Appendix C

Noise Impact Assessment

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Consultants in Acoustics and Performing Arts Technologies

Project No. 03-45

ENVIRONMENTAL NOISE REPORT
KAIPAPAU STREAM BRIDGE REPLACEMENT
KAMEHAMEHA HIGHWAY
O'AHU, HAWAII

April 2004

Prepared for
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Honolulu, Hawaii

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CONTENTS

1.0 EXECUTIVE SUMMARY

1.1 The Kaipapau Stream Bridge Replacement project is proposed to replace the existing bridge structure with a new bridge. The new bridge will keep the same number of vehicle lanes but will be much wider to accommodate pedestrian and bicycle traffic paths on both sides of the new bridge.

1.2 At a distance of 15 feet from the edge-of-pavement of Kamehameha Highway, the existing noise levels range from approximately 70 dBA during the daytime hours to approximately 60 dBA during the night. Any residence within 60 feet of the Kamehameha Highway currently exceeds the FHWA guidelines of 67 dBA (maximum) at the exterior of a residence. The dominant noise source is vehicular traffic on Kamehameha Highway, but other noises include wind, birds, and an occasional small aircraft flyover.

1.3 The dominant noise sources during project construction will probably be earth moving equipment, such as bulldozers and diesel powered trucks. Typical road construction equipment, such as asphalt paving machines will also be required. Pile driving equipment may be required for the new bridge foundation. Noise from construction activities will occur on the project site. Noise from construction activities should be short term and must comply with State Department of Health noise regulations.

1.4 Traffic on Kamehameha Highway is not expected to increase or decrease as a result of the bridge replacement project. Therefore, traffic noise as a result of the project is also not expected to increase or decrease after the work is complete. Future traffic projections show an approximate 16% increase the number of vehicles in the year 2026. This results in less than 1 dB increase in traffic noise over the existing noise levels. A 1 dB increase is not perceptible to most listeners.

2.0 PROJECT DESCRIPTION

The Kaipapau Stream Bridge is part of the Kamehameha Highway near the north shores of O'ahu, Hawaii. The project site is near single and multi-family residential housing. A map of the area is shown in Figure 1.

The bridge will be completed in stages, so that half of the bridge will be open at all times. When one side of the bridge is complete, the remaining side will be demolished and rebuilt. Although vehicular traffic on the Kamehameha Highway will be modified during construction of the new bridge, an alternate detour route is not planned. During construction only one lane of traffic may be open, so traffic on both sides of the bridge will have to stop and obey traffic signals. The speed of traffic through the construction site will be slower than the existing traffic speeds.

Typical road construction equipment will be on-site throughout the construction of the new bridge. The proposed bridge will be wider than the existing bridge and will carry a total of 2 vehicular traffic lanes and 2 bicycle/pedestrian paths.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State of Hawaii, Department of Health, Community Noise Control

The State of Hawaii Department of Health Community Noise Control Statute [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to stationary noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc., and equipment related to agricultural, construction, and industrial activities. These levels are enforced by the State Department of Health (DOH) for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 2. With respect to mixed zoning districts, the statute specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level.

3.2 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 2]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

3.3 U.S. Federal Highway Administration (FHWA)

The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, L_{eq}, for traffic noise exposure [Reference 3], which are listed in Table 1. For example, Category B, defined as picnic and recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards.

3.4 Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 4]. According to the policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Ambient noise level measurements were conducted from March 31, 2004 to April 5, 2004, at the locations shown on Figure 1 (see "1" and "2"). Both measurement locations are approximately 15 feet from the edge-of-pavement of Kamehameha Highway, which is the approximate distance of the nearest house to the highway. The purpose of these measurements was to assess the existing acoustical environment at the proposed project site. These measurements were taken with a Larson-Davis Laboratories, Model 820, Type-1 Sound Level Meter (S/N 0774) together with a Larson-Davis, Model 2560 Type-1 Microphone (S/N 2231).

The results are graphically presented in Figure 3, which shows the measured equivalent sound levels, L_{eq}, in A-weighted decibels (dBA). The graph shows that the sound levels range from approximately 70 dBA during the daytime hours to approximately 60 dBA during the night. Therefore, the existing daytime noise levels at 15 feet from the edge of the highway exceed the FHWA guidelines of 67 dBA (maximum) at the exterior of the nearest residences. Our noise predictions indicate that any residence within 60 feet of the edge of Kamehameha Highway currently exceeds the FHWA guidelines.

Weather conditions can adversely affect noise measurements. Periods of rain and high winds are typical factors that can skew the noise measurement results. Printouts of the weather conditions reported from the Kaneohe Bay MCBH are available upon request, or can be downloaded from the www.wunderground.com website. The Kaneohe Bay MCBH is approximately 20 miles south east of the project site. The weather conditions show periods of light rain in the morning hours of April 2nd and April 3rd, and in the early morning hours of April 4th. These periods of potential rain are shown in "gray" on the graph in Figure 3.

Presently, traffic is the dominant noise source at the measurement locations. Other noise sources include wind, birds, and small aircrafts.

5.0 POTENTIAL NOISE IMPACT DUE TO THE PROJECT AND NOISE MITIGATION

5.1 Project Construction Noise

Development of project areas will involve excavation, grading, and construction of the new bridge. The various construction phases of the project may generate significant amounts of noise. The surrounding residential properties may be impacted by the project construction noise due to their proximity. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 4.

In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels. In the State of Hawaii, noise permits are required for construction projects. Specific permit restrictions for construction activities are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels . . . before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."

"No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels . . . before 9:00 a.m. and after 6:00 p.m. on Saturday."

"No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of pile drivers, hoe rams, jack hammers 25 lbs. or larger, high pressure sprayers, and chain saws may be restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday.

5.2 Project Generated Traffic Noise

Measured traffic noise levels along with traffic volume and vehicle mix counts obtained during the measurements were used to calibrate the FHWA's Traffic Noise Prediction Model [Reference 5]. Although the traffic patterns and flow will be altered during construction, the traffic counts will not change after construction of the bridge is complete. Therefore, the predicted noise levels after the project is complete are the same as the existing noise levels prior to construction.

The predicted traffic counts for the year 2026 show an approximate 16% increase over the traffic counts in 2003. Assuming the traffic mix remains the same a 16% increase in traffic will result in a noise increase of less than 1 dB. This increase is small and generally not perceptible to most listeners.

Since the existing traffic noise at the project site currently exceeds FHWA guidelines for residences within 60 feet of Kamehameha Highway, the traffic noise after the new bridge is complete will also likely exceed the FHWA guidelines. However, since the traffic noise will not increase after the new bridge is complete, the impact of the project on traffic noise is not considered significant.

5.4 On-Site Equipment

Noise from pumps, air handling units, compressors, condensing units, and other on-site equipment must be addressed during the design phase of the project. Noise at the property line from on-site equipment must be within the State's maximum permissible sound limits for daytime and nighttime hours according to the applicable zoning district class as determined by the primary land use designation. If on-site equipment exceeds this limit, mitigation in the form of barriers, enclosures, silencers, etc. should be included in the design. Noise permits will also be required if noise from on site equipment exceeds the State noise limits.

6.0 REFERENCES:

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

2. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.

3. *Department of Transportation, Federal Highway Administration Procedures for Abatement of Highway Traffic Noise,* Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.

4. *Noise Analysis and Abatement Policy,* Department of Transportation, Highways Division, State of Hawaii, June 1977.

5. *Federal Highway Administration's Traffic Noise Model,* FHWA-RD-77-108; U.S. Department of Transportation, December 1978

APPENDIX A

ACOUSTICAL TERMINOLOGY

Sound Pressure Level

Sound or noise consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. It is measured in terms of decibels (dB) using precision instruments known as sound level meters. Noise is defined as "unwanted" sound.

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

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

where P is the sound pressure fluctuation (above or below atmospheric pressure) and Pref is the reference pressure, 20 micropascals, which is approximately the lowest sound pressure that can be detected by the human ear. For example, if P is 20 micropascals, then SPL = 0 dB, or if P is 200 micropascals, then SPL = 20 dB. The relation between sound pressure in micropascals and sound pressure level in decibels (dB) is shown in Figure A-1.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound levels, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined 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 a sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 5 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

The human ear is more sensitive to sound in the frequency range of 250 Hertz (Hz) and higher, than in frequencies below 250 Hz. Due to this type of frequency response, a frequency weighting system, was developed to emulate the frequency response of the human ear. This system expresses sound levels in units of A-weighted decibels (dBA). A-weighted sound levels de-emphasizes the low frequency portion of the spectrum of a signal. The A-weighted level of a sound is a good measure of the loudness of that sound. Different sounds having the same A-weighted sound level are perceived as being about equally loud. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

Statistical Sound Levels

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 developed. It is known as the Exceedence Level, L_n. The Exceedence Level, L_n, represents the sound level which is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration at the measurement period, the sound level exceeded 60 dBA 10% of the time. Commonly used Exceedence Levels include L_1, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. Figure A-2 illustrates the relationship between selected statistical noise levels.

Equivalent Sound Level

The Equivalent Sound Level, L_{eq}, represents a constant level of sound having the same total acoustic energy as that contained in the actual time-varying sound being measured over a specific time period. L_{eq} is commonly used to describe community noise, traffic noise, and hearing damage potential. It has units of dBA and is illustrated 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 pm and 7 am 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. Qualitative descriptions, as well as local examples of L_{dn}, are shown in Figure A-3.

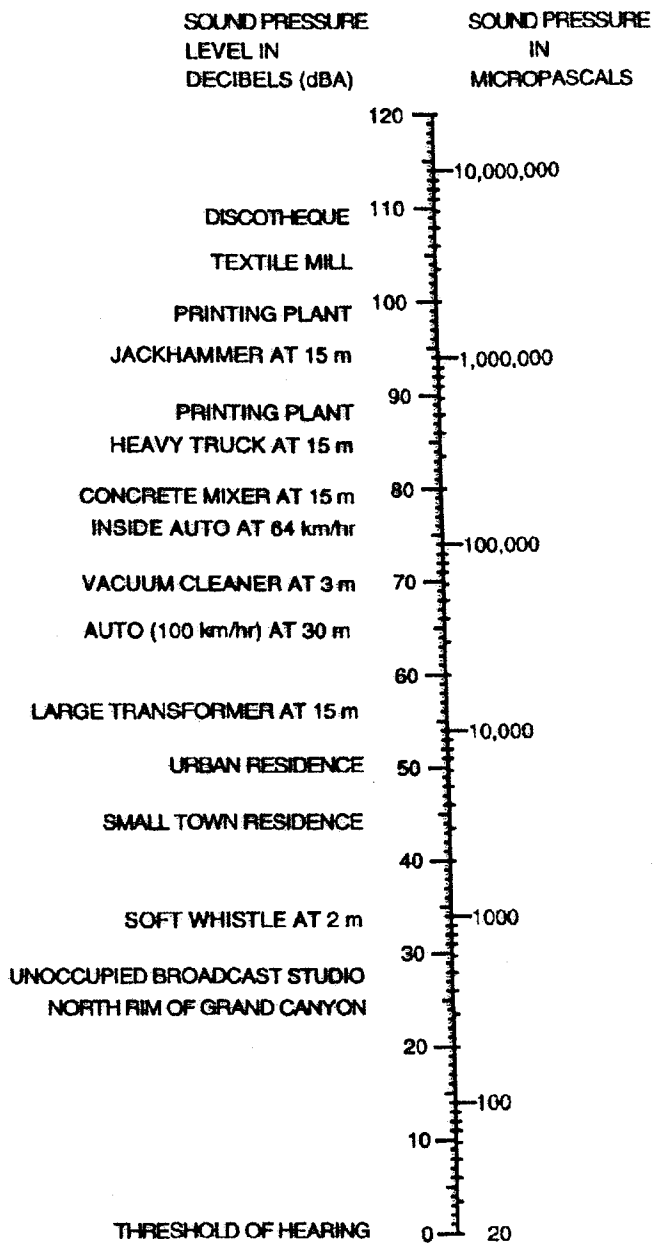

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FIGURE A-1 - THE RELATION BETWEEN SOUND PRESSURE, P, AND SOUND PRESSURE LEVEL, SPL. ALSO SHOWN ARE TYPICAL VALUES OF A-WEIGHTED SOUND LEVELS OF VARIOUS NOISE SOURCES.

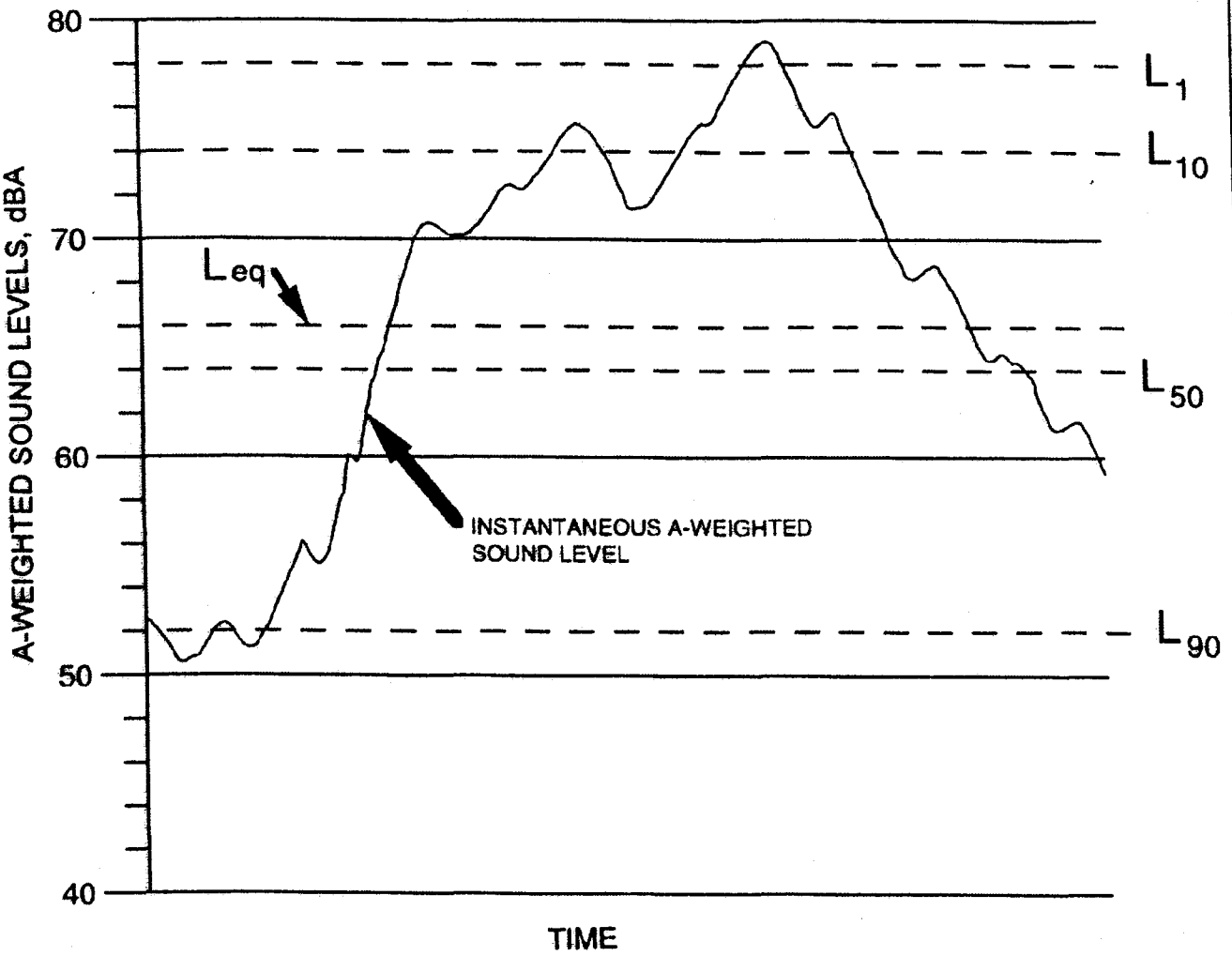

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FIGURE A-2 - COMPARISON OF AN INSTANTANEOUS SOUND LEVEL AND THE CORRESPONDING STATISTICAL SOUND LEVELS

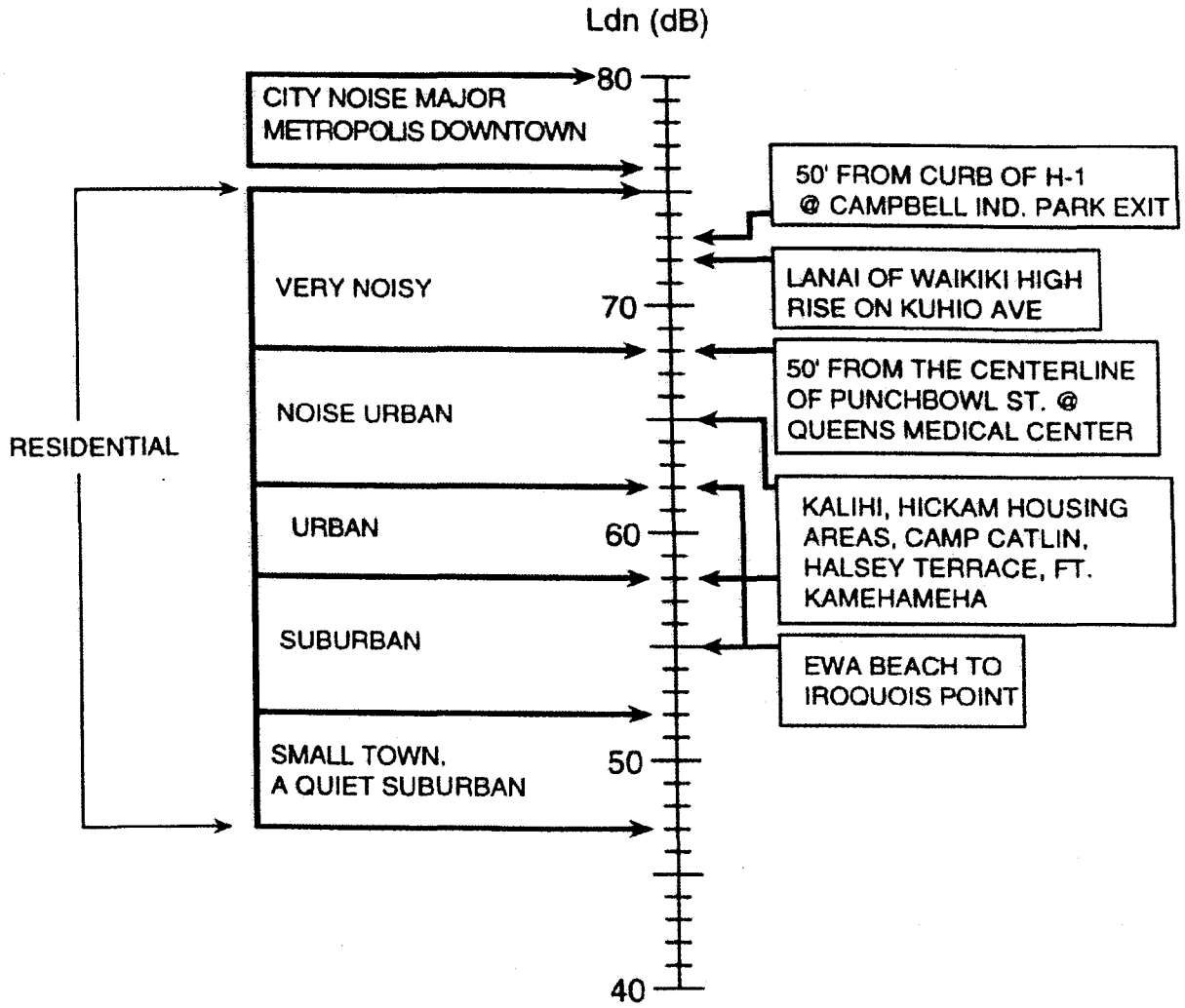

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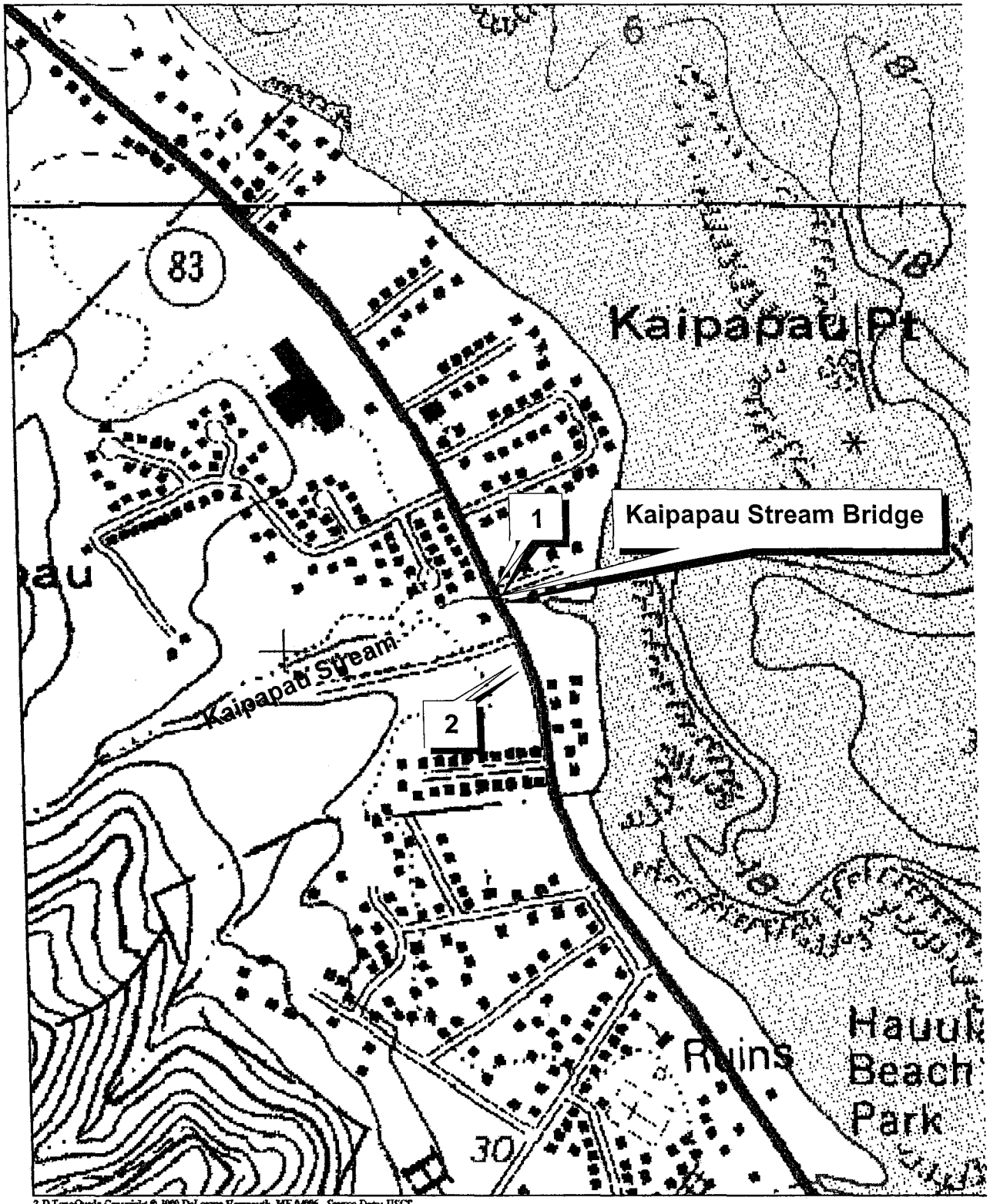
FIGURE A-3 - QUALITATIVE DESCRIPTION OF THE DAY-NIGHT EQUIVALENT SOUND LEVELS (Ldn) AND EXAMPLE Ldn's AT SELECTED LOCATIONS ON OAHU

TABLE 1
Federal Highways Administration Recommended Equivalent Hourly Sound Levels Based On Land Use [Reference 3]

Activity Category	$L_{eq(h)}$	Noise Reduction Exterior-to-Interior
A	57 (Exterior)	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.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	---	Undeveloped Land
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.



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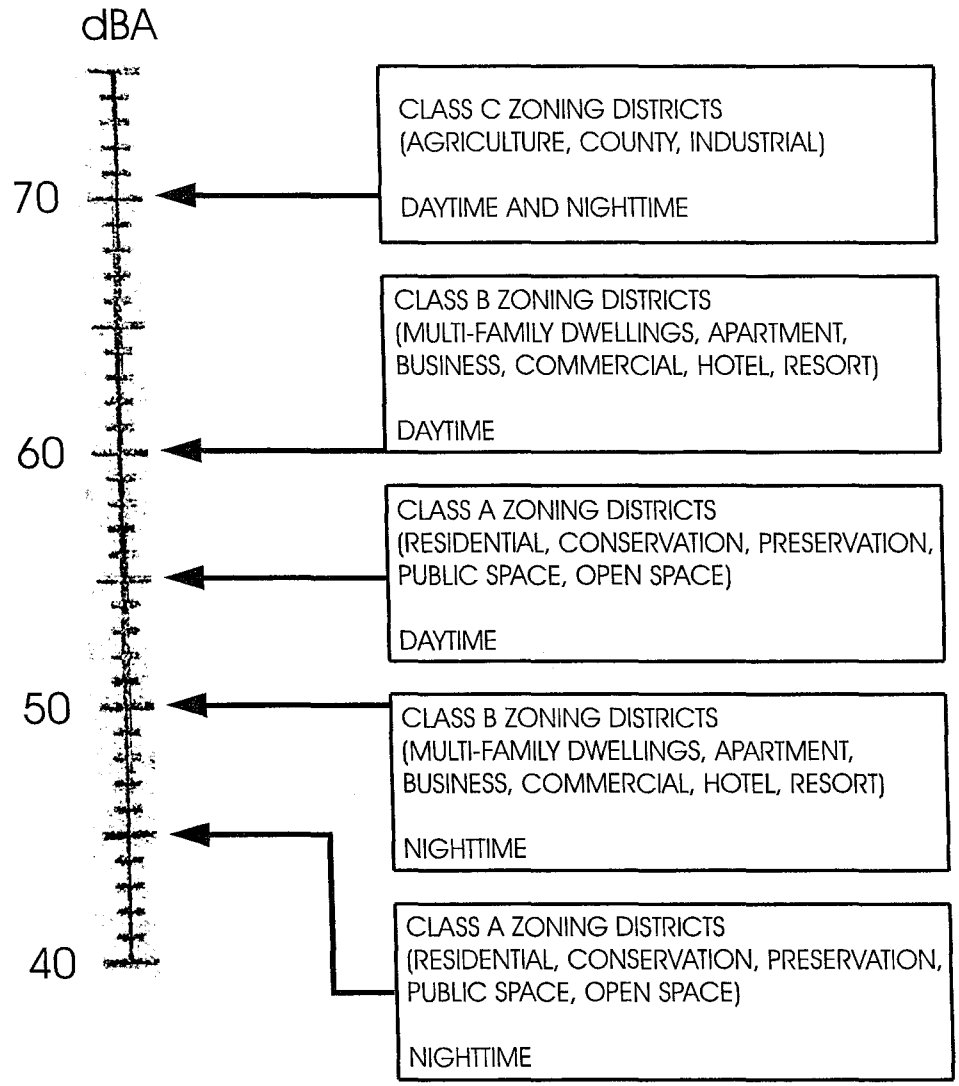
Map of Project Location		
Kaipapau Stream Bridge Replacement		Figure No. 1
not to scale		
Date April 6, 2004		Drawn By trb



NOTE: SOUND LEVELS INDICATED BY ZONING DISTRICT ARE THE "MAXIMUM PERMISSIBLE" SOUND LEVELS DUE TO EXCESSIVE NOISE SOURCES SUCH AS STATIONARY MECHANICAL EQUIPMENT AND EQUIPMENT RELATED TO AGRICULTURAL, CONSTRUCTION AND INDUSTRIAL ACTIVITIES THAT SHALL NOT BE EXCEEDED FOR MORE THAN 10% OF THE TIME WITHIN ANY 20-MINUTE PERIOD DURING THE TIME PERIOD SHOWN.

(DAYTIME: 7:00 A.M. TO 10:00 P.M., NIGHTTIME: 10:00 P.M. TO 7:00 A.M.)

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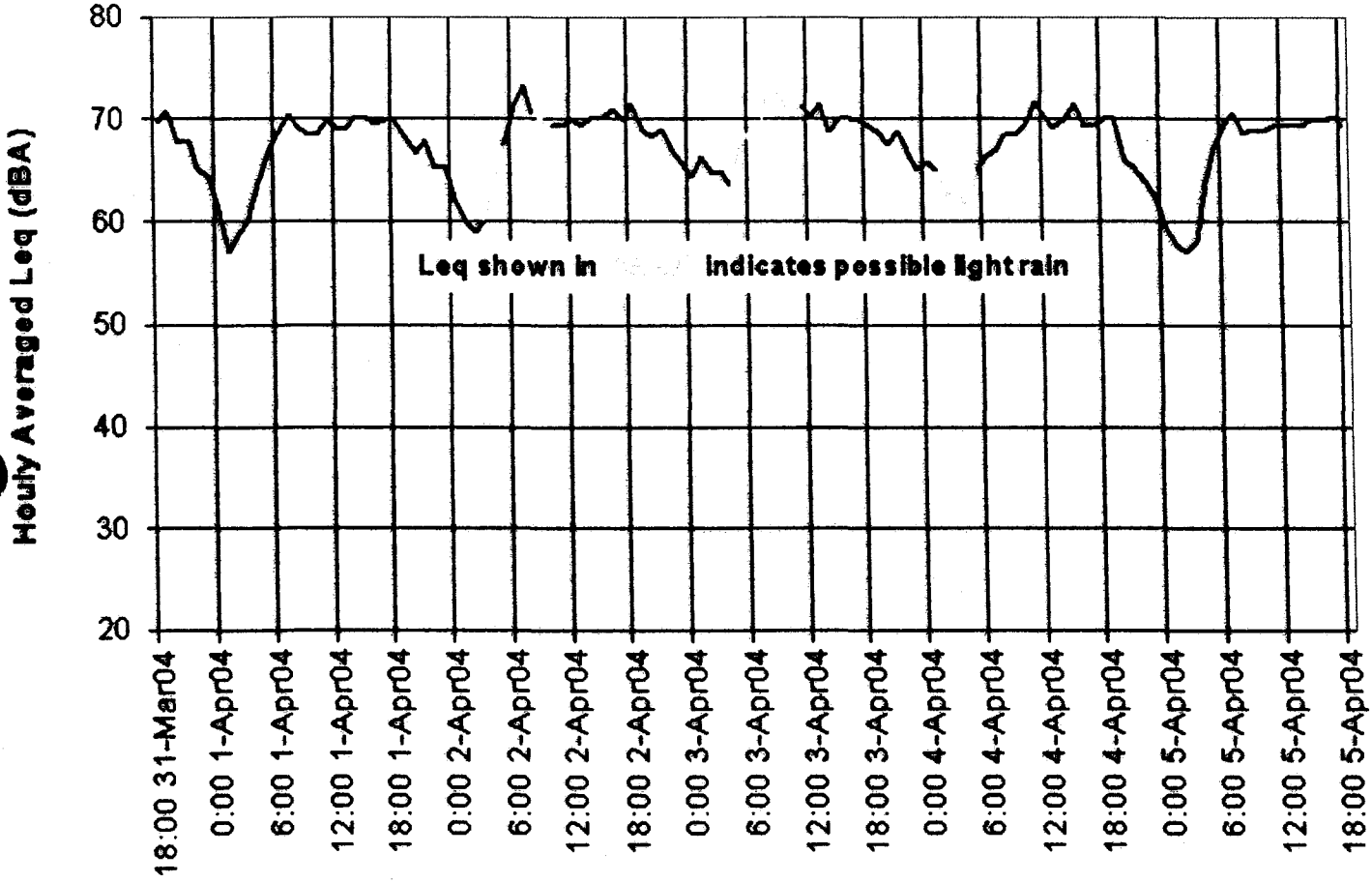
State of Hawaii Maximum Permissible Sound Levels for Various Zoning Districts			
Kaipapau Stream Bridge Replacement			Figure No. 2
not to scale			
Date April 6, 2004		Drawn By trb	



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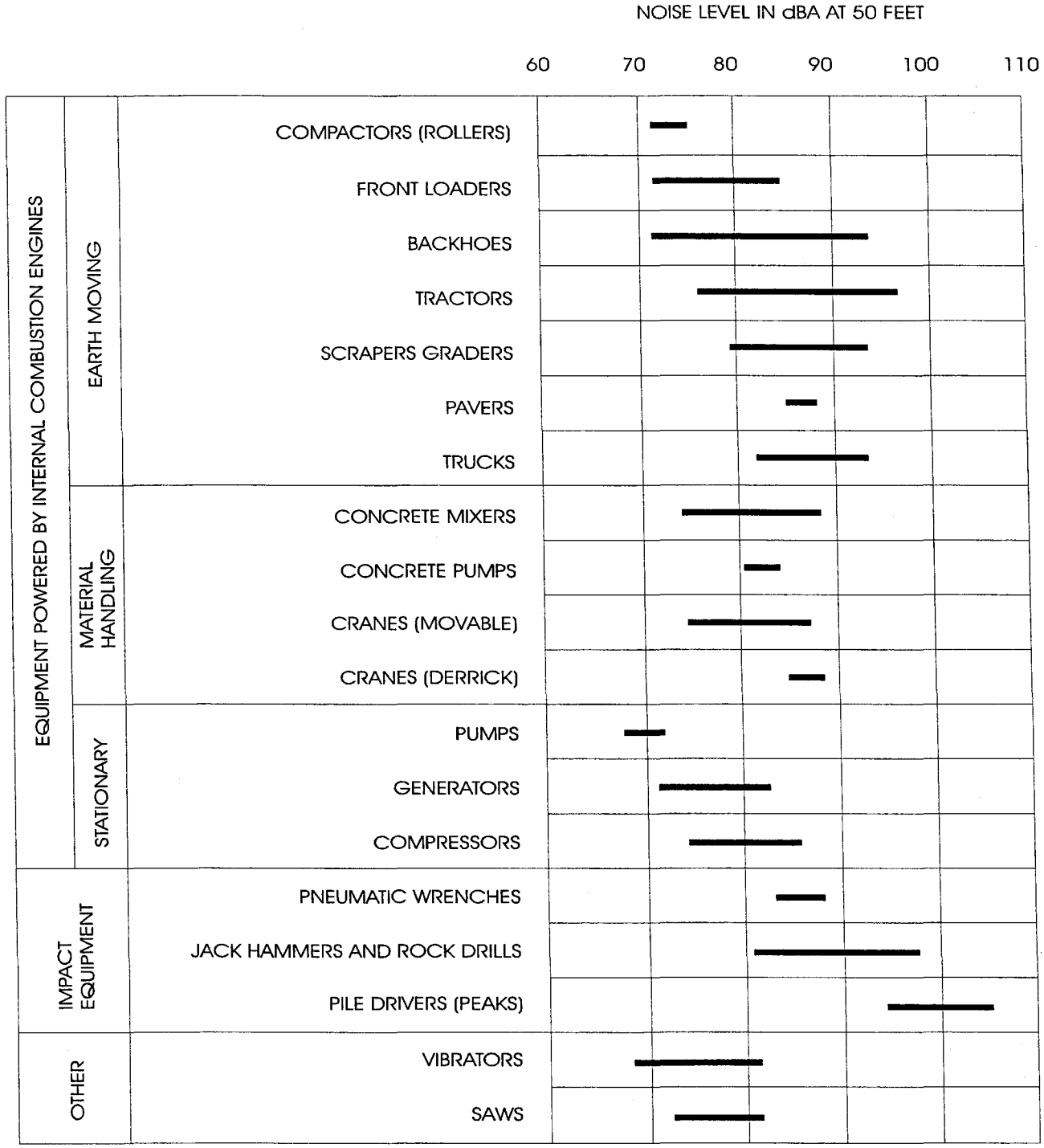
Measured Sound Levels			
Kaipapau Stream Bridge Replacement			Figure No. 3
no scale			
Date April 6, 2004		Drawn By trb	



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

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Typical Sound Levels from Construction Equipment			
Kaipapau Stream Bridge Replacement			Figure No. 4
no scale			
Date April 6, 2004		Drawn By trb	