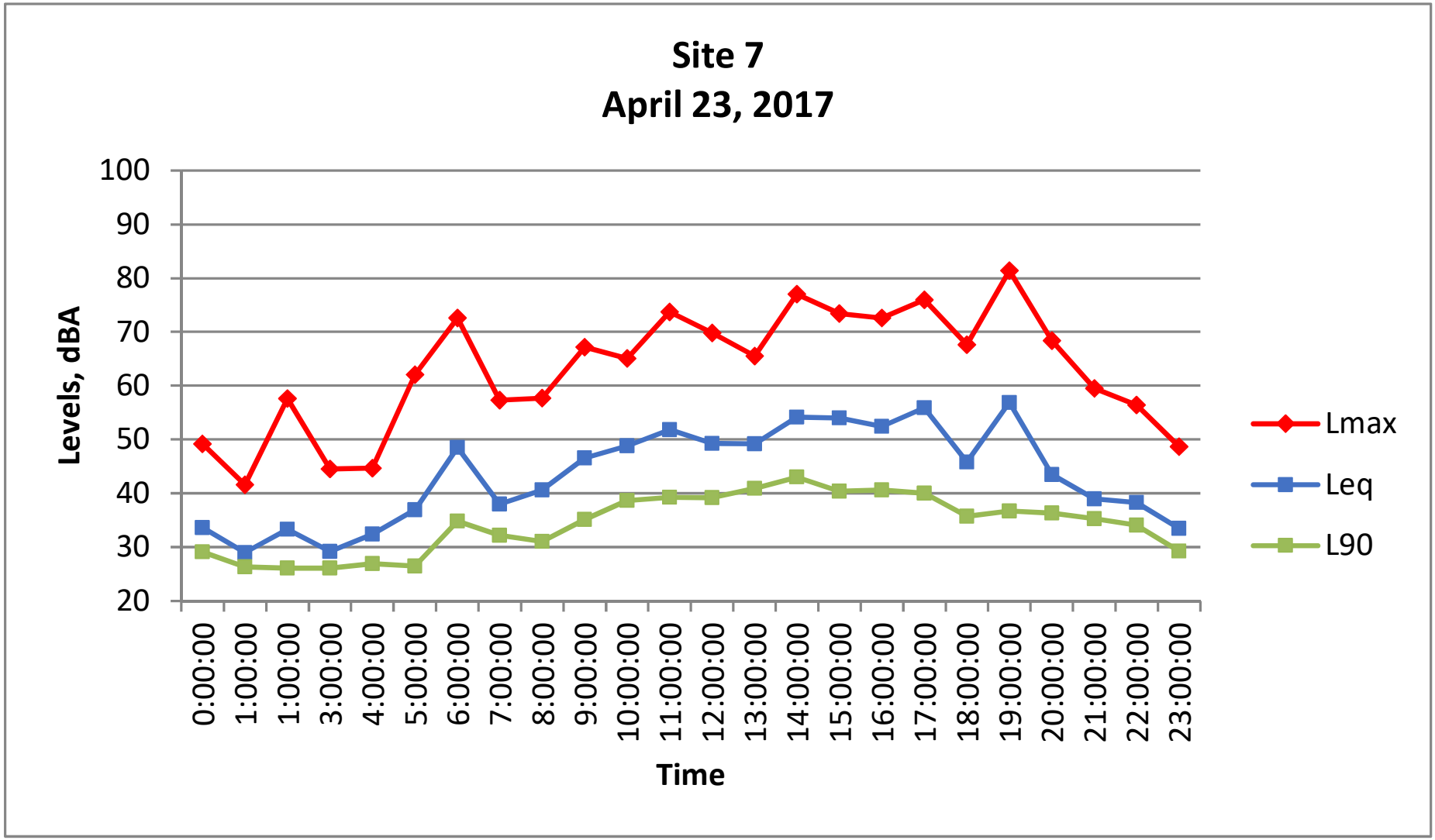
Site 7
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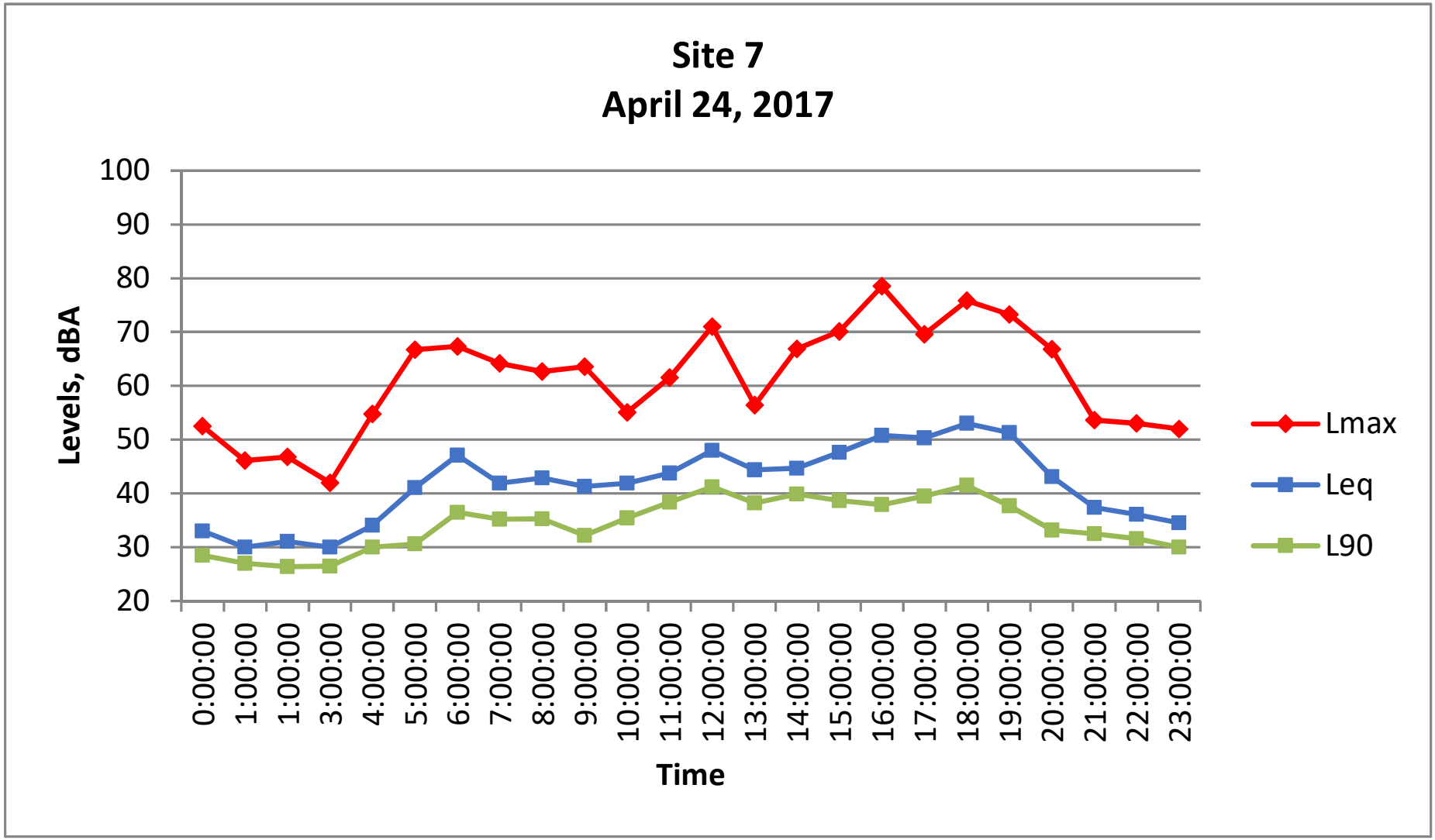
Site 7
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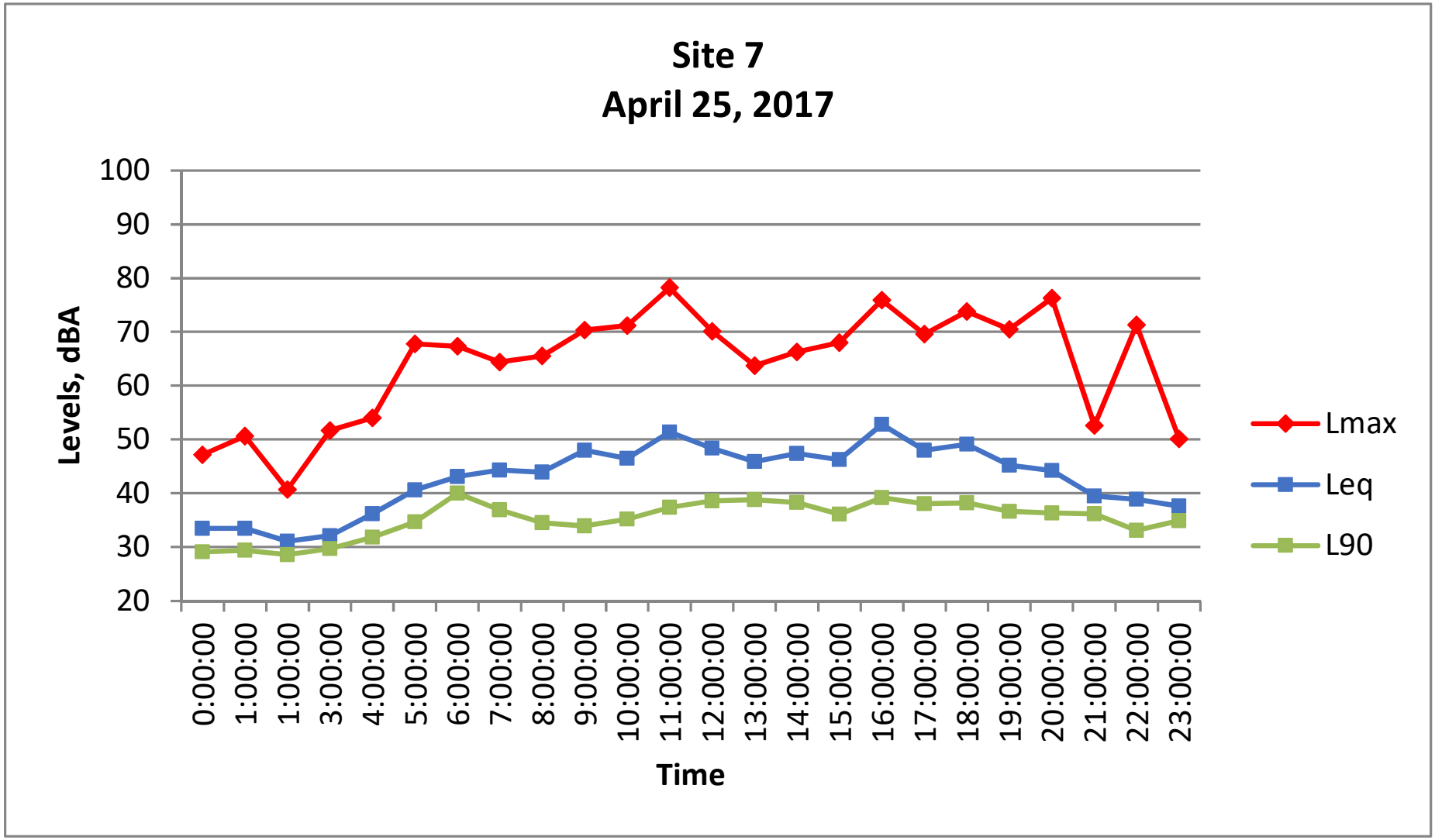
Site 7
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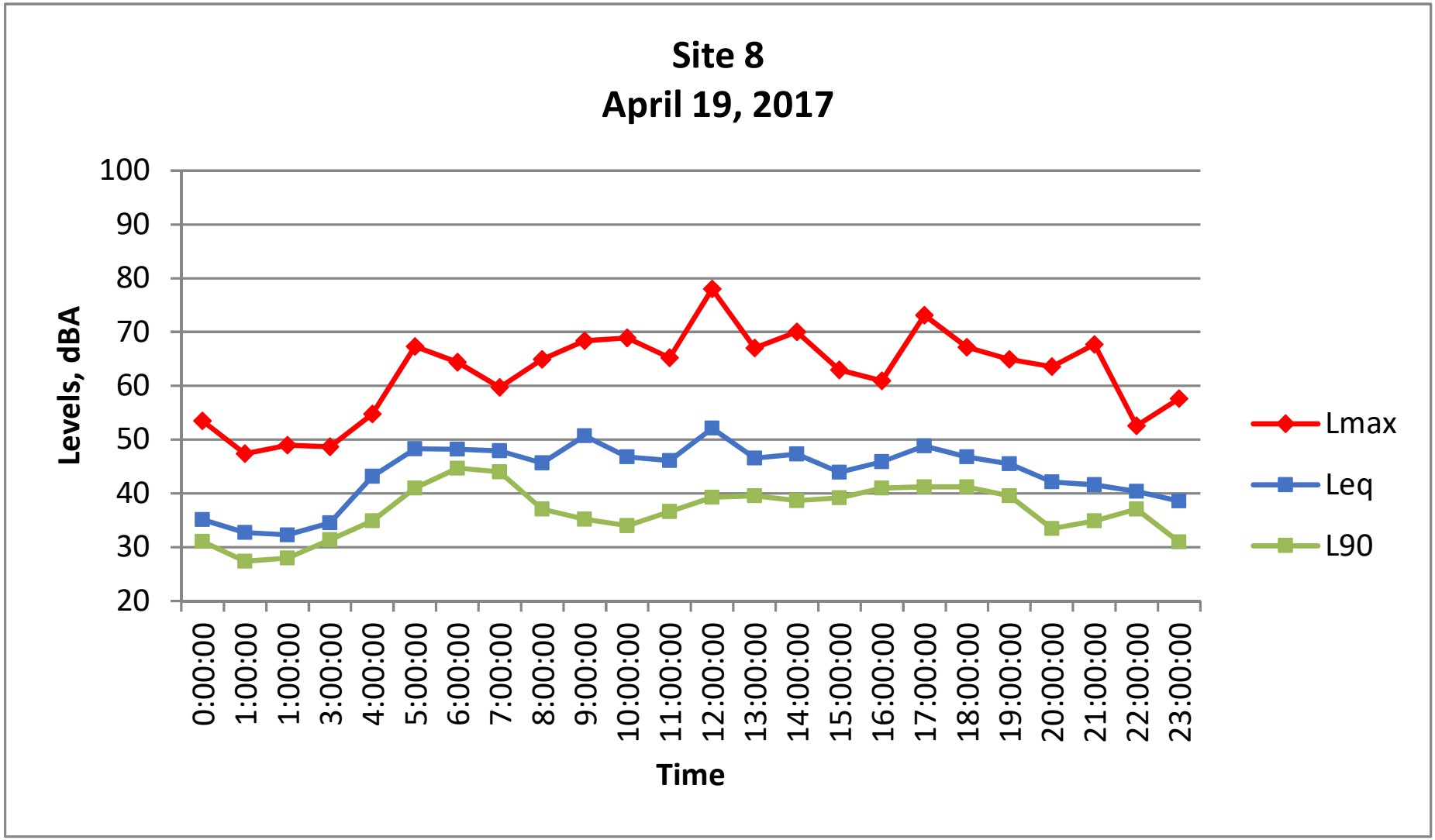
Site 8
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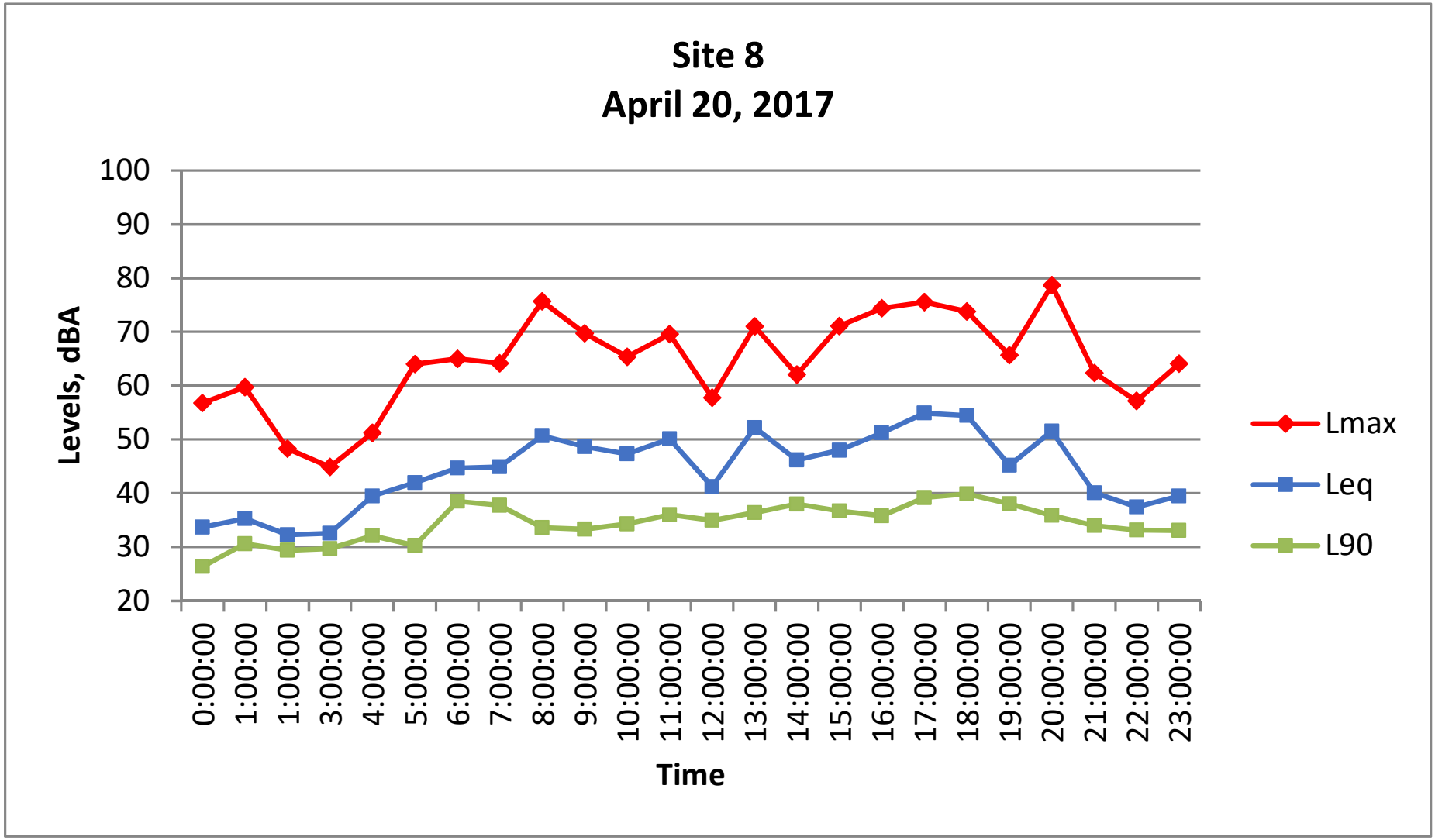
Site 8
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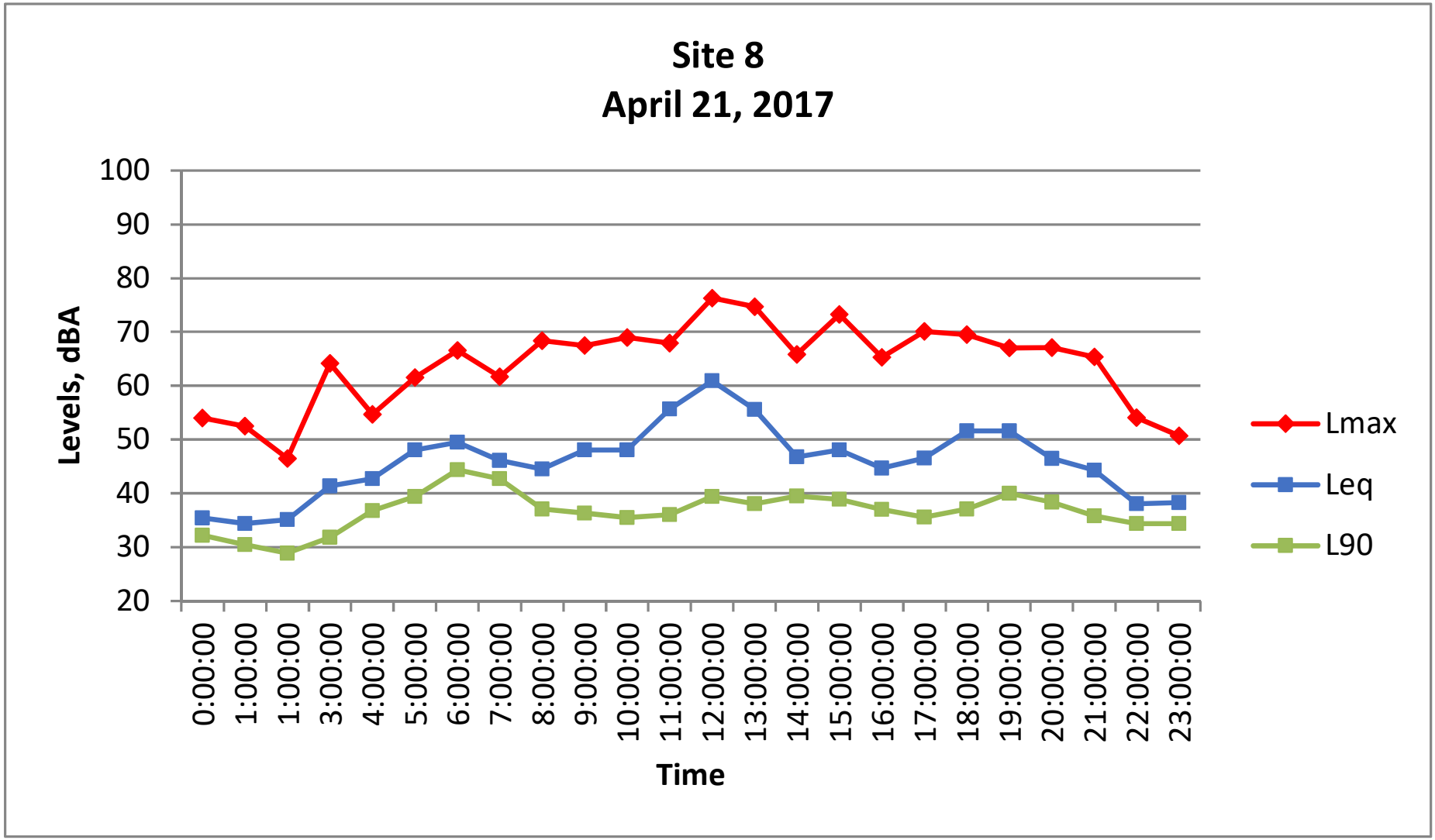
Site 8
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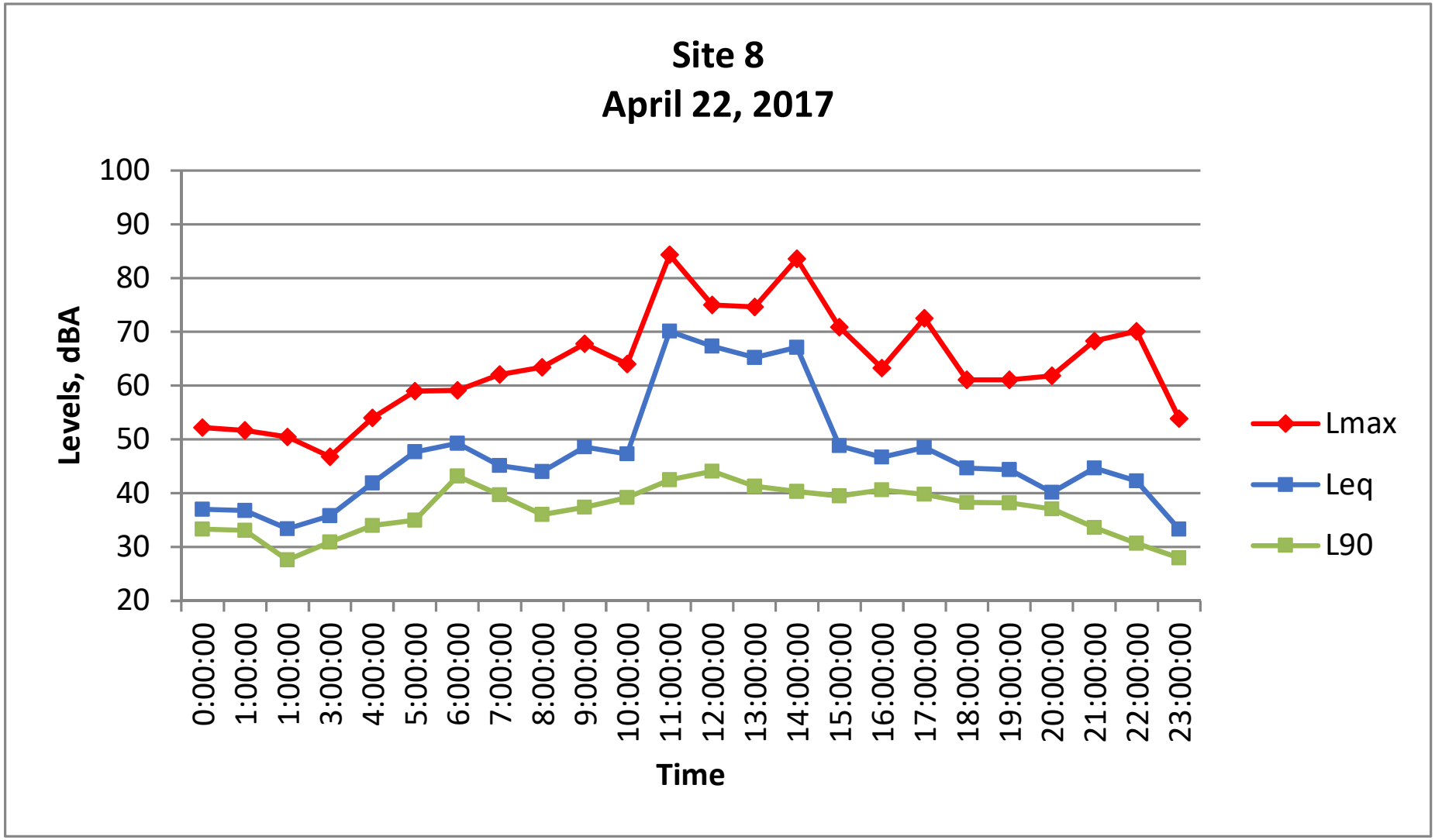
Site 8
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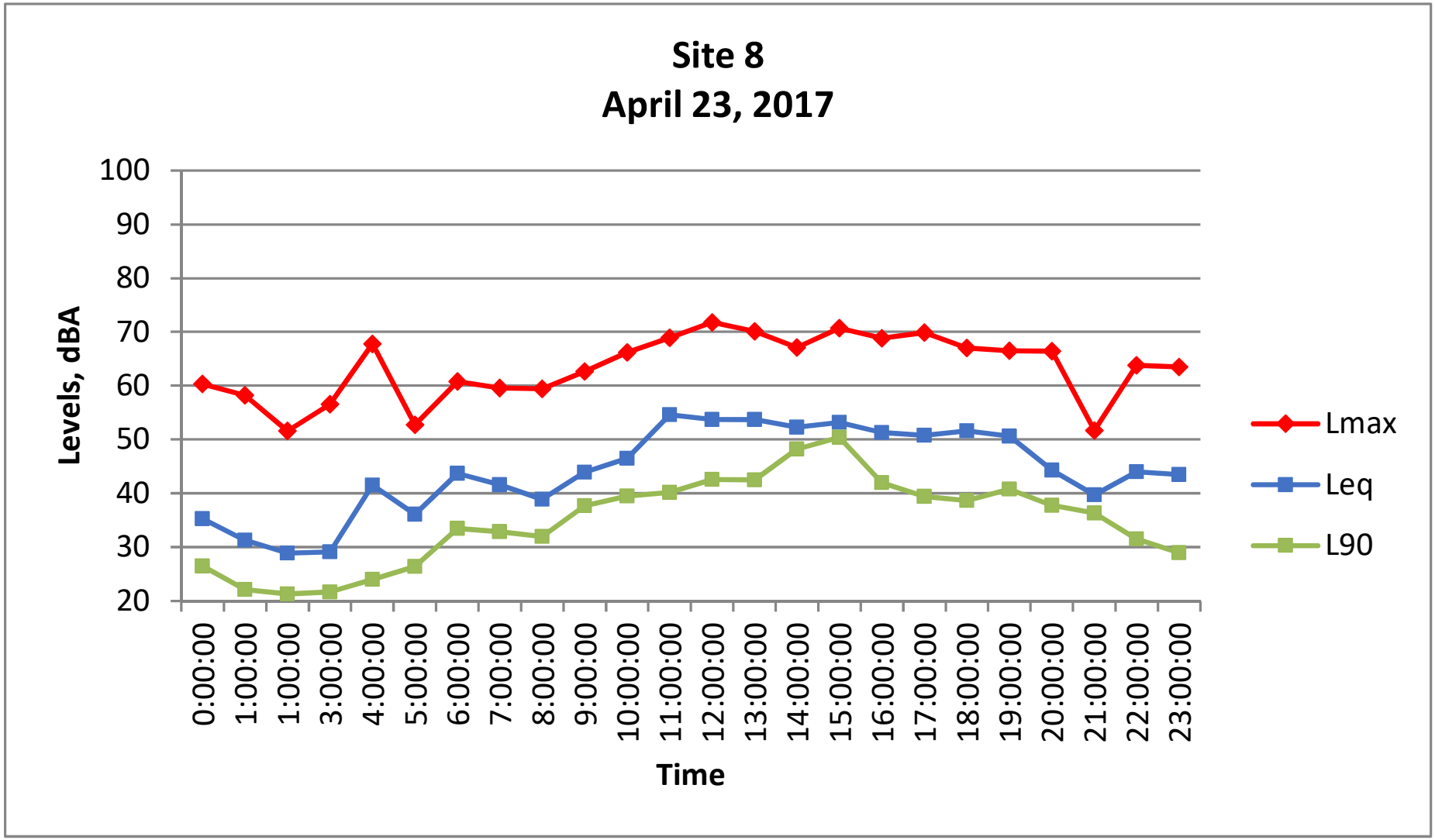
Site 8
April 23, 2017
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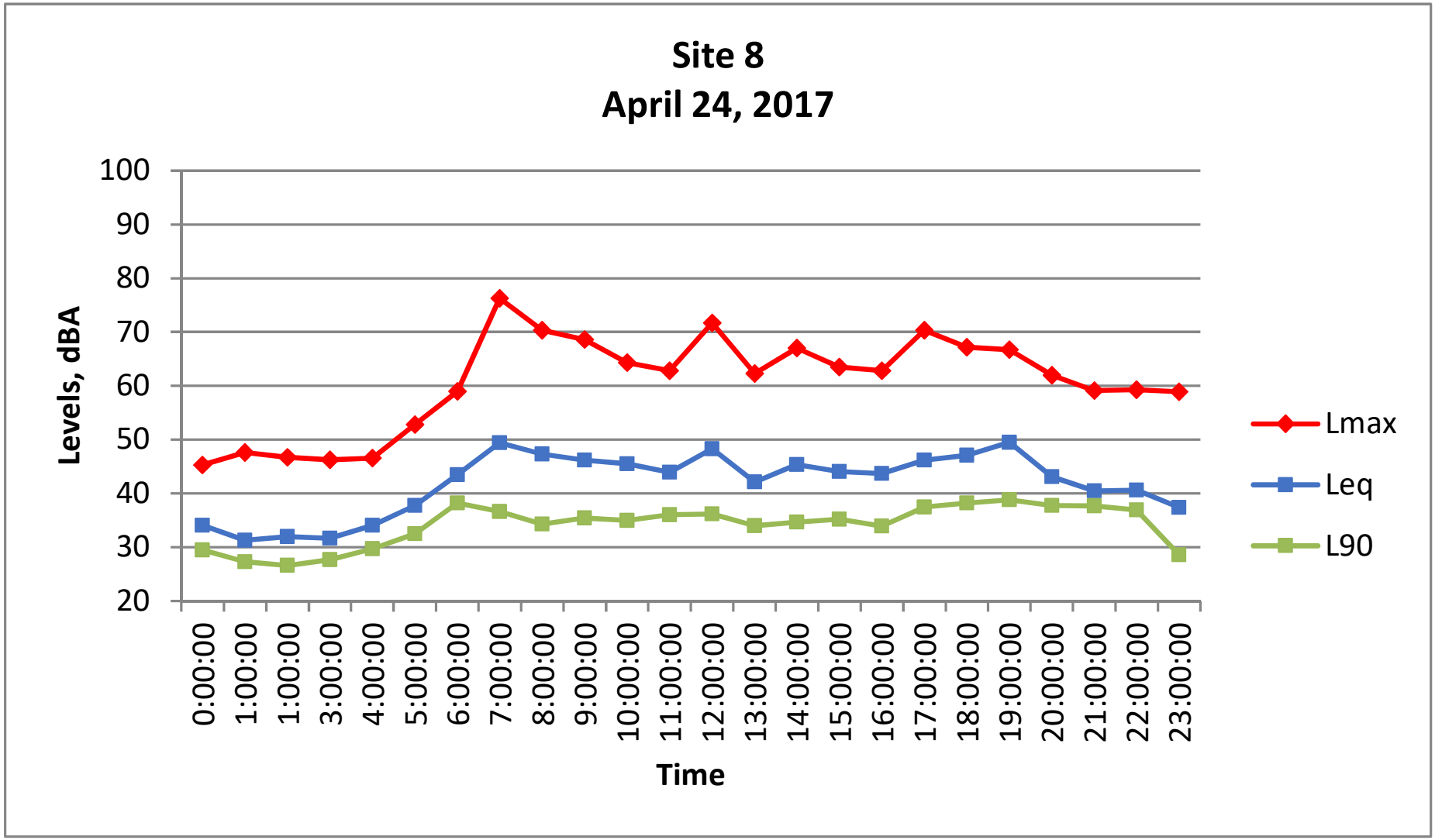
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April 24, 2017
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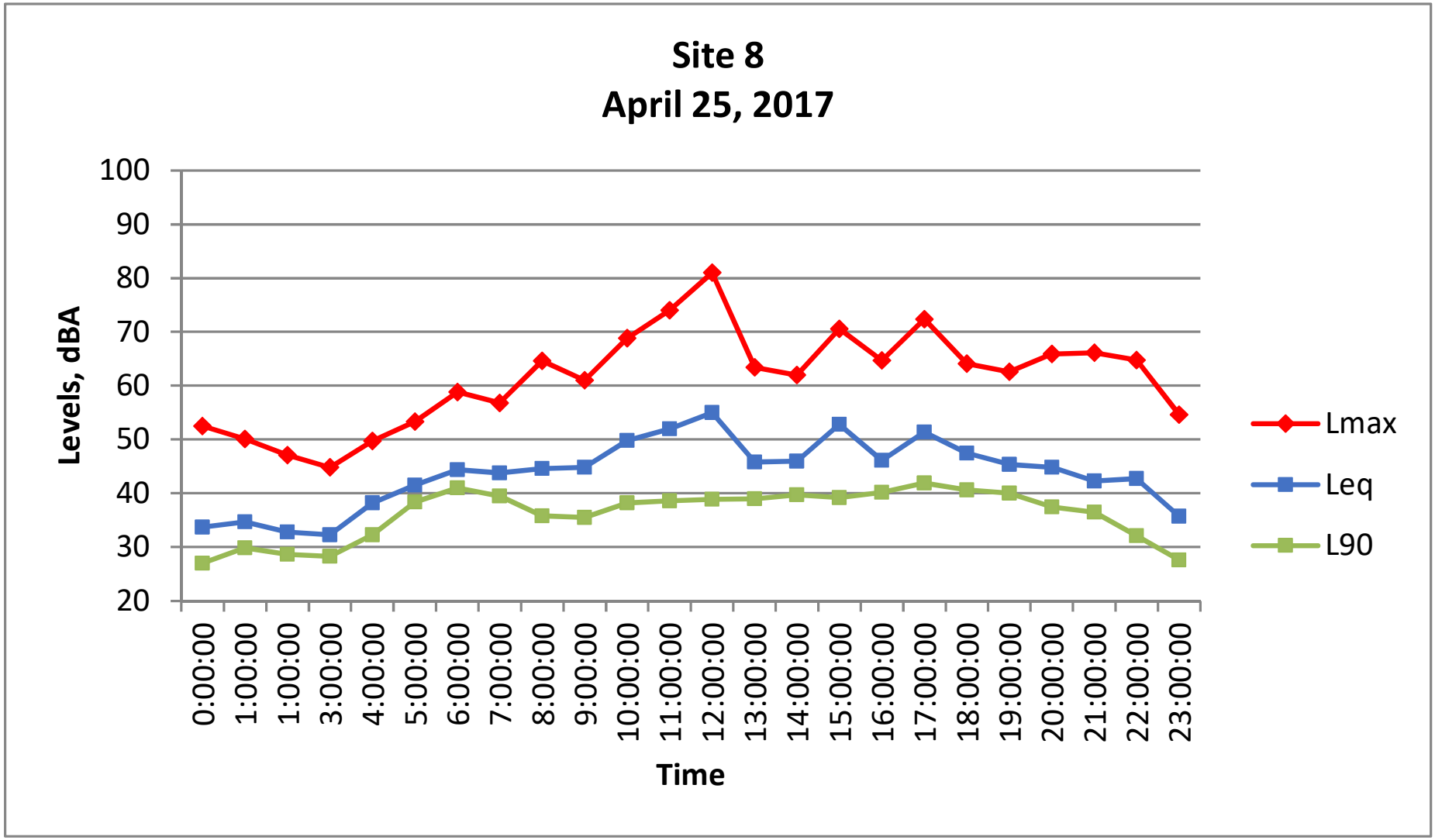
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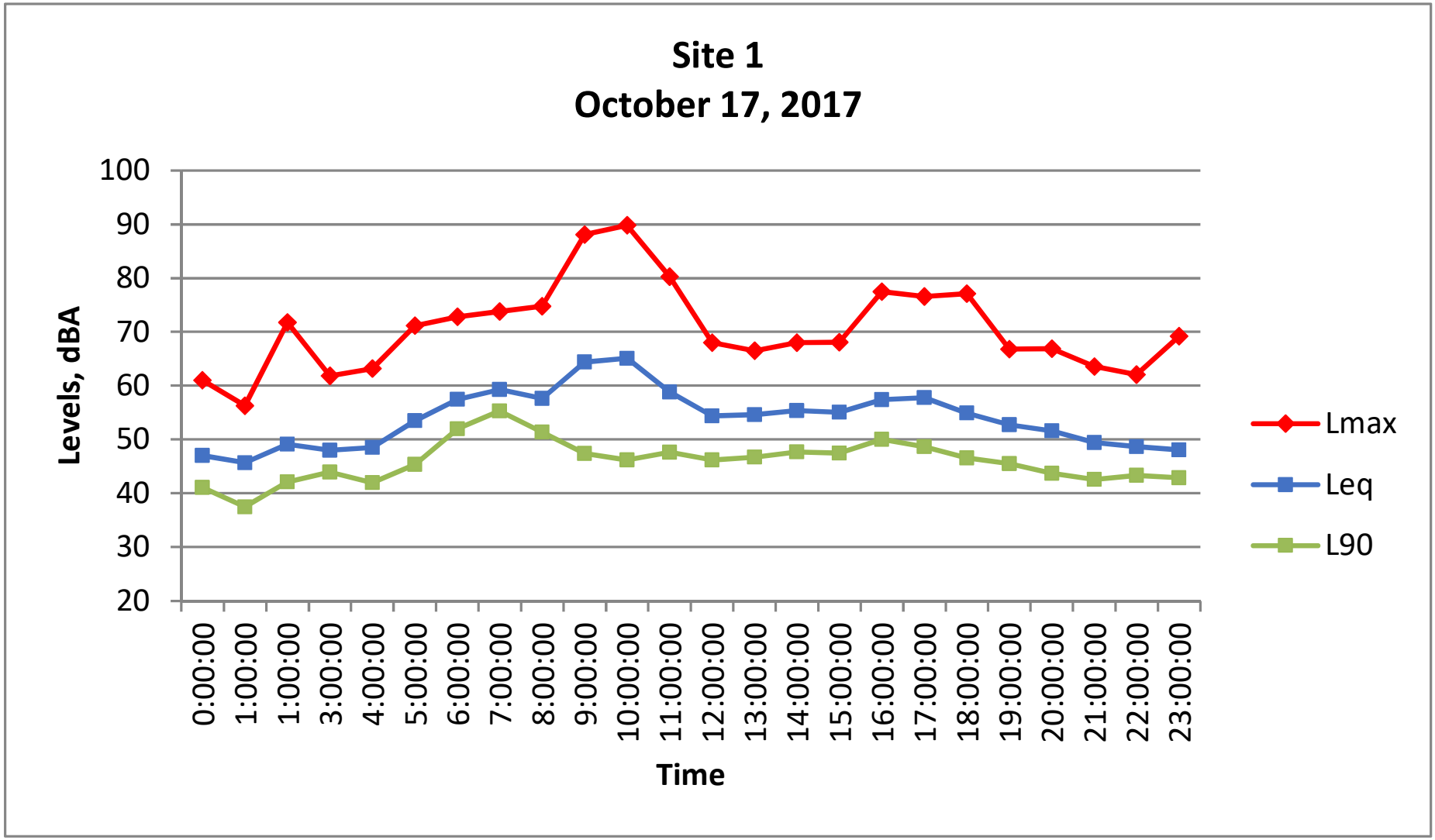
Site 1
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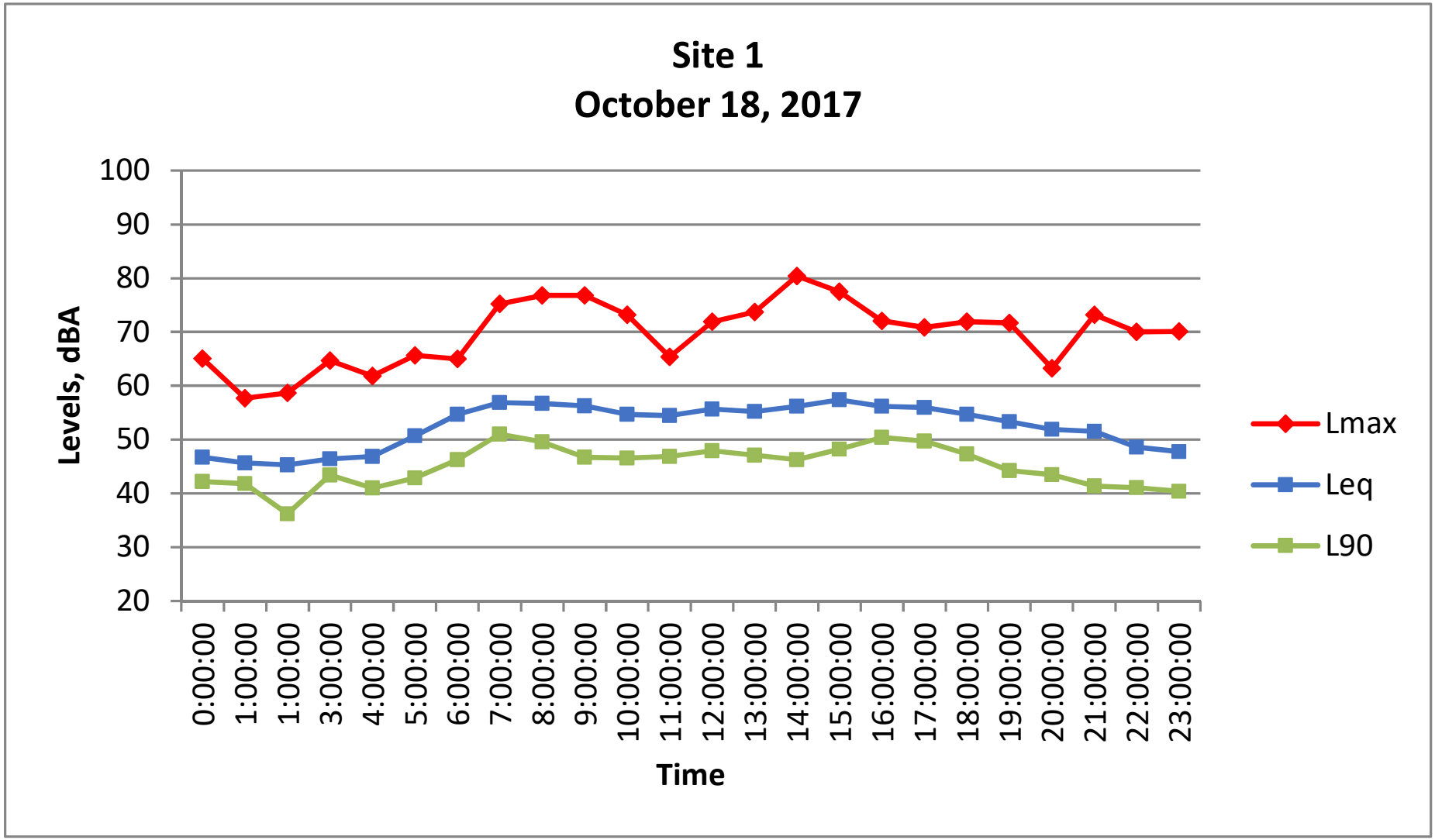
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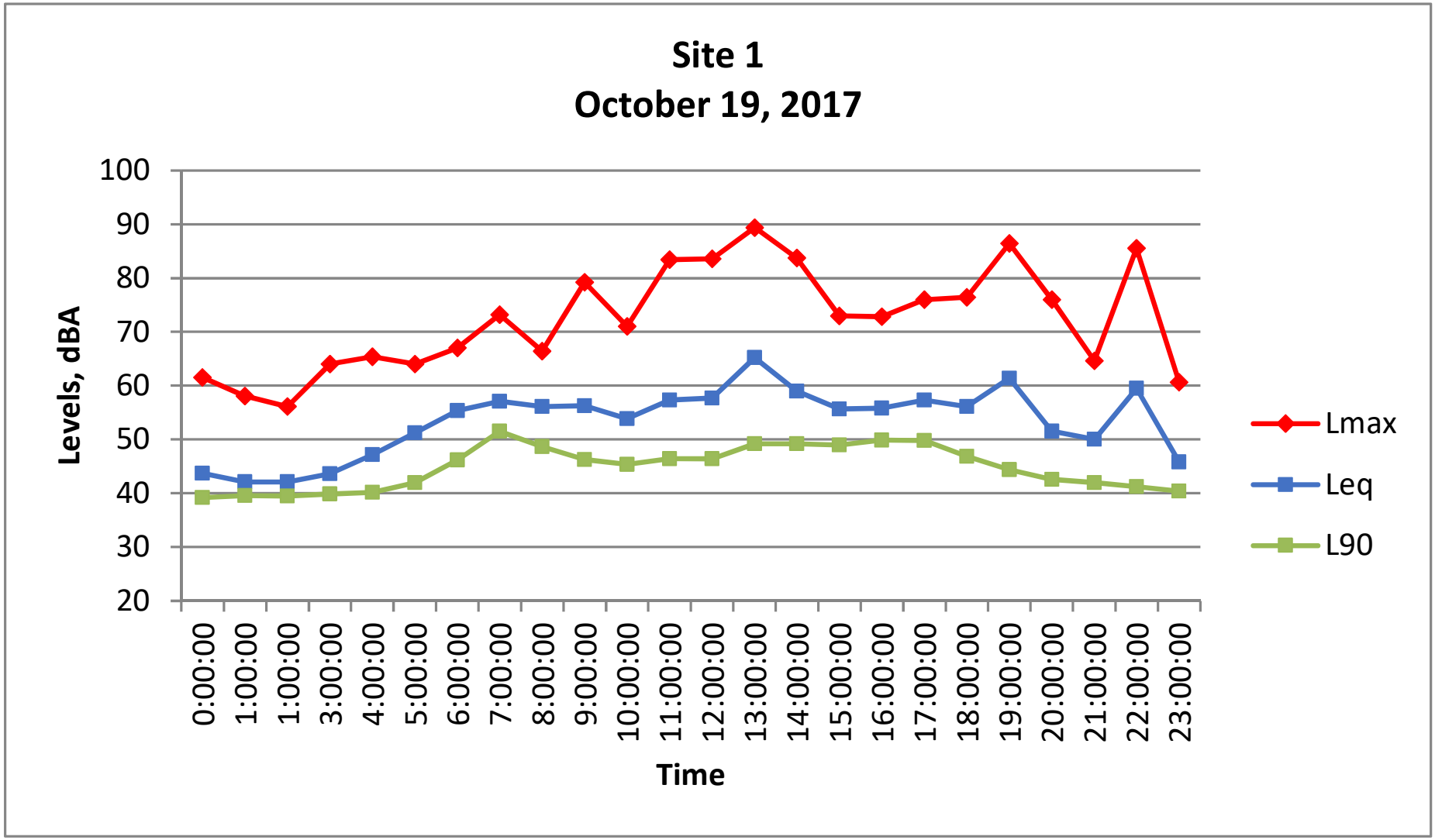
Site 1
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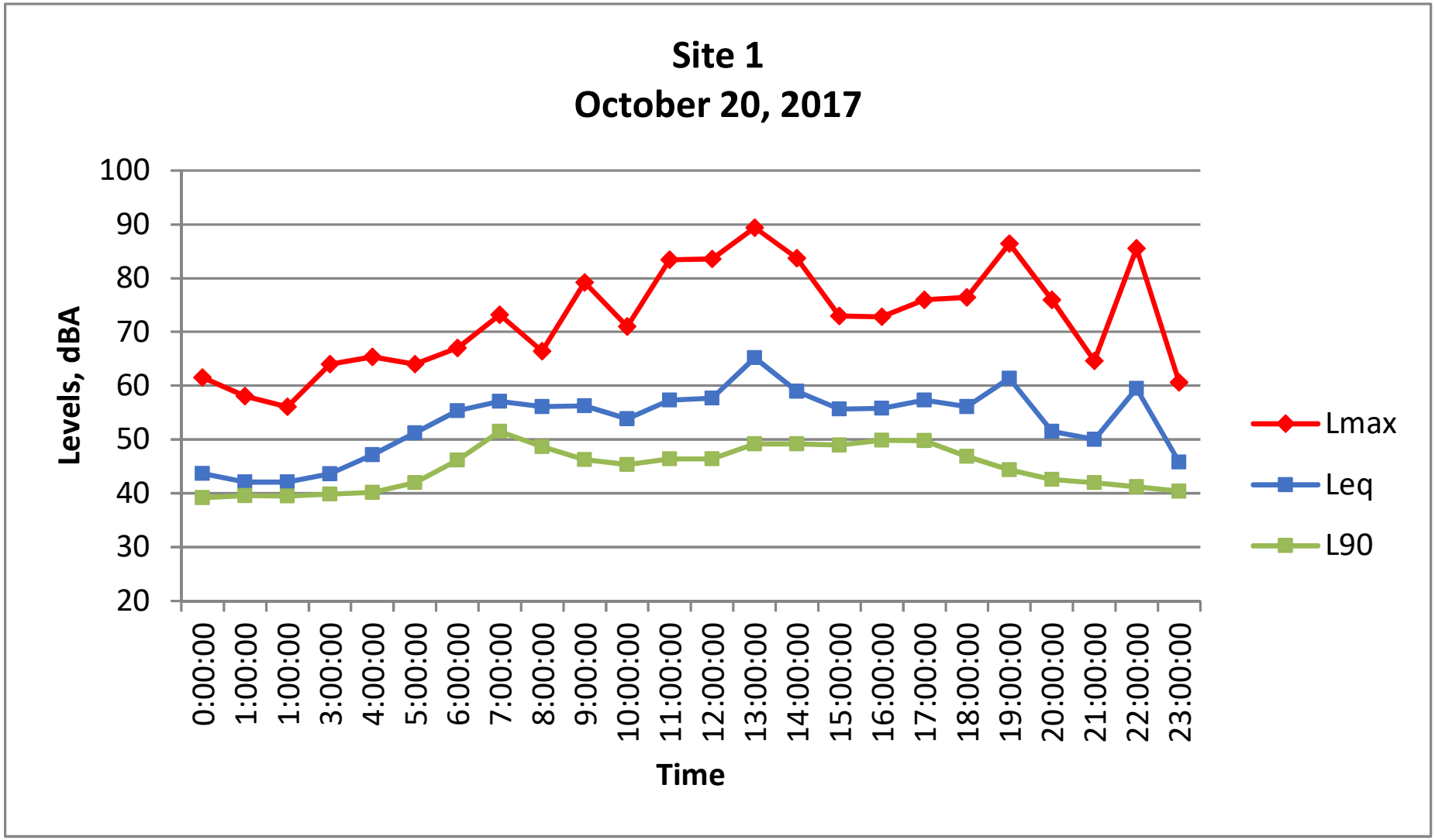
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October 20, 2017
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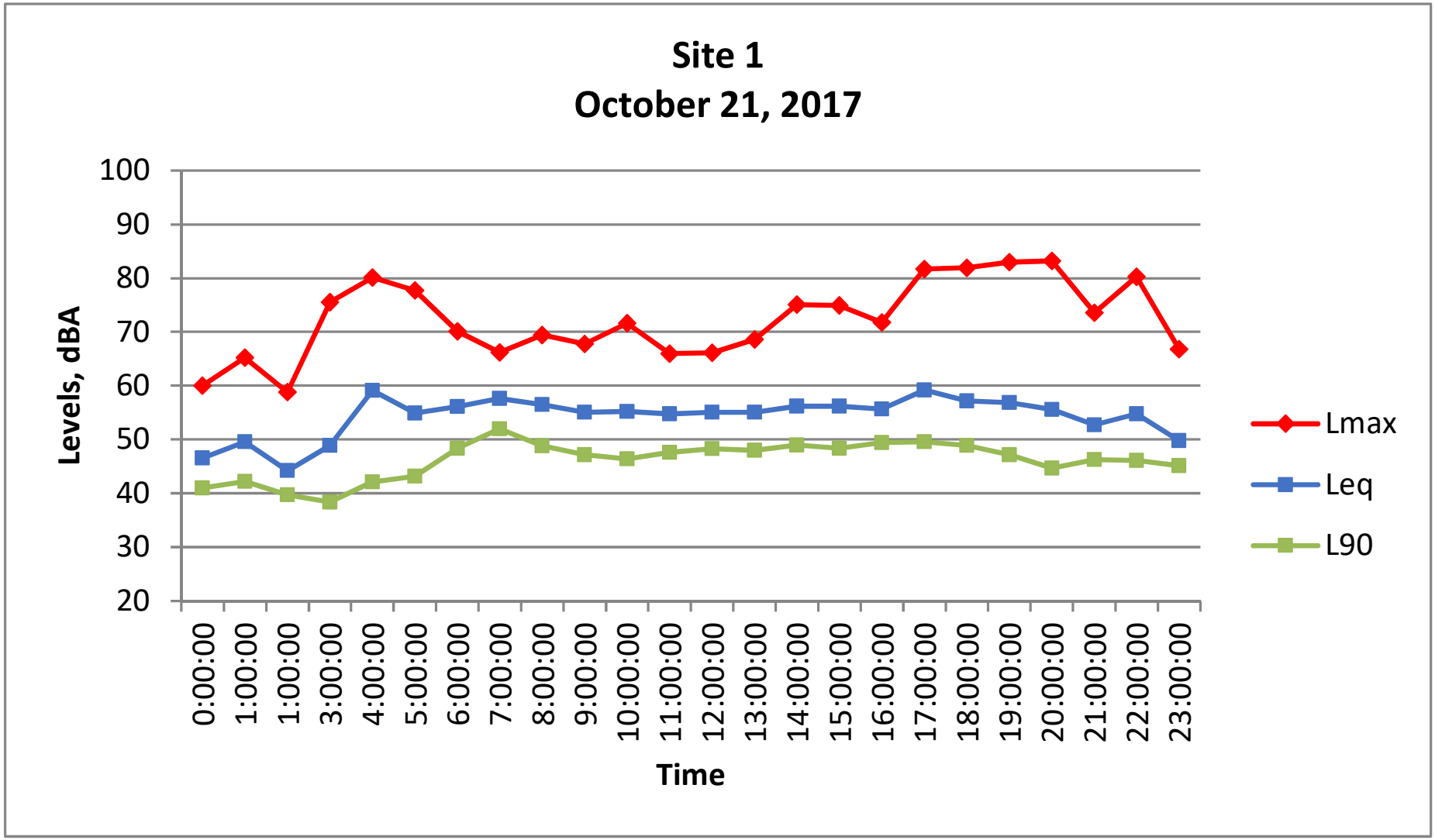
Site 1
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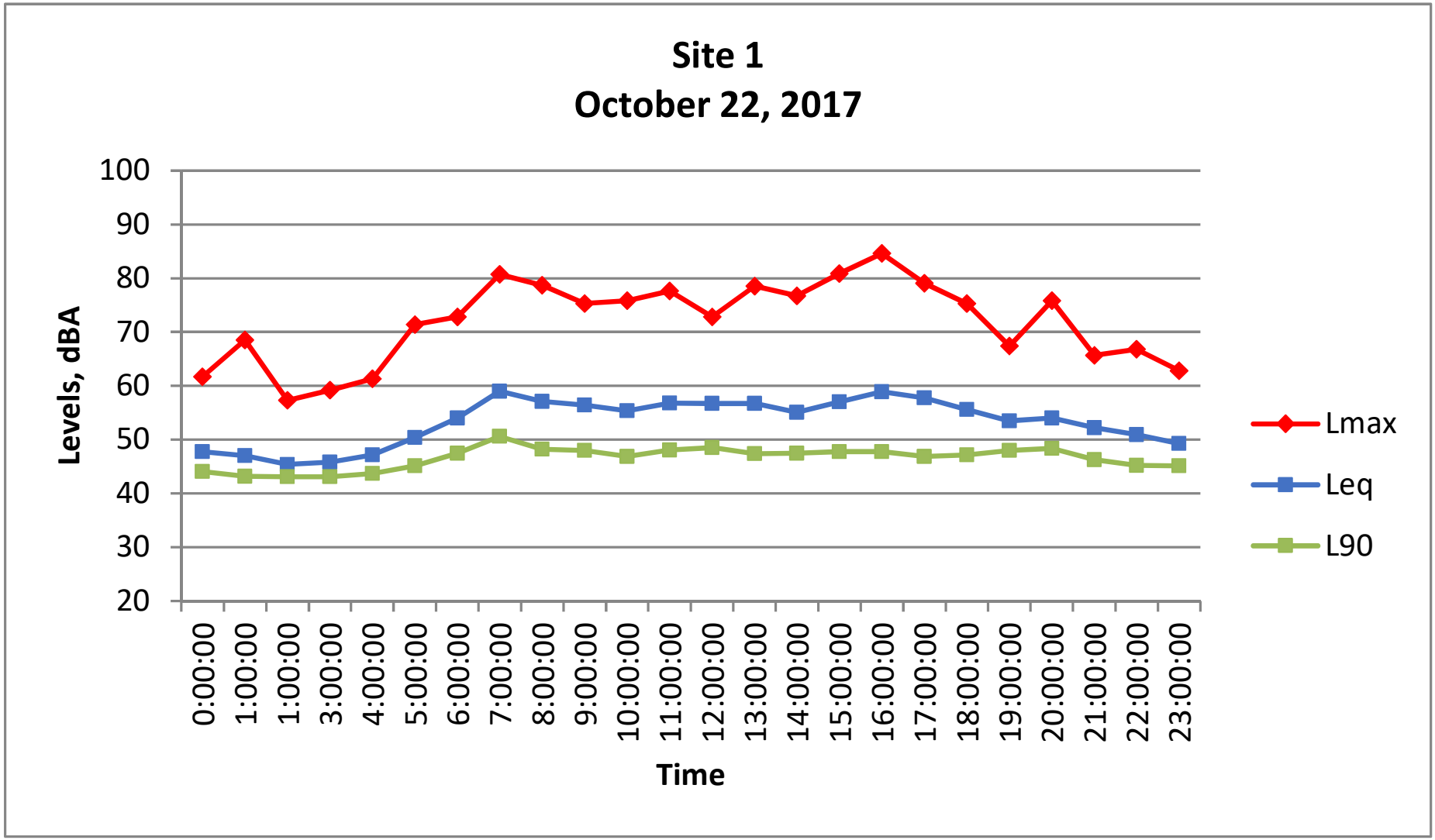
Site 1
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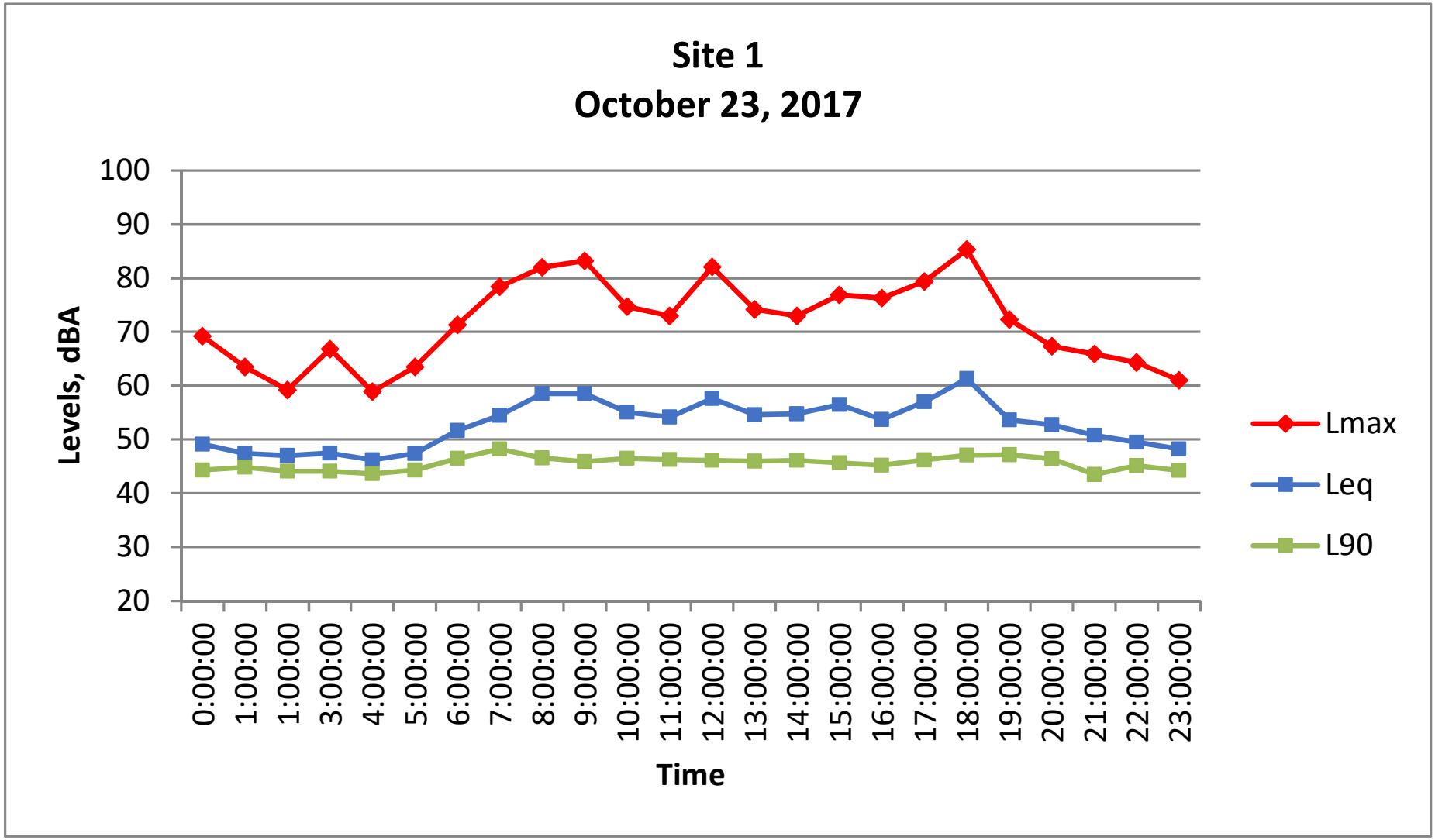
Site 1
October 23, 2017
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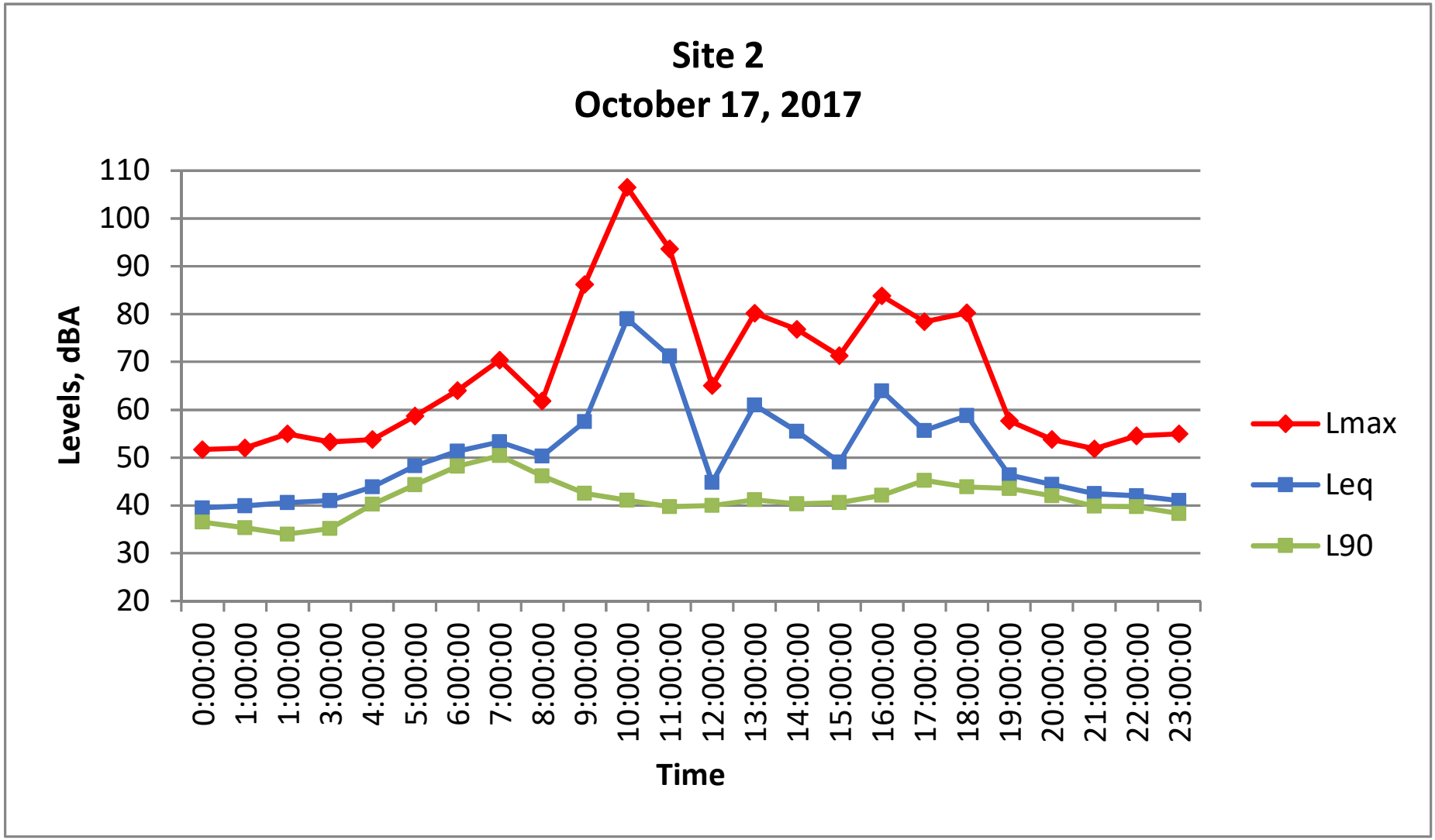
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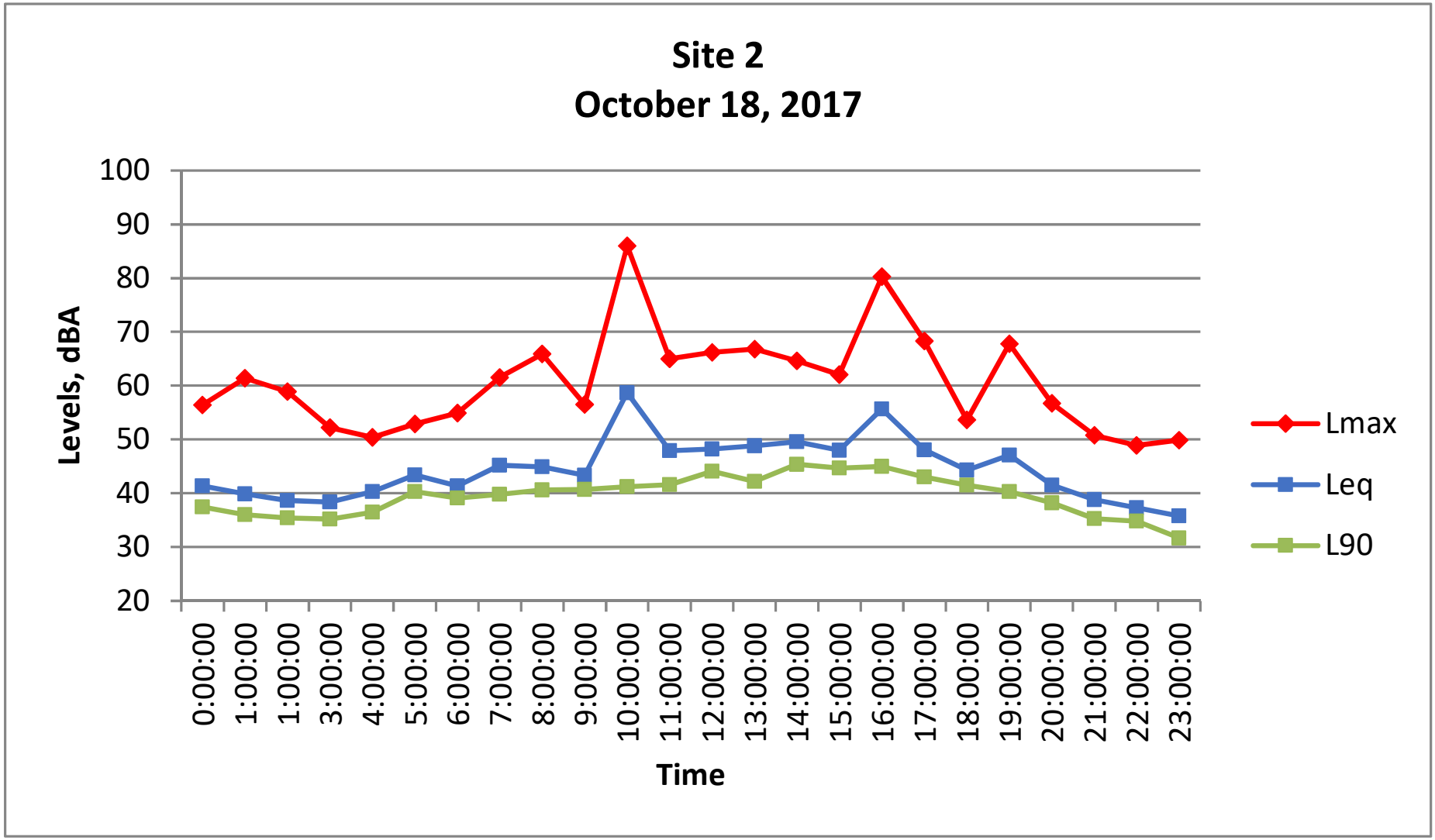
Site 2
October 18, 2017
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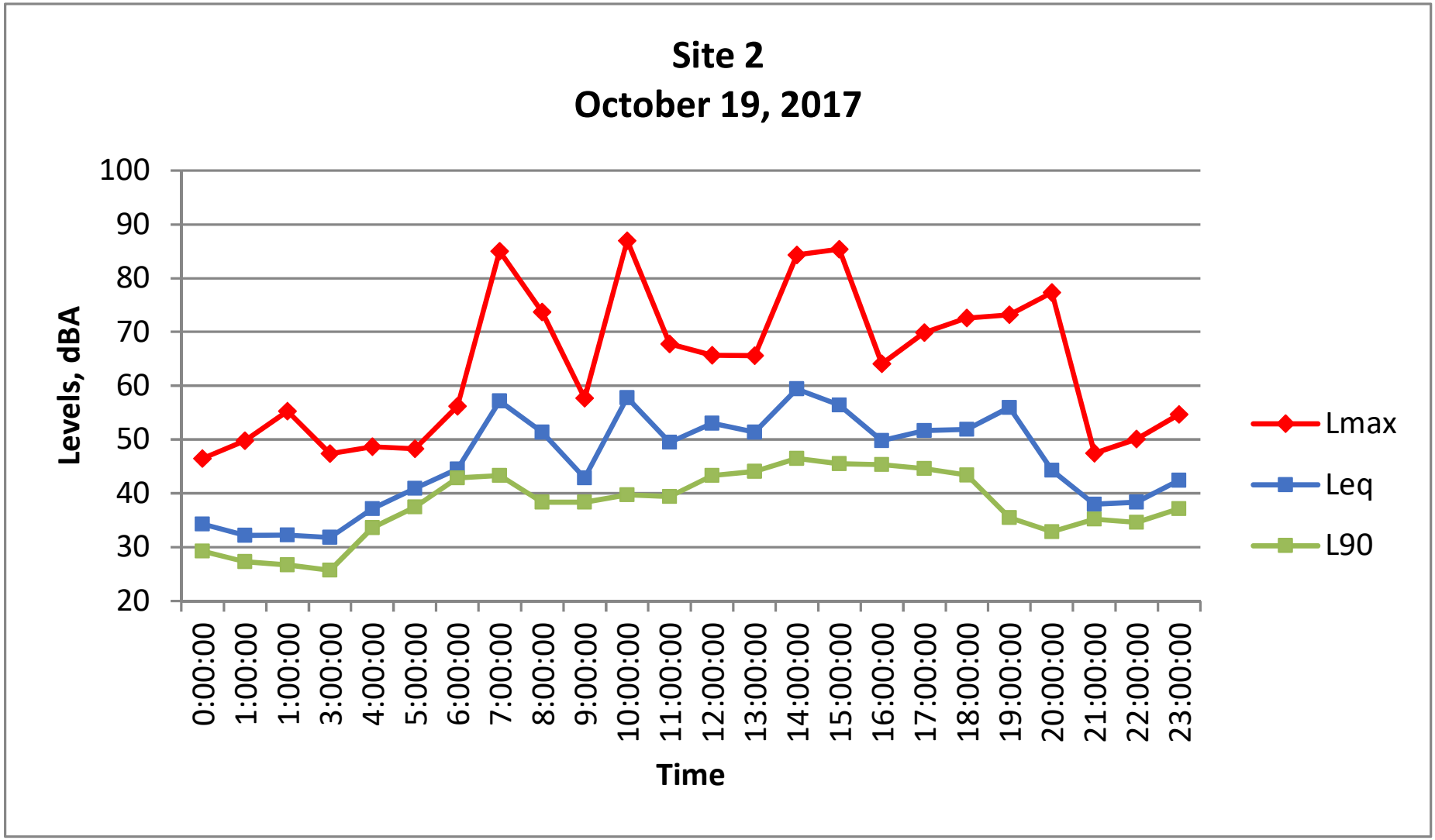
Site 2
October 19, 2017
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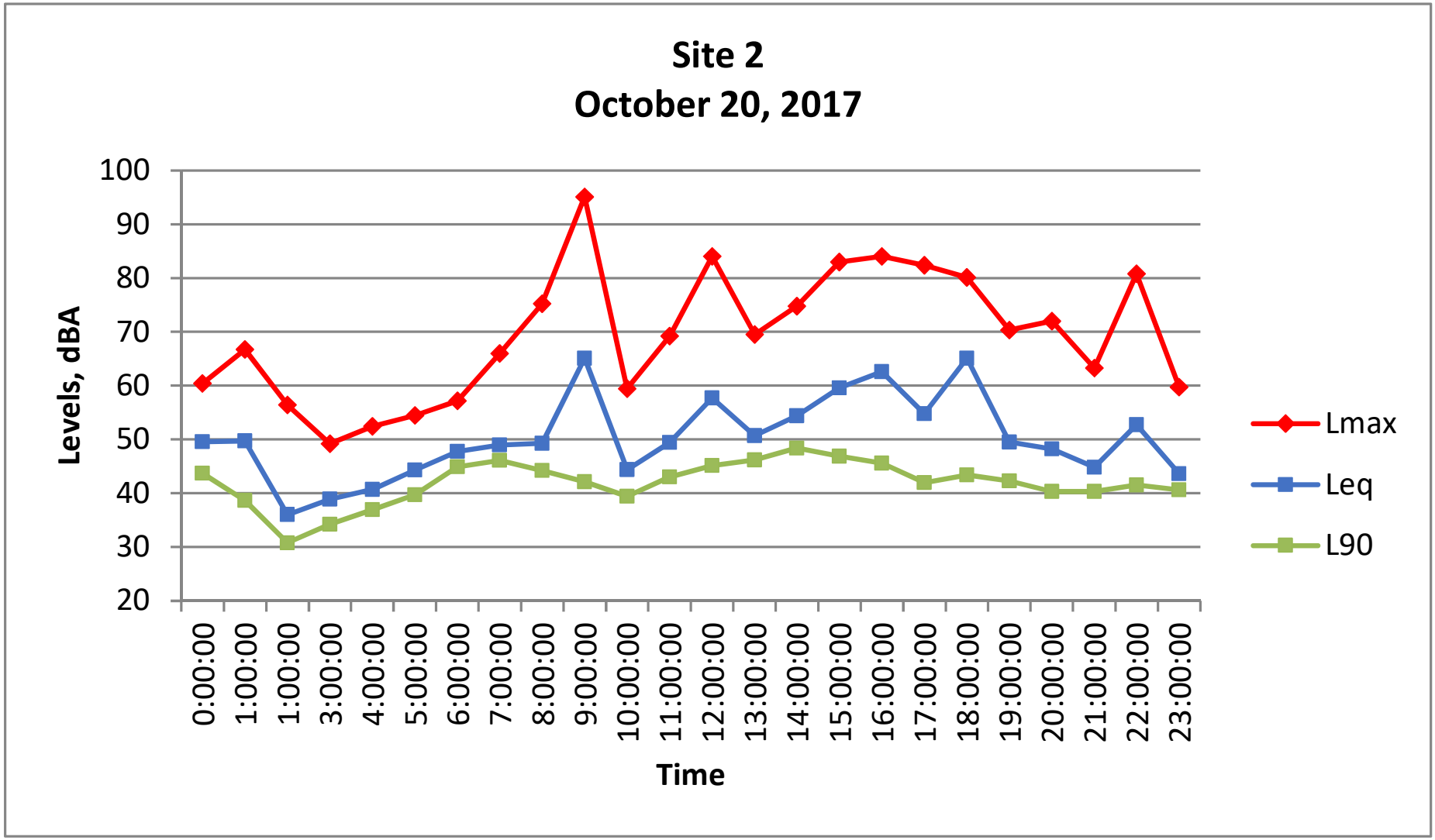
Site 2
October 20, 2017
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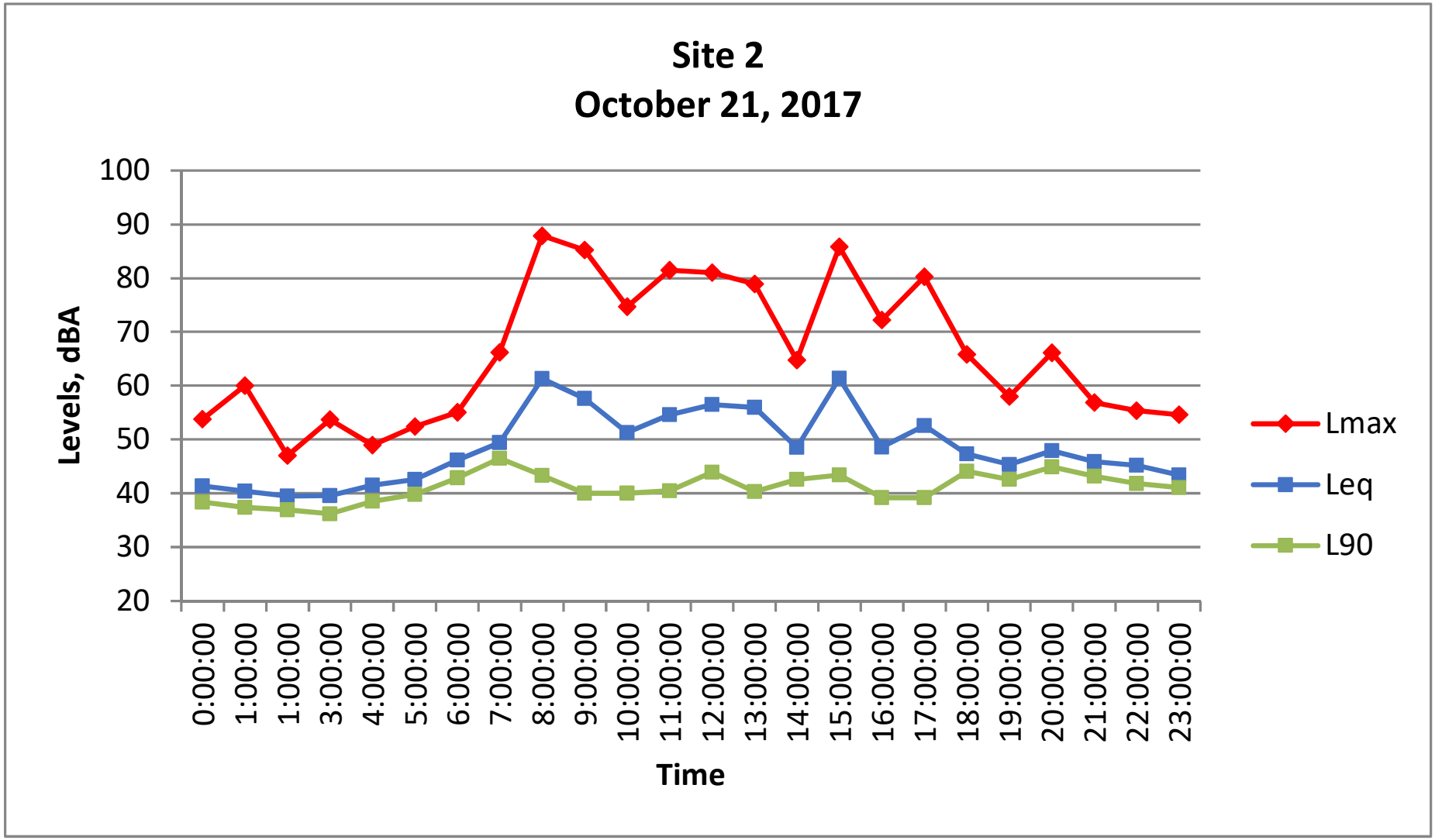
Site 2
October 21, 2017
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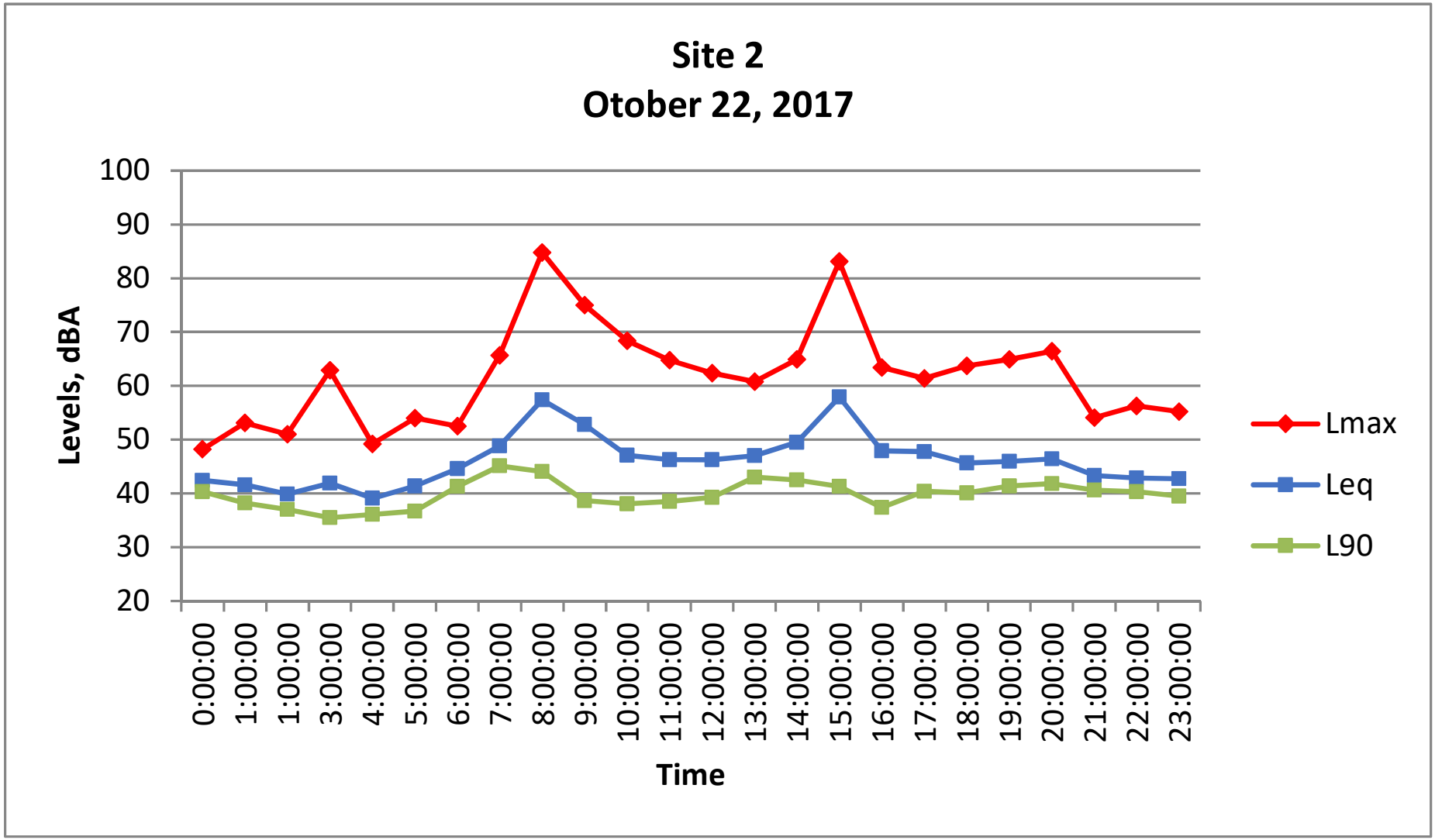
Site 2
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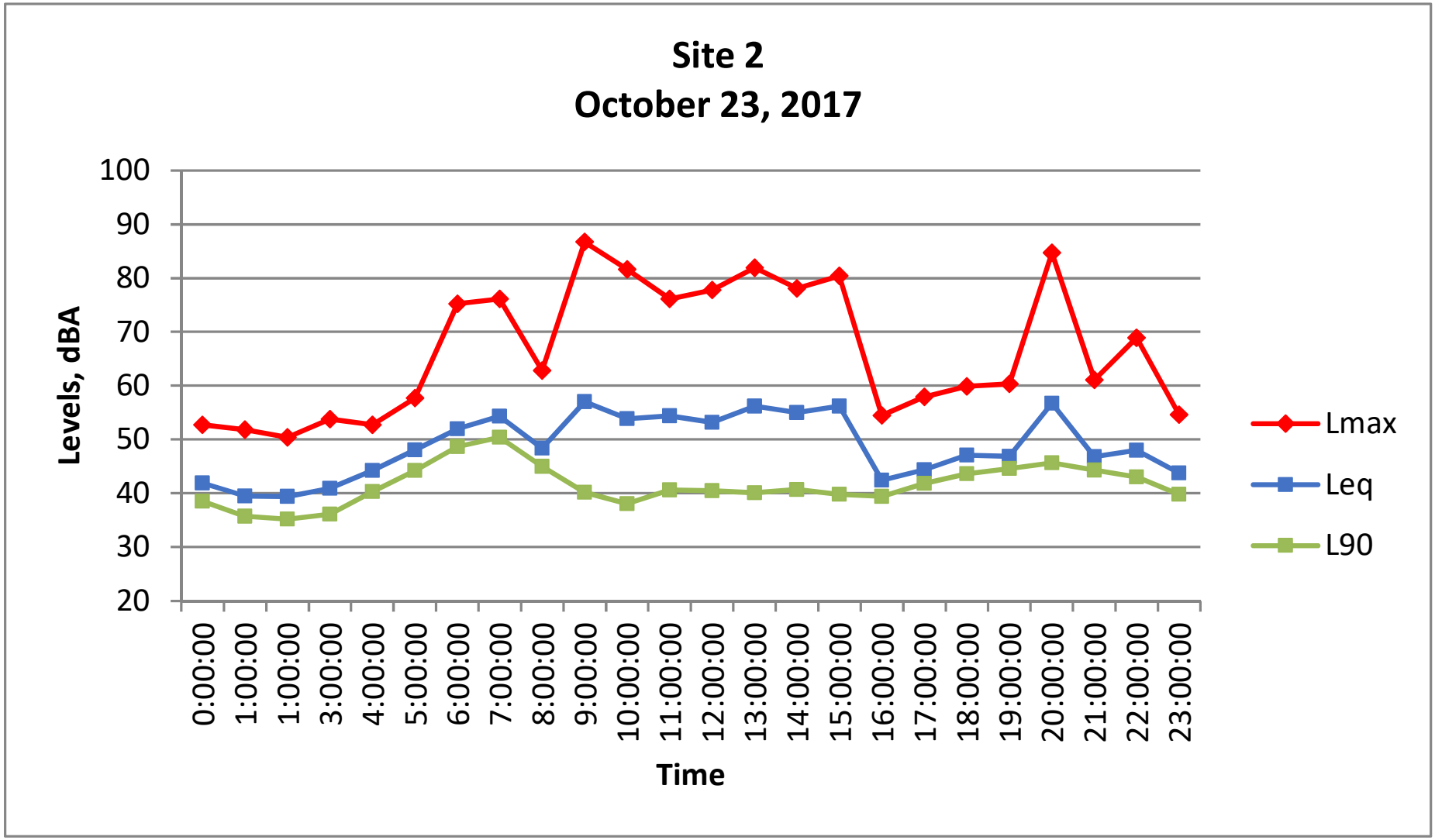
Site 2
October 23, 2017
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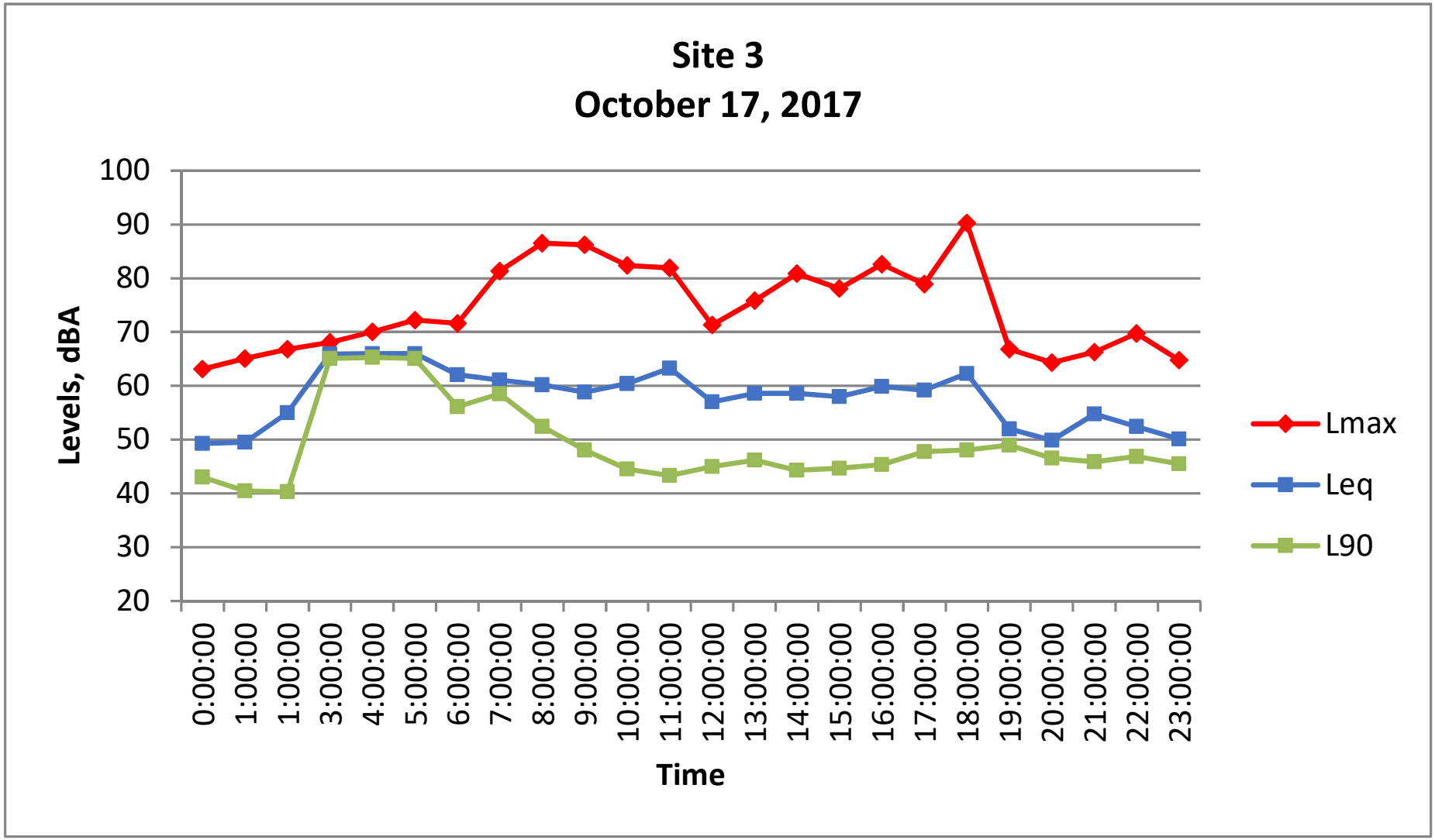
Site 3
October 17, 2017
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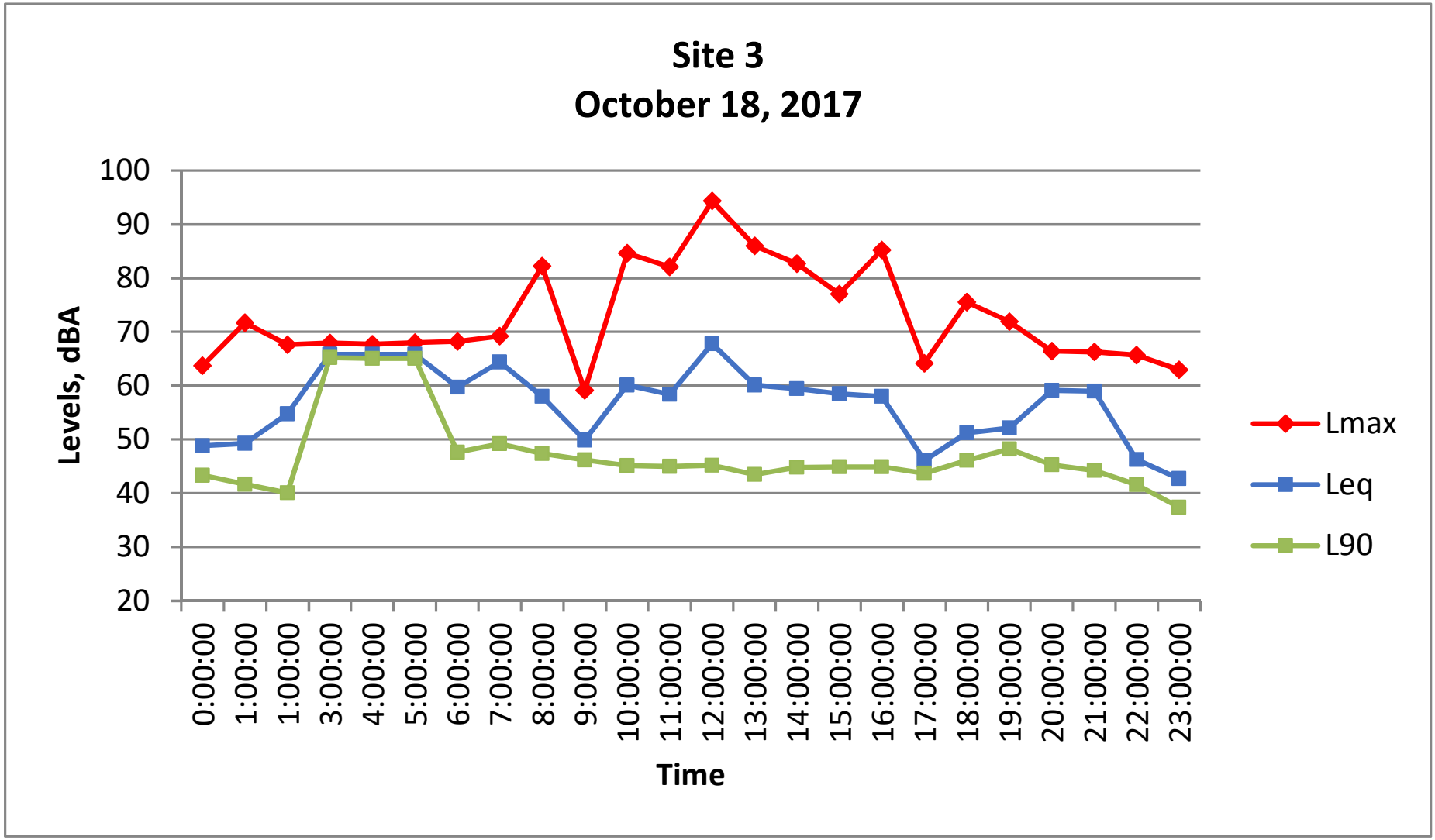
Site 3
October 18, 2017
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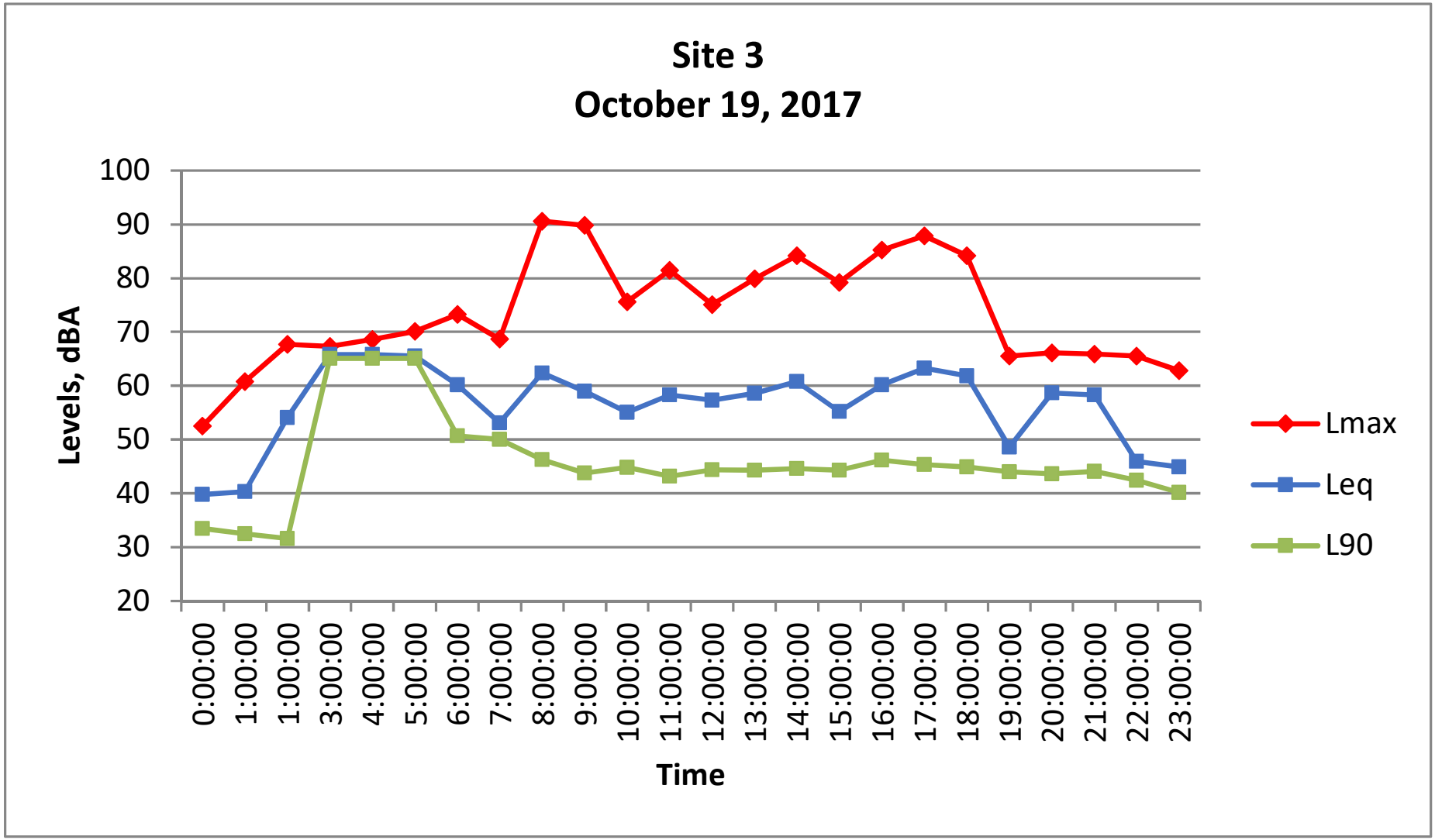
Site 3
October 19, 2017
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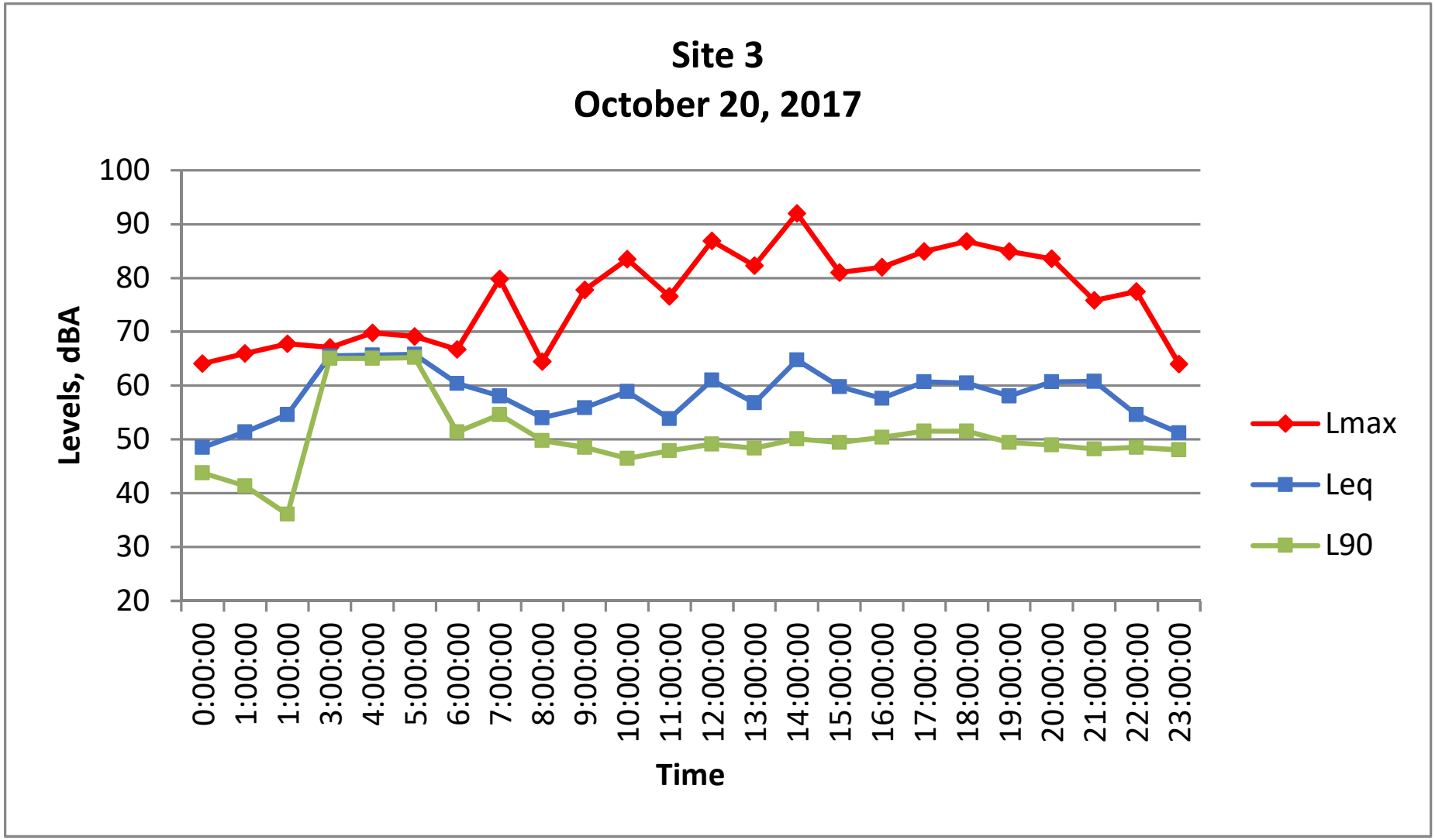
Site 3
October 20, 2017
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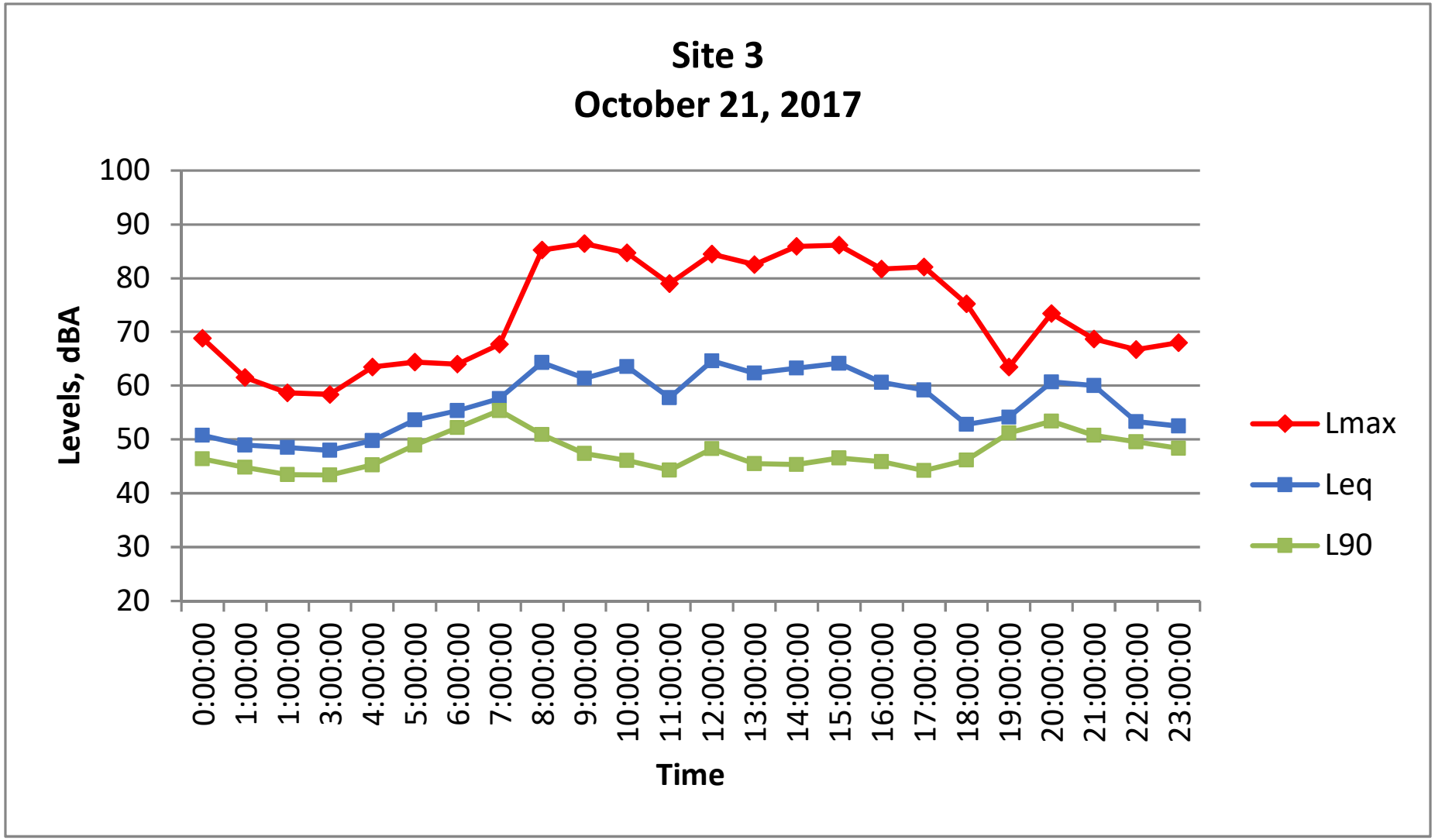
Site 3
October 21, 2017
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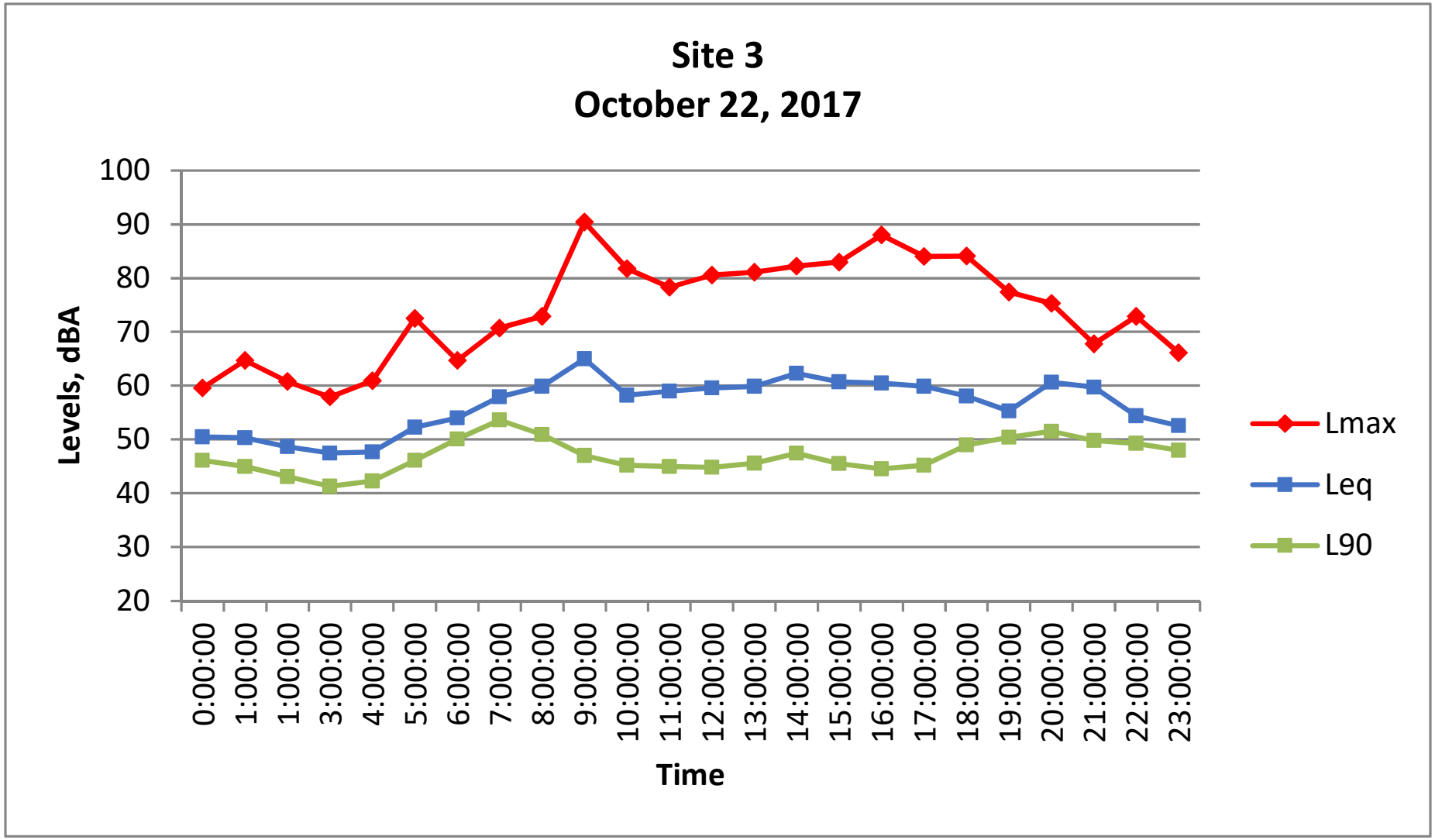
Site 3
October 22, 2017
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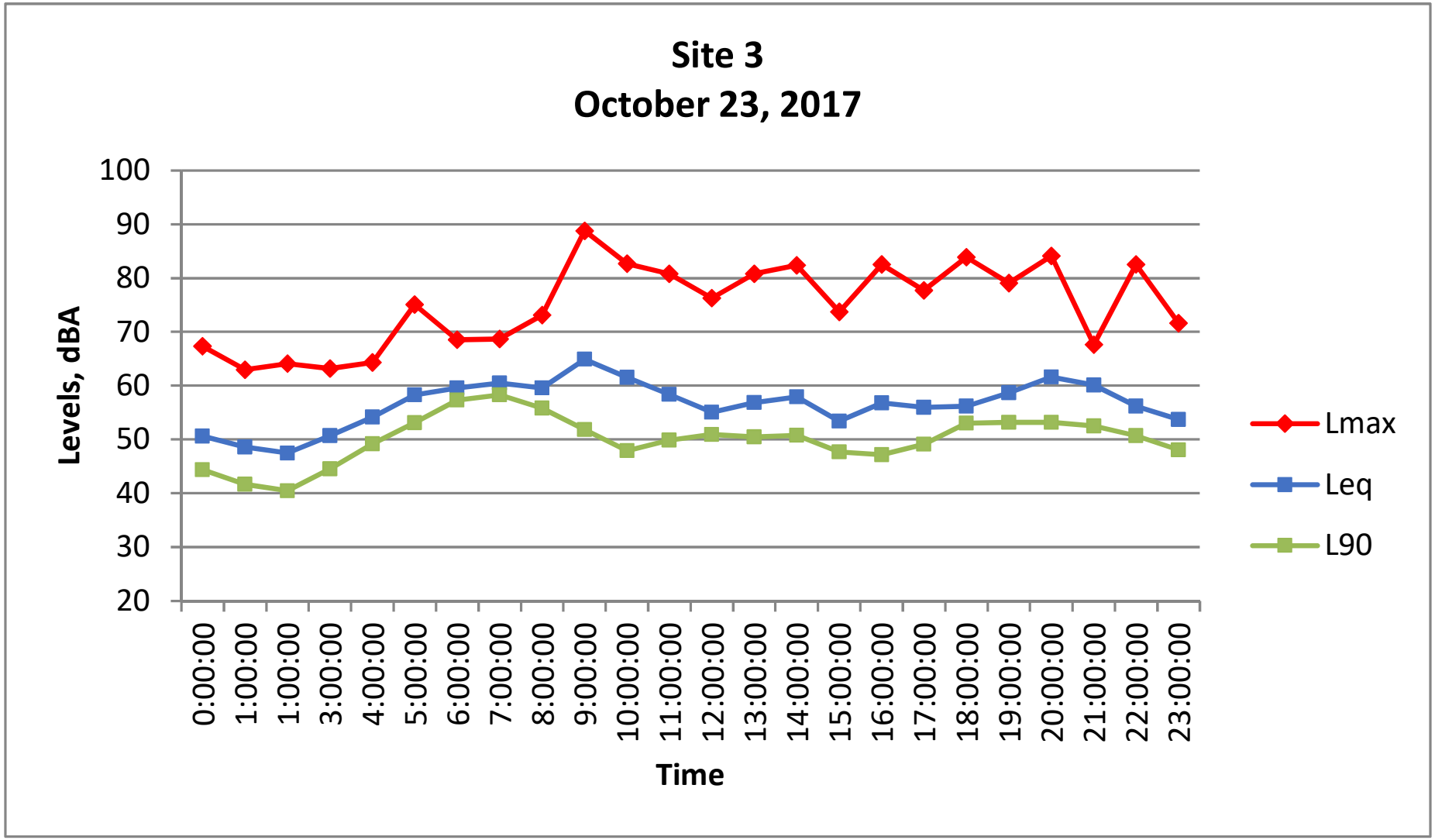
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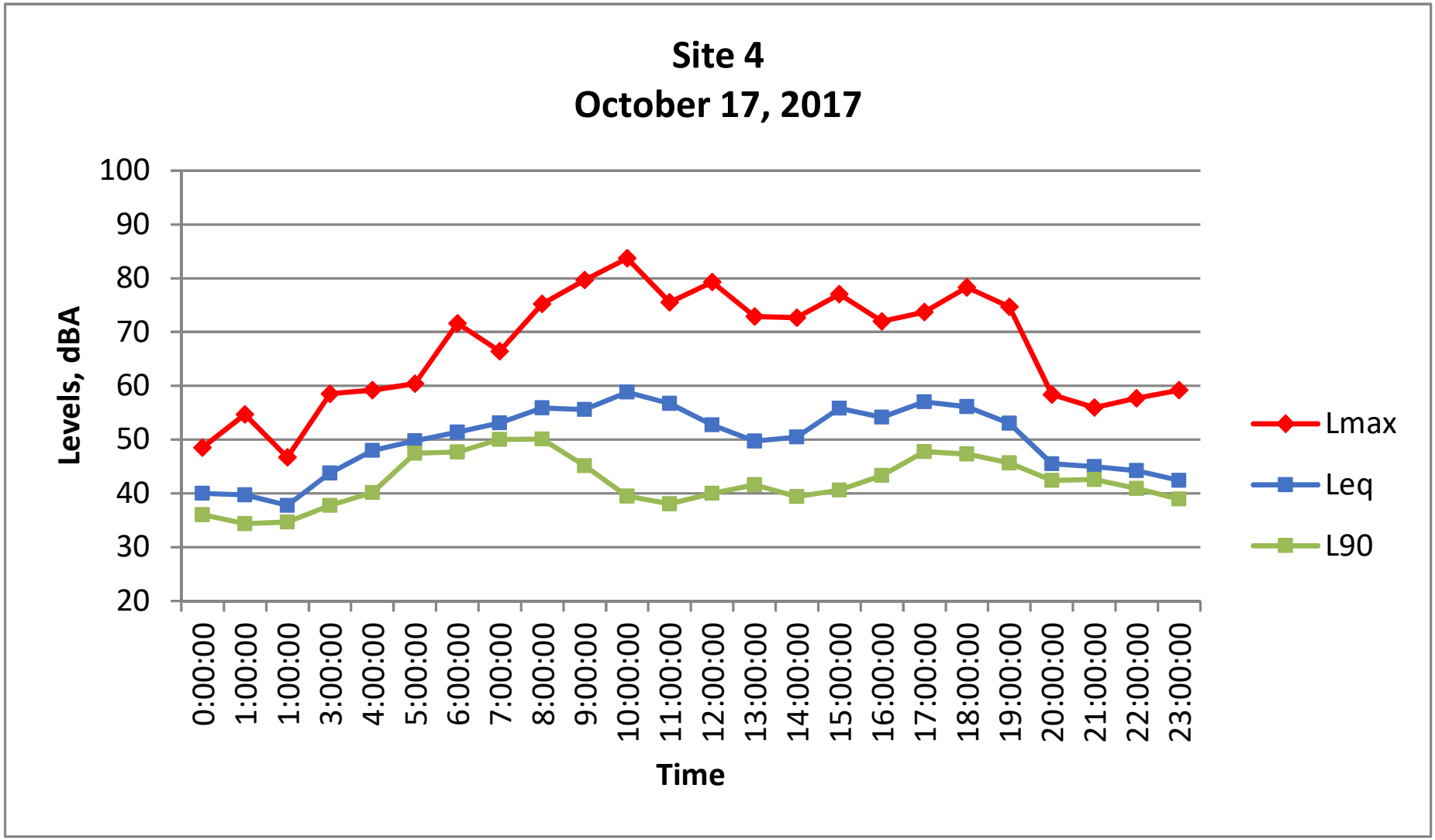
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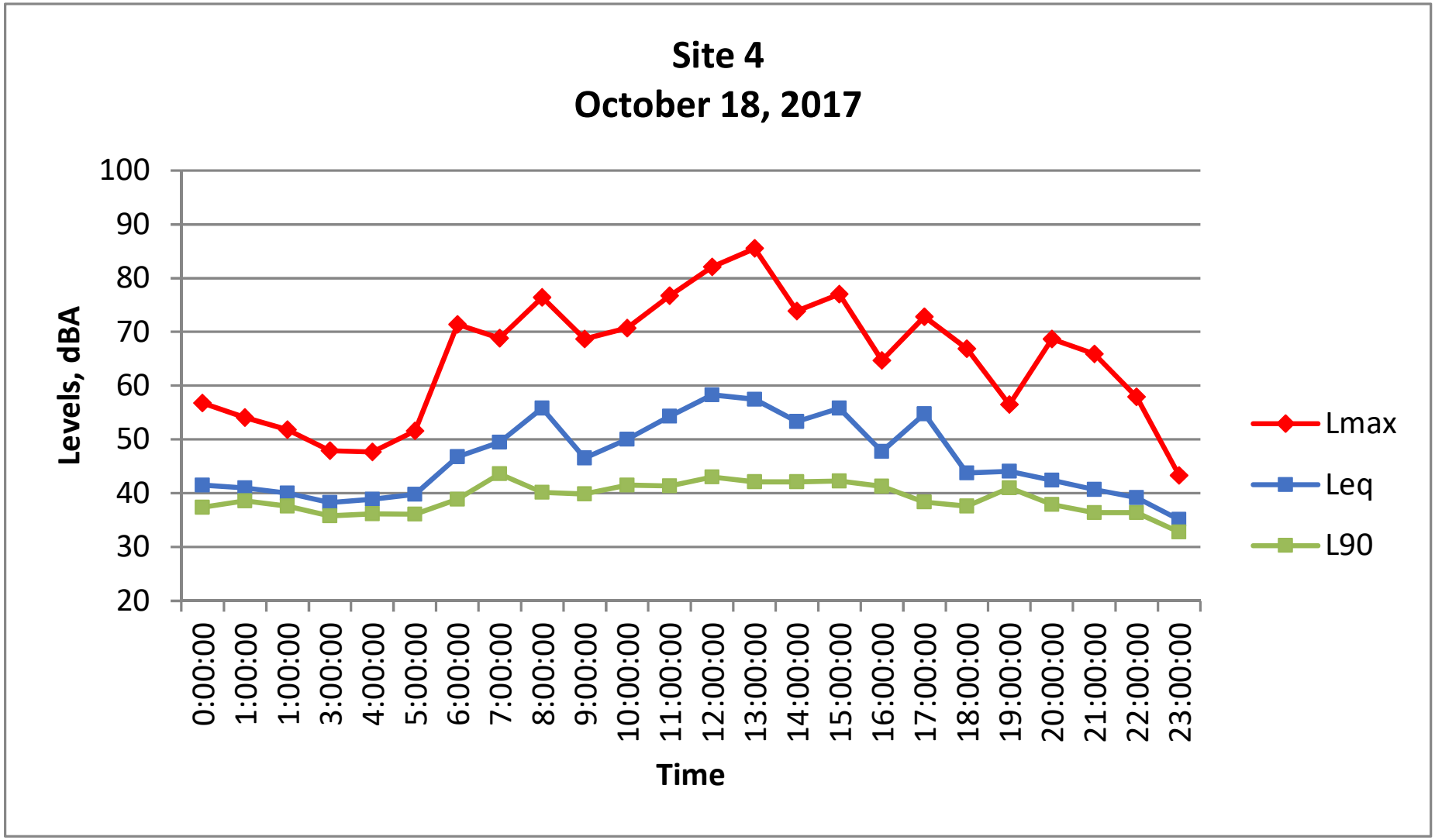
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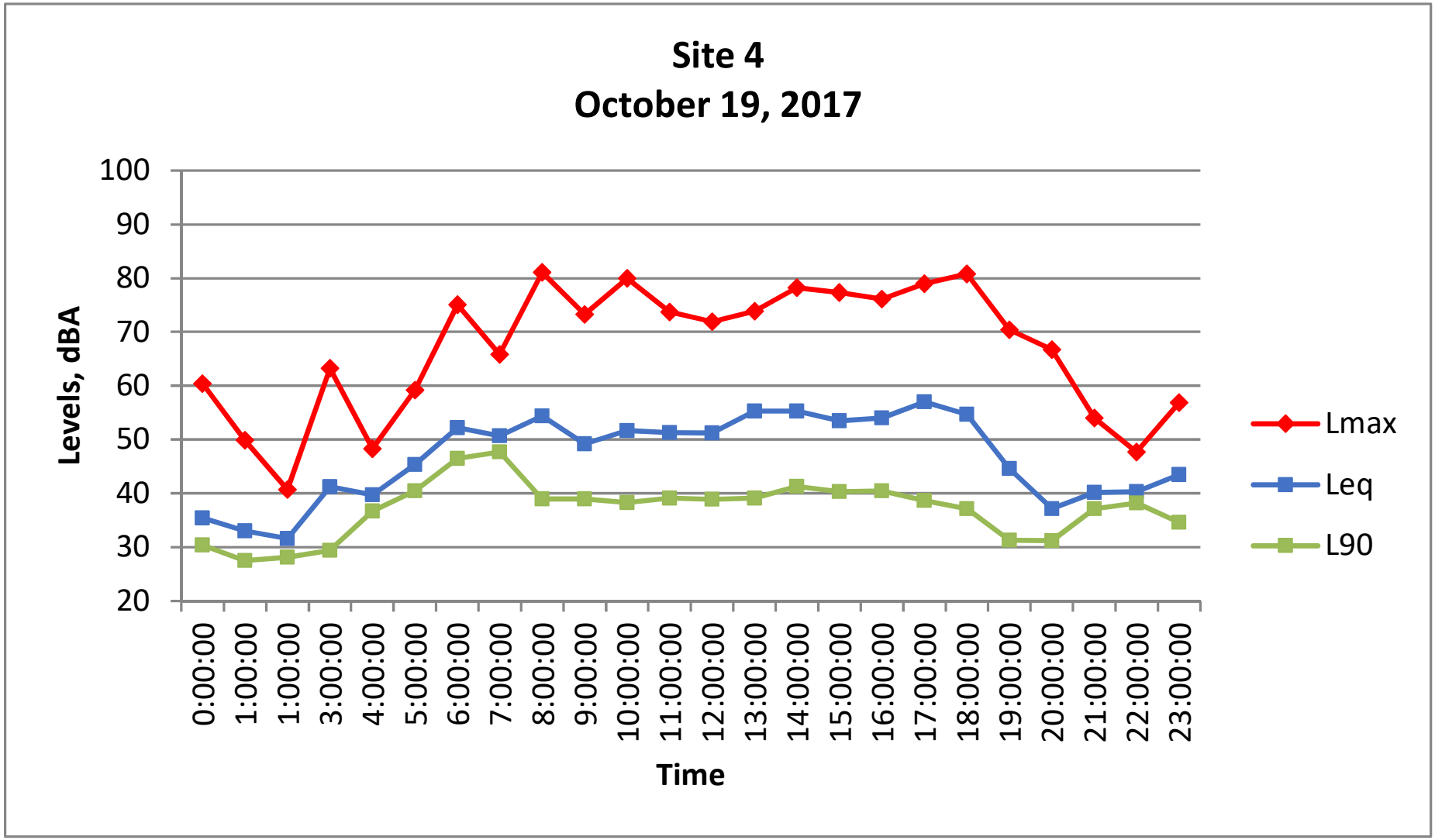
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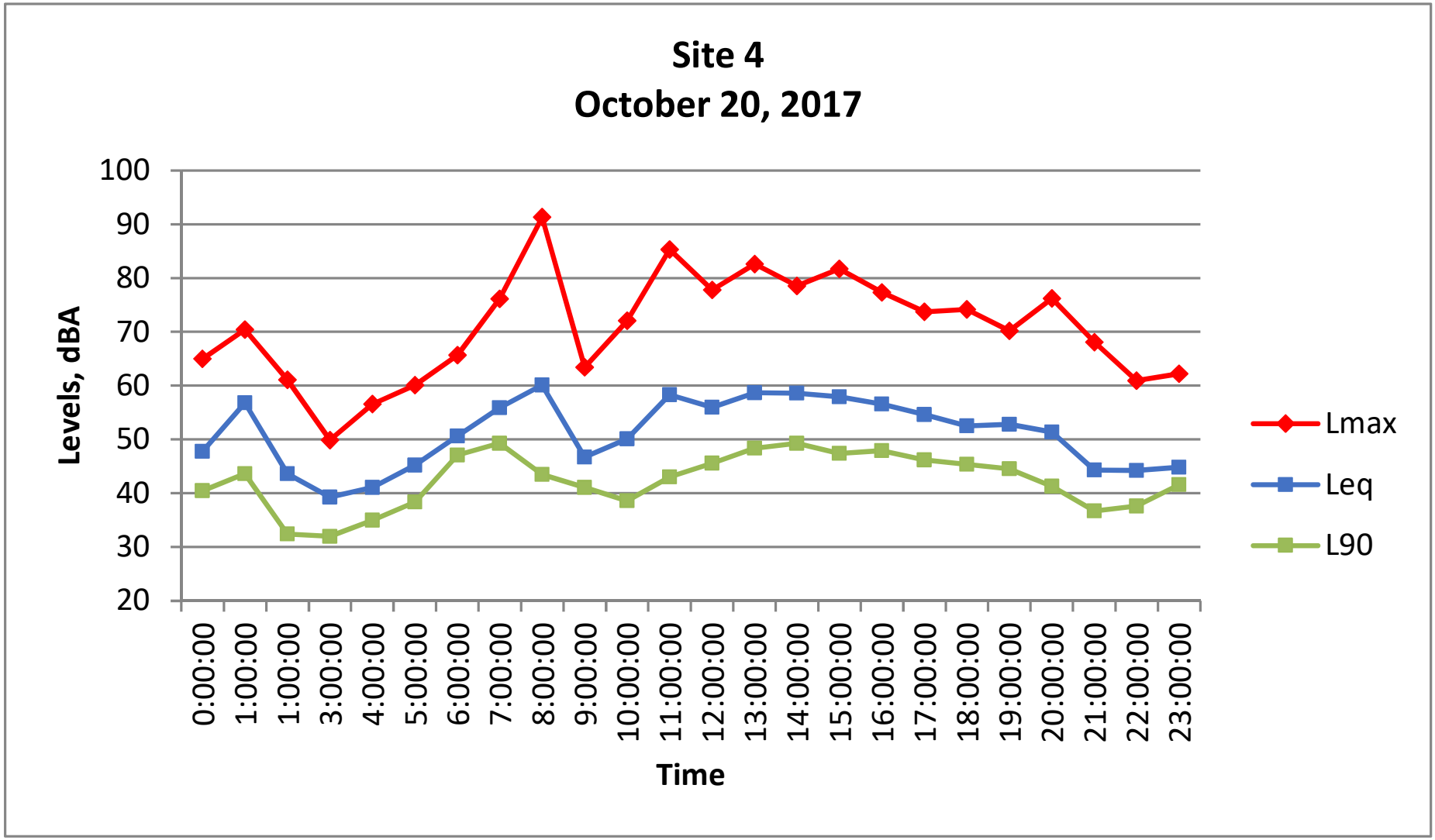
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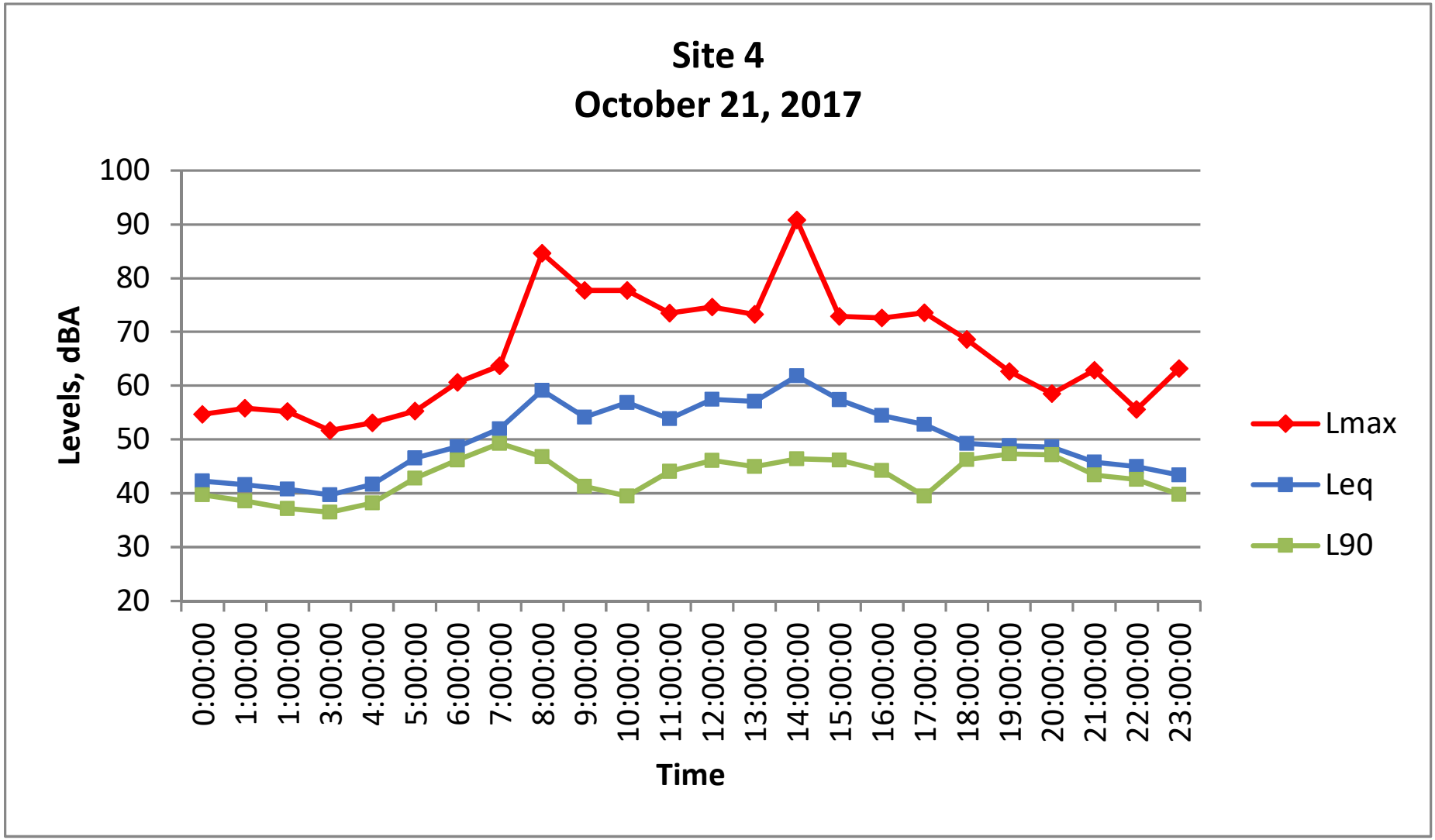
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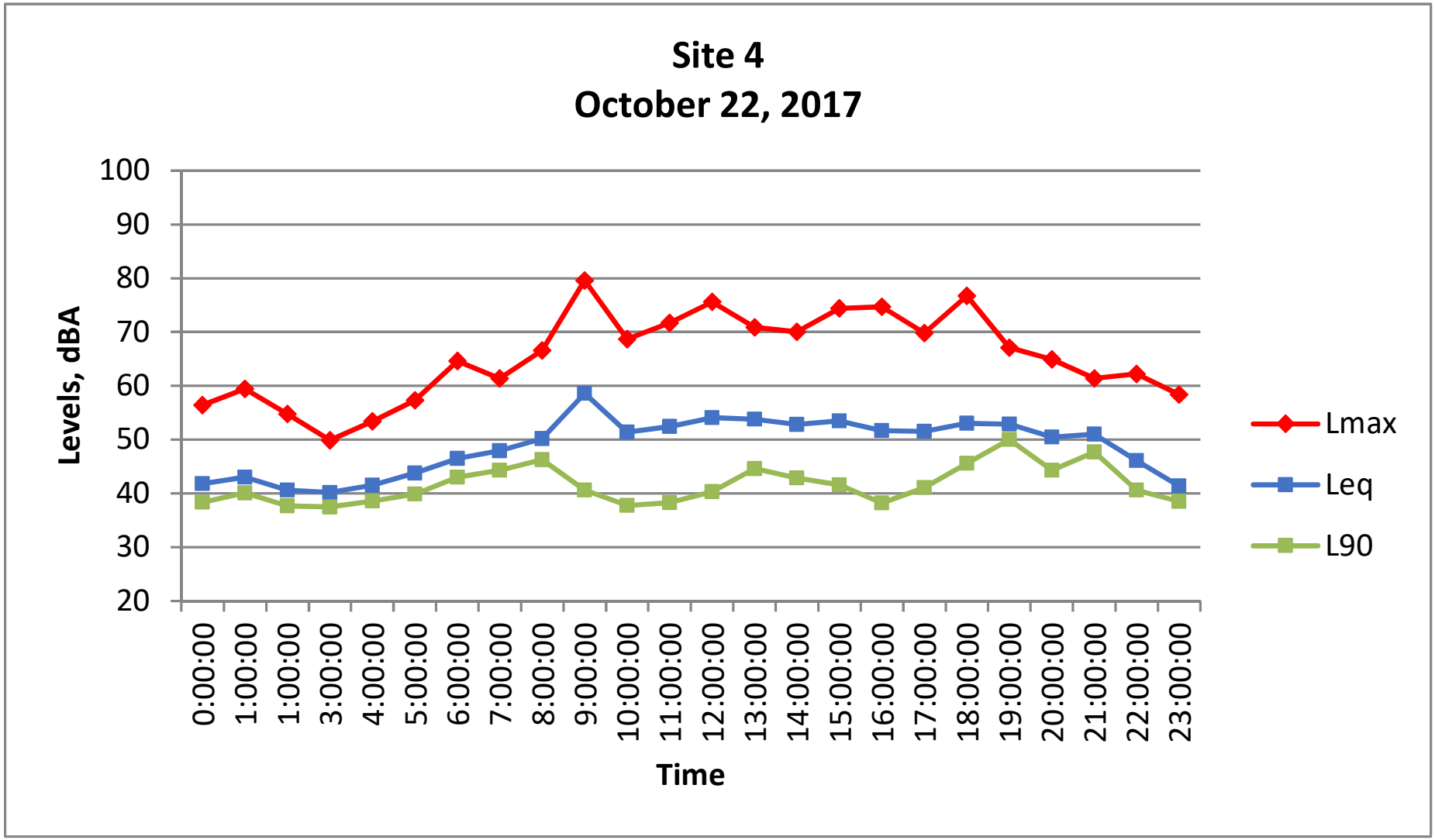
Site 4
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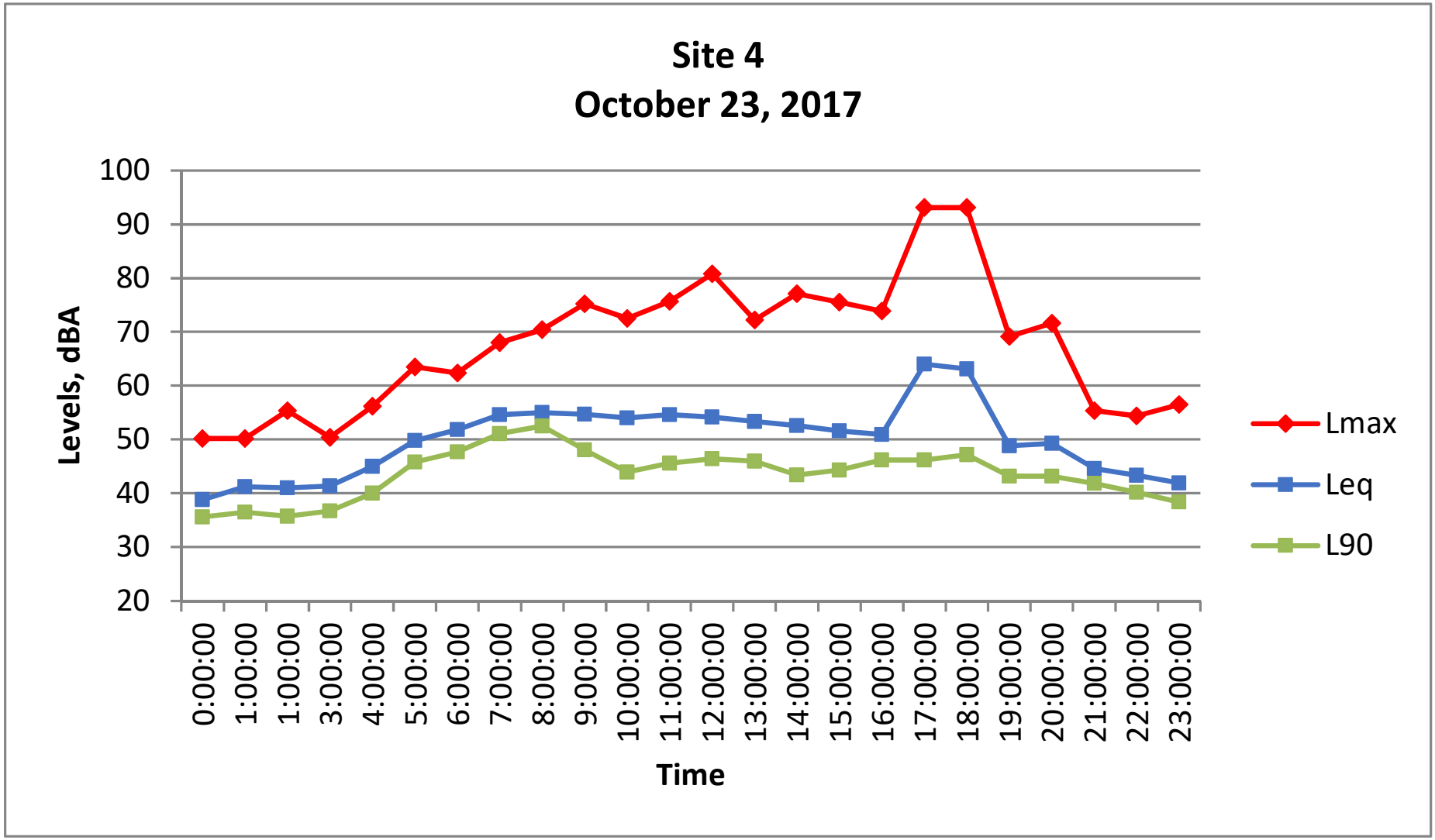
Site 4
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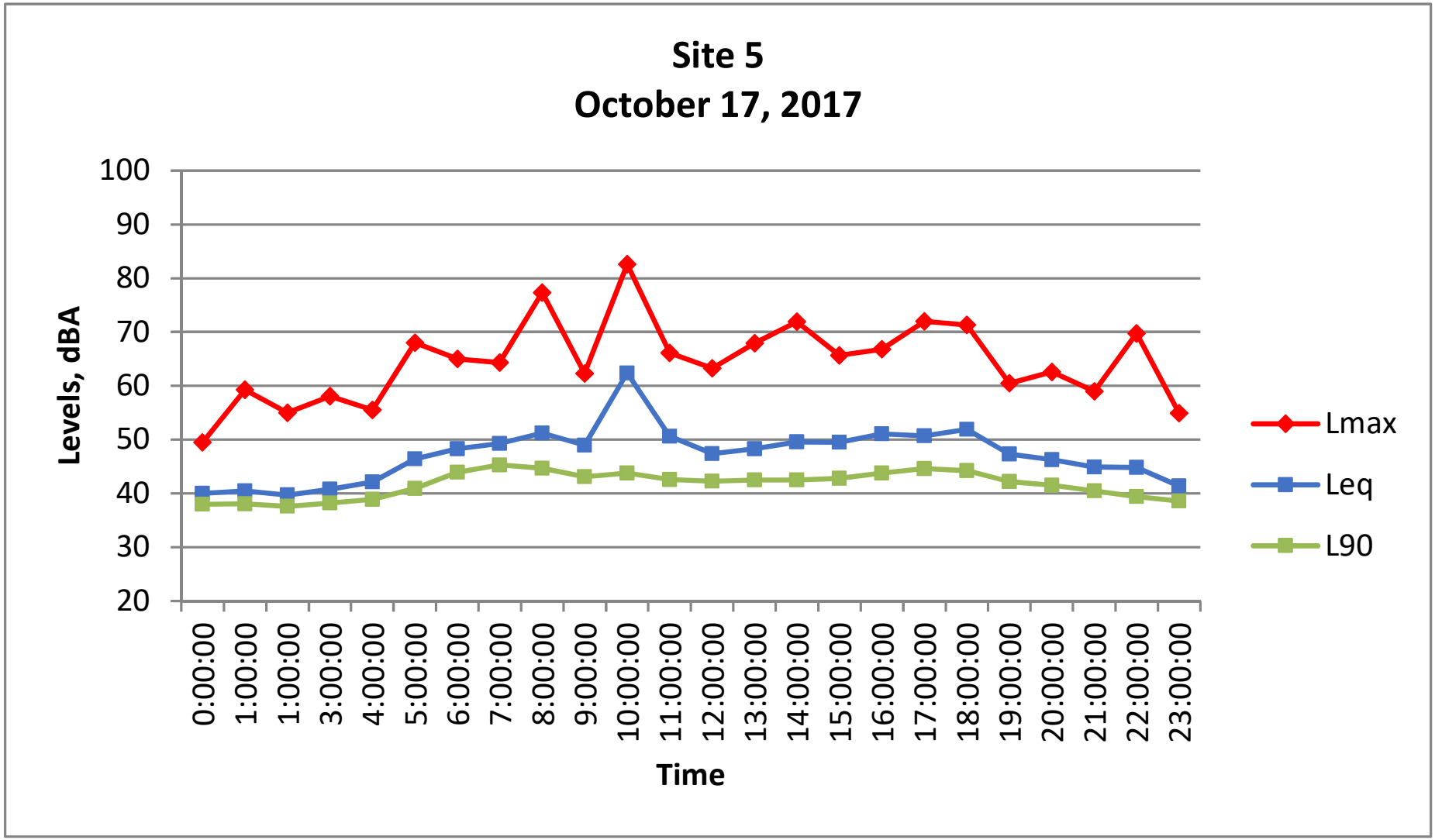
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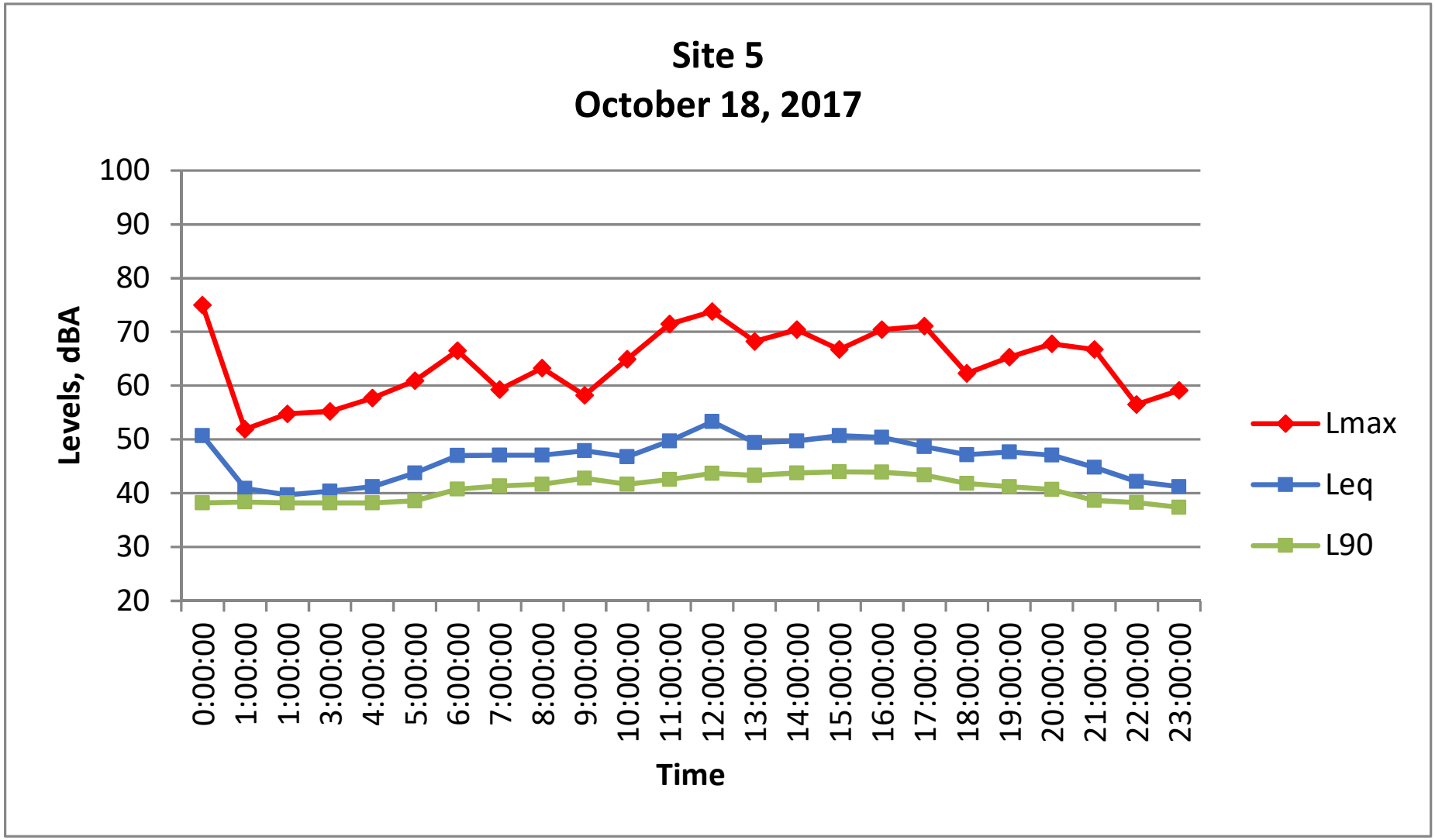
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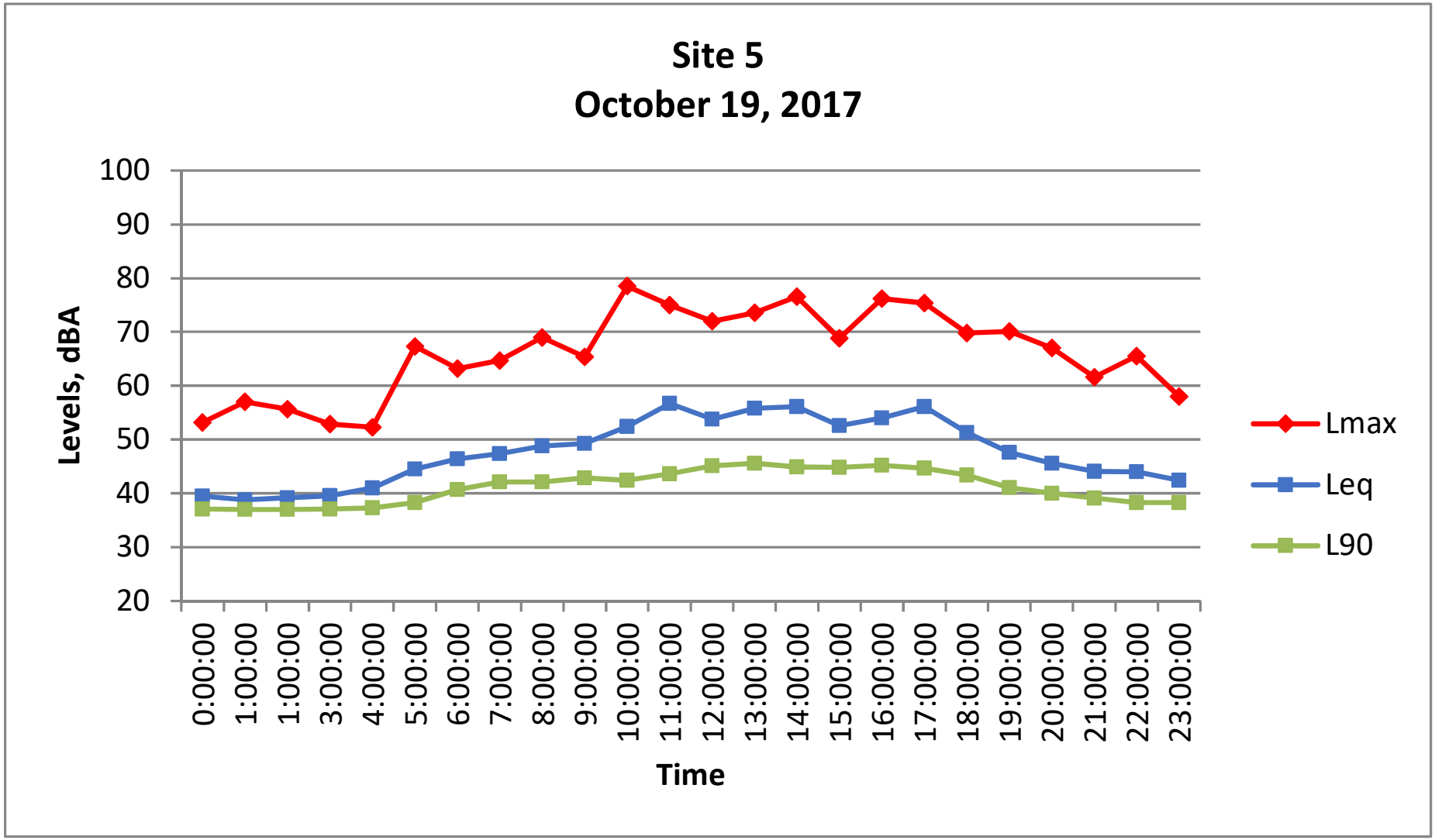
Site 5
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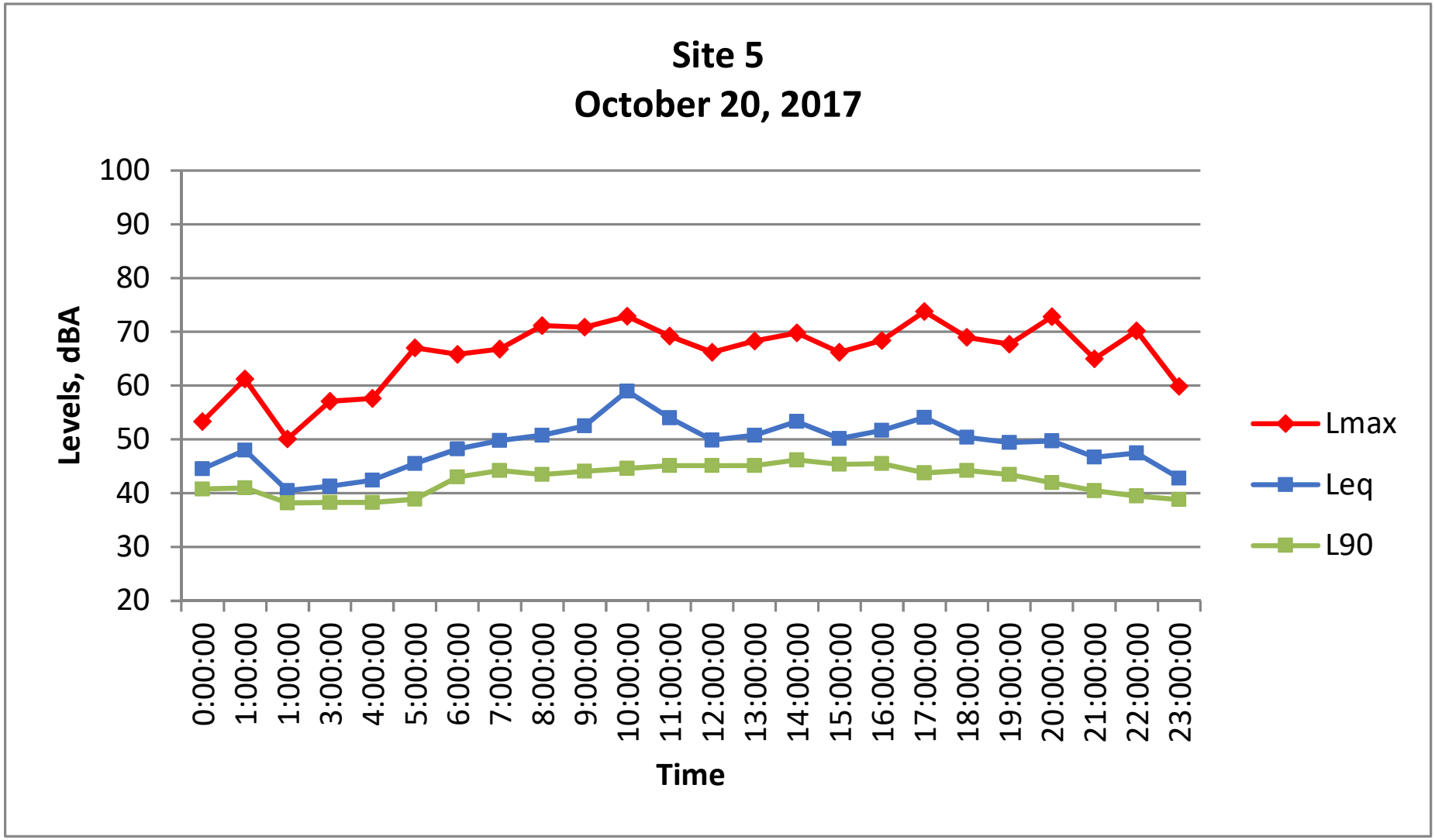
Site 5
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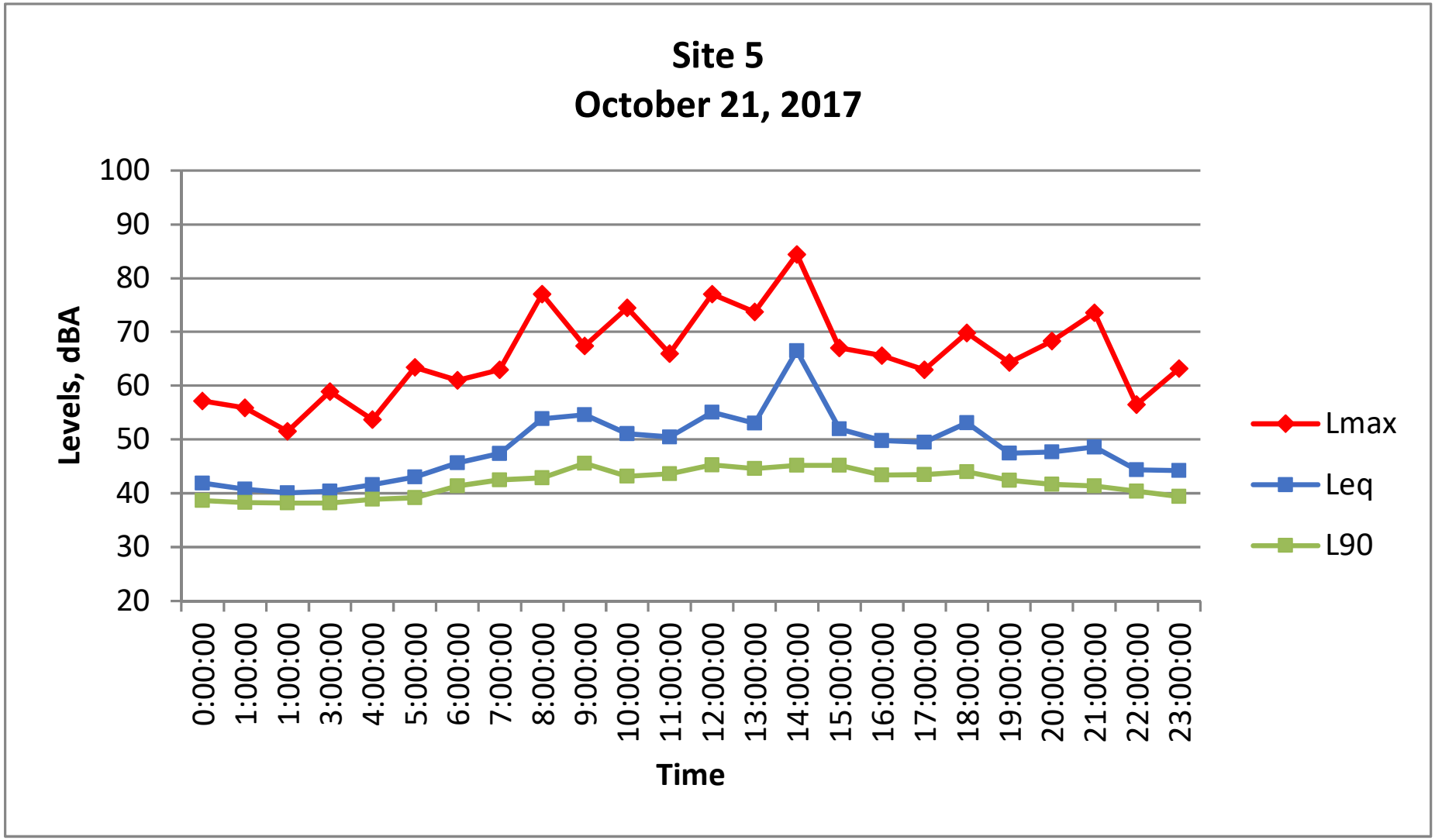
Site 5
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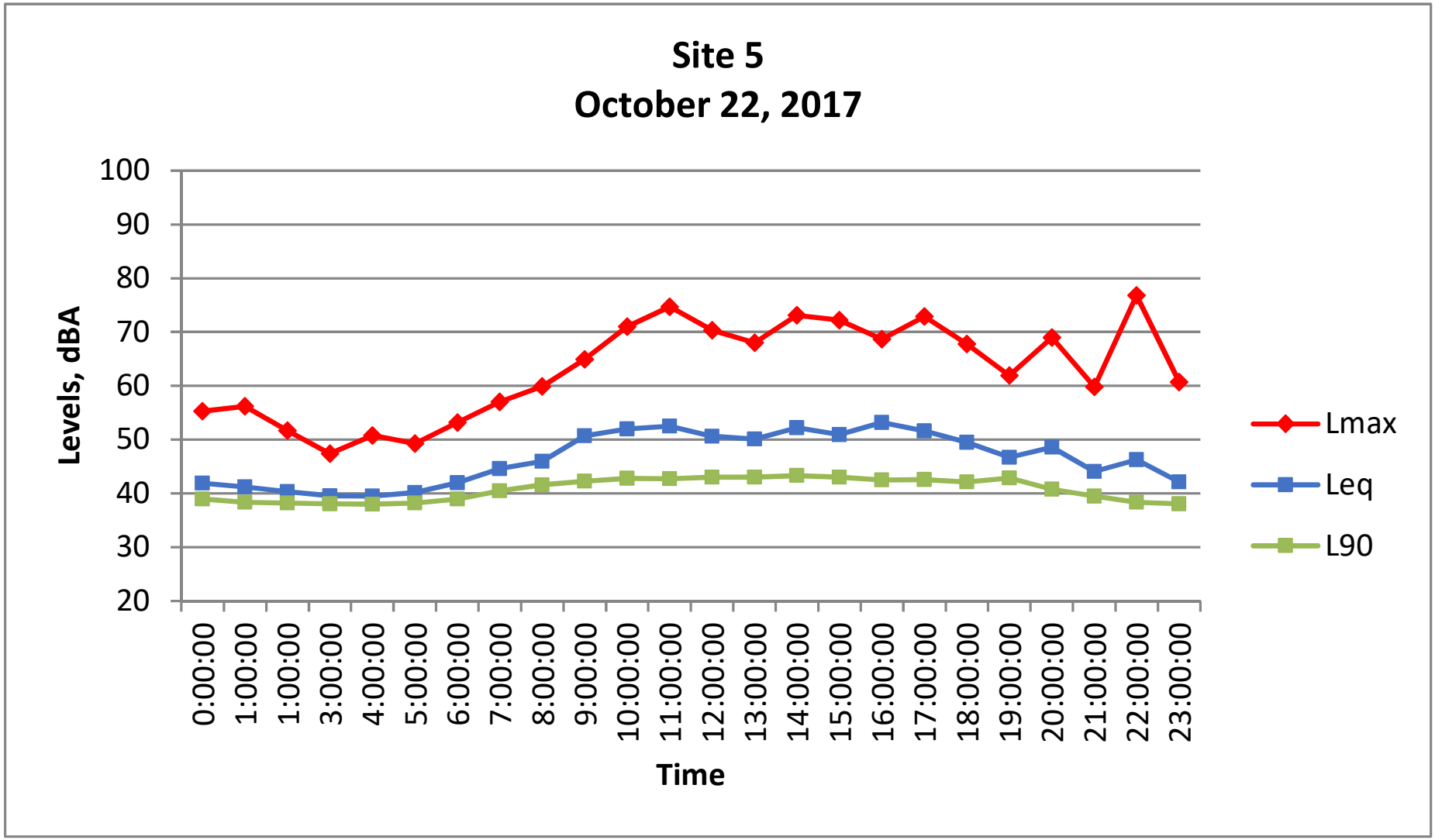
Site 5
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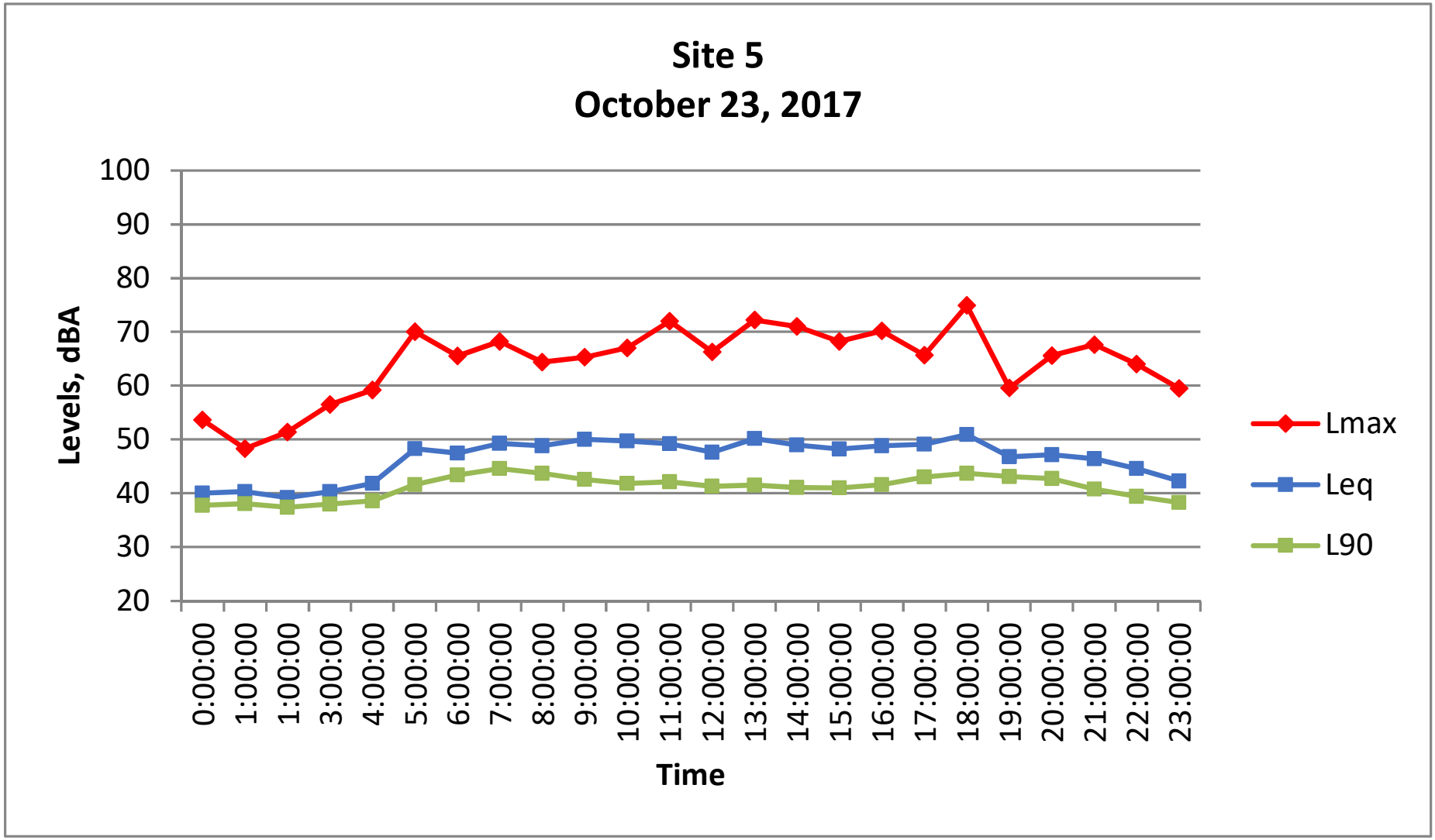
Site 5
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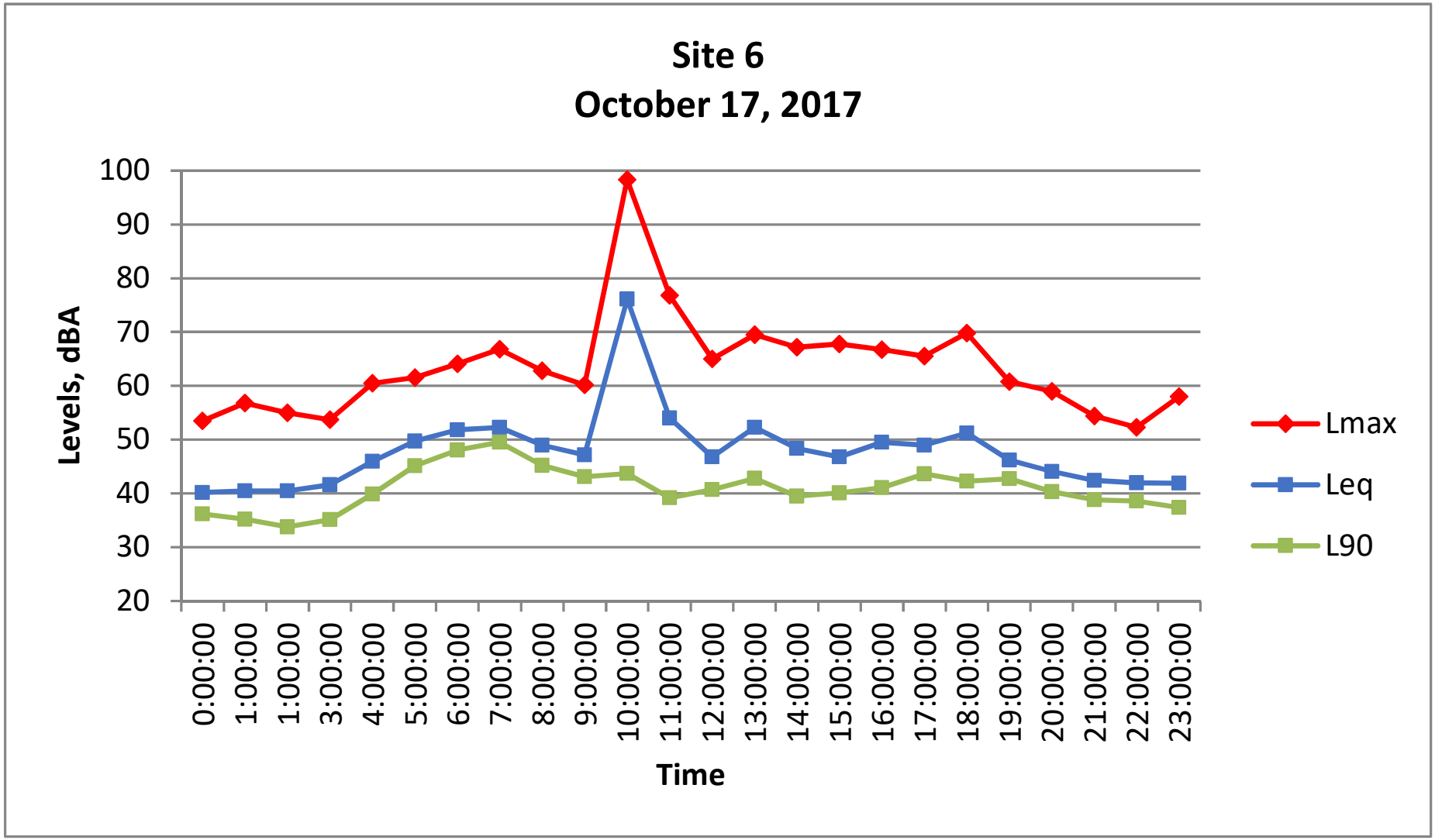
Site 6
October 17, 2017
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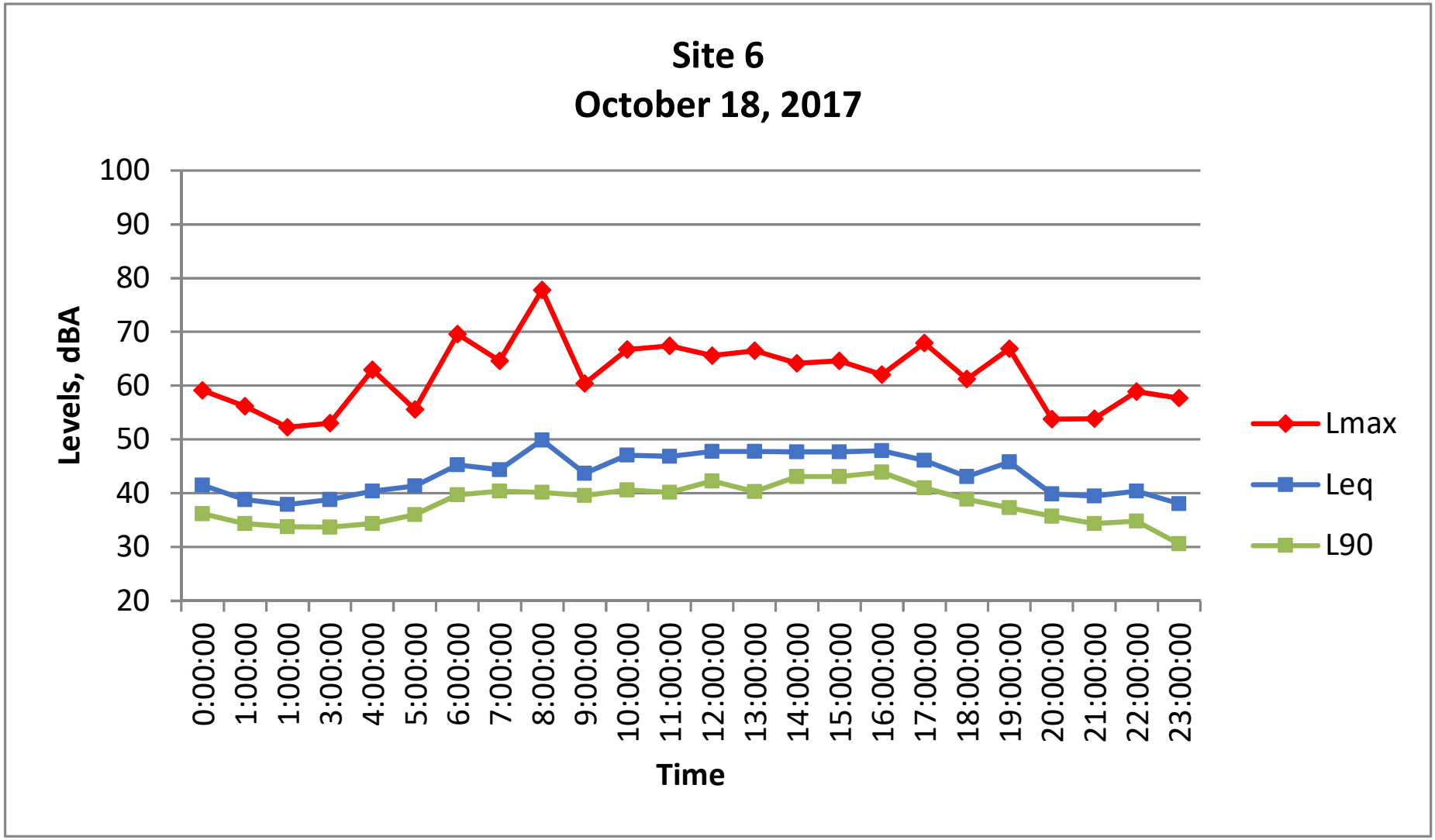
Site 6
October 18, 2017
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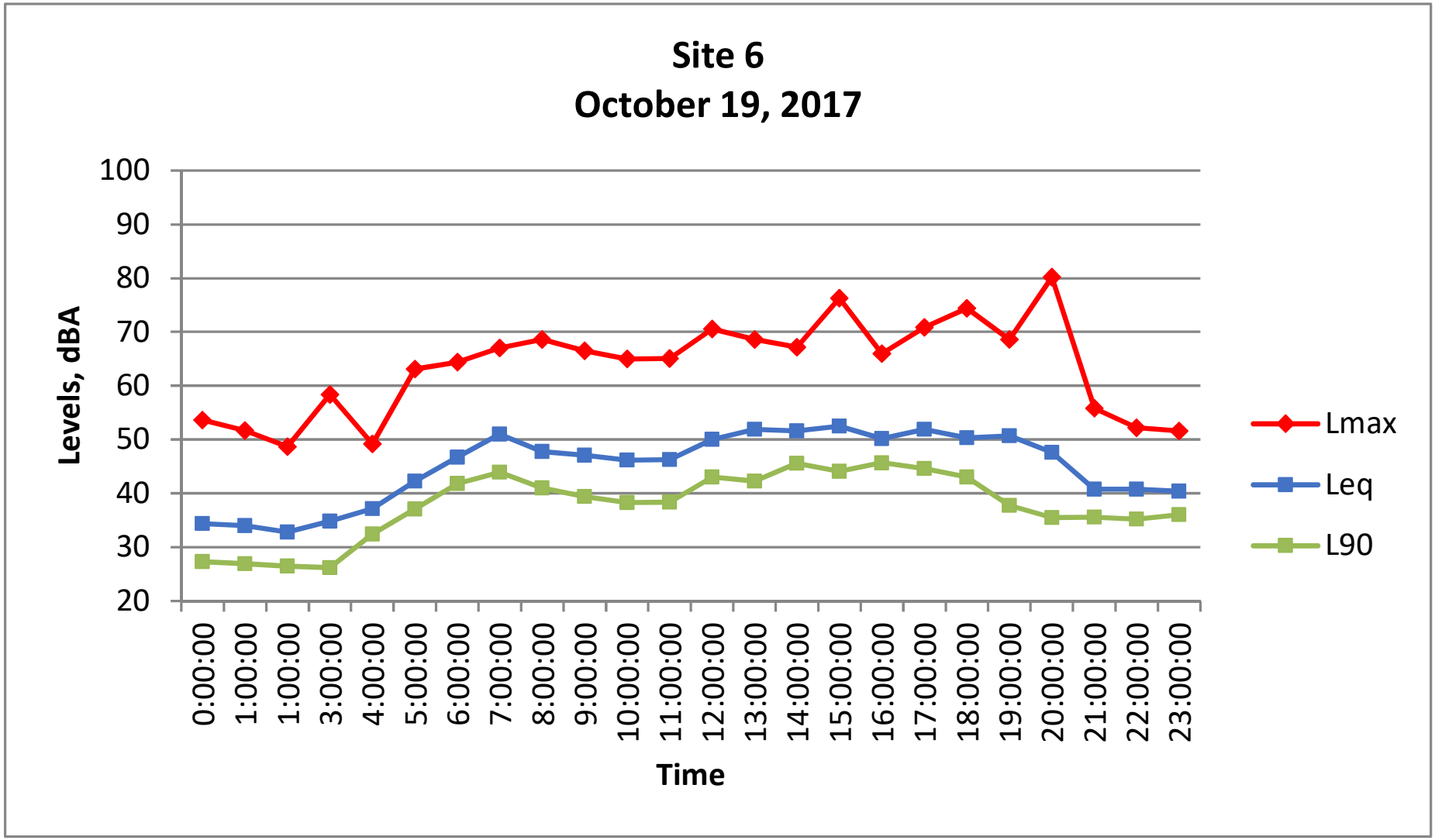
Site 6
October 19, 2017
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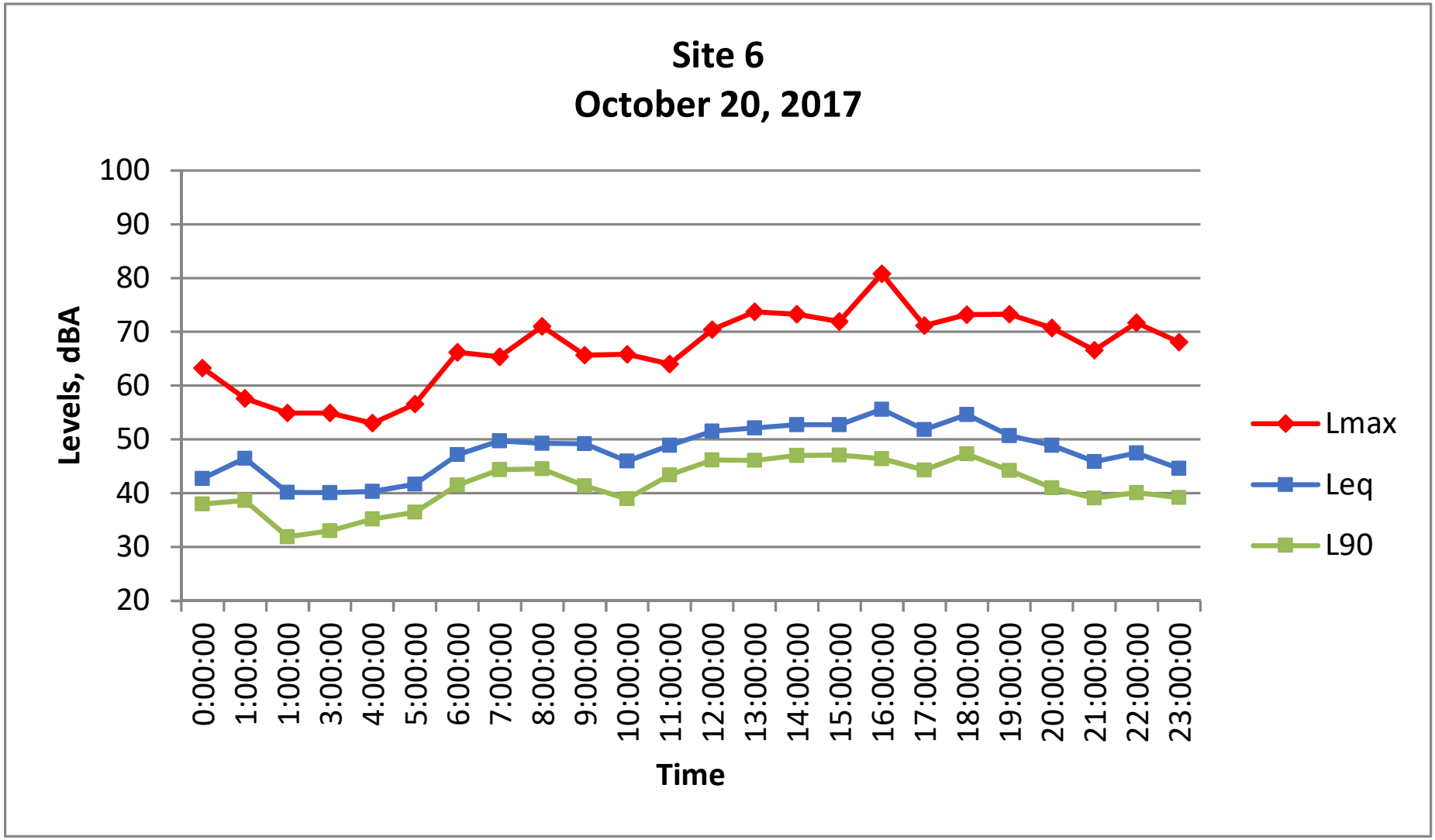
Site 6
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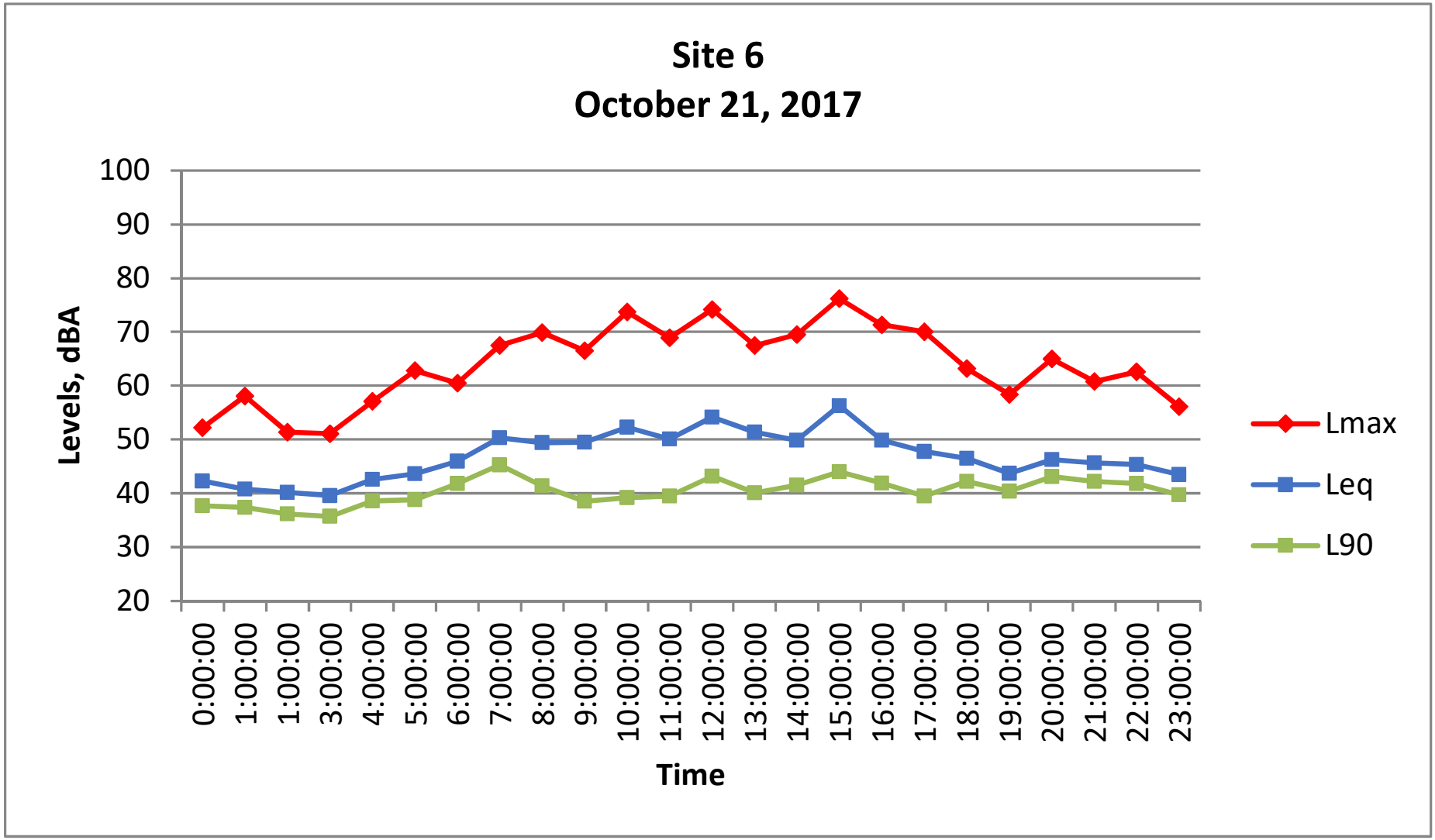
Site 6
October 21, 2017
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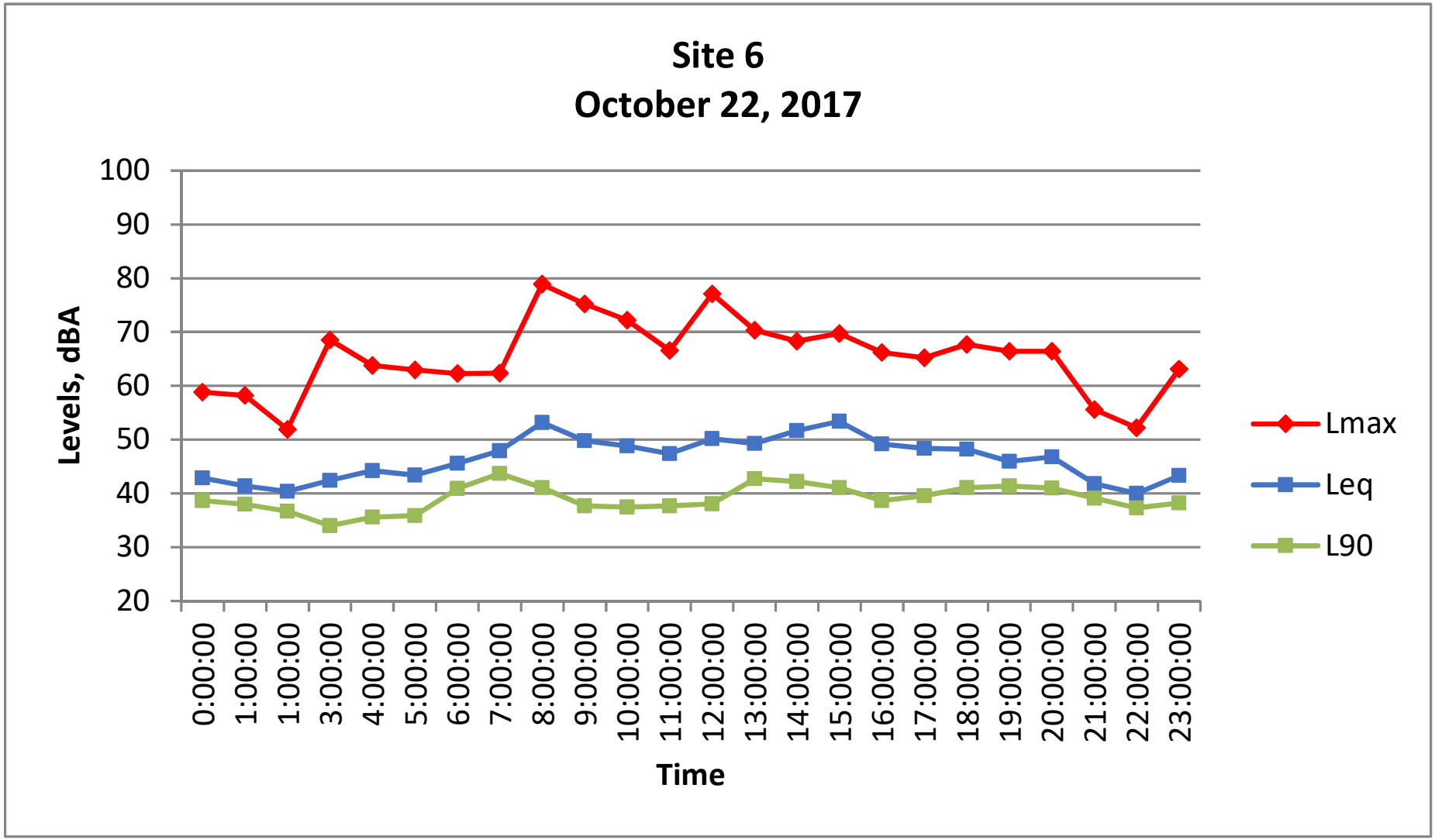
Site 6
October 22, 2017
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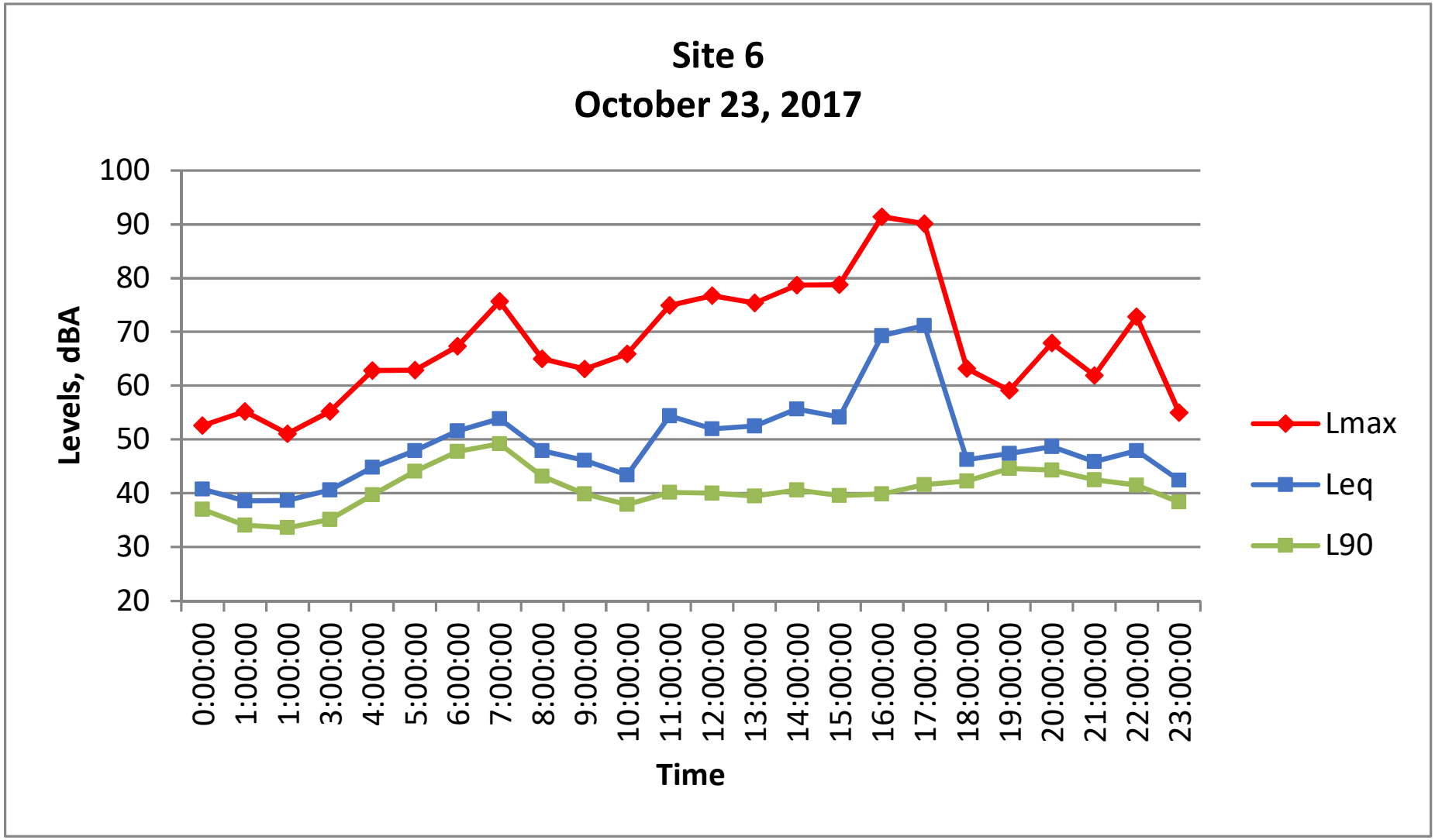
Site 6
October 23, 2017
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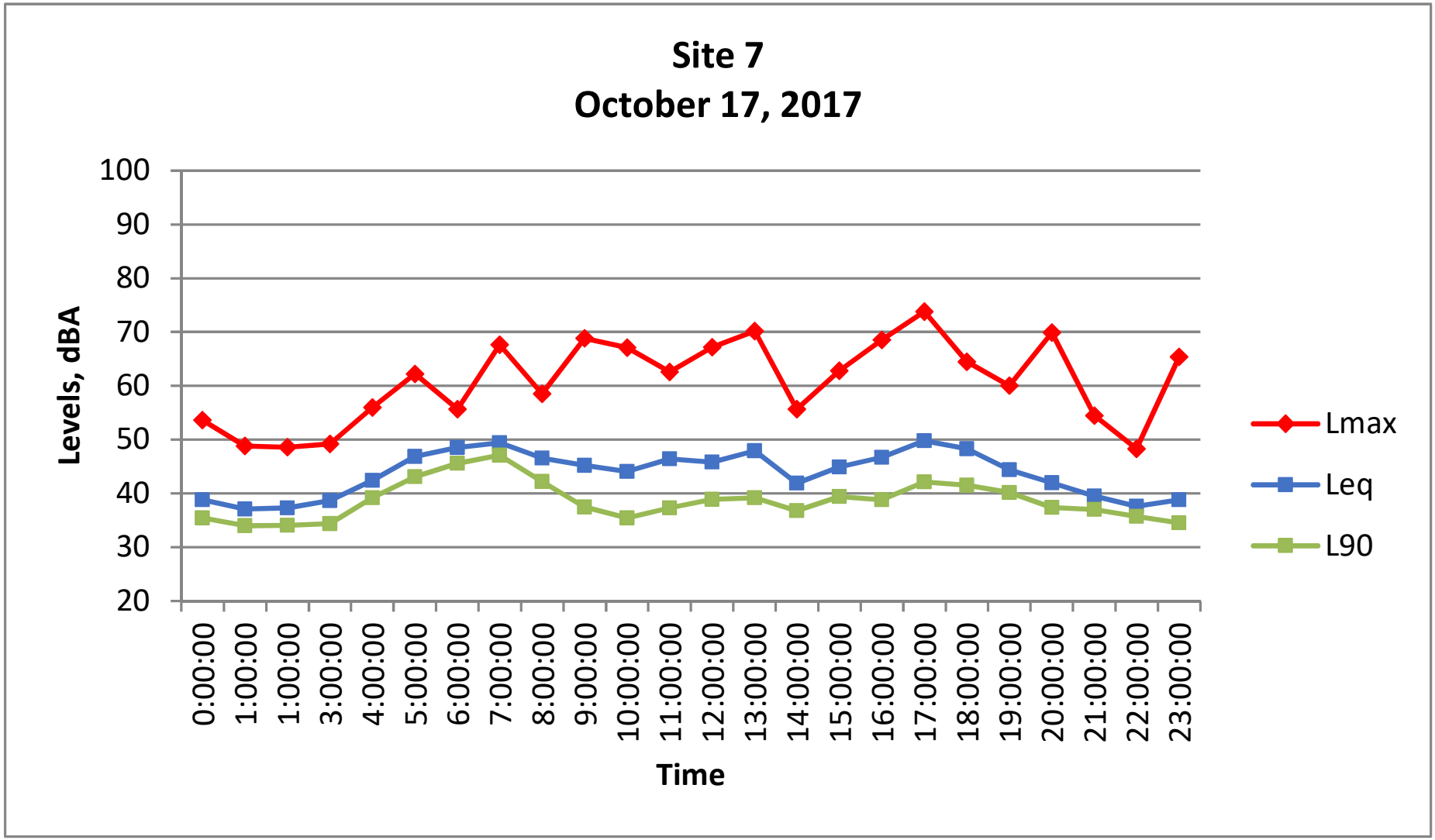
Site 7
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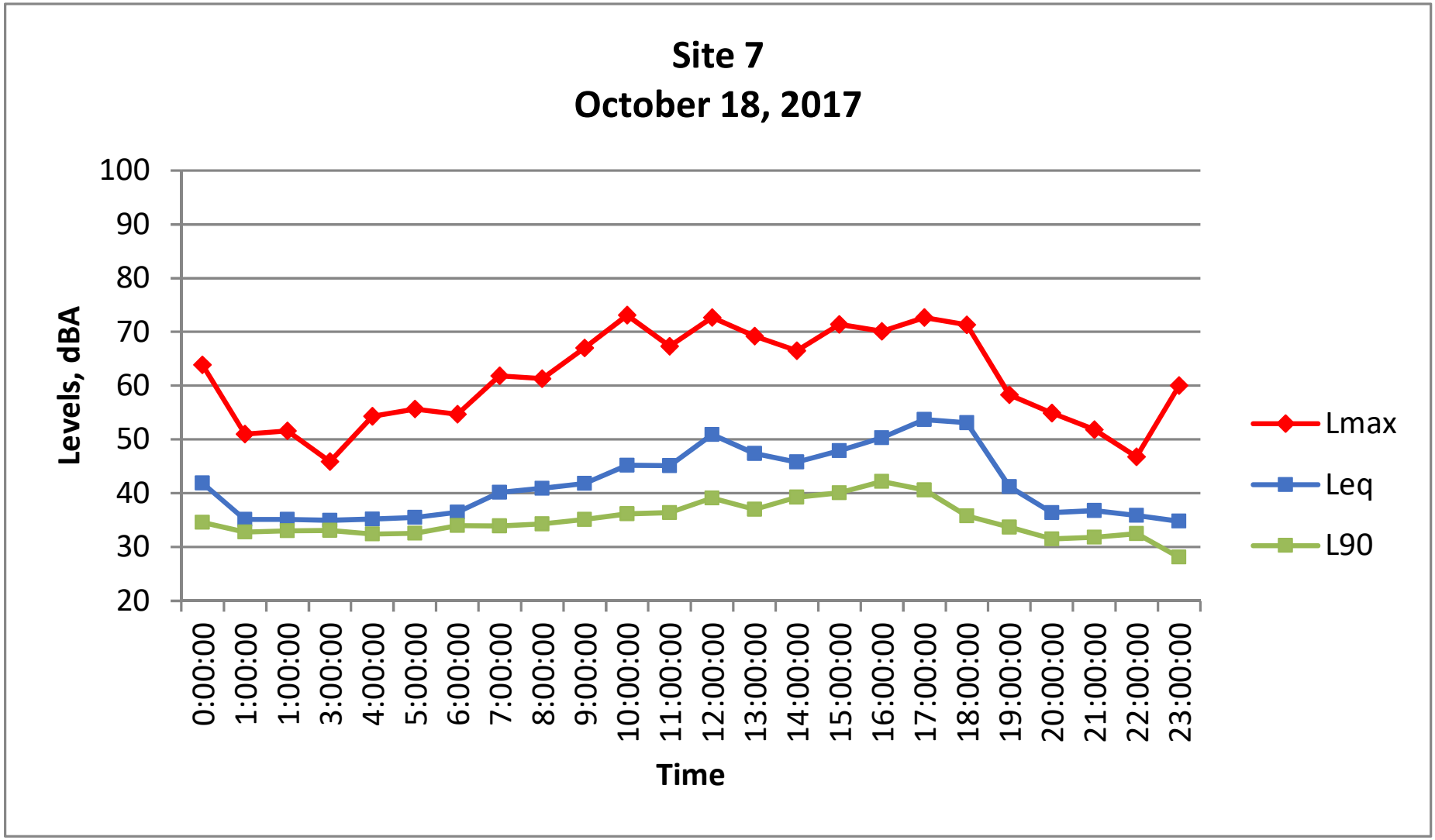
Site 7
October 18, 2017
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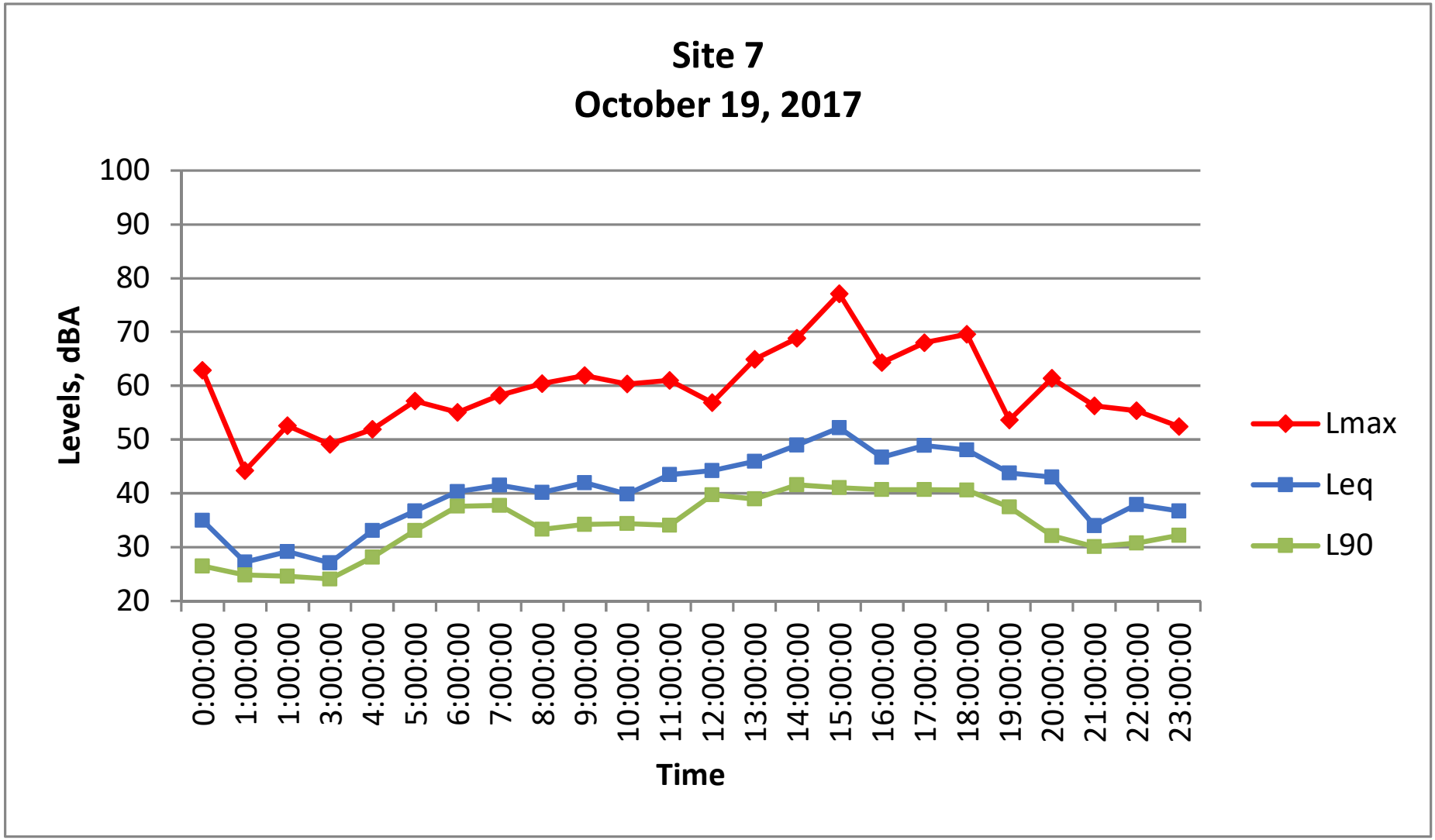
Site 7
October 19, 2017
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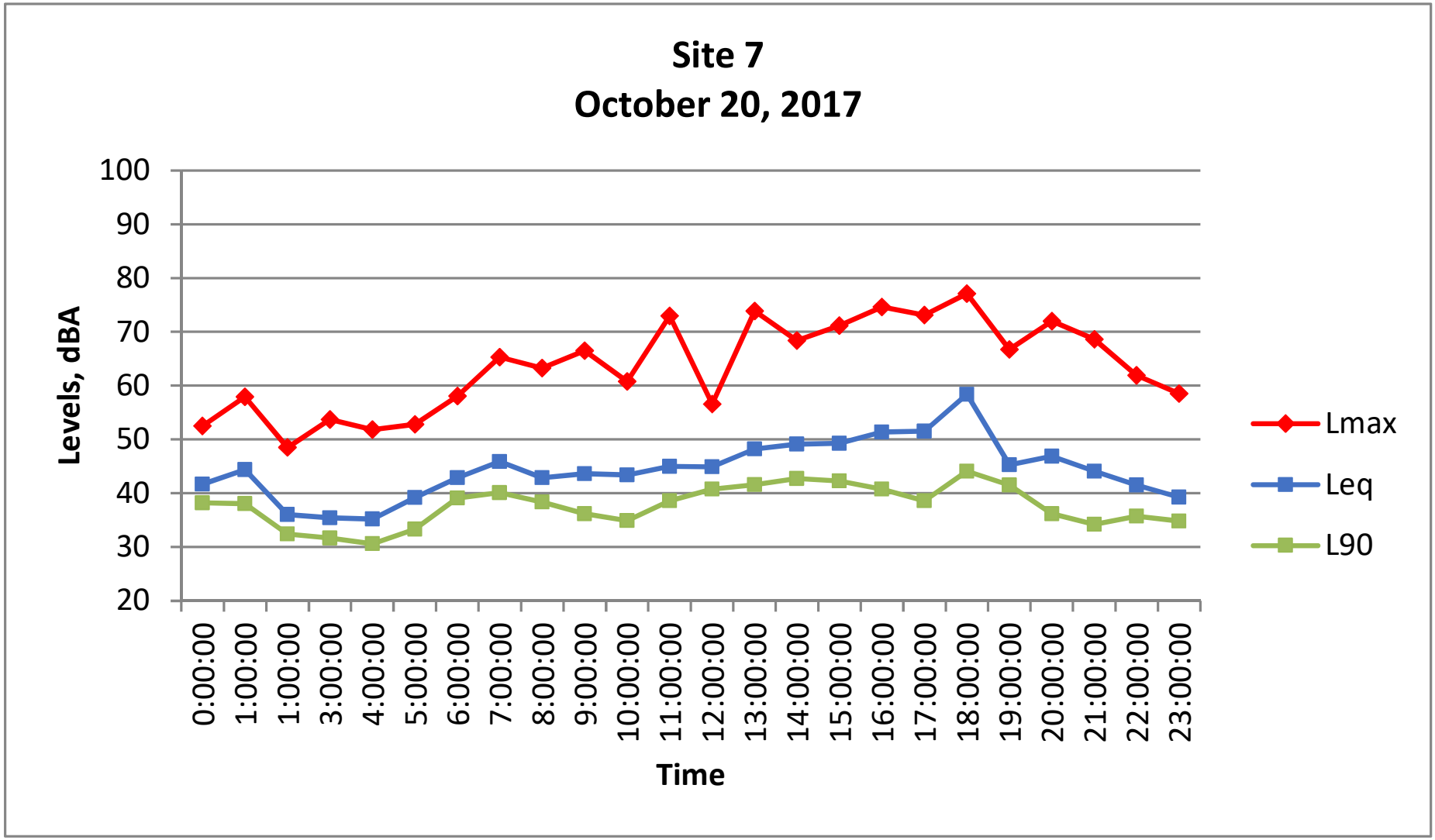
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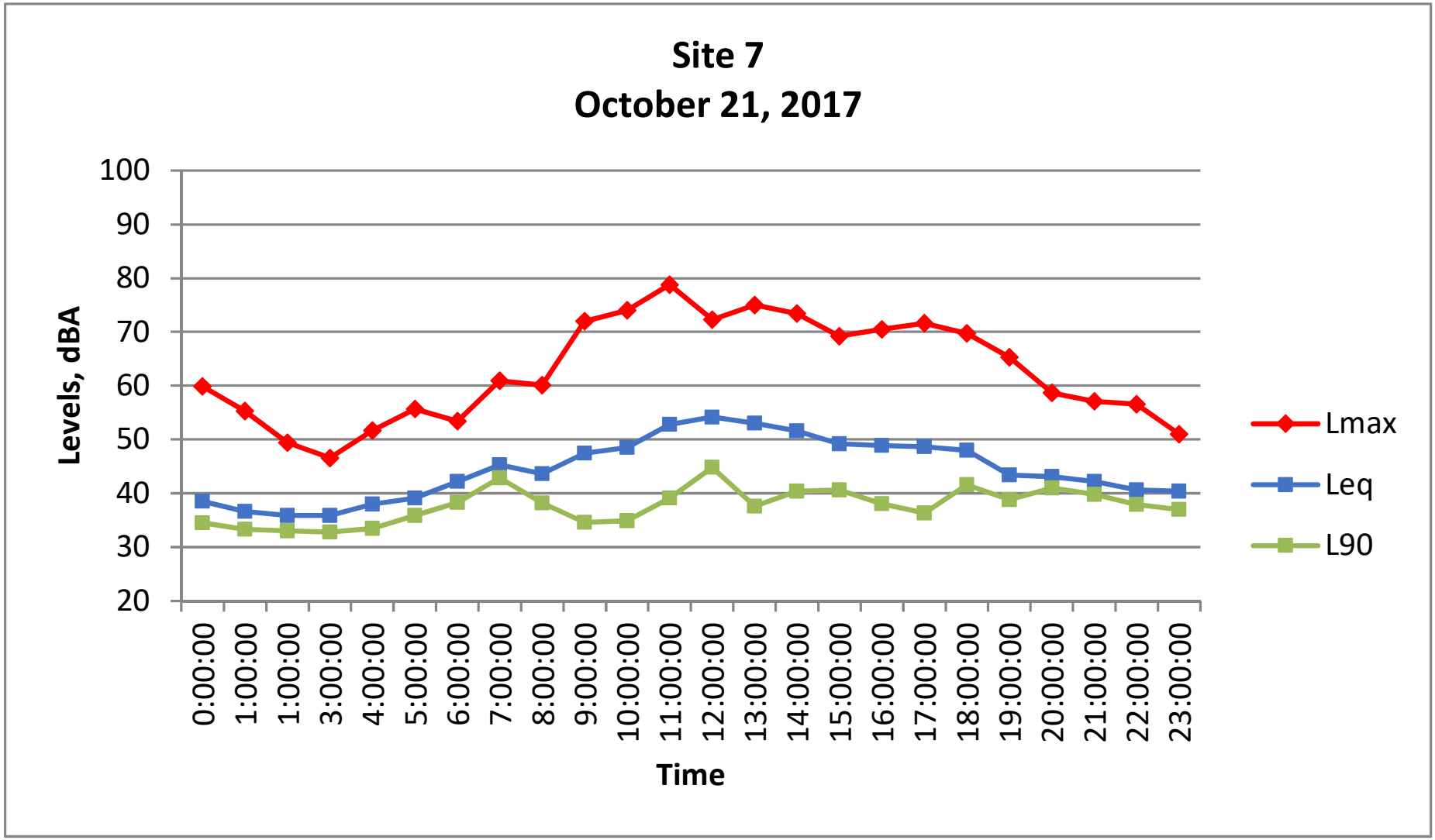
Site 7
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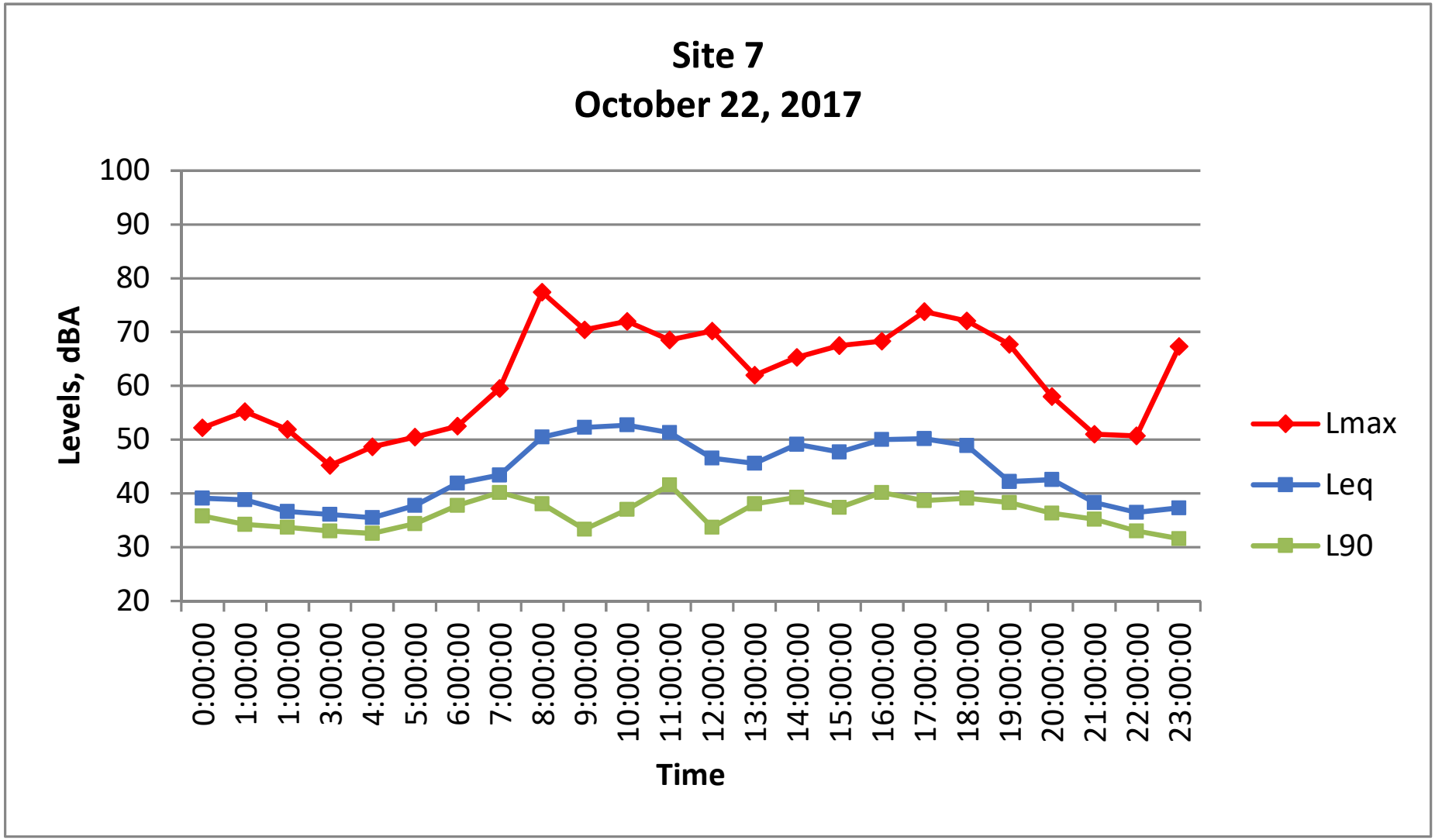
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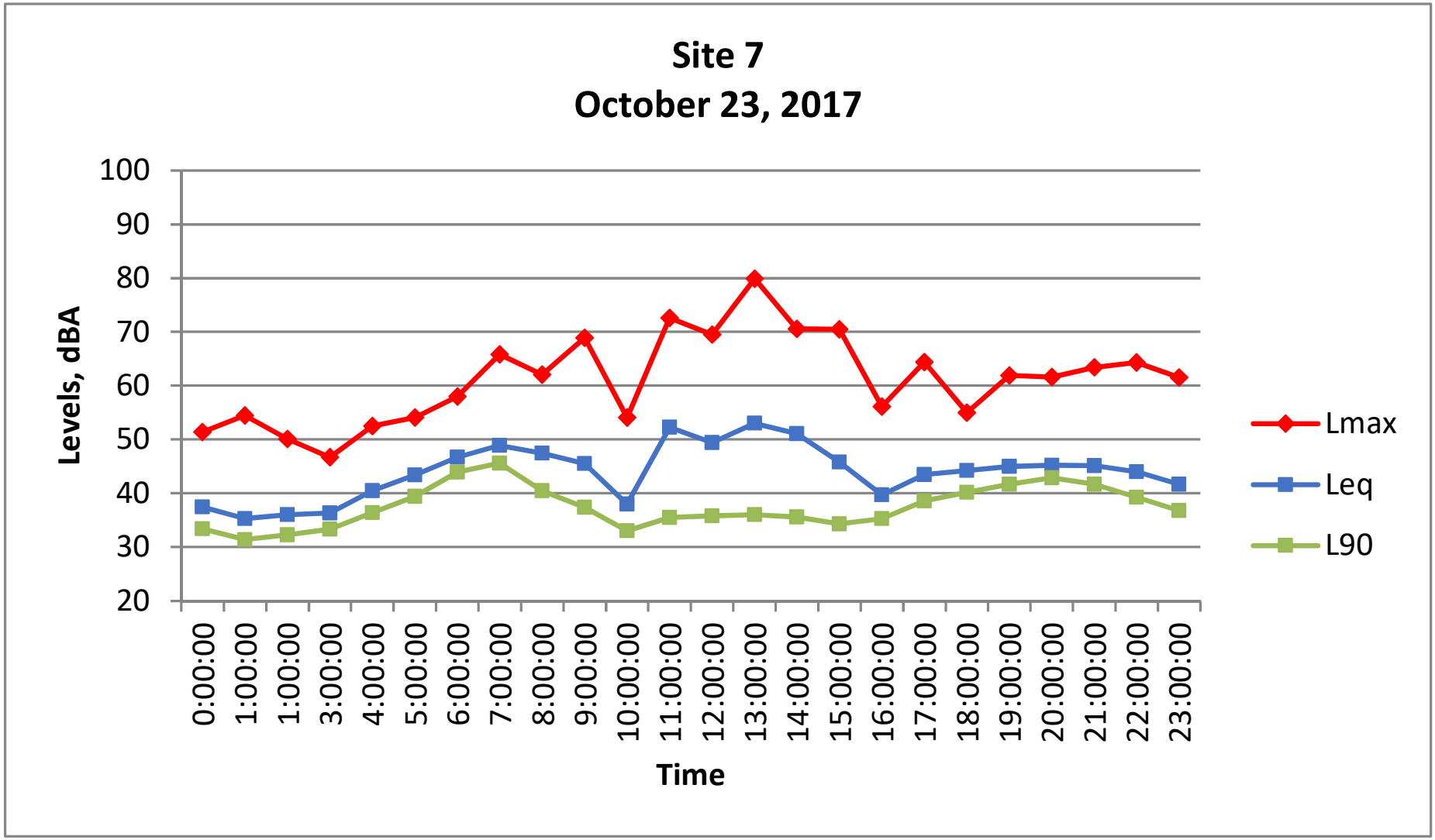
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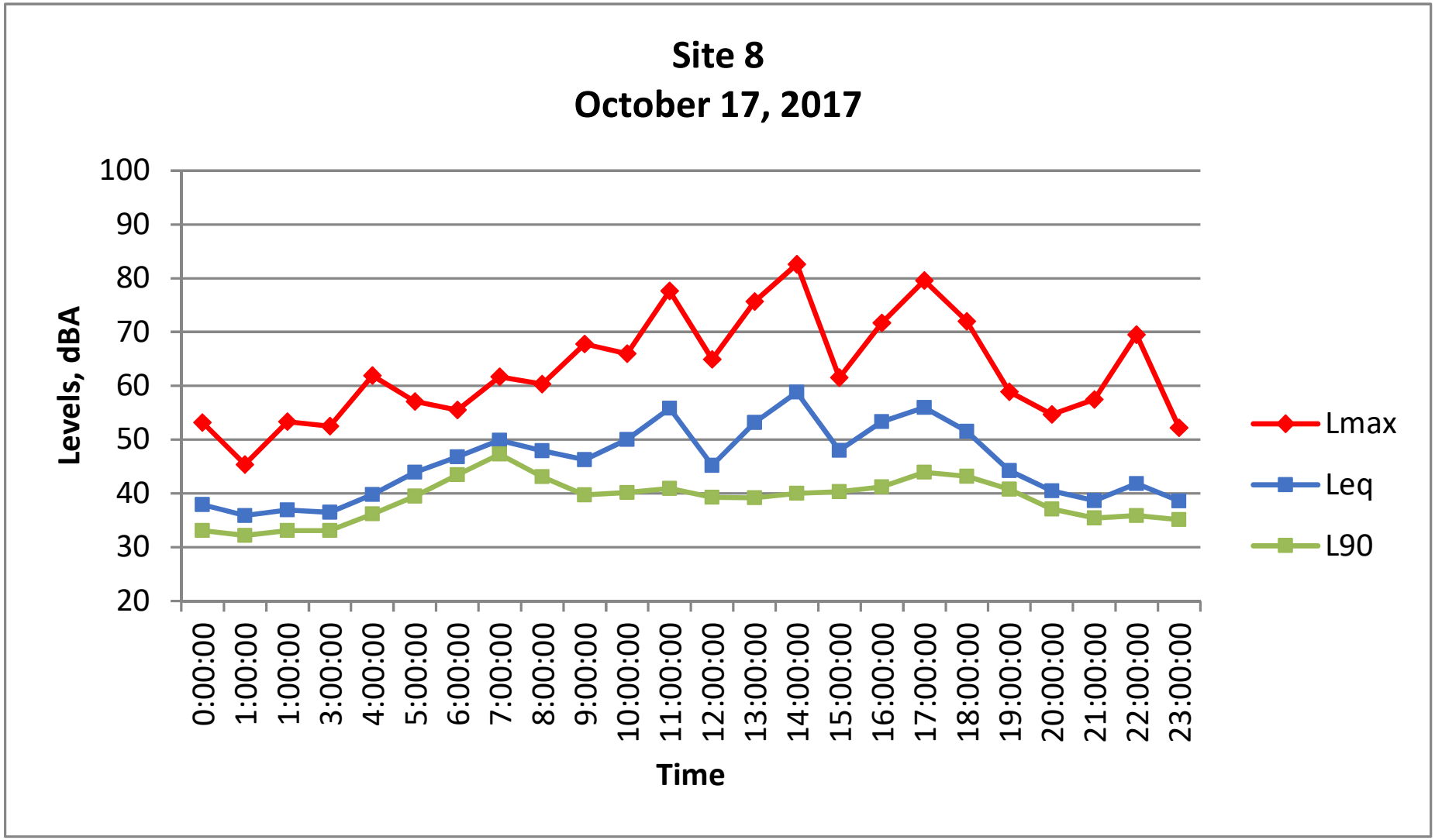
Site 8
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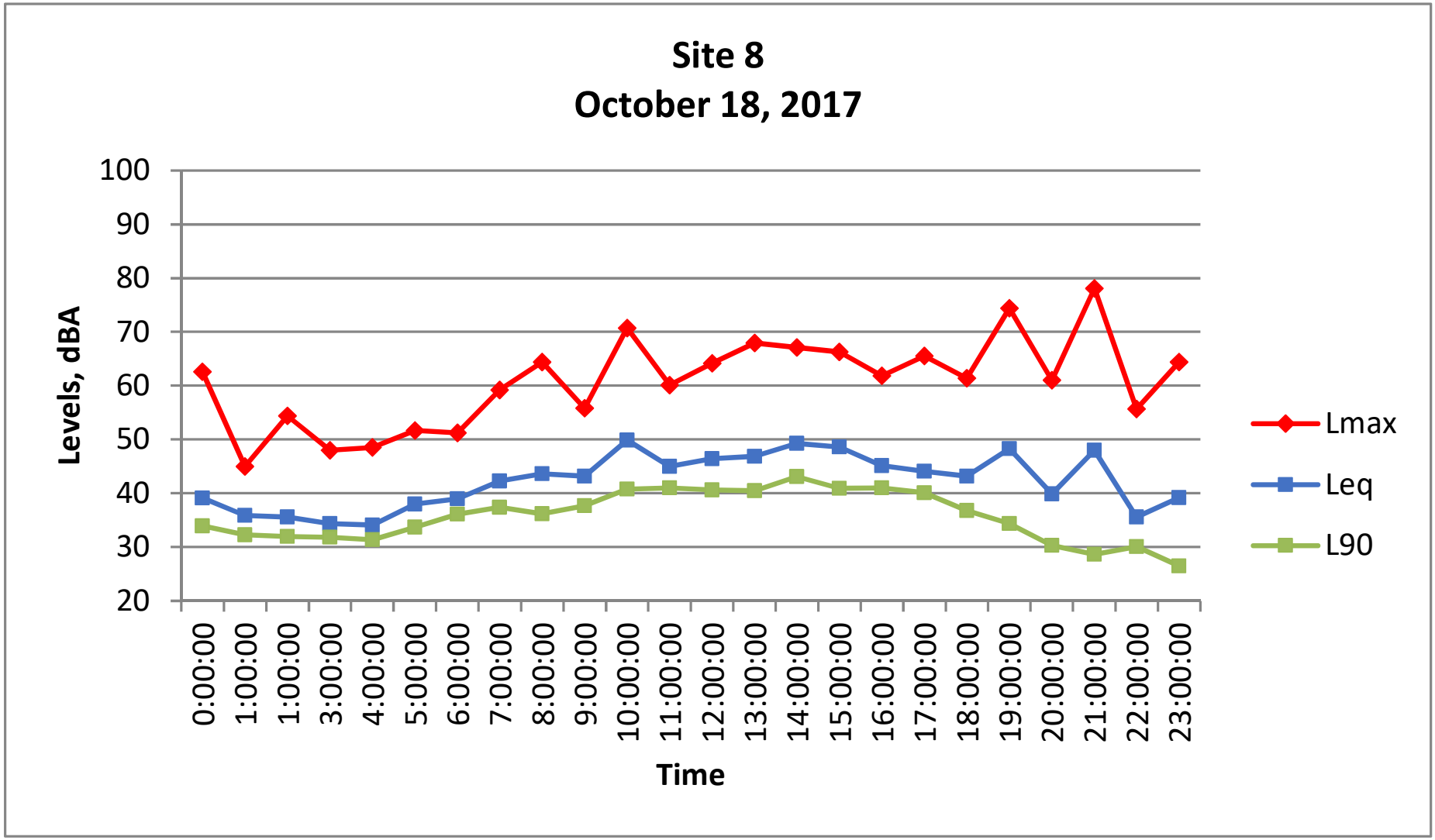
Site 8
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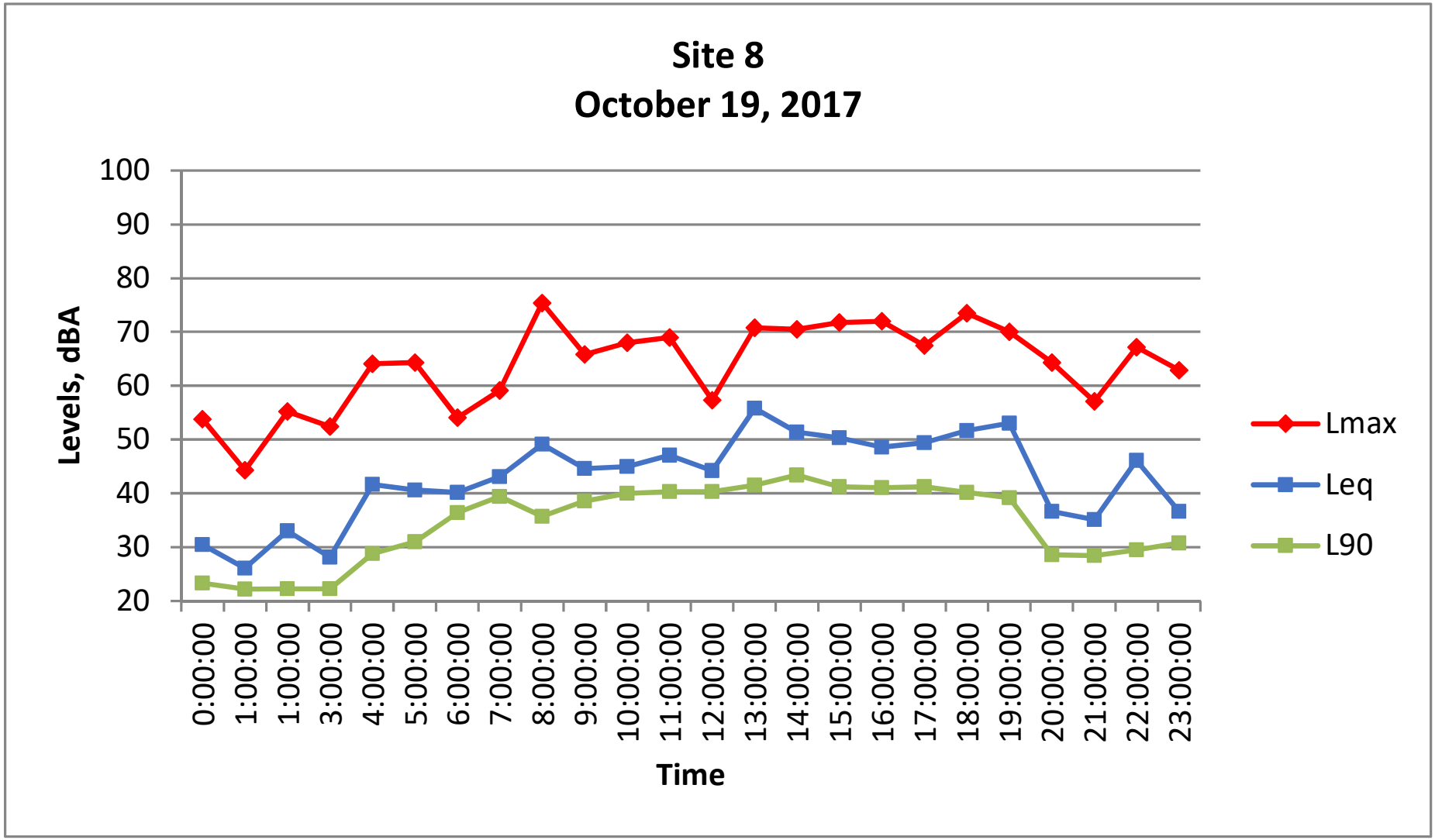
Site 8
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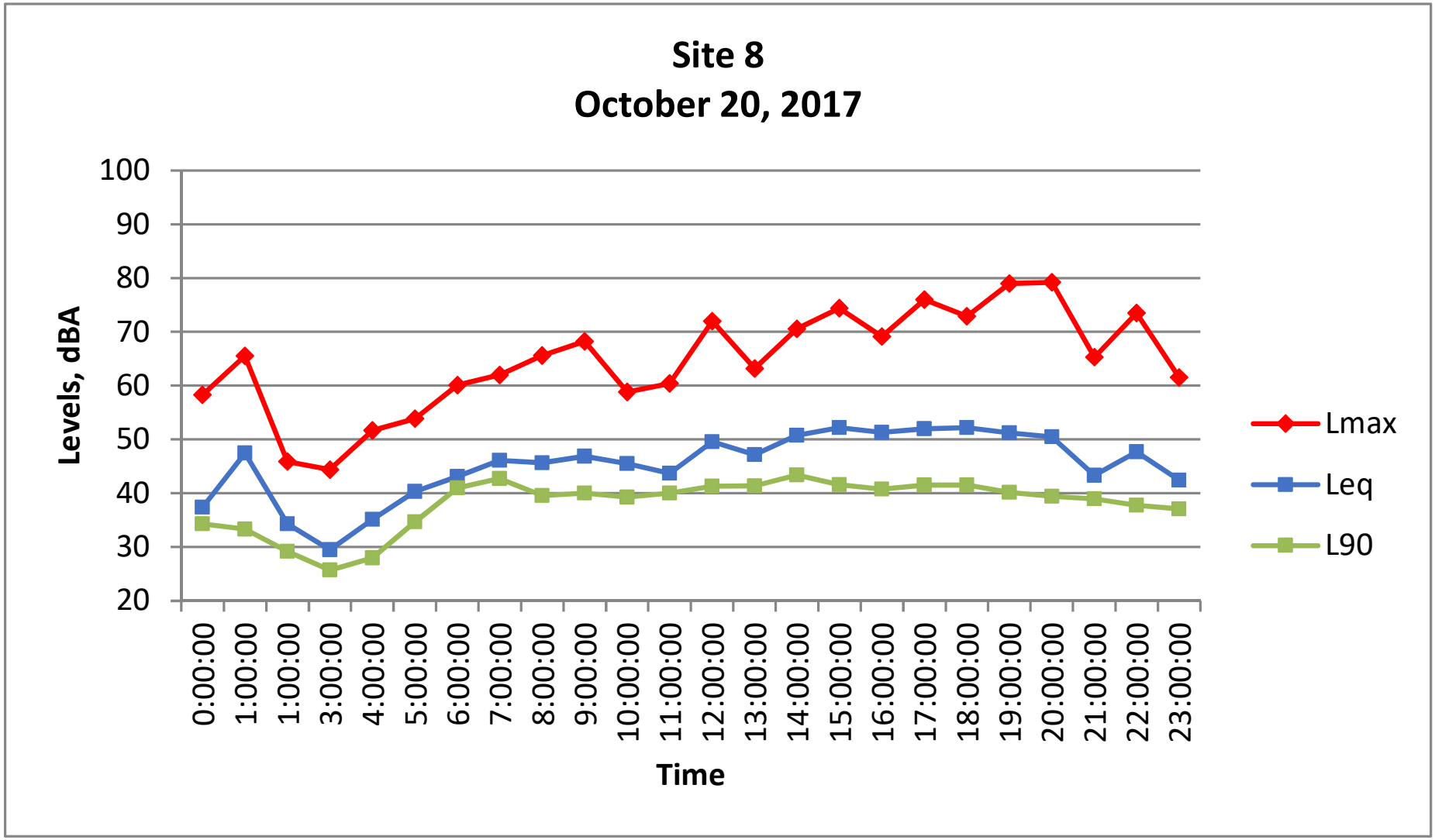
Site 8
October 20, 2017
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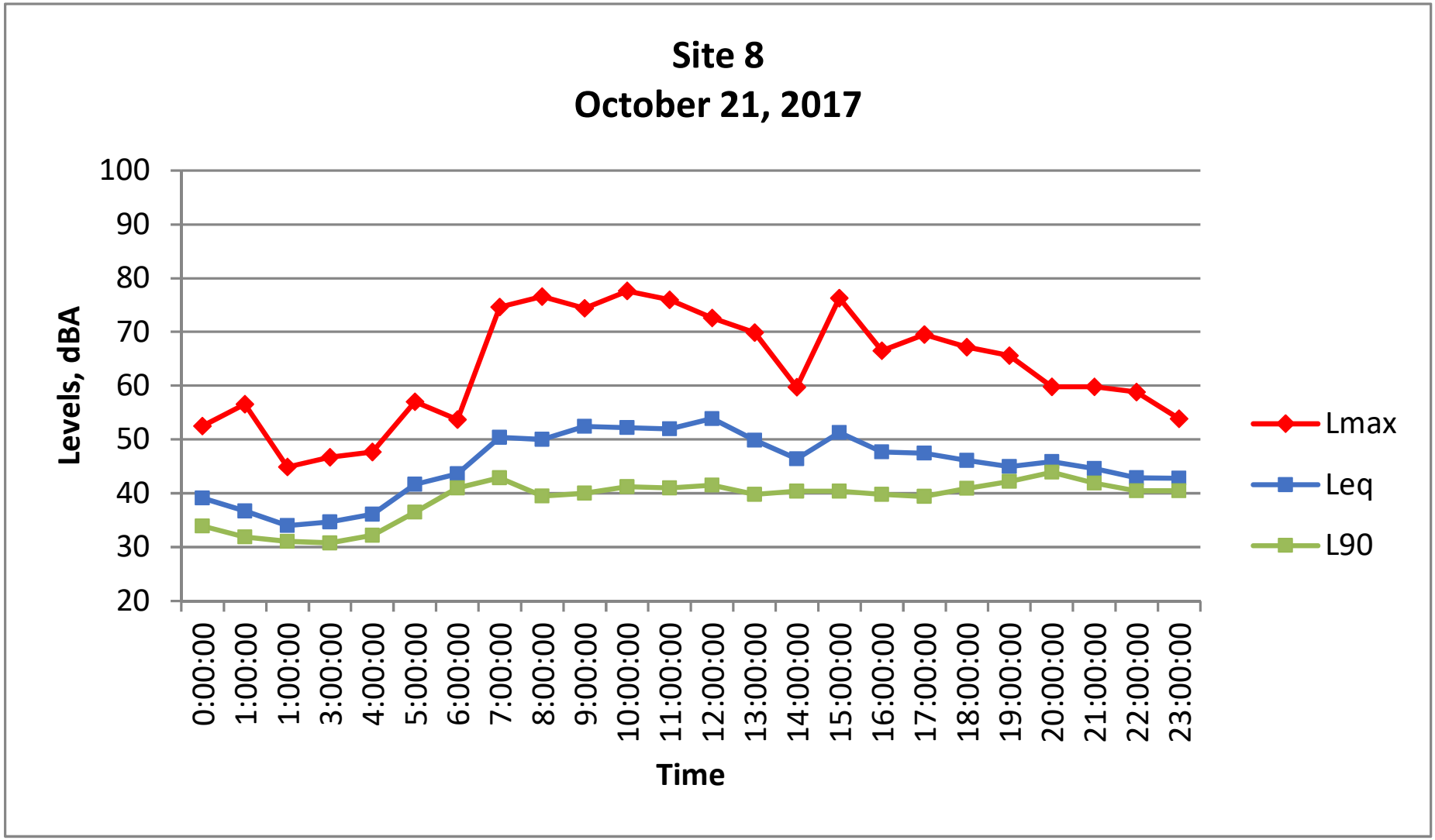
Site 8
October 21, 2017
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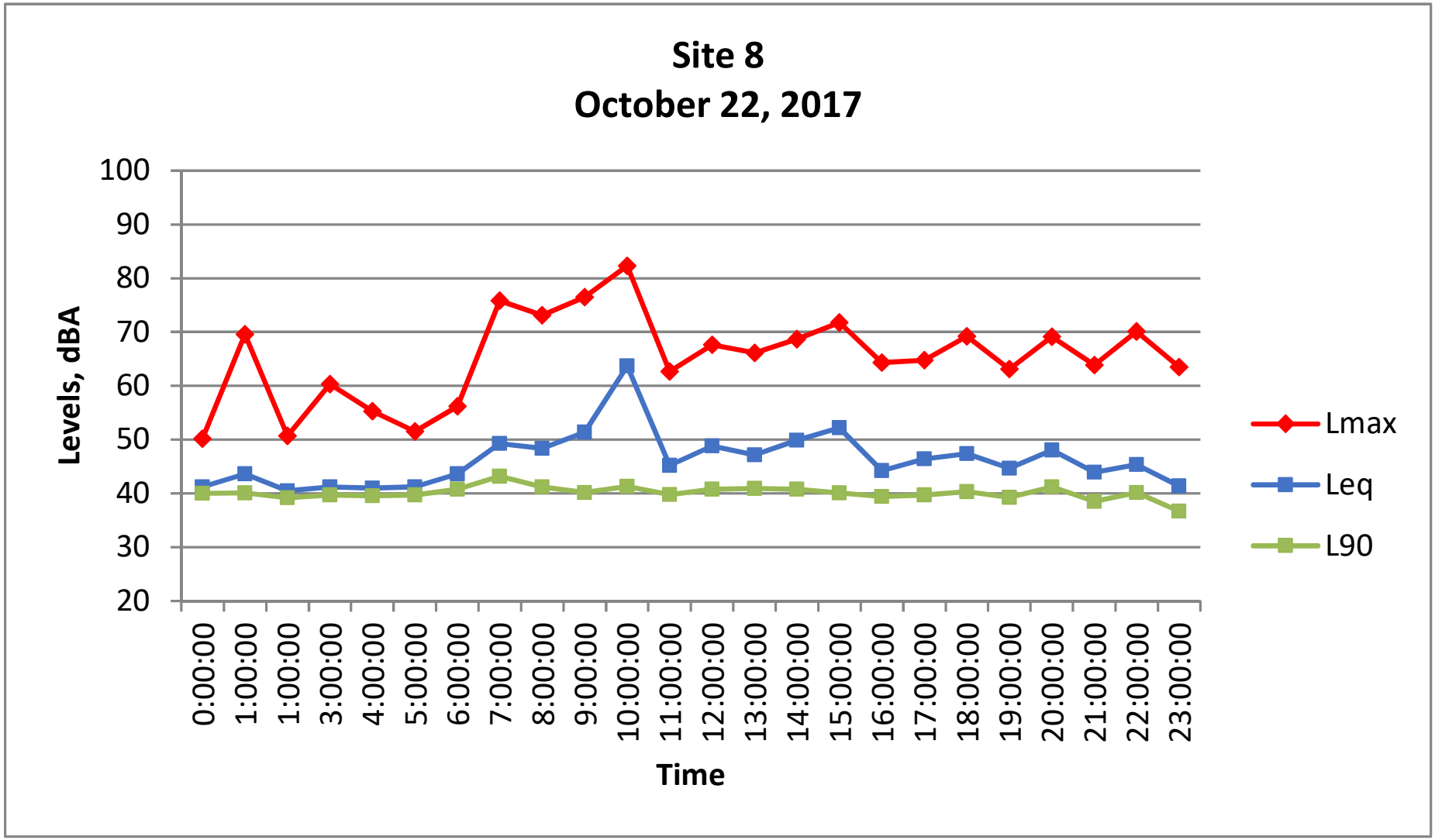
Site 8
October 22, 2017
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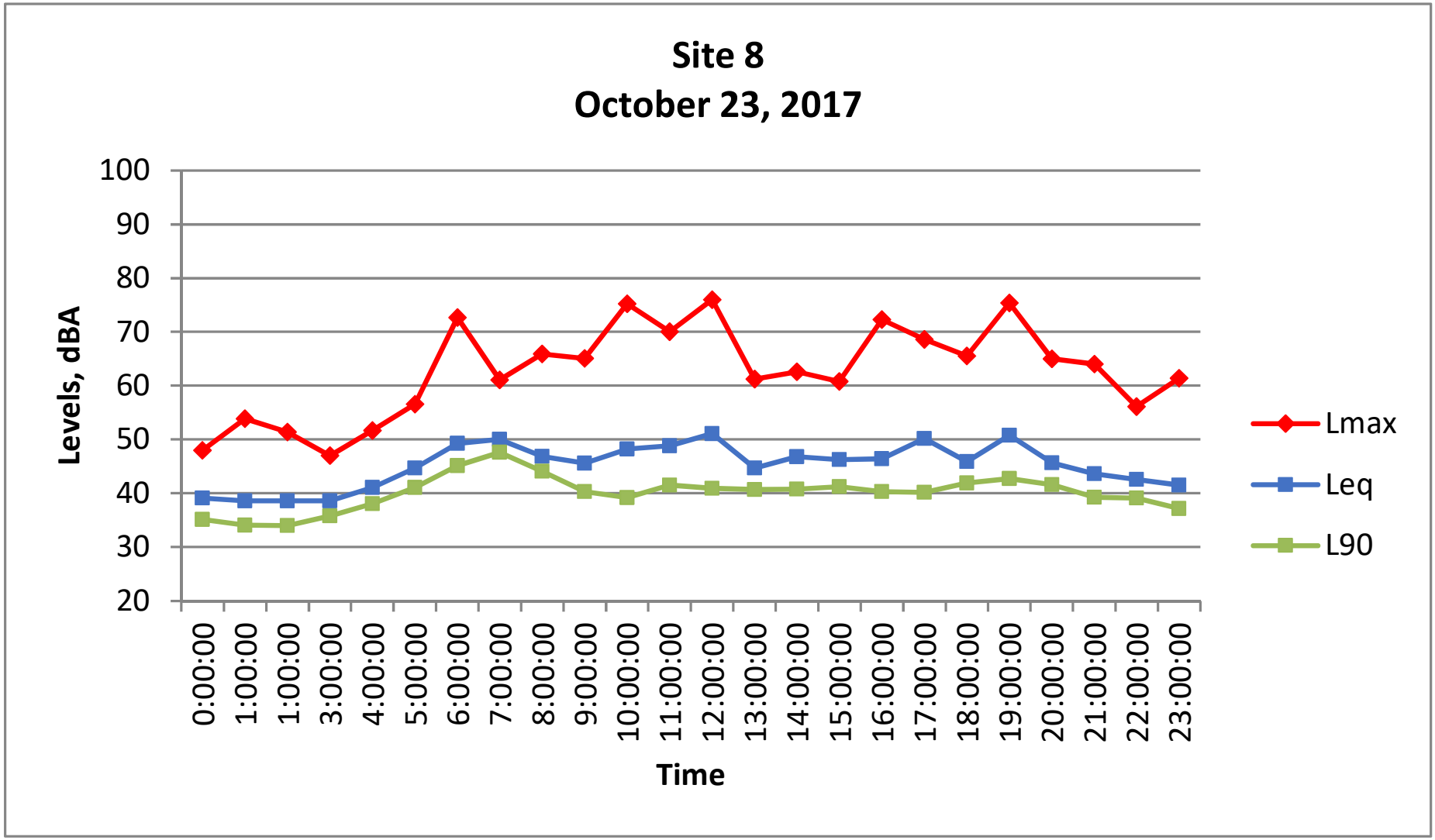
Site 8
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