Michael Theriault
ACOUSTICS INC
NOISE CONTROL CONSULTING SERVICES

November 5, 2009

via Electronic Transmittal

Mr. Kevin Warner PE
**Grays Harbor Energy LLC**
401 Keys Road
Elma, WA 98541

(360) 482-4353 x224 Direct
(360) 561-5909 Mobile

RE: Results of Noise Level Monitoring
Grays Harbor Energy Center

Dear Mr. Warner:

As requested, Michael Theriault Acoustics (MTA) has completed an analysis of noise emissions produced during start-up, baseload, and shut-down operations of the Grays Harbor Energy Center (GHEC). MTA was retained by GHEC after sporadic noise complaints were received from residents living in the vicinity of the plant.

Since 1998, Michael Theriault Acoustics (MTA) has specialized in noise control and environmental noise impact assessment for the electric power industry. With work experience on over 100 energy facilities, ranging in size from 1 to 2,000 megawatts, MTA has been retained by owners and developers to prepare environmental noise impact licensing applications; by architectural engineering firms to design and implement large-scale noise control programs; by owners and constructors to perform noise level compliance testing; and by financial underwriters and municipalities to complete noise control due-diligence reviews. In addition, MTA has provided expert testimony in several legal arenas with respect to noise from the construction and operation of electric power facilities.

Noise produced by the GHEC (Facility) is limited by Washington Administrative Code, Chapter 173-60, *Maximum Environmental Noise Levels* (WAC 173-60). WAC 173-60 generally limits noise from an industrial facility at residential properties to 60 dBA during daytime hours (7 am to 10 pm) and to 50 dBA during nighttime hours (10 pm to 7 am).

In June, July and August of 2009, noise levels were measured continuously for approximately one week at three locations near the closest residences to the GHEC, in accordance with the monitoring plan previously submitted to and approved by the Energy Facility Site Evaluation Council (EFSEC). At no time during normal plant operations did noise levels attributable to the Facility exceed the limits imposed by WAC 173-60.

The following describes the noise analysis methods and results, including applicable regulations, measurement equipment and methodologies, measured noise levels, and compliance assessment. In addition, a comparison of noise levels measured as part of the present study to those measured prior to construction of the GHEC in 2001 is provided. All of the figures referenced in the text are included at the end of the report.

## 1.0 Site and Facility Description

The GHEC is located in Grays Harbor County, Washington, approximately five miles southwest of Elma, Washington (Figure 1). More specifically, the GHEC is located on Keys Road, as shown in Figure 2. Also shown in Figure 2 are the locations of the nearest residences to the Facility, and the locations where noise levels were measured (measurements are discussed in the following section). There are approximately eight residences located on the west side of Keys Road South. The closest residence is located approximately 2,500 feet from the center of the Facility, and the furthest is located approximately 3,300 feet away.

The GHEC consists of the following major components:

- Two General Electric Frame 7FA combustion turbine generators.
- Two heat recovery steam generators (HRSG) with supplemental duct firing.
- One steam turbine generator (STG) rated at 300 MW.
- One auxiliary boiler.
- One forced draft cooling tower system.



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## 2.0 General Information on Noise

The following paragraphs briefly describe how environmental noise levels are measured, quantified, and reported in order to aid the reader with concepts and terms used in this report.

***Sound Level Meters.*** Noise is measured using a standardized instrument called a 'sound level meter.' All sound level meters are equipped with microphones that detect minute changes in atmospheric pressure caused by the mechanical vibration of air molecules. Healthy human hearing can detect air pressures as low as 0.00002 Pascals (threshold of hearing) and as high as 100 Pascals (threshold of pain).[1] Since this dynamic range is enormous, (greater than one million to one) sound pressures are instead reported using a logarithmic scale, which compresses the numbers to keep them more manageable. Once converted, they are referred to as sound pressure levels, followed by 'decibels' (abbreviated dB) as the unit of measure. On a logarithmic scale, the threshold of hearing and the threshold of pain become 0 and about 130 decibels, respectively.

***A-Weighted Levels.*** Noise is generally characterized by amplitude (level) and by frequency (pitch). Amplitude can be reported using various human-perception scales, similar to describing temperature in terms of wind chill or heat index. The latter are better indicators of perceived cold and warmth. Similarly, noise level measurements are often reported using the 'A-weighting' scale of a sound level meter. A-weighting slightly boosts high frequency sound, while reducing low frequency components (similar to the way stereo bass and treble controls work) providing a better indicator of perceived loudness at relatively modest volumes. These measures are called A-weighted levels (abbreviated dBA). Figure 3 illustrates ranges of A-weighted levels for common noise sources.

***Frequency Analysis***. To better approximate the response of human hearing, sound level meters are often equipped with octave band filters. Octave band filters divide the audible hearing range into nine separate 'frequency-bins' much like a prism separates white-light into bands of different color or wavelengths. Imagining a piano with only nine keys to represent the full range of audible sound is a good analogy. Sound levels are sometimes measured using one-third octave band filters. As the name implies, one-third octave band filters divide octaves into three additional 'bins' for greater resolution. An analogous piano would have twenty-seven 'keys' representing the full range of audible sound (rather than only 9).

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1 - A Pascal is a unit of pressure, (one Pascal is equivalent to about 0.02 $lbs/ft^2$.) A single Pascal of pressure will produce a *sound pressure level* of 94 dB.



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***Quantifying Fluctuating Sound Levels***. Environmental noise levels constantly change with time and at any given moment are often the combination of natural sounds from birds, insects or tree rustle; noise from local or distant traffic; and/or noise from industrial, commercial or residential activities. The equivalent level ($L_{eq}$) is a metric commonly used to quantify fluctuating levels with a single value. The $L_{eq}$ has the same acoustic energy as the fluctuating level over a stated time period. The one-hour $L_{eq}$ was measured as part of this study, and is the metric used to determine compliance with applicable standards (refer to Section 3.0).

Another metric used to quantify fluctuating sound levels is the statistical level. In order to separate low-level constant noise sources (e.g. the din of distant traffic or an industrial facility) from louder, short-duration events (such as aircraft flyovers or nearby vehicle pass-bys) statistical or 'exceedance' measurements are often used. These measures help describe the 'average' noise level as well as the range of 'highs' to 'lows' for any given measurement period. Figure 4 provides an example of the calculation of statistical and equivalent levels. The statistical level $L_{90}$, which is the level exceed 90% of the time during a stated period, is generally considered representative of ambient sounds, and was used as part of this study to help separate Facility noise from other sources of sound. Other statistical levels ($L_{2.5}$, $L_{8.3}$, and $L_{25}$) were used to represent additional limits established by Chapter 173-60 of the State of Washington Administrative Code (as described in Section 3.0).

The statistical noise level metrics used in this report are as follows:

$L_{2.5}$ ('L-Two Point Five') is the level exceeded 2.5% of the time during a given time period. It was measured as part of this study to determine the level exceeded 1.5 minutes of any one hour, which is one limit of the applicable regulation. The $L_{2.5}$ generally represents the loudest and shortest noise events occurring in the environment, such as car and truck pass-bys or aircraft flyovers.

$L_{8.3}$ ('L-Eight Point Three') is the level exceeded 8.3% of the time. That is, levels are higher than this value only 8.3% of the measurement time. It was measured as part of this study to determine the level exceeded for 5 minutes of any one hour, which is one limit of the applicable regulation.

$L_{25}$ ('L-Twenty Five') is the level exceeded 25% of the time. That is, levels are higher than this value only 25% of the measurement time. It was measured as part of this study to determine the level exceeded for 15 minutes of any one hour, which is one limit of the applicable regulation.



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$L_{90}$ ('L-Ninety') is the level exceeded 90% of the time and is often called the 'background' sound level. It was measured on this project to assist with separating Facility-only noise levels from other sources of sound.

## 3.0 Applicable Noise Regulation

Chapter 173-60 of the State of Washington Administrative Code (WAC), *Maximum Environmental Noise Levels*, limits noise emissions from the Facility. Specifically, WAC 173-60 contains noise level limits based on the "environmental designation for noise abatement" (EDNA) of the property generating the noise, as well as on the EDNA of the property receiving the noise. EDNA classes are based on land use. The neighboring residences are considered a Class A EDNA (residential), while the Project itself is considered a Class C EDNA (industrial).

Given these designations, the noise level limit for the Project is 60 dBA during daytime hours (7 am to 10 pm) and 50 dBA during nighttime hours (10 pm to 7 am) at neighboring residential land uses. Note that the code allows for occasional excursion of these limits (5 dBA for a total of 15 minutes in any one-hour period; or 10 dBA for a total of 5 minutes in any one-hour period; or 15 dBA for a total of 1.5 minutes in any one-hour period). Given the allowable excursions for any one hour period, the 50 dBA (nighttime) and 60 dBA (daytime) limits were interpreted as being one-hour equivalent levels ($L_{eq}$).

WAC 173-60-050 contains a list of exemptions to the specified noise limitations. One exemption that is relevant to the Project is:

- Sounds created by safety and protective devices where noise suppression would defeat the intent of the device or is not economically feasible.

In summary, the daytime (7 am to 10 pm) noise level limit for the Facility is 60 dBA at the residences, and the nighttime limit (10 pm to 7 am) is 50 dBA at the residences (one-hour $L_{eq}$). Noise levels can exceed these limits by 5 dB for 15 minutes in any one hour, by 10 dB for 5 minutes in any one hour, or by 15 dB for 1.5 minutes in any one hour. Noise created by safety devices or during an emergency is exempt at all times.



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## 4.0 Measurement Procedures

### Measurement Locations and Durations

As shown in Figure 2, noise levels were measured at three residential locations; two on the north side of Keys Road West and one on the south side of Keys Road West. Noise levels were recorded at Measurement Location 1 for approximately eight days from June 29 to July 7, 2009. The monitor was placed adjacent to the east property line (closest to the Facility). Noise levels were recorded at Measurement Location 2 for approximately 20 days from July 14 to August 6, 2009. The monitor was placed adjacent to the east property line. Noise levels were recorded at Measurement Location 3 for approximately nine days from August 6 to August 14, 2009. The monitor was placed along the Keys Road South right of way, adjacent to the east property line.

Noise levels were also measured at a 'Control Location' concurrently with the measurements at Locations 1, 2, and 3. As shown in Figure 2, the Control Location is located approximately 400 feet west of the sound wall that runs along the west side of the Facility. By measuring noise levels at the Control Location, it was possible to determine whether elevated noise levels at the Measurement Locations were the result of Facility operations or another noise source. Meteorological data was also collected at the Control Location during the entire study.

### Measurement Equipment and Configuration

Noise levels were measured using two Bruel & Kjaer (B&K) Type 2250 integrating sound level meters connected to B&K Type 4952 outdoor microphones. This measurement system meets the tolerance requirements of American National Standards Institute Type 1 specifications. The systems were calibrated upon installation using a Larson Davis Model CAL-200 Acoustic Calibrator. Each meter was housed in a weatherproof enclosure. The microphones were mounted approximately six to eight feet above the ground, and were fitted with windscreens.

The sound level meters were configured to measure and record the one-hour value of the equivalent level ($L_{eq}$) in each one-third octave band from 25 to 10,000 Hertz. Also measured were the one-third octave band levels of certain statistical levels ($L_{2.5}$, $L_{8.3}$, $L_{25}$, $L_{90}$). Refer to Section 2.0 for an explanation of these quantities.

Meteorological data (wind speed, wind direction, temperature, and relative humidity) was collected continuously using a Davis Instruments weather monitoring station (results shown in Figure 11).



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## 5.0 Noise Level Measurement Results and Analysis

As described in Section 3.0, Washington regulations limit the amount of noise that can be generated by the GHEC as measured at neighboring residences. Because noise levels at the Measurement Locations are affected by multiple sources (e.g. the Facility, birds, activities of residents, aircraft), the data collected does not directly represent 'Facility-only' noise (which is what the standard applies to). Therefore, measured levels required analysis to determine the contribution from the Facility. First, it was determined whether noise levels at each receiving property ever exceeded the regulatory limits. If they did not, no further analysis was necessary. If noise levels did exceed regulatory limits, the following analysis steps were taken:

1. Noise levels at the Measurement Location were compared to those at the Control Location, because if the Facility was the cause of the elevated noise levels at the residences then noise levels at the Control Location would also be elevated.

2. The frequency spectrum, or 'acoustic signature', of the noise exceedence was compared to the frequency spectrum of the Facility, because if the Facility was the cause of the elevated noise levels then the two spectra should be similar.

3. Audio recordings collected at the Measurement Locations were reviewed to determine the cause of the exceedance (when available).

4. Finally, if an exceedance was caused by the GHEC, the source was identified to determine whether it fell within the regulatory exemption for safety-related upsets.

**Results at Measurement Location 1**

The noise levels collected at Measurement Location 1 are shown in Figure 5, as are the 50 dBA (nighttime) and 60 dBA (daytime) noise level limits. As shown, at no time during the measurement period did the noise levels at Measurement Location 1 exceed the limits specified by WAC 173-60. Although measured noise levels were as high as 57 dBA on June 30, 2009 at 11 am, this level occurred during daytime hours when the applicable noise limit is 60 dBA. More importantly, this noise level is not attributable to the Facility, since a concurrent rise in noise level did not occur at the Control Location (see Figure 6, which shows noise levels collected at Measurement Location 1 and the Control Location, as well as the power output of the Facility).

From Figure 6 it can be seen that the power output of the GHEC varies from approximately 500 to 600 megawatts (MW). Variations in the power output throughout the day are typical due to variation in the load on the grid. Plant operation generally followed a pattern of increased load during peak, daytime hours and slightly reduced load at night. Note that noise levels at Measurement Location 1 also fluctuate, but not in concert with plant power output, suggesting that noise levels at the residences are not due to the Facility.

Also from Figure 6, note that noise levels at the Control Location ranged from approximately 55 to 65 dBA from June 29 through July 2, 2009, then became relatively steady between approximately 50 to 53 dBA thereafter. A review of audio recordings at the Control Location and of plant logs indicates that the elevated noise levels from June 29 through July 2 were due, at least in part, to a leaking steam valve that has since been repaired. It is interesting to note that even with these elevated Facility noise levels, noise levels at the residences were below WAC 173-60 limits.

**Results at Measurement Location 2**

Noise levels collected at Measurement Location 2 are shown in Figure 7, as are the 50 dBA (nighttime) and 60 dBA (daytime) noise level limits. As shown, noise levels only exceeded the limits specified by WAC 173-60 at one time during the measurement period.

Specifically, on July 24, 2009 at approximately 4 am, noise levels exceeded 50 dBA at Measurement Location 2 for 30 to 45 minutes. A review of concurrent noise levels at the Control Location indicates that the GHEC was likely the cause of this exceedance. Investigation into Facility operations revealed that the noise occurred when the high pressure steam safety relief valve lifted after a steam turbine trip. This was an upset condition that is not a part of normal operations and is not expected to reoccur. As such, this event is considered exempt from the regulatory limits, as stated in Chapter 173-06-050 of the WAC, because it was a "sound created by safety and protective devices where noise suppression would defeat the intent of the device or is not economically feasible."

Referring to Figure 7, note that the noise monitor was taken out of service between July 25 and 28, 2009 in order to re-charge its batteries.

Figure 8 provides a plot of noise levels collected at Measurement Location 2, along with the noise levels measured concurrently at the Control Location and the power output of the Facility. As noted above, plant power output fluctuates as a function of load on the grid. It can be seen in Figure 8 that the fluctuation of noise levels at Measurement Location 2 does not follow the same pattern. Specifically, the periods of maximum power output last for approximately 20 hours, while the periods of maximum noise levels at Measurement Location 2 last for only an hour or two. As such, the fluctuation in noise levels at the residences is due to other sources, such as traffic and birds.



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**Results at Measurement Location 3**
The noise levels collected at Measurement Location 3 are shown in Figure 9, as are the 50 dBA (nighttime) and 60 dBA (daytime) noise level limits. As shown, at no time during the measurement period did noise levels attributable to the Facility exceed the limits specified by WAC 173-60.

Although noise levels exceeded the WAC 173-60 noise standards on the three occasions noted in Figure 9, none of these excursions are considered to be the result of noise from the Facility. This is because: (a) the noise levels at the Control Location did not rise correspondingly (see Figure 10); (b) the frequency spectra of these events were reviewed and do not correlate to the frequency spectrum of the Facility; and (c) the level of 70 dBA was the result of lawn mowing and other activities of residents (as determined from a review of audio recordings).

## 6.0 Comparison to Ambient Noise Measurements of 2001

Ambient noise levels were measured in the vicinity of the GHEC in 2001 prior to construction and operation of the plant. The following compares measured levels from 2001 to those measured during operation of the Facility.

**Measurement Location 1**
In 2001, the average nighttime (10 pm to 7 am) ambient noise level ($L_{eq}$) observed near Measurement Location 1 was 32 dBA (Table 4.1-2 of the Project's Environmental Impact Statement, Location 5). In 2009, the average nighttime ambient noise level ($L_{eq}$) was 41 dBA. The increase in level, however, is not considered fully attributable to the Facility. One consideration is that the measurements in 2001 were conducted in February, and measurements in 2009 were conducted in August. The primary difference between these periods is the presence of birds and insects, which can substantially increase nighttime noise levels (particularly in the early morning hours). To further compare pre- and post-Facility noise levels, the $L_{90}$ levels from 2001 were compared to the $L_{90}$ levels measured in 2009. The $L_{90}$ is representative of the constantly-occurring sounds in an environment (such as the Facility, when operating) and is not influenced as much by intermittent sounds (such as birds). In 2001 the average measured nighttime $L_{90}$ was 29 dBA, and in 2009 the average measured nighttime $L_{90}$ was 34 dBA.

**Measurement Location 2**
In 2001, the average nighttime (10 pm to 7 am) ambient noise level ($L_{eq}$) observed near Measurement Location 2 was 32 dBA (Table 4.1-2 of the Project's Environmental Impact Statement, Location 5). In 2009, the average nighttime ambient noise level ($L_{eq}$) was 40 dBA. The increase in level, however, is not considered fully attributable to the Facility. This is evidenced by the close relationship between the pre- and post-$L_{90}$ levels (in 2001



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the average nighttime $L_{90}$ was 29 dBA, and in 2009 the average measured nighttime $L_{90}$ was 31 dBA).

**Measurement Location 3**

In 2001, the average nighttime (10 pm to 7 am) ambient noise level ($L_{eq}$) observed near Measurement Location 3 was 35 dBA (Table 4.1-2 of the Project's Environmental Impact Statement, Location 7). In 2009, the average nighttime ambient noise level ($L_{eq}$) was 45 dBA. In 2001 the average nighttime $L_{90}$ was 29 dBA, and in 2009 the average measured nighttime $L_{90}$ was 40 dBA. The latter is relatively high for a nighttime ambient, but it is not considered attributable to the Facility. This is because noise levels at the Control Location did not fluctuate from day to day, yet the nighttime $L_{90}$ levels at the residences did.

## 7.0 Conclusion

In June, July and August 2009, noise levels were measured continuously for approximately one week at each of three locations near the closest residences to the Facility, in accordance with the monitoring plan previously submitted to and approved by the Energy Facility Site Evaluation Council. At no time during normal plant operations did noise levels attributable to the Facility exceed the limits imposed by Washington Administrative Code, Chapter 173-60, *Maximum Environmental Noise Levels* (60 dBA during daytime hours and 50 dBA during the nighttime hours).

On one occasion during the survey the Facility experienced an upset in which the high pressure steam relief valve lifted after a steam turbine trip. Noise levels exceeded 50 dBA at the residences for approximately 30 to 45 minutes during nighttime hours. However, this event is considered exempt from the limits, as stated in Chapter 173-60-050 of the WAC ("Sounds created by safety and protective devices where noise suppression would defeat the intent of the device or is not economically feasible.")

There were a few other instances when noise levels at the residences exceeded the WAC 173-60 limits, but investigations into their cause determined that they were not attributable to Facility operations.



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This completes our current review of GHEC noise levels. If I can answer any questions or provide additional information, please feel free to contact me at (608) 345-1445.

Sincerely,
**MICHAEL THERIAULT ACOUSTICS, INC.**

Michael Hankard
*Senior Acoustical Consultant*

Attachments: Figures 1 – 11



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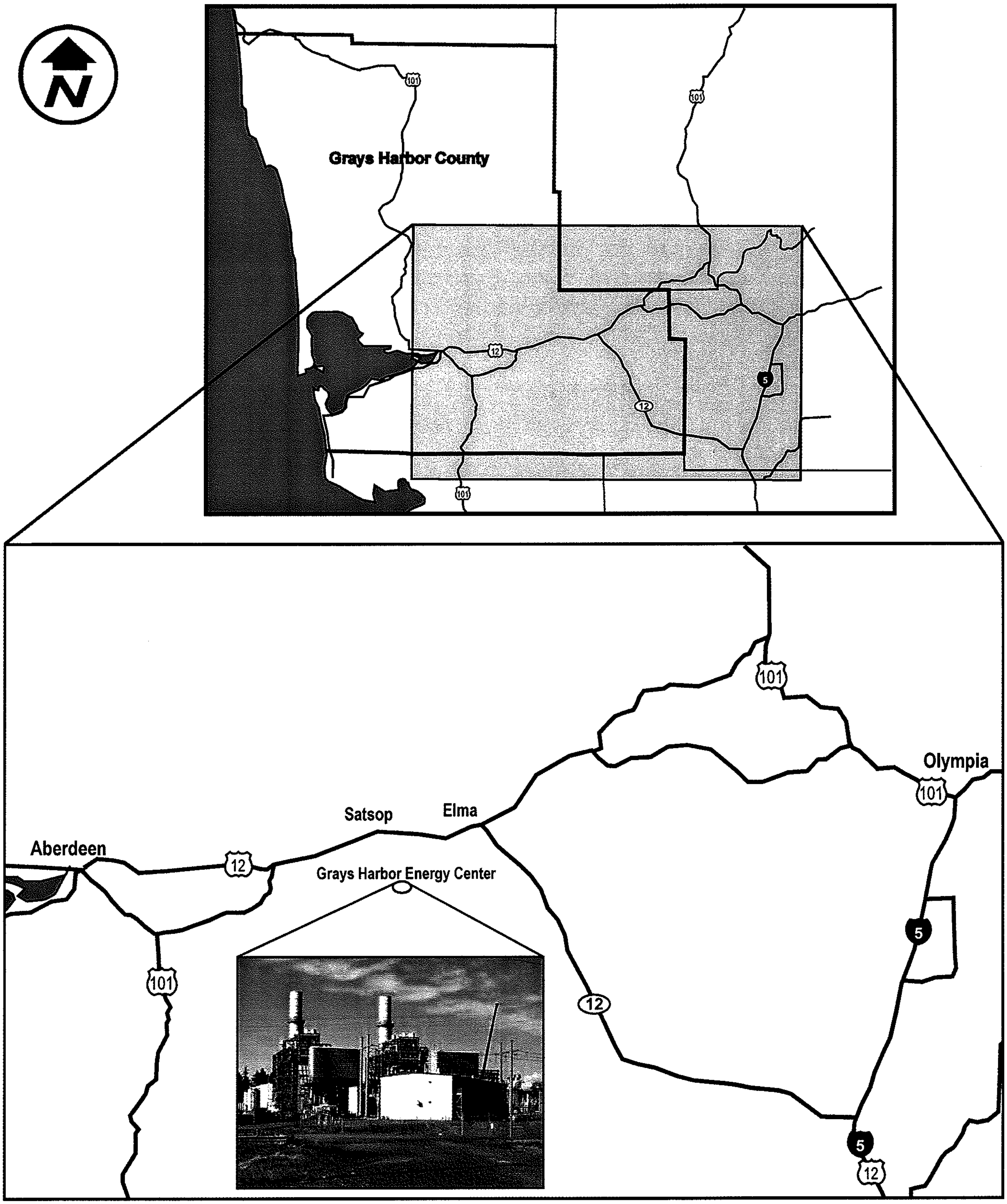


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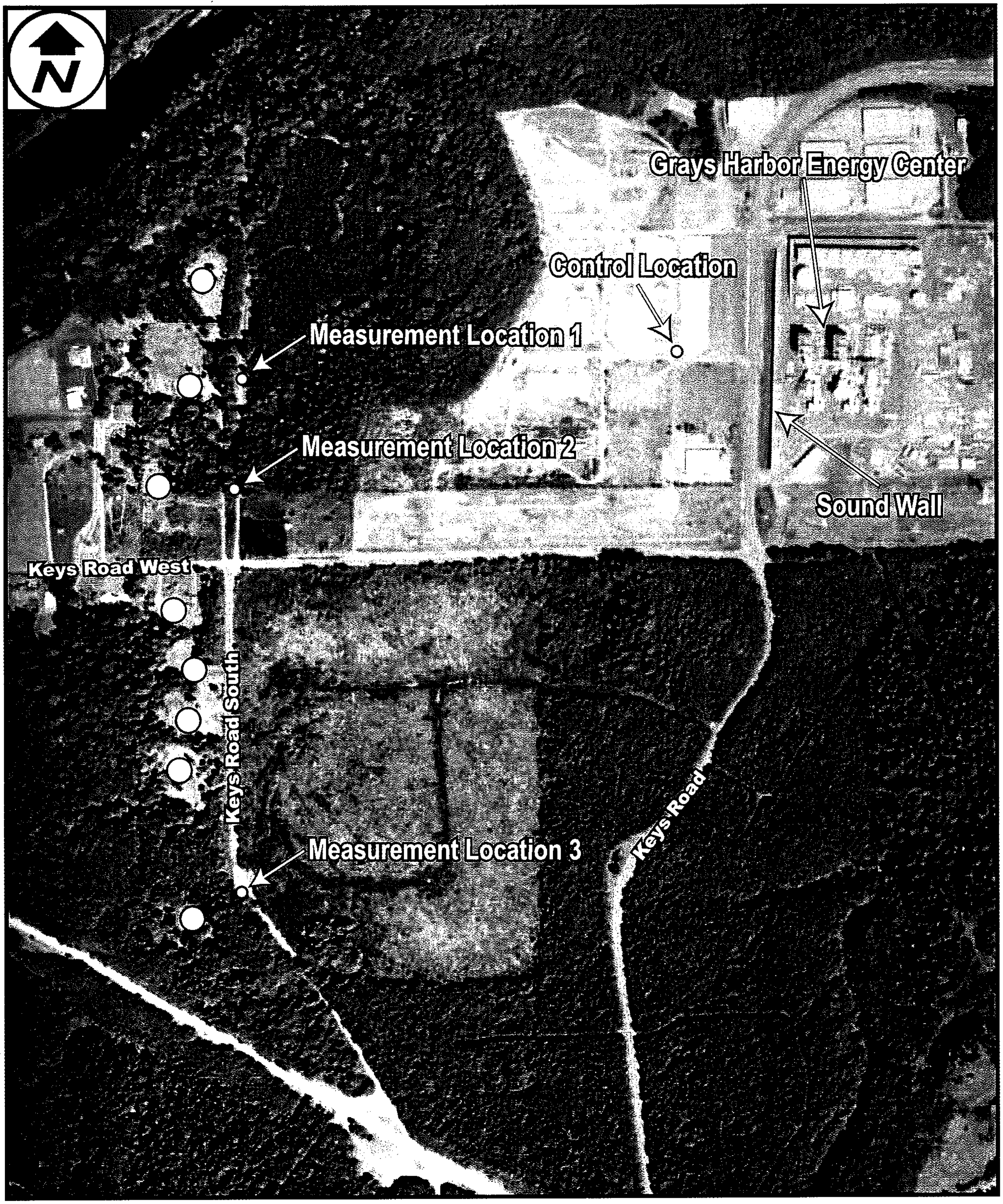
GHEC GENERAL LOCATION

GRAYS HARBOR ENERGY CENTER
SATSOP, WASHINGTON

FIGURE 1

PROJ. NO. 1791




○ Residence Location

0 250 500 1,000
Feet
(approximate)

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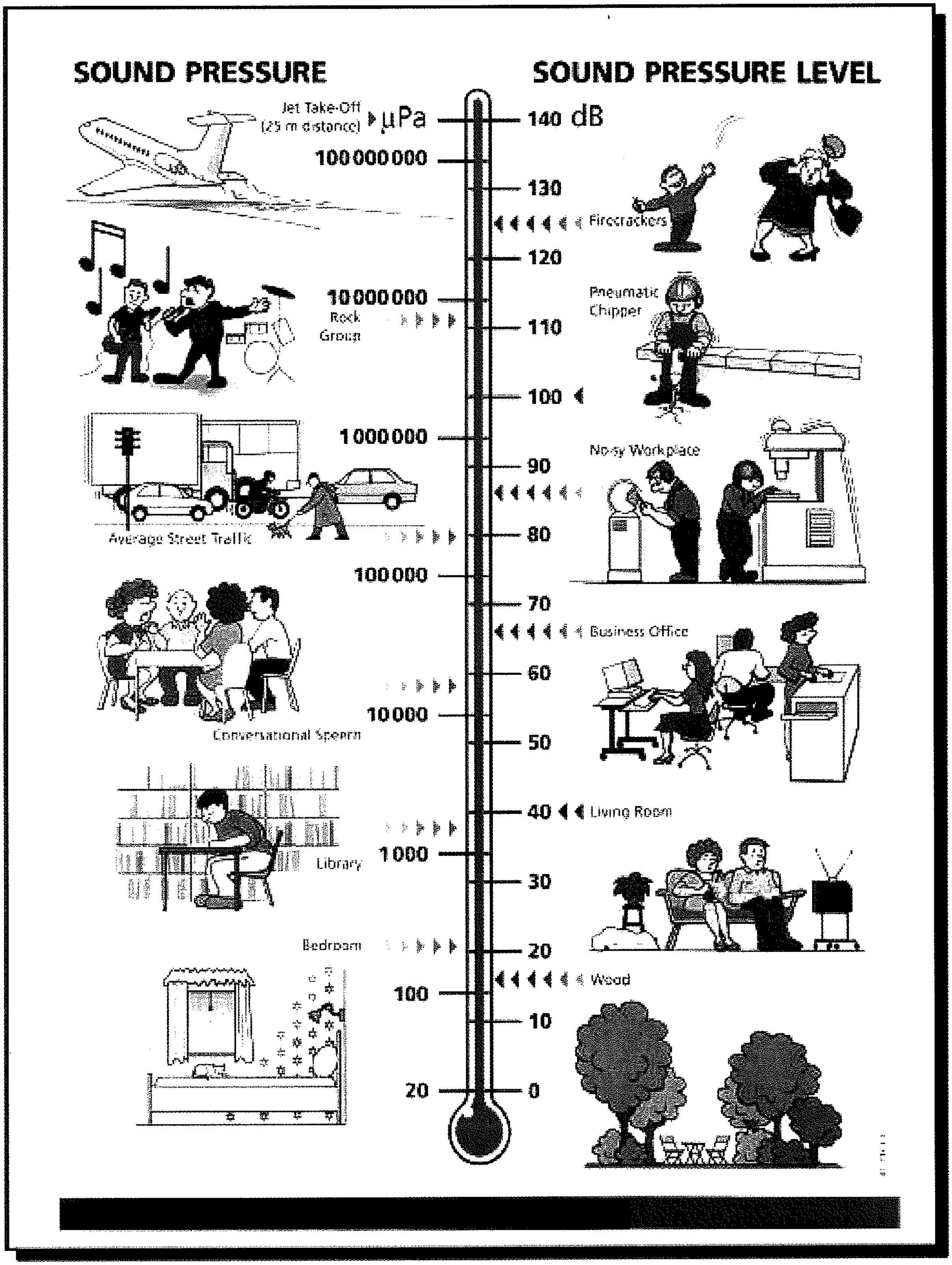
MONITORING LOCATIONS

GRAYS HARBOR ENERGY CENTER
SATSOP, WASHINGTON

FIGURE 2

PROJ. NO. 1791

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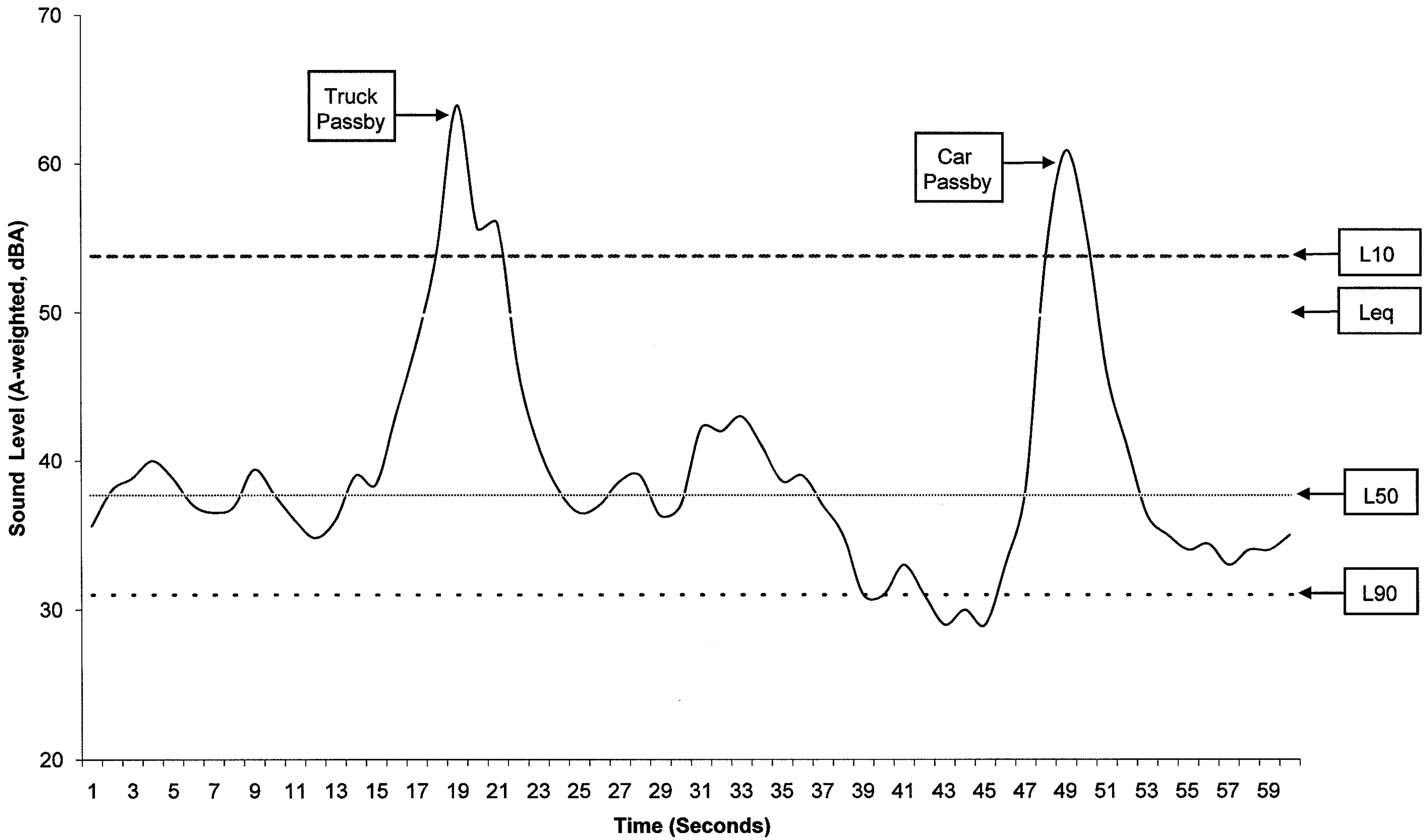
| SOURCE: BRÜEL & KJÆR, DENMARK | Michael Theriault INC ACOUSTICS NOISE CONTROL CONSULTING SERVICES | **TYPICAL SOUND PRESSURE LEVELS**<br>**GRAYS HARBOR ENERGY CENTER SATSOP, WASHINGTON**<br>**FIGURE 3** — **PROJ. NO. 1791** |

# Statistical Sound Level Analysis

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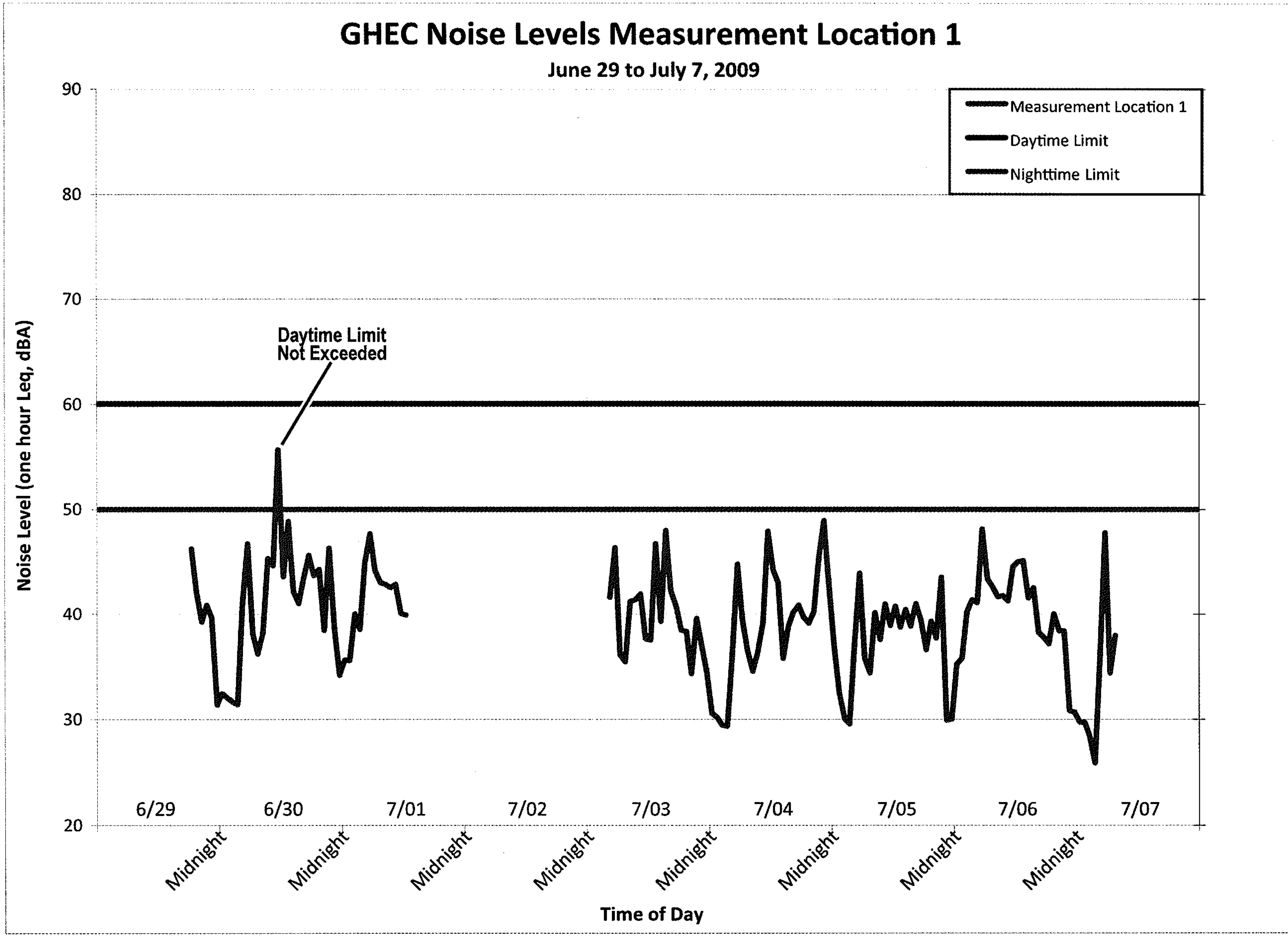
| | |
|---|---|
| EXAMPLE STATISTICAL ANALYSIS | |
| GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON | |
| FIGURE 4 | PROJ. NO. 1791 |

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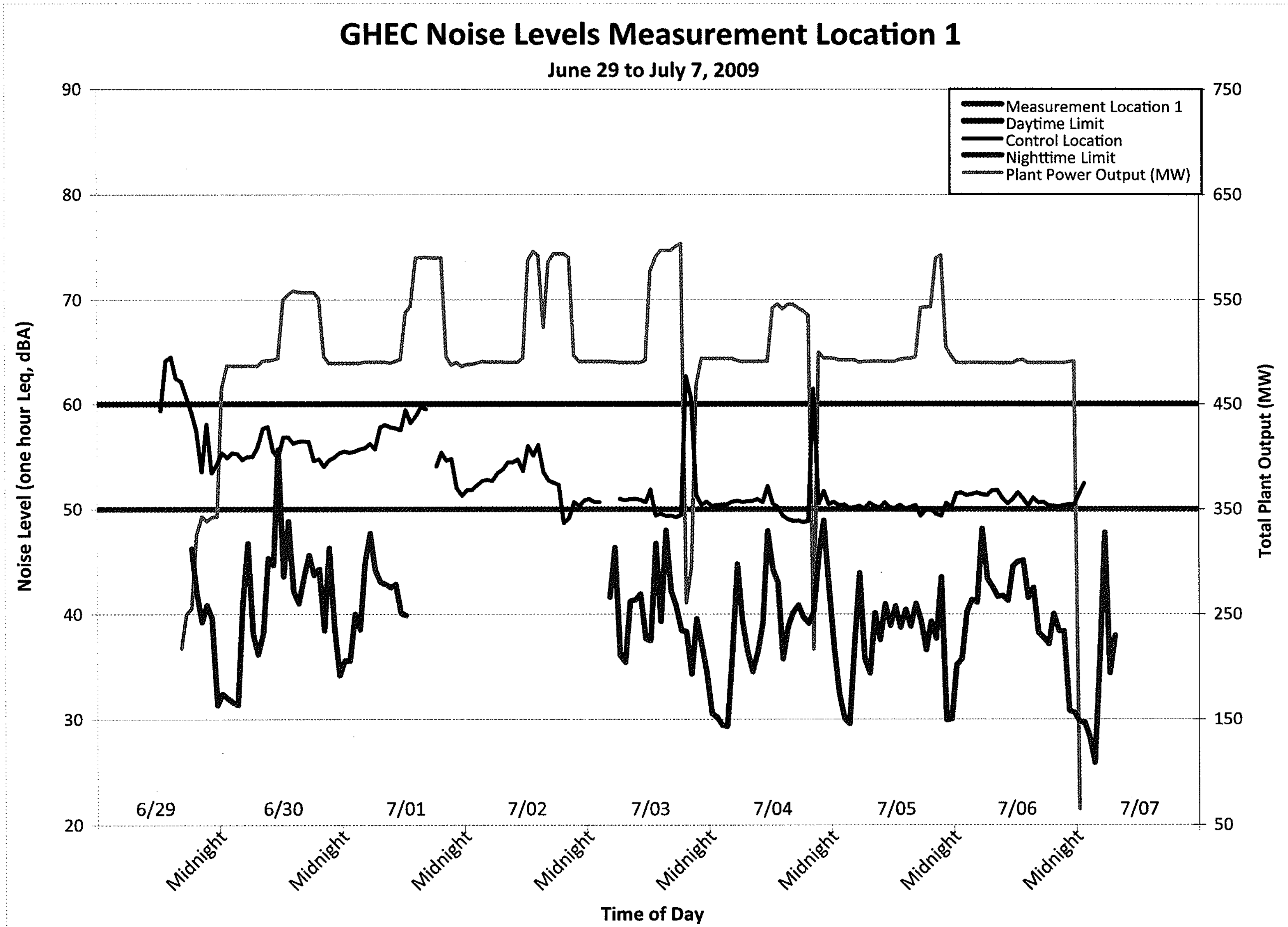
| | |
|---|---|
| NOISE LEVELS LOCATION 1 | |
| GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON | |
| FIGURE 5 | PROJ. NO. 1791 |

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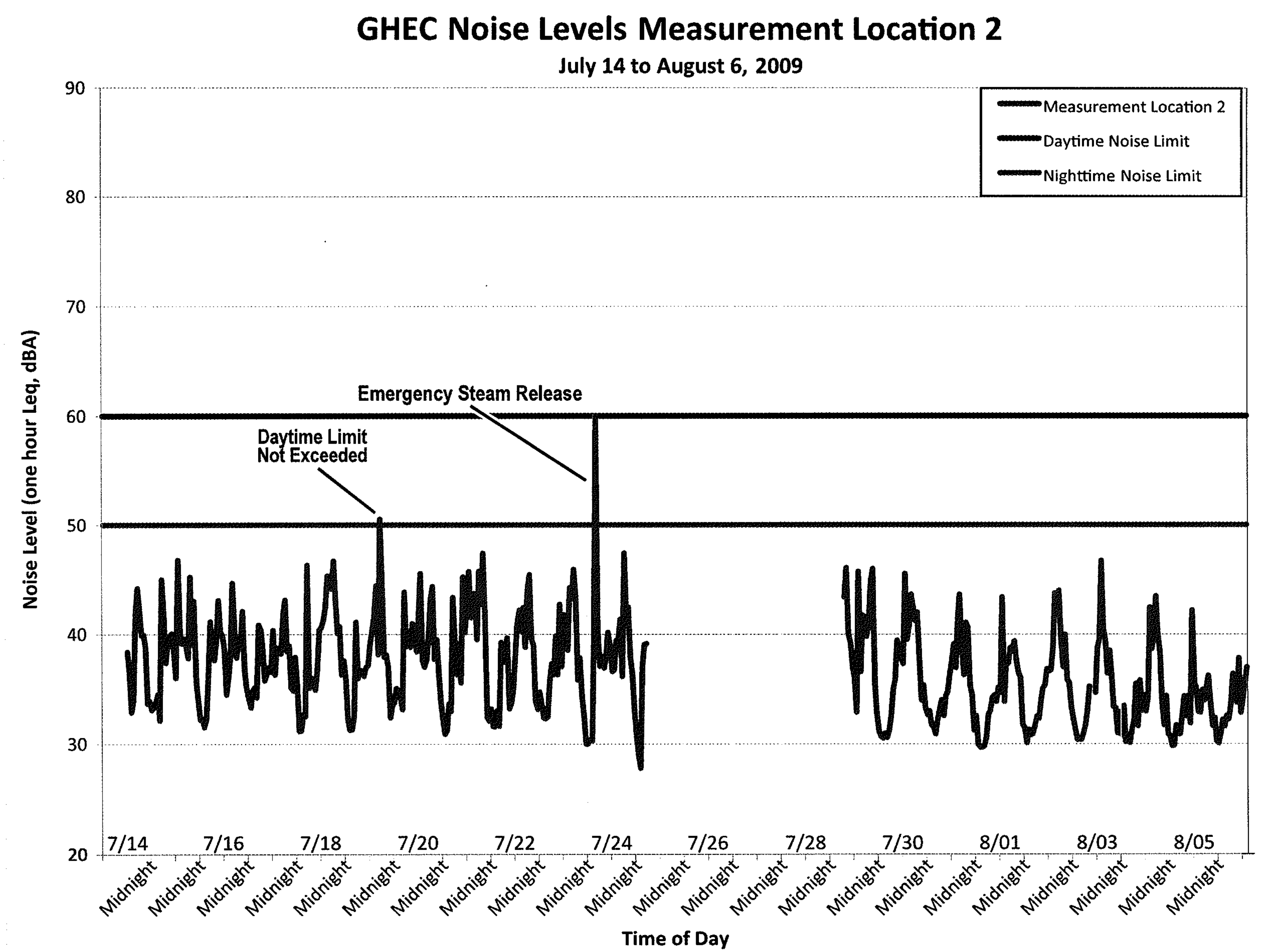
|---|---|
| NOISE LEVELS LOCATION 1 | |
| GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON | |
| FIGURE 6 | PROJ. NO. 1791 |

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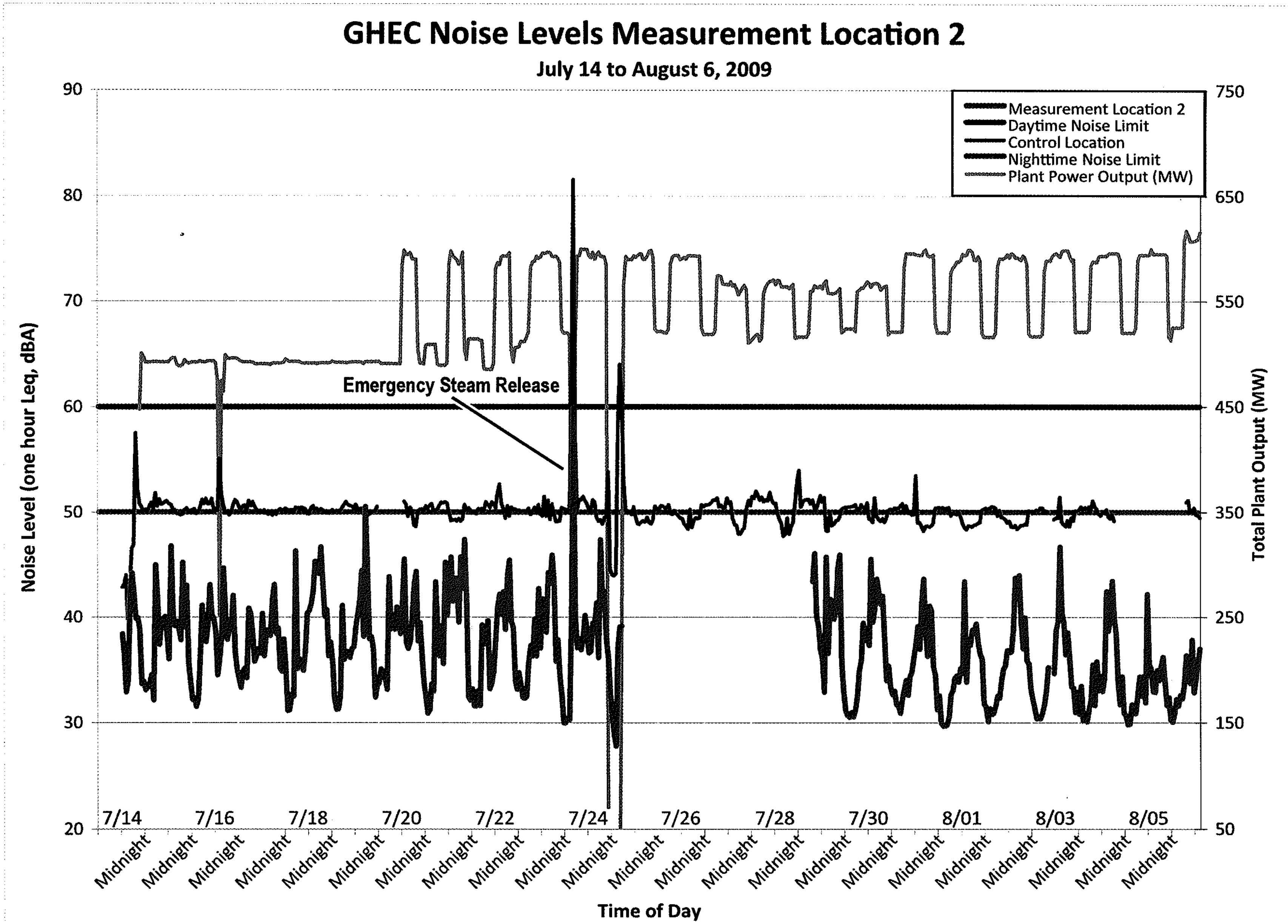
| | |
|---|---|
| NOISE LEVELS LOCATION 2 | |
| GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON | |
| FIGURE 7 | PROJ. NO. 1791 |

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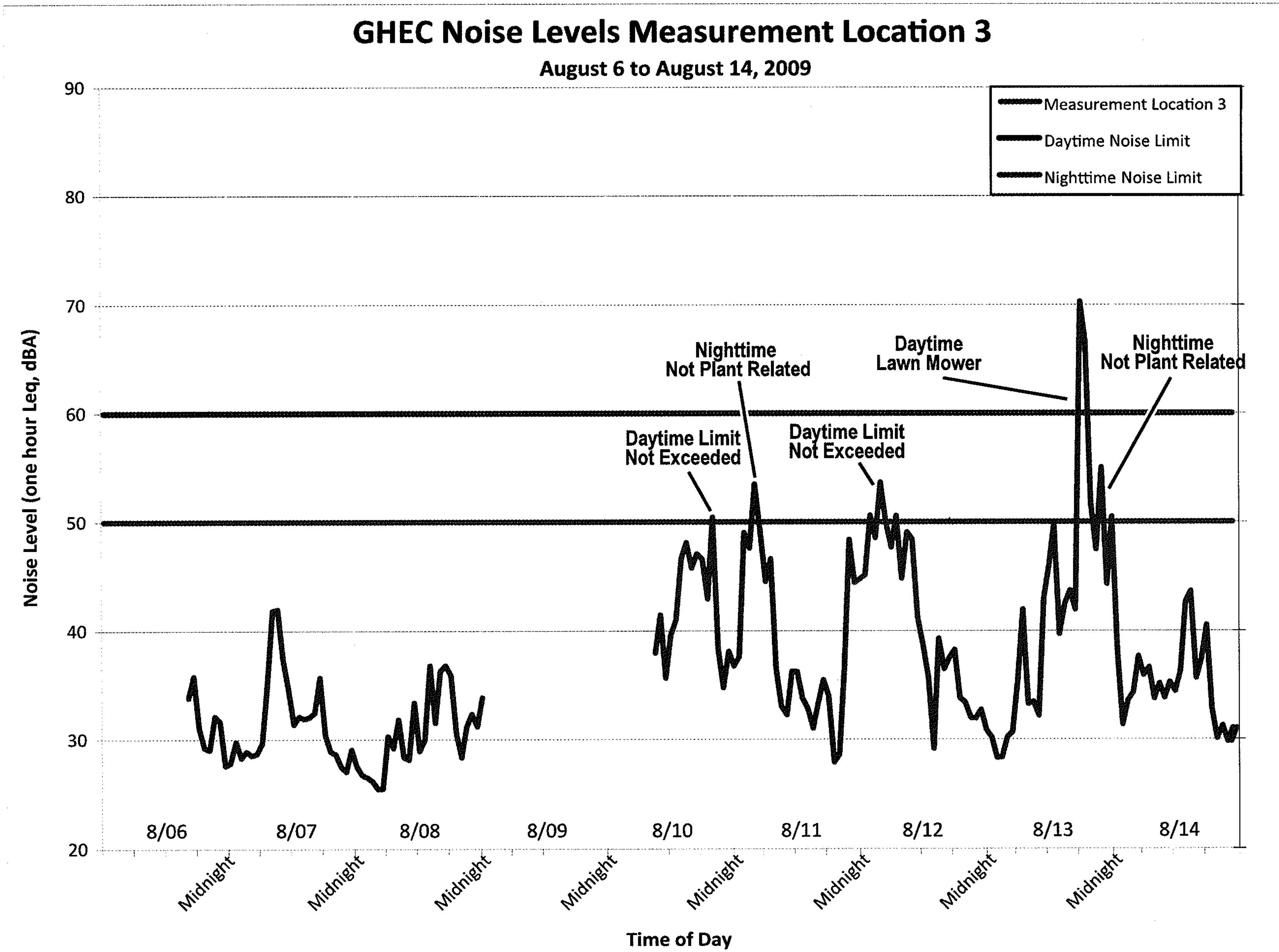
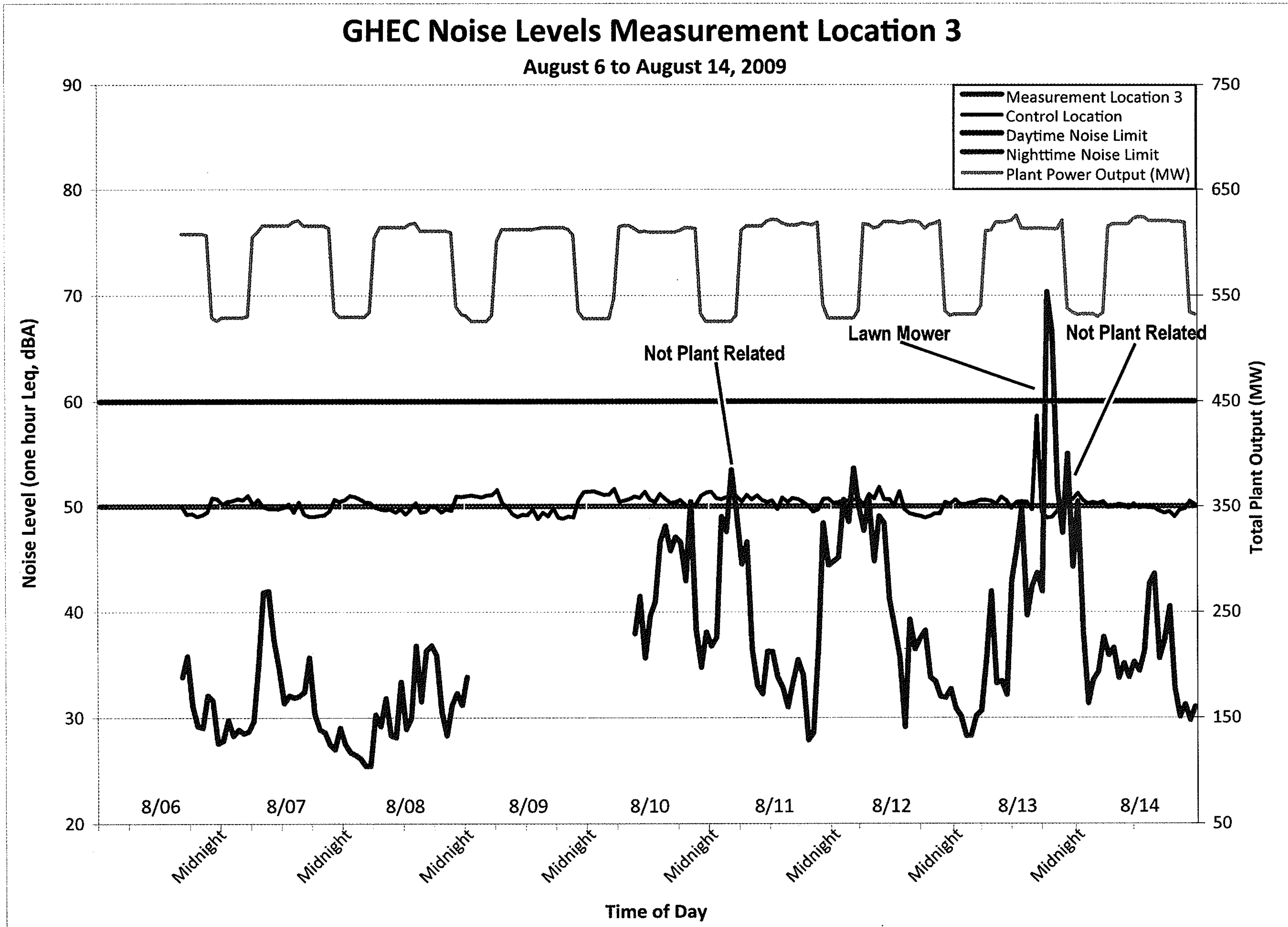
| NOISE LEVELS LOCATION 2 | |
|---|---|
| GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON | |
| FIGURE 8 | PROJ. NO. 1791 |




| | | |
|---|---|---|
| Michael Theriault Acoustics Inc, Noise Control Consulting Services | NOISE LEVELS LOCATION 3 | |
| | GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON | |
| | FIGURE 9 | PROJ. NO. 1791 |

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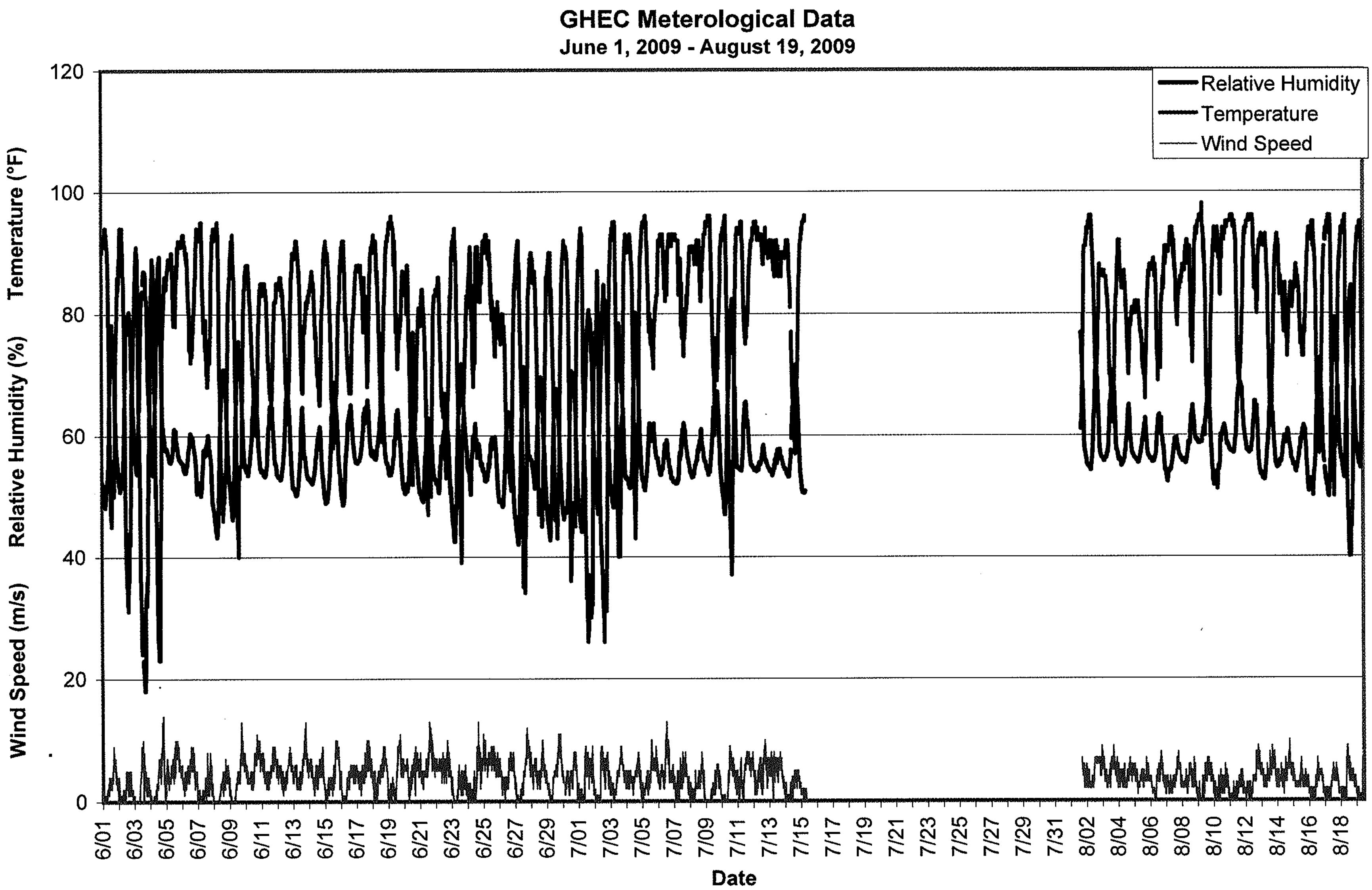
|---|---|
| Michael Theriault Acoustics Inc — Noise Control Consulting Services | NOISE LEVELS LOCATION 3 |
| | GRAYS HARBOR ENERGY CENTER<br>SATSOP, WASHINGTON |
| FIGURE 10 | PROJ. NO. 1791 |

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METEROLOGICAL DATA

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FIGURE 11

PROJ. NO. 1791