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Baseline Environmental Noise Survey
Leaf-on Season

Calvert Cliffs Nuclear Power Plant (CCNPP) Expansion Project
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1.0_Introduction

Hessler Associates has been contracted by AREVA NP Inc. to conduct a baseline environmental noise level measurement survey in the surrounding environs at the existing Calvert Cliffs Nuclear Power Plant (CCNPP) located near the town of Lusby in Calvert County, Maryland. It is planned to expand the plant from two to three units.

A wintertime (leaf-off) survey (Hessler Associates, Inc. Report Number 121106-1) was completed in November 2006. A leaf-off survey was completed because any noise emissions in the community from the existing CCNPP would be highest due to the lack of tree leaf noise reduction over the buffer distance between plant and residences. A leaf-on survey was recommended to collect additional data and observations during a warmer season when potentially sensitive receptors might be outdoors.

Baseline ambient noise data is required to conduct an environmental noise assessment. Levels at the closest potentially sensitive receptors are used as existing conditions to assess any potential noise impact from the plant expansion. Typical receptors of concern are residential units, hospitals and houses of worship. For this site, residential receptors were the closest receptors to consider.

Baseline residual levels measured under leaf-on and leaf-off conditions provide the always-present masking noise for evaluation of any new predicted emissions. Ambient or existing environmental community noise levels were to be measured over at least a 24 hour period during leaf-on seasonal conditions. Ideally, environmental levels should be measured during quiescent or calm and still weather conditions when minimum levels occur to provide the most conservative baseline[1].

2.0_Methodology

Figure 2.0.1 (following text) shows the established measurement locations surrounding the plant. The identical methodology described and used for the leaf-off survey was repeated for this survey with one exception. Continuous monitors (photograph of typical monitor on title sheet) were set-up only at the critical locations to the south. The on-site location of the expansion project and the wintertime survey demonstrated that locations S1, S2 and S3 are the critical receptors. Manual measurements were made at all locations for two days and two nights to collect frequency data and make observations of noise sources.

3.0_ Executive Summary and Conclusions

Environmental sound levels were measured at locations N1, S1, S2, S3, W1, W2 and W3 over a 48 hour period from 1 p.m. on Monday, August 6th through Wednesday, August 8th, 2007. Wind speed was negligible for the entire survey with prevailing calm and still quiescent conditions. Temperatures were high in the upper nineties. Nighttime levels increased dramatically (24 dBA) due to summertime cicada/insect sounds, particularly to the south that is natural woodland. Frequency analysis was used to show that residual levels were as quiet or quieter at night than the leaf-off survey by comparing the frequency spectrum below 1000 Hz that excludes cicada/insect sound.

The survey results show that Table 2.0.1 in the winter survey report should be updated and replaced as presented in **Table 3.0.1** below: Table 3.0.1 tabulates the major survey results for both surveys giving a tabulation of L_{90} residual and the Day/Night average (DNL) sound levels at all locations in each of the metrics most commonly used for assessing noise impact. See Section 7.0 in report 121106-1 for a discussion of assessment metrics.

LOCATION	MINIMUM L_{90} (1)	AVERAGE DAYTIME L_{90} (2)	24 HR DNL (3,5)	24 HR DNL (4,5)
P1	N/A	N/A	65	65
N1	34	44	55	56
W1	30	40	49	52
W2	37	56	65	66
W3	33	46	59	60
S1	31	42 (was 43)	49	51
S2	30	36 (was 39)	49	51
S3	30 (was 33)	35 (was 44)	53	55

Notes:

1 Minimum measured hourly L_{90} over 45-48 hour sampling period.

2 Arithmetic average of the measured hourly L90 for the 28 hours from 7 a.m. to 10 p.m.

3 Calculated for 24 hours from noon 11/20/06 to noon 11/21/06 with lowest wind speed, nearly calm & still.

4 Calculated for 24 hours of 11/21/06 with increasing wind speed.

5 DNL for summertime survey not included due to cicada/insect sounds

Table 3.0.1: *Table of measured A-weighted sound levels in the metrics commonly used to assess noise level impact.*

There was no observed or audible plant noise from the existing facility at any of the locations day or night, except for one night only (8/6/07) at location S3 only. There was a very faint “hum” from the plant direction that was only observable with careful and purposeful listening. It was learned by inquiries to the plant the next morning that there were issues with the 5 MW diesel/generator set, and it is suspected that this is the transient source of the very faint observed hum.

The combined results of both leaf-on and leaf-off surveys provide baseline environmental noise measurements that may be used to assess any new noise introduced by the planned expansion.

4.0_ Definitions and Background Information

Units and Discussion of Sound Levels

The universal measure of noise in decibels used throughout the world is the A-weighted sound level, abbreviated dB(A) or dBA. The overall sound level is defined as the summed level in decibels over the entire *audible* frequency range (for young adults) of approximately 20 to 20,000 cycles/second (Hertz). The A-weighted sound level is a convenient single number to quantify the entire spectrum of a sound. A-weighting is an electronic filter applied to the spectrum that reshapes the spectrum to simulate human hearing response to frequency content. Lower frequency sound is subtracted by the A-weighting filter since humans perceive higher frequencies easier than lower notes. The reshaped or weighted new spectrum is summed over the same audible frequency span and is called the overall A-weighted level. Thus, the A-weighted sound level becomes an excellent single number descriptor for audible sounds.

Reference [2] is an informative and a more detailed reference source for definitions and units used in this report.

Table 4.0.1 below is a scale of common sound levels that have similar character to the sounds created by a well designed power plant and many industrial facilities. These data come from the author's files over many years. All of the sounds are broadband, meaning the spectrum is smooth without sharp peaks or tonal noise. Examples of broadband noise are slow speed airflow from HVAC ducting, rushing water, tree leaf rustling and traffic noise without truck diesel tones. More irritating non-broadband tonal noise examples are an alarm clock, siren, diesel engine or digital alert tone.

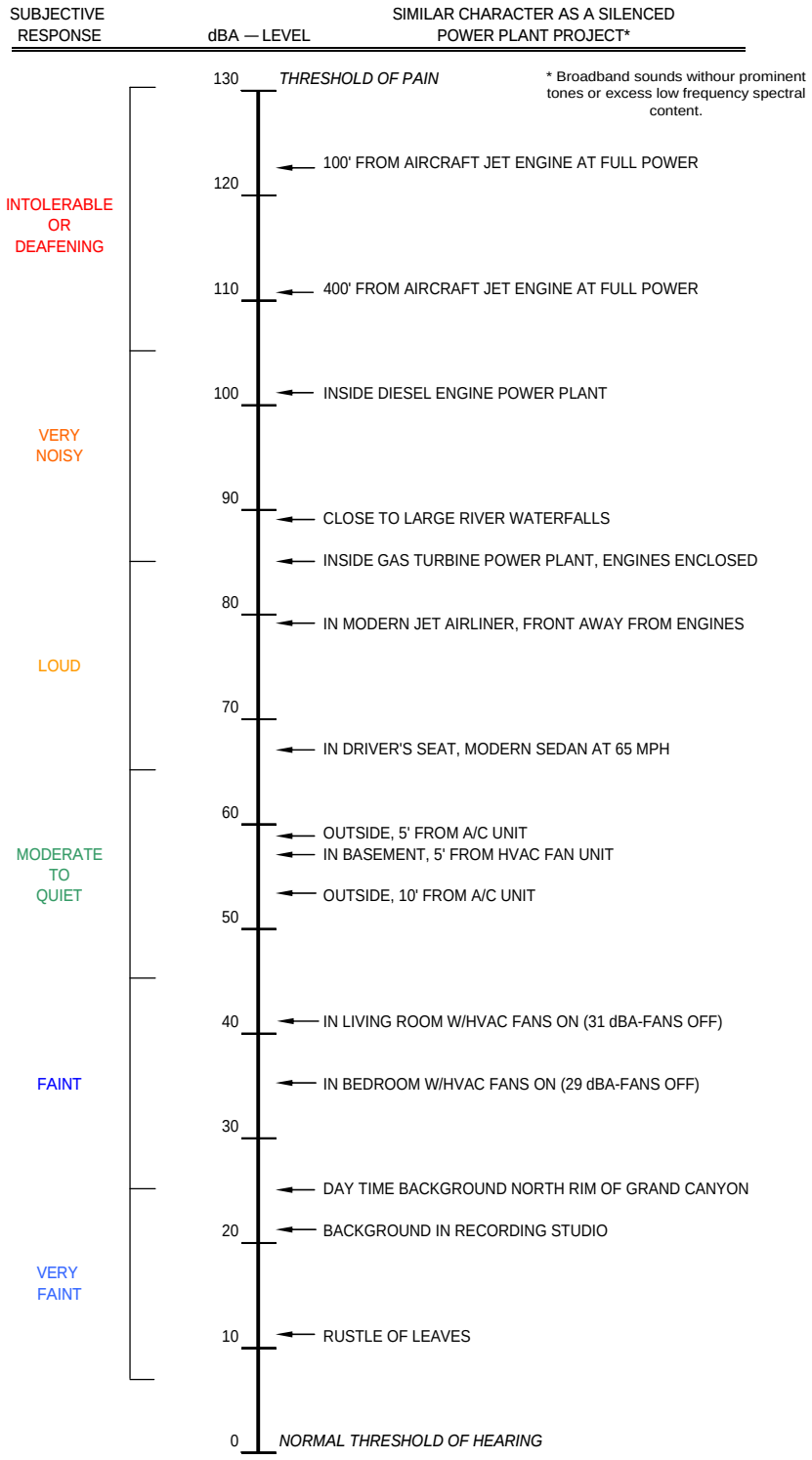


Table 4.0.1: *Table of Common Sounds in A-weighted dBA Units*

The *instantaneous* A-weighted sound level in any residential community over any sampling period varies as sporadic noise events occur. Such events may be passing vehicles, aircraft or rail events, dog barking, tree leaf rustle, song birds, etc. **Figure 4.0.1** below shows the instantaneous level for two distinctly different environments:

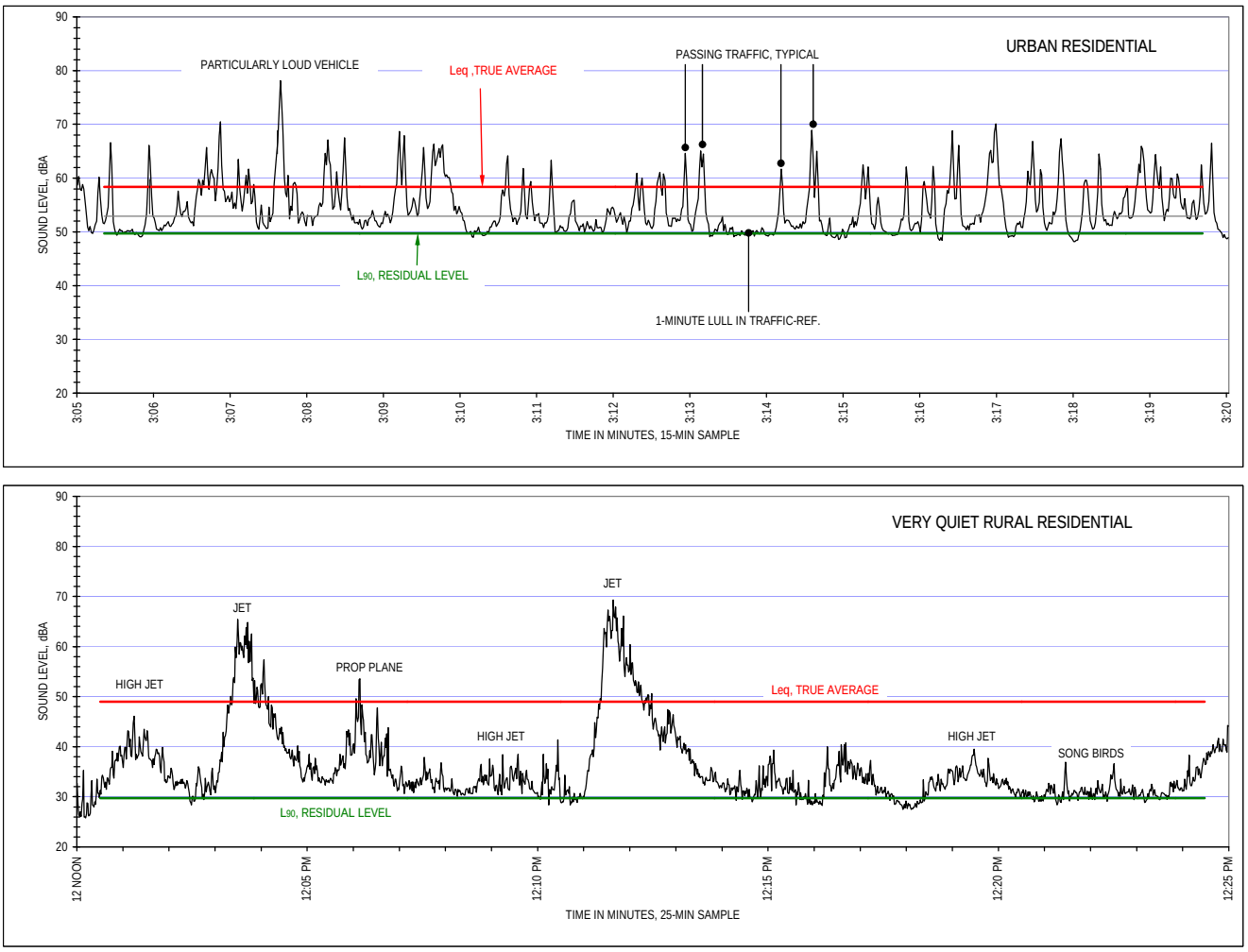


Figure 4.0.1: *Instantaneous sound level plots for a very quiet and moderately loud residential environment. Measurements from HAI files.*

To condense this widely varying data to a more usable form, standard measurement metrics are defined in reference 2. The obvious ones are the minimum, maximum and average levels that occur over the interval. The max and min are the highest and lowest measured level during the sampling period. The average, designated Leq is the *equivalent* steady sound level that has the same acoustic energy as the actual time varying signal. It can be thought of as the true energy average, and is not simply the arithmetic average over the period.

Percentile levels or exceedence levels, designated L_1, L_{10}, L_{50} and L_{90} are statistically derived units over the sampling period. They are the levels exceeded for 1, 10, 50 and 90% of the sampling time. Of all the units, Leq and L_{90} are the most useful for evaluating community noise. Of course, all of these units would be identical if the sound were perfectly steady without any variance with time, i.e., L_{min} would equal L_{max} would equal L_{eq}. etc.

The L_{90} percentile level is the most common for evaluating community noise in residential environments. L_{90} is defined in reference 5 as the "residual" sound level, which is the quasi-steady level that occurs in the absence of all identifiable sporadic sound levels occurring over the interval. The vast majority of all residual sound levels found in communities come from far-away unidentifiable steady levels from traffic and/or industrial sources.

The L_{eq} equivalent and L_{90} residual levels are shown in red and green on **Figure 4.0.1** above and are computed from the actual time-varying level over the measurement interval. Observe that the residual level *excludes* the sporadic sources and is the near-minimum measurement, while L_{eq} *includes* the sound energy from the sporadic events.

Typical residual daytime levels[3 4 5] found throughout the U.S. under calm and still wind conditions are shown in **Table 4.0.2** below:

Typical Residential Area Sound Levels
Daytime Residual Level, dBA, Level Exceeded 90% of the Time, L90

Description	Typical Range	Average
Very Quiet Rural or Remote Area	26 to 30 inclusive	28 (New, HAI Study) [3]
Very Quiet Suburban or Rural Area	31 to 35 inclusive	33 (ANSI B133.8)[4]
Quiet Suburban Residential	36 to 40 inclusive	38
Normal Suburban Residential	41 to 45 inclusive	43
Urban Residential	46 to 50 inclusive	48
Noisy Urban Residential	51 to 55 inclusive	53
Very Noisy Urban Residential	56 to 60 Inclusive	58

Table 4.0.2: *Typical Residual Sound levels in Residential Communities.*

Based on the above table, we should expect to find residual daytime levels in the range from 36 to 45 dBA in the surrounding suburban residential neighborhoods at CCNPP depending on the proximity of major roads. Still quieter levels may exist to the south which is natural woodlands with sparse development and roadways.

5.0_Discussion and Analysis of Results

5.1_Monitor Measurement Results

Figure 5.1.1 below gives the temporal pattern at the indicated locations over the two day period. These locations are natural woodlands and cicada/insect sounds increase the daytime levels by approximately 24 dBA such that highest levels occur at night. The pattern is completely opposite for road traffic dominated environments with minimum levels occurring at night with reduced traffic volumes.

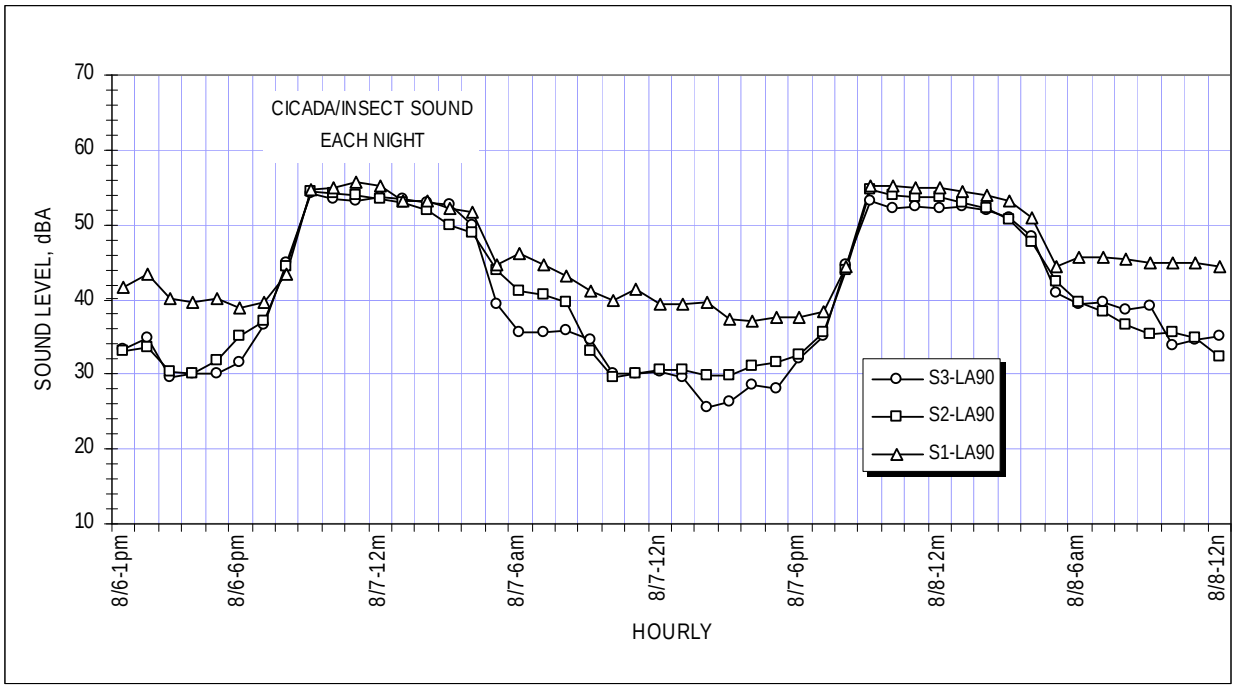


Figure 5.1.1: *Continuous monitor results at locations S1, S2 and S3, summertime leaf-on conditions.*

The ever-present residual level at the remote locations S2 and S3 is 30 dBA. The minimum levels measured during the wintertime were 30 and 33 dBA. At S1, there is more traffic noise from Route 765, and fan noise was observed during the manual survey. This was traced to the Southern Middle School on 765 that was operating some large propeller fans in a cooling effort. The wintertime residual level of 31 dBA is still appropriate for location S1.

5.2_Attended Measurement Results

Manual observations for at least 10-minute intervals were conducted for two day (12 noon – 5 p.m.) and two night (10 p.m. – 12 midnight) periods to record the residual spectra at each location. **Table 5.2.1** below tabulates the overall A-weighted L90 residual level at each location and period.

	N1	S1	S2	S3	W1	W2	W3
MON 8/6/07 DAY	41	42	29	31	32	53	33
TUE 8/7/07 DAY	37	40	30	31	32	49	32
MON 8/6/07 NIGHT (NOTE 1)			54			54	56
TUE 8/7/07 NIGHT (NOTE 1)			53			55	57

NOTE 1: NIGHTTIME MEASUREMENTS DOMOINATED BY CICADA/INSECT NOISE

Table 5.2.1: *Residual level measured at each location for day and night intervals.*

The results are quite consistent from day to day so the measured residual level can be relied upon as ever-present masking background sound. It is notable that nighttime levels increased approximately 24 dBA at S2 and W3. An increase of approximately 4 dBA occurred at W2, a location dominated by traffic noise. W2 is just 285 feet away from Routes 2 & 4. Such a location should become quieter as traffic decreases at night. The reason for this is readily apparent to an observer (loud cicadas/insect nighttime noise) and is quantified on **Figure 5.2.1** below that shows the 10-minute residual spectra for a day and night measurement. Cicada sounds dominate the spectra above 1000 Hz, while traffic flow noise dominates below 1000 Hz. It is seen that the nighttime residual level attributable to traffic is about 7 to 9 dBA quieter as one would expect at such a location, but the A-weighted overall level is higher due to cicada/insect sources.

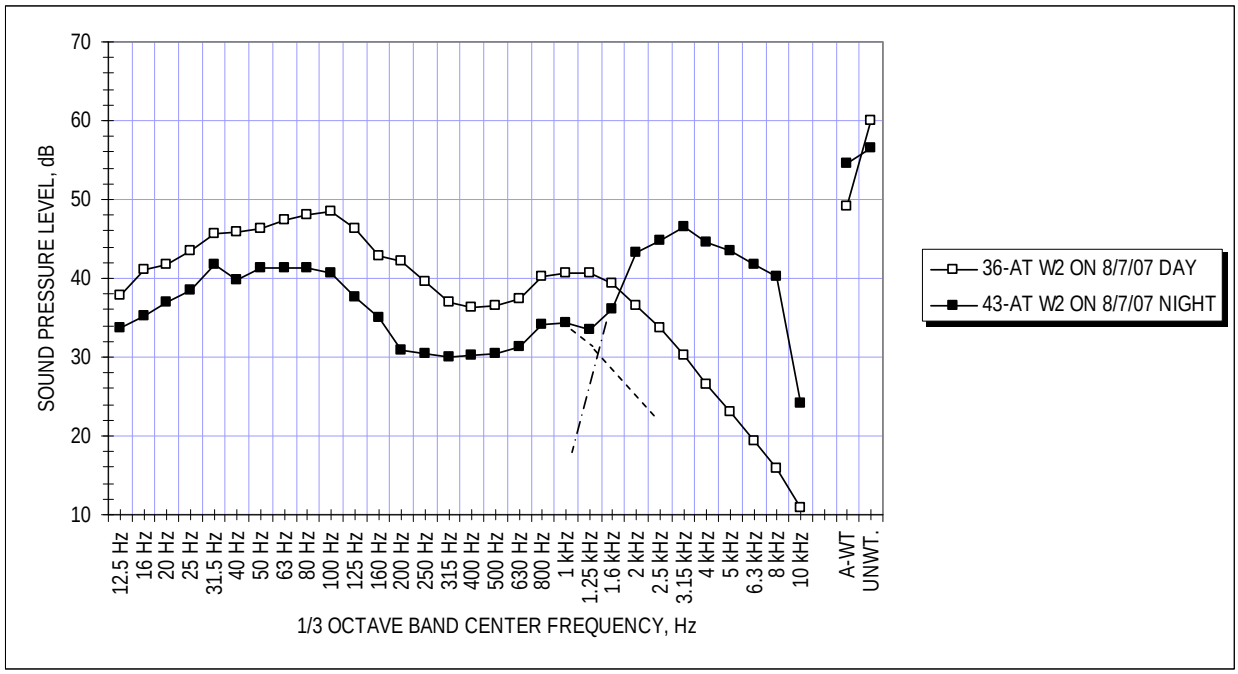
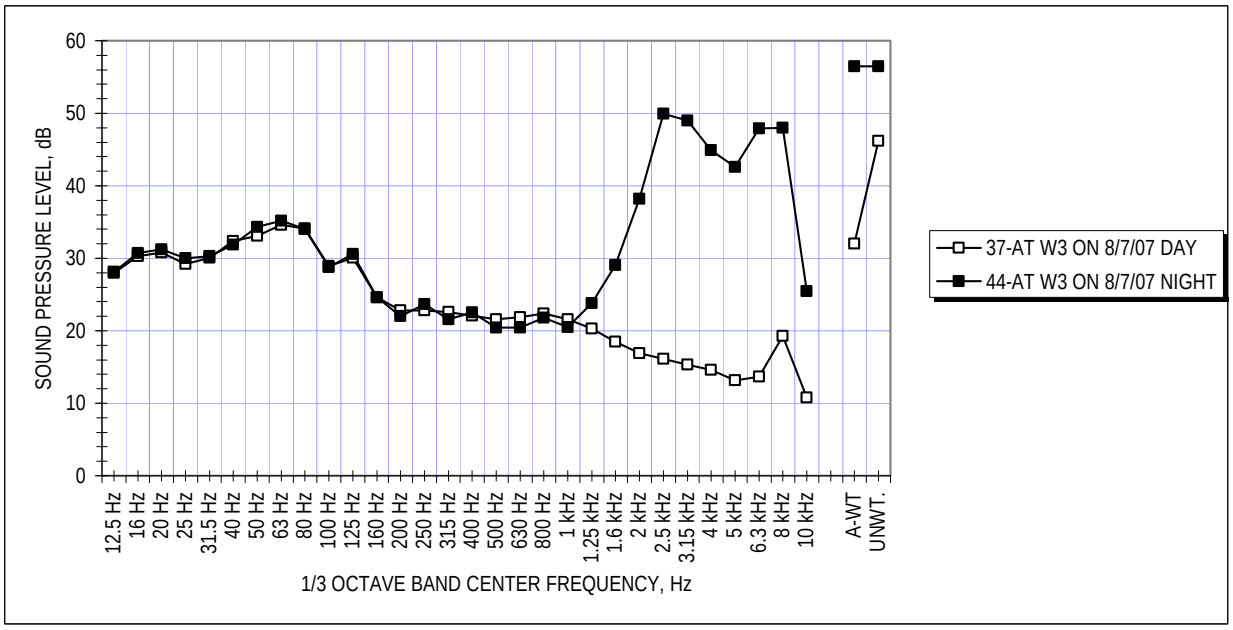


Figure 5.2.1: *Measured residual spectra plots at W2.*

Spectra plots at S2 and W3 are given below that show the same dominance of cicada/insect noise at night.



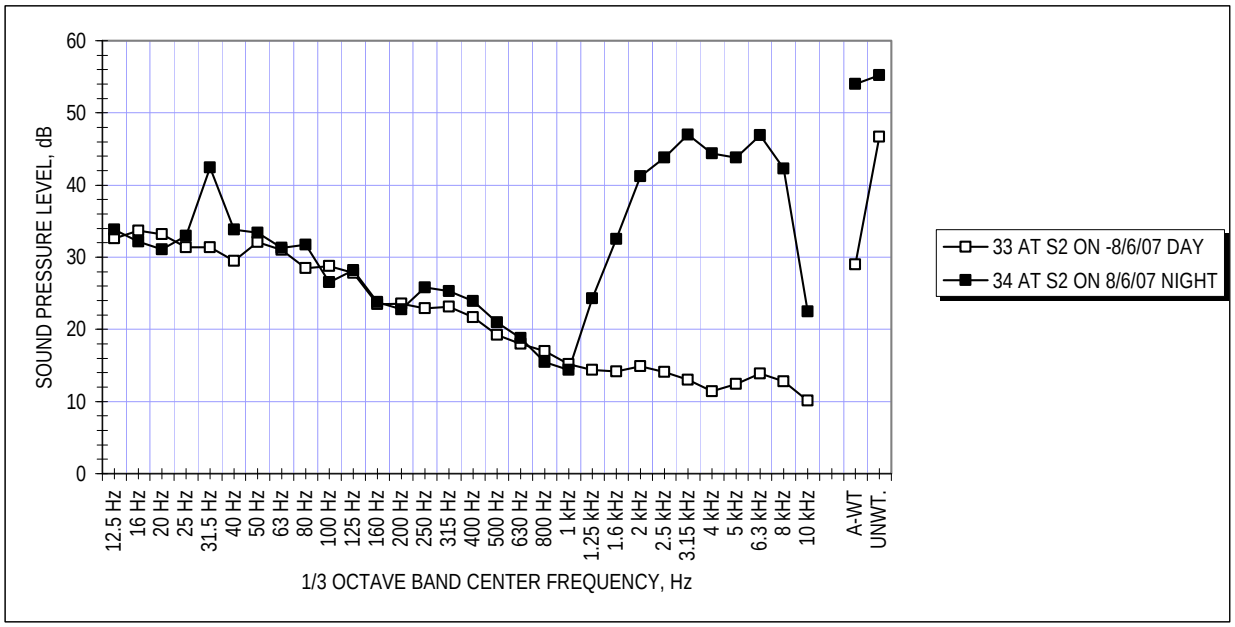


Figure 5.2.2: *Measured residual spectra plots at locations W3 and S2.*

End of Text

6.0_References

[1] Hessler, G. F., "Controlling Noise Impact in the Community from Power Plant Operations – Recommendations for Ambient Noise Measurements", *Noise Control Engineering Journal*, Volume 48, Number 5, 2000 Sept-Oct

[2] "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", US EPA Report PB-239 429, March 1974

[3] Hessler, G.F., Hessler, D.M., "Power Plant Noise Impact Policy for Quiet Ambient Environments", Prepared for Calpine Corp., Report # 1598A, November 2001.

[4] ANSI B133.8, "Gas Turbine Installation Sound Emissions", 1977, Reaffirmed 1987.

[5] "Community Noise", US EPA Report NTID300.3, Dec. 1971.

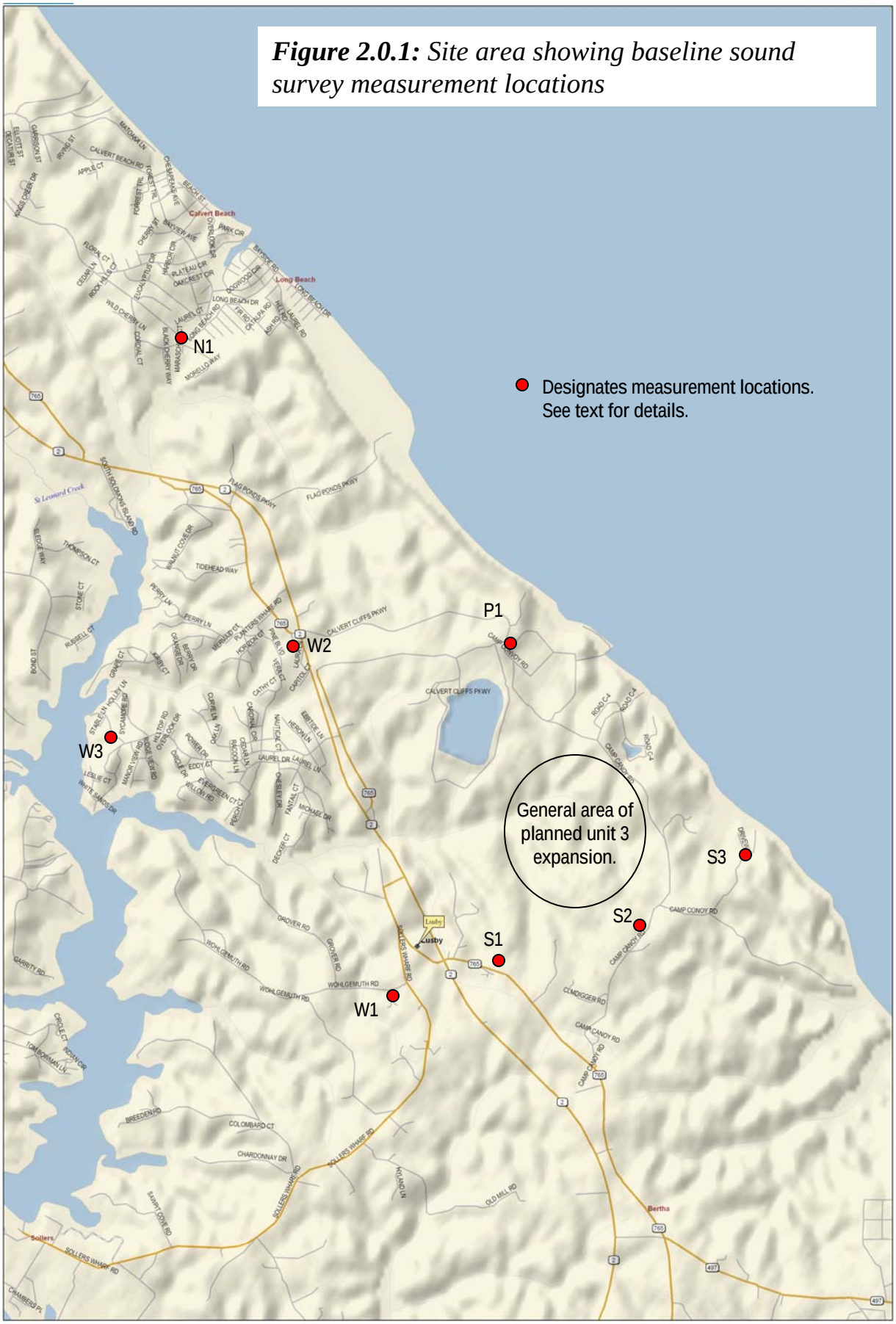



Figure 2.0.1: *Site area showing baseline sound survey measurement locations*