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Environmental Noise Study
Queen Kaahumanu Highway Widening Phase 2
in the vicinity of Kaloko-Honokohau National Historic Park
North Kona, Island of Hawaii, Hawaii

December 2014

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1.0 EXECUTIVE SUMMARY

1.1 The Queen Kaahumanu Highway Widening Project includes design and construction services to widen Queen Kaahumanu from the existing two lanes into a four lane divided highway. The project corridor is approximately 4.5 miles long and is located in the North Kona District of the County of Hawaii. Phase 2 begins at approximately 1150 feet south of Kealakehe Parkway and extends to approximately 1700 feet north of Keahole Airport Road. This noise study focuses on the traffic noise impacts from the highway widening project to the Kaloko-Honokohau National Historical Park.

1.2 While various local and federal agencies have established guidelines and standards for assessing environmental noise impacts, this noise study was initiated to address FHWA 23 CFR 774 requirements and help to determine if a constructive use of a Section 4(f) property occurs.

1.3 The project area is currently exposed to varying daytime ambient noise levels, depending on the proximity to Queen Kaahumanu Highway. The trails that intersect the highway, e.g., Kings Trail, Ala Hue Hue, and Ala Kahako, are exposed to noise levels around 65 dBA at a distance of 150 feet from the highway. However, many of the noise sensitive sites within the park are sufficiently far from the highway that traffic noise is not a dominant noise source. The ambient noise environment at these sites is highly dependent on natural noise sources such as wind, surf, birds, and insects. Noises specific to the park such as park ranger ATVs, cultural activities at the Hale Hookipa Visitor Center or the Na Leo Kahiko Cultural Center, and hikers are also audible throughout the park. Generally, the site is very quiet where the noise levels range from 35 to 59 dBA.

1.4 Atmospheric conditions specific to the island of Hawaii shift daytime on-shore wind patterns to higher speed off shore wind at night. Because of these atmospheric conditions, man-made noises from Queen Kaahumanu Highway, the light industrial area, and the quarry are audible at off peak hours and nighttime hours as far away as 2000 feet from the highway. Aircraft flyovers were also audible due to the proximity of the site to the airport.

1.5 Existing and future noise levels were predicted using the Federal Highway Administration Traffic Noise Model (TNM 2.5) using the procedures outlined in the FHWA and HDOT Noise Policy and Abatement Guidelines. Traffic noise was calculated at three noise sensitive receptor locations, Hale Hookipa Visitor Center, Ala Hue Hue Trail, and Na Leo Kahiko Cultural Center. Future traffic noise levels at all three locations are expected to be below the FHWA Noise Abatement Criteria of 67 dBA. Furthermore, the increase in traffic noise due to the widening of Queen Kaahumanu Highway is less than 1 dB at all receiver locations.

2.0 PROJECT OVERVIEW

The Queen Kaahumanu Highway Widening Project includes design and construction services to widen Queen Kaahumanu from the existing two (2) lanes into a four (4) lane divided highway. Other work consists of, but is not limited to the design and construction of: new pavements and pavement markings; the drainage systems; sidewalks; the traffic signal systems and traffic signs; guardrails and landscape plantings; the highway lighting plus the relocation and installation of utilities.

The project corridor is approximately 4.5 miles long and is located in the North Kona District of the County of Hawaii. Phase 2 begins at approximately 1150 feet south of Kealakehe Parkway and extends to approximately 1700 feet north of Keahole Airport Road. However, this noise study focuses on the traffic noise impacts from the highway widening project to the Kaloko-Honokohau National Historical Park. While various local and federal agencies have established guidelines and standards for assessing environmental noise impacts, this noise study was initiated to address FHWA 23 CFR 774 requirements and help to determine if a constructive use of a Section 4(f) property occurs.

3.0 NOISE STANDARDS

While various local and federal agencies have established guidelines and standards for assessing environmental noise impacts, this noise study was initiated to determine whether a constructive use occurs within the Kaloko-Honokohau National Historical Park as a result of the proposed project, as defined by the FHWA regulation 23 CFR 774 [Reference 1]. A constructive use may occur when a transportation project does not physically incorporate land, but substantially impairs the historic features of a Section 4(f) property that qualify the resource for protection (23 CFR 774.15). Applicable regulations governing Section 4(f) resources and environmental noise impacts are as described in Section 3.1 below. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 U.S. Federal Highway Administration (FHWA) 23 CFR 774

Per 23 CFR 774.15(a), “A constructive use occurs when the transportation project does not incorporate land from a Section 4(f) property, but the project's proximity impacts are so severe that the protected activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired. Substantial impairment occurs only when the protected activities, features, or attributes of the property are substantially diminished.”

23 CFR 774.15(f)(3) defines certain situation in which a “constructive use” does not occur, specifically when projected traffic noise levels are in exceedance of the FHWA noise abatement criteria due to existing high noise levels, but the increase in the projected noise levels if the project were constructed (i.e., “Build” condition) is 3 dBA or less when compared to projected noise levels if the project were not constructed (i.e., “No Build” condition). Refer to Section 3.2 and Figure 1 below for further explanation of the noise abatement criteria as it relates to the Kaloko-Honokohau National Historical Park.

3.2 U.S. Federal Highway Administration (FHWA) 23 CFR 772

The FHWA regulation 23 CFR 772 contains highway traffic noise abatement criteria (NAC) for seven land use activity categories and assigns corresponding maximum hourly equivalent sound levels for traffic noise exposure [Reference 2, 3]. The NAC for all seven categories are listed in Figure 1. The Kaloko-Honokohau National Historical Park would fall under Category C, defined for parks, trails, recreation areas, or Section 4(f) sites, and has a corresponding maximum exterior hourly equivalent sound level ($L_{eq(h)}$) of 67dBA.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Two types of noise measurements were conducted to assess the existing acoustical environment in the vicinity of the project location. The first noise measurement type consisted of continuous long-term ambient noise level measurements. The second type of noise measurement was short-term and included traffic counts. The purpose of the short-term noise measurements and corresponding traffic counts is to calibrate a traffic noise prediction model. The field measurements were conducted in general accordance with guidelines from the FHWA [Reference 4].

The methodology, location, and results for each of the measurements are described below and the measurement locations are illustrated in Figure 2. Photographs of the measurements locations are provided in Appendix B.

4.1 Long Term Noise Measurements

Continuous long-term ambient noise level measurements were conducted to assess the existing acoustical environment of Kaloko-Honokohau National Historic Park. Long-term measurements (taken continuously over the course of multiple days) offer a baseline for establishing existing ambient noise levels in the area and are used for estimating future noise levels by adding the ambient levels to other noise levels generated from the proposed project.

4.1.1 Long-Term Noise Measurement Procedure

Long term noise level measurements were conducted in three locations within the boundaries of the Kaloko-Honokohau National Historic Park. The measurement period was from January 15, 2014 to February 10, 2015. In accordance with National Park Service protocol, continuous, 1 second equivalent sound levels ($L_{eq(s)}$) were recorded for approximately 27 days at each location. Hourly equivalent sound levels ($L_{eq(h)}$) were also recorded. The measurements were taken using three Larson-Davis, Model 831, Type 1 integrating sound level meters together with Larson-Davis, Model 377B20 Type 1 Microphones. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. This equipment satisfies the ANSI S1.4-1983 specification and has been certified by the manufacturer within the recommended 2-year calibration period. In addition to sound levels, wind speed and direction data and sound recordings were collected for the entire period. The microphones and anemometers were mounted on tripods, approximately 6 feet above grade. Windscreens covered the microphones during the entire measurement period. The sound level meters and recorders were secured in weather-resistant cases.

4.1.2 Long-Term Noise Measurement Locations

Location A: The sound level meter was located near the Hale Hookipa Visitor Center, approximately 900 feet west of the center line of Queen Kaahumanu Highway. Dominant noise sources included vehicular traffic from the highway. Secondary noise sources included aircraft flyovers, birds, and wind.

Location B: The sound level meter was located near the center of the park adjacent to the Ala Hue Hue Trail. This location was just over 2000 feet west of the highway.

Location C: The sound level meter was located near the Na Leo Kahiko Cultural Center at the north end of the project site, approximately 3700 feet west of the highway.

4.1.3 Long-Term Noise Measurement Results

The measured hourly equivalent sound levels ($L_{eq(h)}$) and 90 percent exceedance level ($L_{90(h)}$) are graphically presented in Figures 3, 4 and 5 for each location. The graphs show the period from January 15, 2014 to January 21, 2014 which is a representative week during the total measurement period of 27 days.

The ambient noise environment at the Kaloko-Honokohau National Historic Park is relatively dynamic and highly dependent on environmental noise sources such as wind, surf, birds, and insects. Atmospheric conditions specific to the island of Hawaii shift daytime on-shore wind patterns to higher speed off shore wind at night. This creates a counterintuitive phenomenon where noise levels increase throughout the night and drop off in the morning.

Because of these atmospheric conditions, man-made noises from Queen Kaahumanu Highway, the light industrial area, and the quarry were audible at off peak hours and as far away as Location B (over 2000 feet from the highway). Aircraft flyovers were audible throughout the site due to the close proximity to Kona International Airport. Noises specific to the site such as park ranger ATVs, cultural activities at the Hale Hookipa Visitor Center or the Cultural Center, minor construction at the Kaloko fishpond, and trail users were audible at all measurement locations but did not significantly contribute to the hourly averaged sound levels.

Generally, the site is very quiet where the noise levels range from 35 to 59 dBA. The day-night level (L_{dn}) which was averaged over the entire measurement period was generally 55 dBA throughout the site. The range of $L_{eq(h)}$ during the day (7:00 AM to 10:00 PM) and during the night (10:00 PM to 7:00 AM) and average L_{dn} is summarized for each location in Table 1 below.

Table 1. Summary of Noise Measurement Results (dBA)

Measurement Location	Daytime $L_{eq(h)}$ Range	Nighttime $L_{eq(h)}$ Range	Average L_{dn}
A – Hale Hookipa Visitor Center	35-57	39-54	55
B – Ala Hue Hue Trail	35-57	38-56	55
C – Na Leo Kahiko Cultural Center	35-59	38-56	54

4.2 Short Term Noise Measurements

An approximate 30-minute equivalent sound level was measured at one location (D) during the AM and PM peak traffic hours. The sound level meter was located on the east side of Queen Kaahumanu Highway near the Allied Quarry Road intersection, approximately 80 feet from the center line. Vehicular traffic counts and traffic mix were documented during the measurement period. The noise measurements were taken using a Larson-Davis Laboratories, Model 831, Type-1 integrating sound level meter together with a Larson-Davis, Model 377B20 Type 1 Microphone. This equipment satisfies the ANSI S1.4-1983 specification and has been certified by the manufacturer within the recommended 2-year calibration period. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period. As with the long term measurements, the microphone and sound level meter were mounted on a tripod and a windscreen covered the microphone.

5.0 POTENTIAL NOISE IMPACTS

5.1 Highway Traffic Noise Analysis

5.1.1 Traffic Noise Model Overview

Existing and future (2035) noise levels were predicted using the Federal Highway Administration Traffic Noise Model (TNM) [Reference 5]. Typical input parameters include traffic volumes and speeds, conceptual alignment design, receptor locations, and terrain features. Peak hour traffic volumes and posted roadway speeds were provided by the Traffic Consultant [Reference 6] and are summarized in Appendix C. The alignment design was provided for the existing Queen Kaahumanu highway and the proposed widened highway. Traffic was modeled on the centerlines of the existing northbound and southbound travel lanes for the existing condition. For the future condition, lane by lane volume data was not available from the Traffic Consultant. Therefore, the center of the two northbound travel lanes and the center of the two southbound travel lanes were used to model traffic. Roadway shoulders and medians were not modeled.

For the purposes of this noise analysis, the terrain was assumed to be gently sloping with no significant shielding features so topographical contours were not included in the model, which would be considered a worst-case condition. In addition, the terrain surrounding the project corridor was assumed to be hard (i.e., acoustically reflective) since much of the land is lava rock with minimal vegetative ground cover. An average pavement type was used, per FHWA requirements for highway noise analysis. Sound levels predicted at the receptor locations were calculated at approximately 5 feet above ground to represent the areas where frequent human activity occurs.

A base model of the existing roadway conditions was developed using the existing roadway alignments for Queen Kaahumanu Highway and the traffic volumes and mix data that was collected at measurement location D (described in Section 4.2 above). The TNM model predicted sound levels at the short term measurement location D and these levels were compared to the measurement results. This comparison allows for the TNM model to be “validated”, thus verifying the accuracy of noise model. A difference of 3 decibels or less between the monitored and modeled level is considered acceptable. It was found that the difference between the model and the noise measurements was less than 3 dB, so the model was considered valid.

Following the validation of the existing conditions noise model, the same methodology was applied in the development of TNM models for the existing (2014) condition, the future (2035) “No Build” condition and the future (2035) “Build” condition. These conditions were modeled for peak hour AM and PM traffic using the volumes provided by the Traffic Consultant.

5.1.2 Noise Receptor Locations

A majority of the noise sensitive sites within Kaloko-Honokohau National Historic Park are located a substantial distance (more than 400 feet) from the roadway. These sites include the Hale Hookipa Visitor Center, Na Leo Kahiko Cultural Center, fishponds, wetlands, beaches, Heiau, restrooms, shoreline trails, etc. Due to uncertainties in the TNM prediction software regarding terrain, it is impractical to model traffic noise at large distances from the roadway. In fact, TNM results have not been sufficiently validated for distances greater than 600 feet for soft ground and 900 feet for hard ground. In addition, the model does not have provisions for dealing with the effects of meteorology. With increasing distances, meteorological conditions have an increasing effect on noise levels due to atmospheric refraction.

Wind can have a significant effect at 200 to 400 feet, and the effects of temperature gradients can be dominant at greater distances. The TNM prediction model is accurate only for neutral atmospheric conditions, i.e. no wind and no temperature gradients.

Despite the limitations of the TNM model at large distances from the roadway, the intent of this analysis is to identify potentially impacted receptors within the park, per FHWA Noise Analysis and Abatement Guidelines [Reference 3]. Therefore, traffic noise was calculated using the methodology described above at the three receptor locations identified in Section 4.1.2, the Hale Hookipa Visitor Center, Ala Hue Hue Trail, and the Na Leo Kahiko Cultural Center.

5.1.3 Traffic Noise Analysis Results and Conclusions

The predicted traffic noise levels at the three noise receptor locations are presented in Table 2 below. The future change in noise level both with and without the project and the change in noise level due to the project are also shown below. The noise levels are expressed in A-weighted decibels (dBA).

Table 2. Summary of Existing and Future Traffic Noise Projections (dBA)

Row ID	**Noise Receptor**	**(A) Hale Hookipa Visitor Center**		**(B) Ala Hue Hue Trail**		**(C) Na Leo Kahiko Cultural Center**	
		AM	**PM**	**AM**	**PM**	**AM**	**PM**
(x)	Existing (2014)	54.1	54.8	47.8	48.3	43.5	44.1
(y)	Future No Build (2035)	56.5	57.4	50.2	50.9	45.9	46.6
(z)	Future Build (2035)	56.8	57.6	50.3	51.0	46.0	46.7
(y-x)	Future increase without project	2.4	2.6	2.4	2.6	2.4	2.5
(z-x)	Future increase with project	2.7	2.8	2.5	2.7	2.5	2.6
(z-y)	**Future increase due to project**	**0.3**	**0.2**	**0.1**	**0.1**	**0.1**	**0.1**
	Distance to future highway EOP	805 feet		1905 feet		3605 feet	

Based on the results of the traffic noise analysis, traffic noise levels at all three receptor locations are expected to be below the FHWA noise abatement criteria for Category C land uses. Category C, defined for parks, picnic areas, recreation areas, trails, trail crossings, and Section 4(f) sites, has a corresponding maximum exterior hourly equivalent sound level ($L_{eq(h)}$) of 67dBA.

Traffic noise levels are expected to increase in the future by 2.5 dB even without the project due to the projected regional growth and traffic demand on Queen Kaahumanu Highway. This demand is expected regardless of whether the highway is widened. Therefore, the increase in projected traffic noise levels *due to the project* (i.e., comparison of the build condition to no build condition) is less than 1 dB at all three noise receptor locations. A 3 dB change or less in noise level is not considered to be significant.

REFERENCES

1. *Department of Transportation, Federal Highway Administration Title 23, Part 774 – Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites (Section 4(f))*, Revised at 73 FR 13395, March 12, 2008.

2. *Department of Transportation, Federal Highway Administration Title 23, Part 772 - Procedures for Abatement of Highway Traffic Noise*, 75 FR 39834, July 13, 2010.

3. *Highway Traffic Noise: Analysis and Abatement Guidance*, U.S. Department of Transportation, Federal Highways Administration, December 2011.

4. *Measurement of Highway-Related Noise*, U.S. Department of Transportation, Federal Highways Administration, May 1996.

5. *Federal Highway Administrations Traffic Noise Model*, Version 2.5, U.S. Department of Transportation, February 2004.

6. *Traffic Study - Queen Kaahumanu Highway Widening Kealakehe Parkway to Keahole Airport Road,* Parsons Brinkerhoff, August 2014

FEDERAL HIGHWAY ADMINISTRATION NOISE ABATEMENT CRITERIA FOR HIGHWAY NOISE

ACTIVITY CATEGORY	ACTIVITY CATEGORY DESCRIPTION	HOURLY EQUIVALENT SOUND LEVEL L_{eq}
A	LANDS ON WHICH SERENITY AND QUIET ARE OF EXTRAORDINARY SIGNIFICANCE AND SERVE AN IMPORTANT PUBLIC NEED AND WHERE THE PRESERVATION OF THOSE QUALITIES IS ESSENTIAL IF THE AREA IS TO CONTINUE TO SERVE ITS INTENDED PURPOSE.	57 dBA (EXTERIOR)
B	RESIDENTIAL	67 dBA (EXTERIOR)
C	ACTIVE SPORT AREAS, AMPHITHEATERS, AUDITORIUMS, CAMPGROUNDS, CEMETERIES, DAY CARE CENTERS, HOSPITALS, LIBRARIES, MEDICAL FACILITIES, PARKS, PICNIC AREAS, PLACES OF WORSHIP, PLAYGROUNDS, PUBLIC MEETING ROOMS, PUBLIC OR NONPROFIT INSTITUTIONAL STRUCTURES, RADIO STUDIOS, RECORDING STUDIOS, RECREATION AREAS, SECTION 4(F) SITES, SCHOOLS, TELEVISION STUDIOS, TRAILS, AND TRAIL CROSSINGS	67 dBA (EXTERIOR)
D	AUDITORIUMS, DAY CARE CENTERS, HOSPITALS, LIBRARIES, MEDICAL FACILITIES, PLACES OF WORSHIP, PUBLIC MEETING ROOMS, PUBLIC OR NONPROFIT INSTITUTIONAL STRUCTURES, RADIO STUDIOS, RECORDING STUDIOS, SCHOOLS, AND TELEVISION STUDIOS .	52 dBA (INTERIOR)
E	HOTELS, MOTELS, OFFICES, RESTAURANTS/BARS, AND OTHER DEVELOPED LANDS, PROPERTIES OR ACTIVITIES NOT INCLUDED IN A-D OR F.	72 dBA (EXTERIOR)
F	AGRICULTURE, AIRPORTS, BUS YARDS, EMERGENCY SERVICES, INDUSTRIAL, LOGGING, MAINTENANCE FACILITIES, MANUFACTURING, MINING, RAIL YARDS, RETAIL FACILITIES, SHIPYARDS, UTILITIES (WATER RESOURCES, WATER TREATMENT, ELECTRICAL), AND WAREHOUSING	N/A
G	UNDEVELOPED LANDS THAT ARE NOT PREMITTED	N/A

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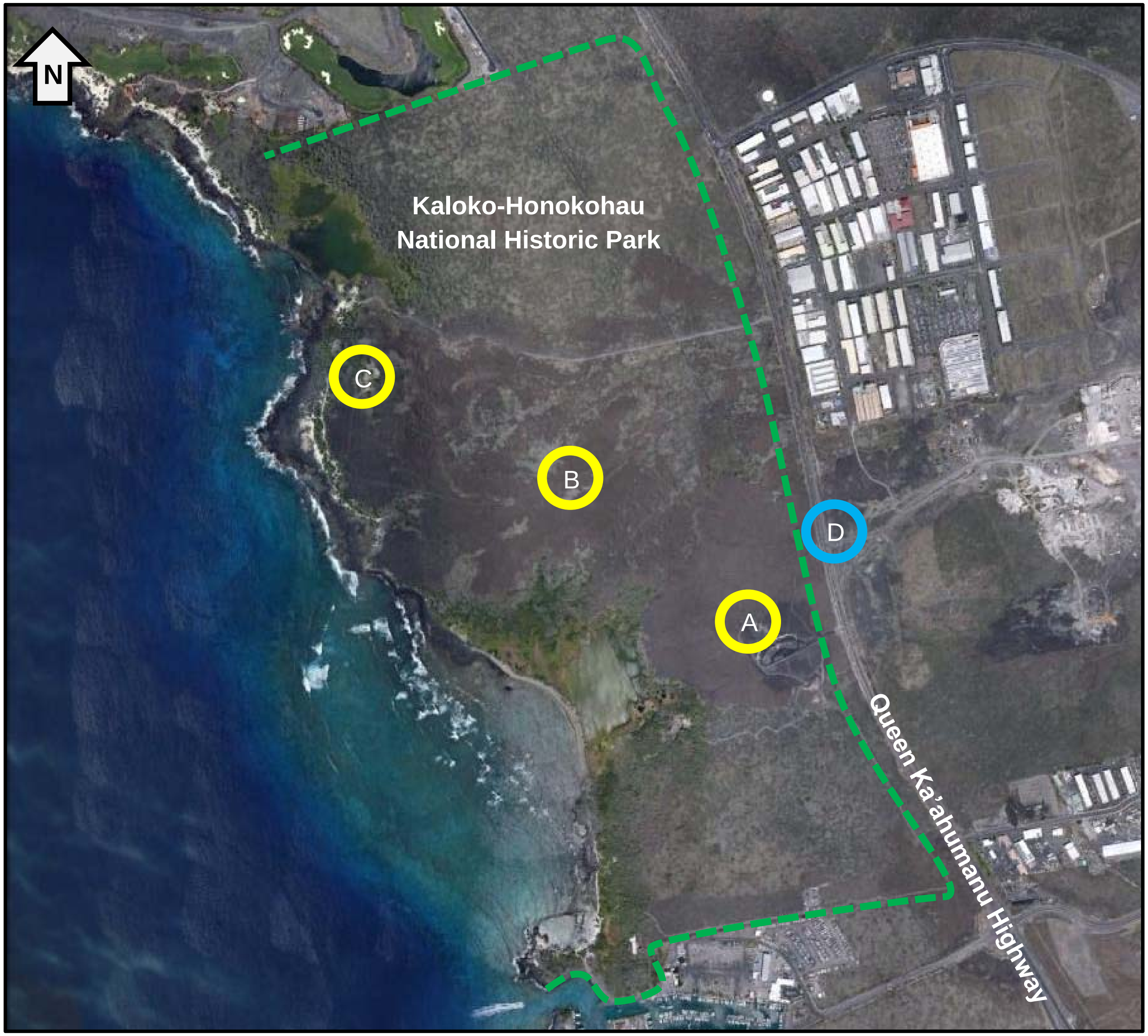
PROJECT: Queen Ka'ahumanu Highway Widening , Phase 2		
PROJECT NO: 14-04	DATE: December 2014	FIGURE: 1

Park Boundary and Noise Measurement Locations



Legend

Short Term Noise Measurement Location

Long Term Noise Measurement Location

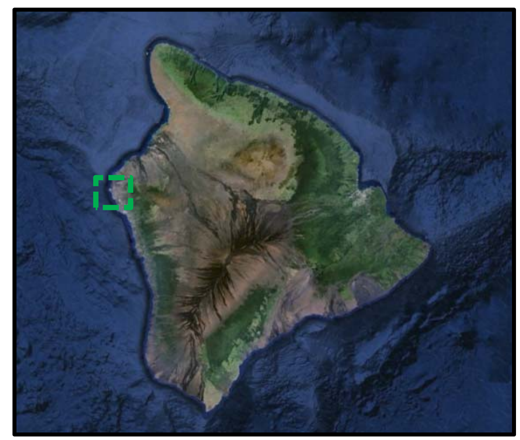
Park Boundary

A Hale Ho'okipa Visitor Center (800 ft west of Queen Ka'ahumanu Hwy)

B Ala Hu'e Hu'e Trail (2000 ft west of Queen Ka'ahumanu Hwy)

C Na Leo Kahiko Cultural Center (500 ft east of shoreline)

D 80 ft east of Queen Ka'ahumanu Hwy



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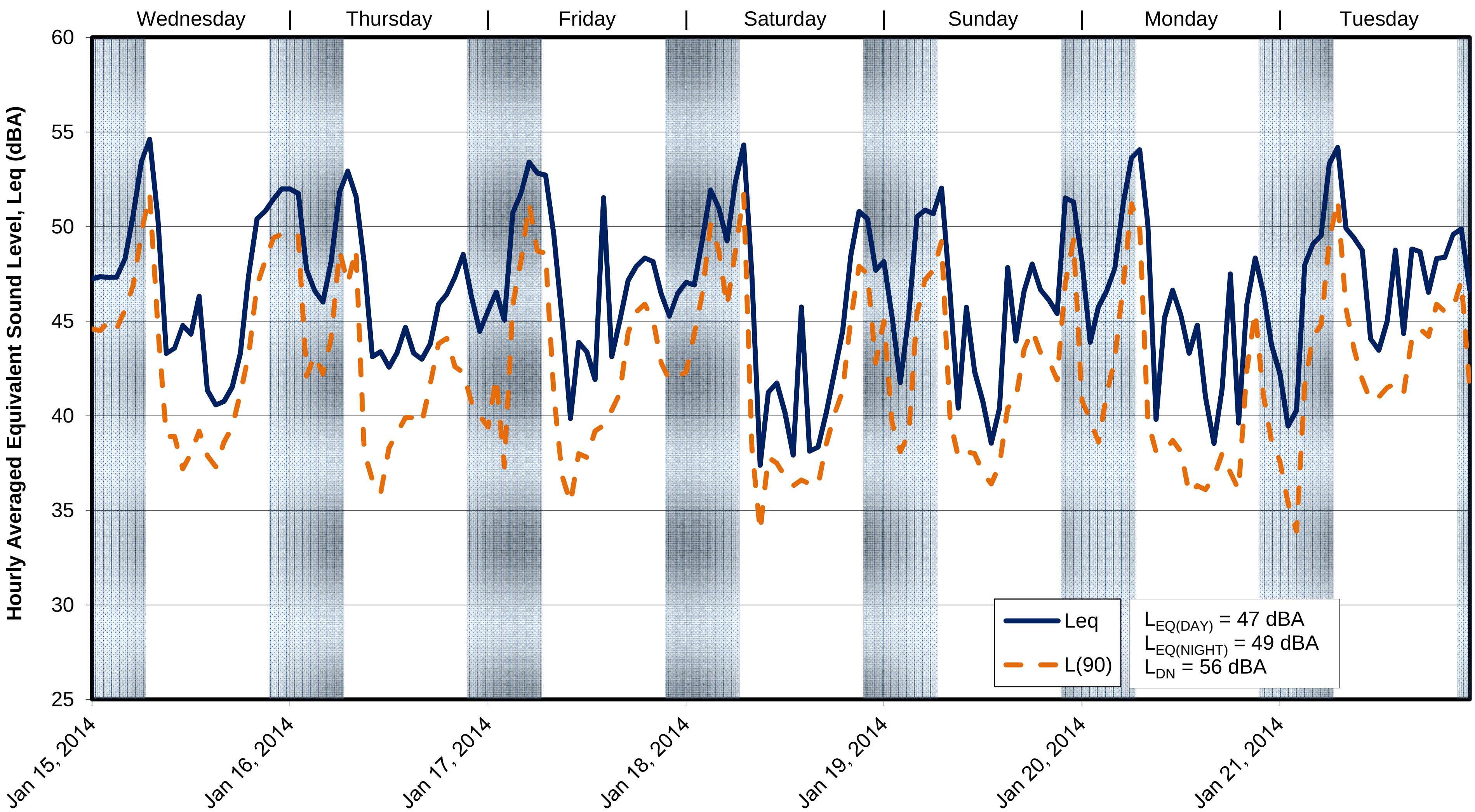
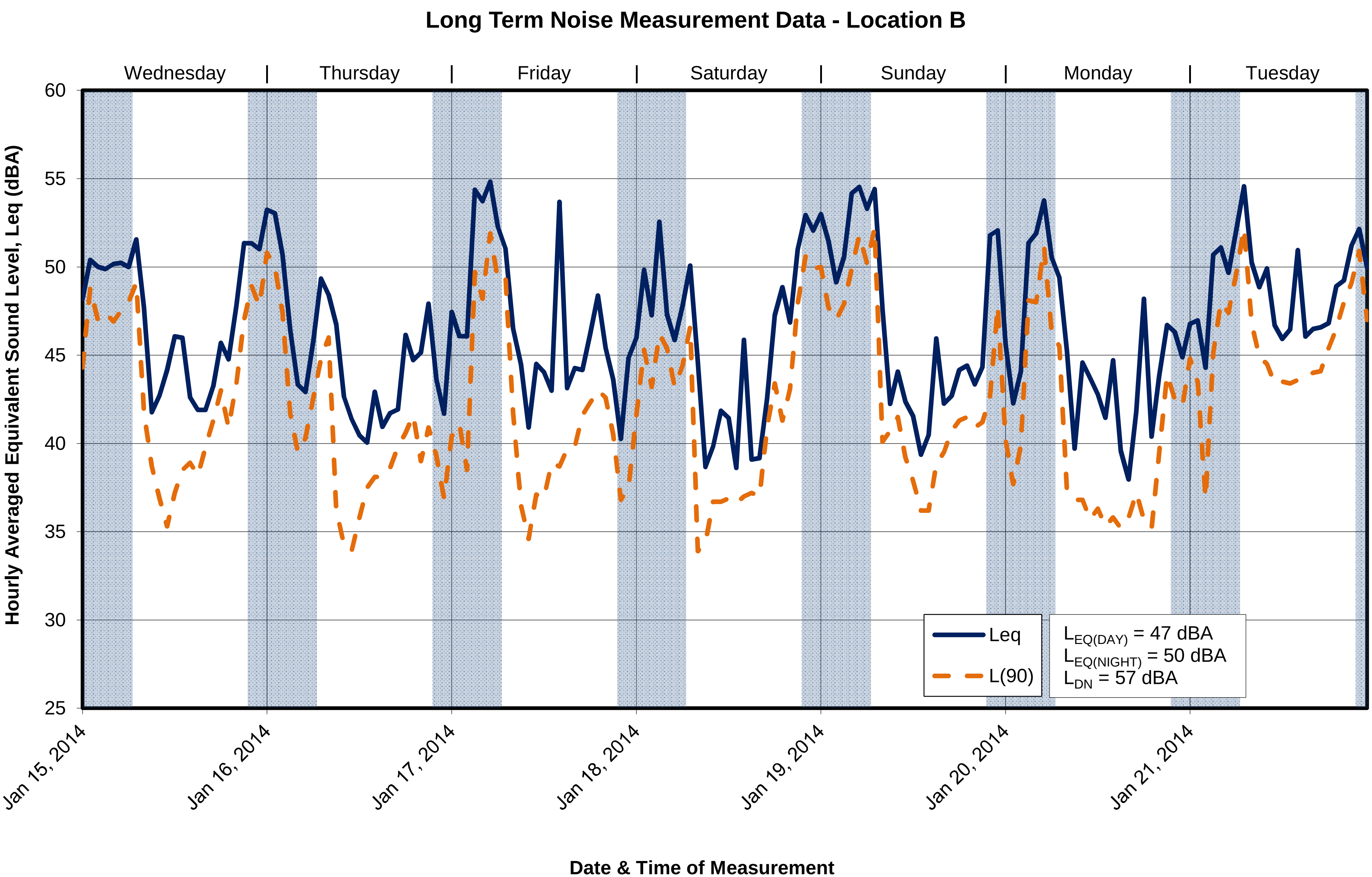
	PROJECT NO: 14-04	DATE: December 2014	FIGURE: 2

Long Term Noise Measurement Data - Location A



Date & Time of Measurement

D. L. ADAMS ASSOCIATES acoustics | performing arts | technology	PROJECT: Queen Ka'ahumanu Highway Widening, Phase 2		
	PROJECT NO: 14-04	DATE: December 2014	FIGURE: 3



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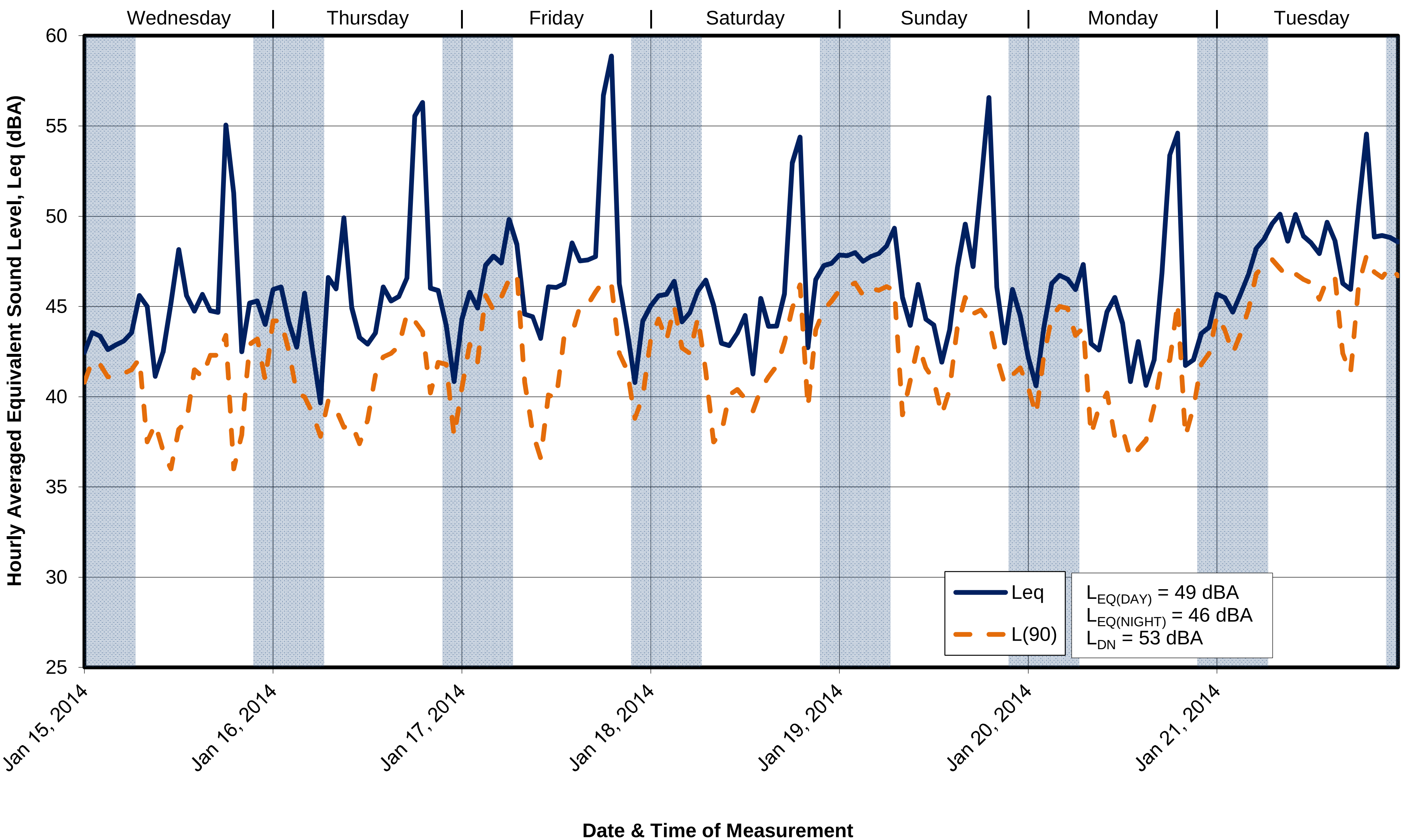
	PROJECT NO: 14-04	DATE: December 2014	FIGURE: 4

Long Term Noise Measurement Data - Location C



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	PROJECT NO: 14-04	DATE: December 2014	FIGURE: 5

APPENDIX A

Acoustic Terminology

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as Aunwanted@ sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 µPa, which is approximately the lowest sound pressure that can be detected by the human ear. For example:

If P = 20 µPa, then SPL = 0 dB
If P = 200 µPa, then SPL = 20 dB
If P = 2000 µPa, then SPL = 40 dB

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

[1] D.W. Robinson and R.S. Dadson, AA Re-Determination of the Equal-Loudness Relations for Pure Tones,@ *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226.

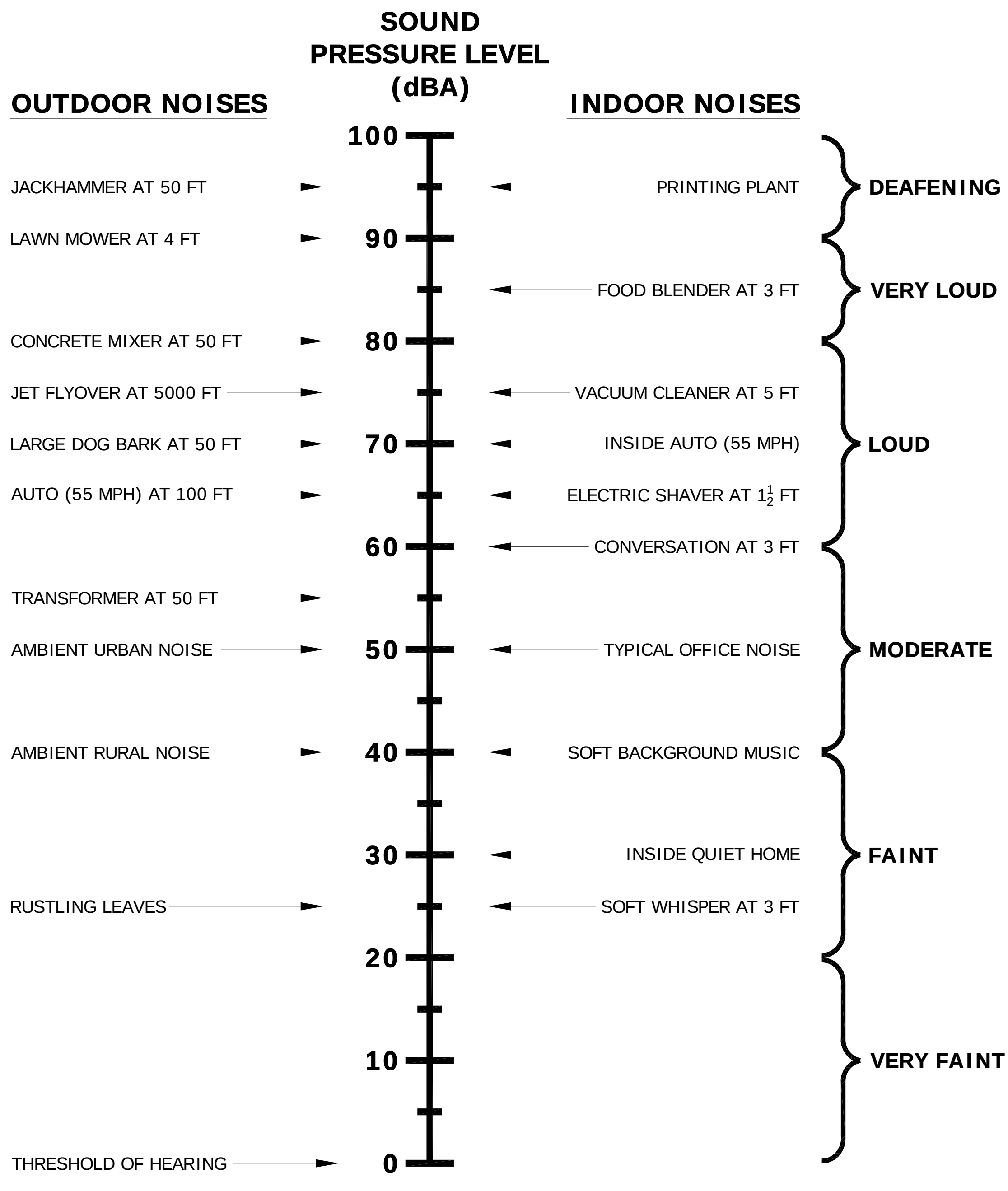

Figure A-1. Common Outdoor/Indoor Sound Levels

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

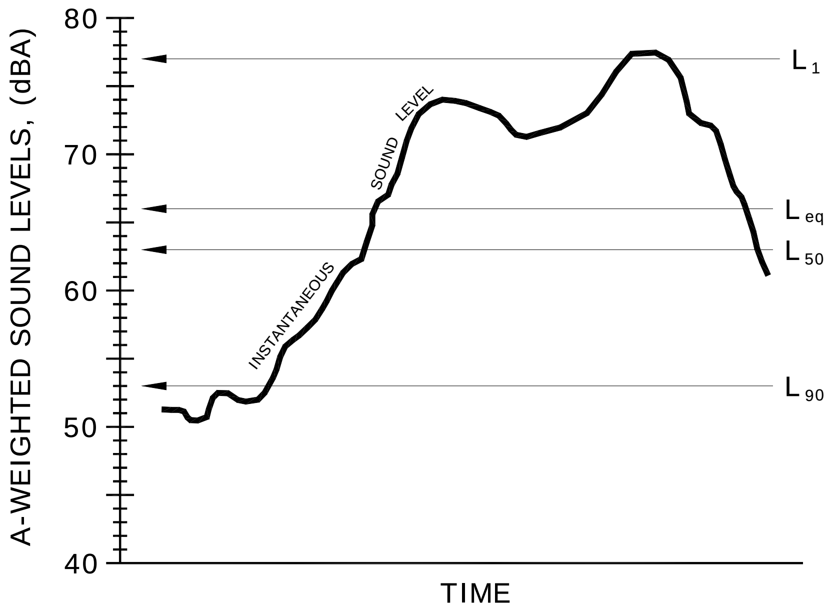

Figure A-2. Example Graph of Equivalent and Statistical Sound Levels

Statistical Sound Level

The sound levels of long-term noise producing activities such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels has been developed. It is known as the Exceedence Level, L_n. The L_n represents the sound level that is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration of the measurement period, the sound level exceeded 60 dBA 10% of the time. Typically, in noise regulations and standards, the specified time period is one hour. Commonly used Exceedence Levels include L_{01}, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

Day-Night Equivalent Sound Level

The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 p.m. and 7 a.m. to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations.

APPENDIX B

Photographs at Project Site

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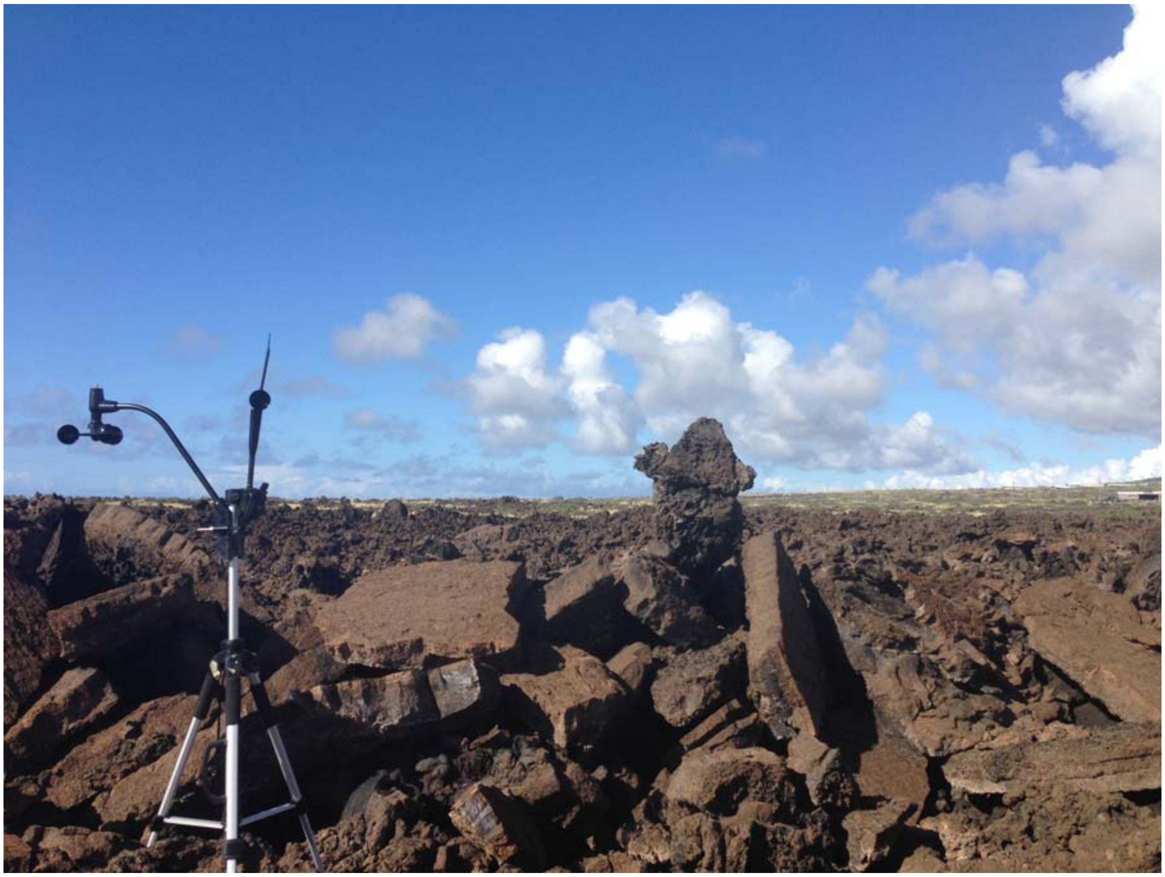
Location A

Microphone, anemometer, and weather statin mounted approximately 5' above grade. Equipment was located near the Hale Ho'okipa Visitors Center, approximately 800 feet west of Queen Ka'ahumanu Highway.

The building in the photographs is the Hale Ho'okipa Visitors Center.



Location B

Microphone and anemometer mounted on tripods approximately 5' above grade. Equipment was located near the Ala Hu'e Hu'e trail, approximately 2000 feet west of Queen Ka'ahumanu Highway.

Location C

Microphone and anemometer mounted approximately 5’ above grade. Equipment was located near the Na Leo Kahiko Cultural Center, approximately 500 feet east of the shoreline.

The building in the photograph is the Na Leo Kahiko Cultural Center.

Location D

Short term measurement location, approximately 80 feet east of the centerline of Queen Ka’ahumanu Highway.

Appendix C: Summary of Traffic Noise Model Speed and Traffic Volume Data[1]

Road	Segment	Speed (mph) [2]	Existing (20114)		Future (2035) No Build		Future (2035) Build	
			AM	PM	AM	PM	AM	PM
Queen Ka'ahumanu Highway	Kealakehe Pkwy to Honokohau St	45	1883	2444	2788	4663	2826	4643
	Honokohau St to Kaloko-Honokohau NHP Access Rd		1902	2428	2833	4465	2771	4445
	Kaloko-Honokohau NHP Access Rd to Allied Quarry Rd		1912	2416	3117	4246	3136	4236
	Allied Quarry Rd to Hina Lani St		1823	2351				

<u>Notes:</u>

1. The traffic volumes shown in the table were calculated based on data provided by the Traffic Consultant [Reference 6]. The values represent the peak hour traffic volume for existing and future conditions. The forecasted volumes for the future (2035) are based on projected regional growth in the area and will remain the same regardless of the highway improvements.
2. Posted speed is currently 45 mph, however, the average operating speed from the Traffic Consultant's field data was, on average, 36 mph. Projected speed limits for the future conditions are, on average, 15 mph and 31 mph for the no build and build conditions, respectively. Per FHWA guidance, the posted speed was used in the TNM model since the actual operating speed is not project to be higher.