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Appendix D
Draft Technical Report:
Environmental Baseline Noise Analysis

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SECTION 1

BACKGROUND INFORMATION ON NOISE

1.1 Introduction

This section presents background information on the characteristics of noise and summarizes the noise metrics and methodologies used to assess noise impacts. This section is divided into the following sub-sections:

- Characteristics of Sound - Presents properties of sound that are important for technically describing noise in the airport setting.
- Factors Influencing Human Response to Sound -Describes factors that influence what is audible to the human ear that can affect subjective perceptions and elicit a response.
- Health Effects of Noise - Sumarizes the potential disturbances and health effects of noise on humans.
- Sound Rating Scales - Presents various sound rating scales and how they are applied to assessing aircraft operations.
- Noise/Land Use Compatibility Guidelines - Summarizes current standards and regulations used to control the use of land in areas affected by aircraft noise.
- Airport Noise Assessment Methodolgy. Describes computer modeling and on site noise measurement surveys used to measure aircraft and other noise in the vicinity of airports.

1.2 Characteristics of Sound

Sound Level and Frequency. Sound is technically described in terms of the sound pressure (amplitude) and frequency (similar to pitch).

Sound pressure measures the magnitude of a sound without consideration for other factors that may influence its perception. The range of sound pressures that occur in the environment is so large that it is convenient to express them on a logarithmic scale. This scale compresses the wide range of sound pressures to a more usable range of numbers. The standard unit of measurement of sound pressure is the Decibel (dB). One decibel is actually an exponent to the reference point of 20 micro Pascals or about .000000003 pounds per square inch.

On the logarithmic scale, a sound level of 70 dB has 10 times as much acoustic energy as a level of 60 dB while a sound level of 80 has 100 times as much acoustic energy as 60 dB. (This differs from the human perception to noise.which typically judges a sound 10 dB higher than another to be twice as loud, 20 dB higher four times as loud, and so forth.)

The frequency of a sound is expressed as Hertz (Hz) or cycles per second. The normal audible frequency range for young adults is 20 Hz to 20,000 Hz. The human ear is not equally sensitive to all frequencies; some frequencies are judged to be louder for a given signal than others. As a result of this, various methods of frequency weighting have been developed. The most common weighting is the A-weighted decibel scale (dBA) which accounts for various frequencies in a manner approximating the sensitivity of the human ear. Most community noise analyses are based upon the A-weighted decibel scale, and everyday sounds normally range from 30 dBA (very quiet) to 100 dBA (very loud) as presented on **Exhibit 1-1, Typical Community Noise Levels (dBA).**

Exhibit 1-1
Typical Community Noise Levels (dBA)

(A-Scale Weighted Sound Levels)

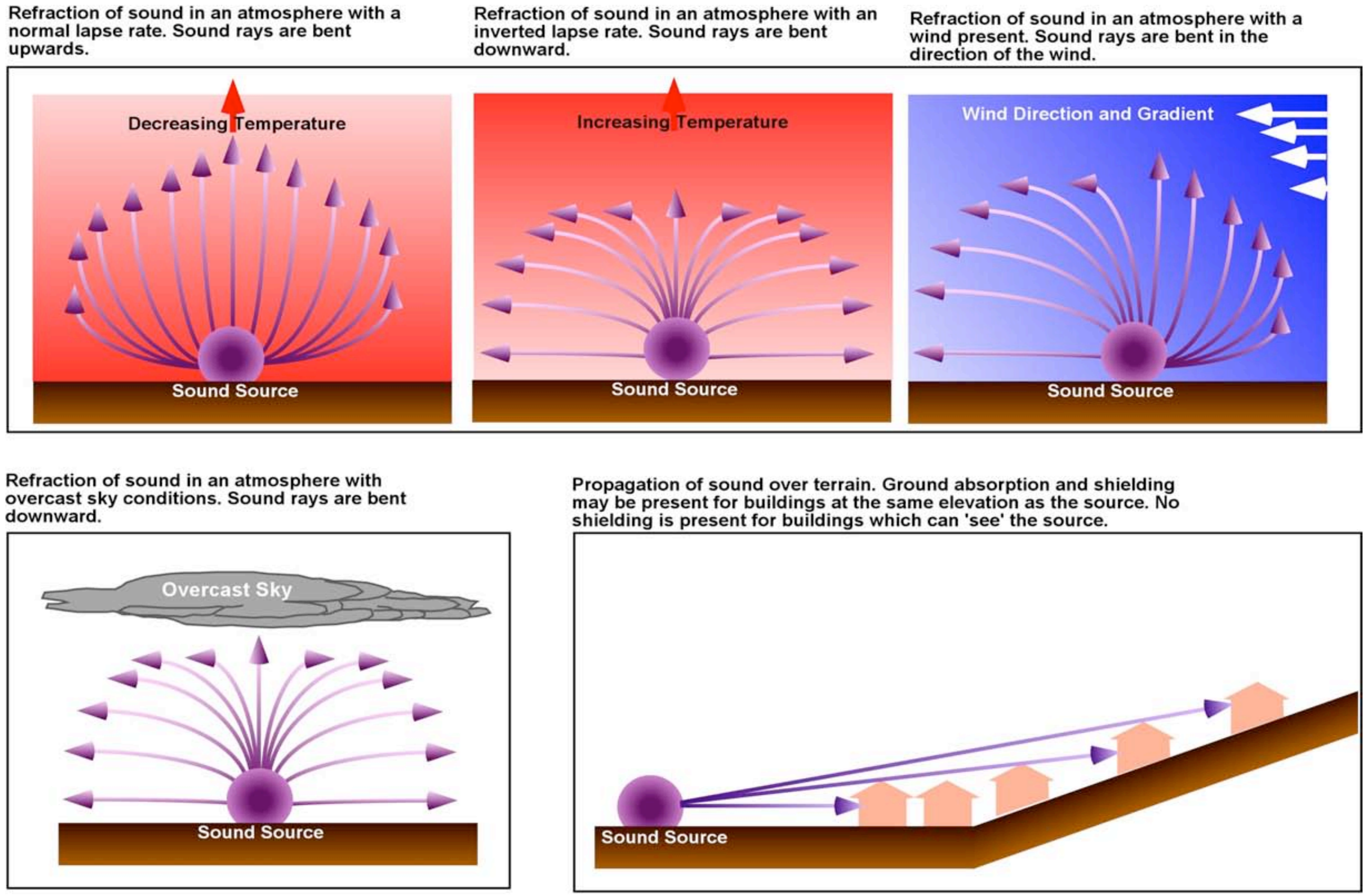
dB(A)	OVER-ALL LEVEL Sound Pressure Level Reference: 0.0002 Microbars	COMMUNITY (Outdoor)	HOME OR INDUSTRY	LOUDNESS Human Judgement of Different Sound Levels
130		Military Jet Aircraft Take-Off With After-burner From Aircraft Carrier @ 50 Ft. (130)	Oxygen Torch (121)	120 dB(A) 32 Times as Loud
120 110	UNCOMFORTABLY LOUD	Turbo-Fan Aircraft @ Take Off Power @200 Ft. (110)	Riveting Machine (110) Rock-N-Roll Band (108-114)	110 dB(A) 16 Times as Loud
100		Jet Flyover @ 1000 Ft. (103) Boeing 707. DC-8 @ 6080 Ft. Before Landing (106) Bell J-2A Helicopter @ 100 Ft. (100)		100 dB(A) 8 Times as Loud
90	VERY LOUD	Power Mower (96) Boeing 737, DC-9 @ 6080 Ft. Before Landing (97) Motorcycle @25 Ft. (90)	Newspaper Press (97)	90 dB(A) 4 Times as Loud
80		Car Wash @ 20 Ft. (89) Prop. Airplane Flyover @ 1000 Ft. (88) Diesel Truck, 40 MPH @ 50 Ft. (84) Diesel Train, 45 MPH @ 100 Ft. (83)	Food Blender (88) Milling Machine (85) Garbage Disposal (80)	80 dB(A) 2 Times as Loud
70	MODERATELY LOUD	High Urban Ambient Sound (80) Passenger Car, 65 MPH @ 25 Ft. (77) Freeway @ 50 Ft. From Pavement Edge, 10:00 AM (76 + or- 6)	Living Room Music (76) TV-Audio, Vacuum Cleaner	70 dB(A)
60		Air Conditioning Unit @ 100 Ft. (60)	Cash Register @ 10 Ft. (65-70) Electric Typewriter @ 10 Ft. (64) Dishwasher (Rinse) @ 10 Ft. (60) Conversation (60)	60 dB(A) 1/2 as Loud
50	QUIET	Large Transformers @ 100 Ft. (50)		50 dB(A) 1/4 as Loud
40		Bird Calls (44) Lower Limit Urban Ambient Sound (40)		40 dB(A) 1/8 as Loud
20	JUST AUDIBLE	Desert at Night (dB[A] Scale Interrupted)		
10	THRESHOLD OF HEARING			

Source: Noise and Vibration Control, Leo L. Beranek, McGraw-Hill, 1971

Propagation of Noise. Outdoor sound levels decrease as a result of increasing distance from the source, due to wave divergence, atmospheric absorption and ground attenuation. If sound is radiated from a source in an even and undisturbed manner, the sound travels in spherical waves. As the sound wave travels away from the source, the sound energy is dispersed over a greater area dispersing the sound power of the wave. Spherical spreading of sound waves reduces the noise level at a rate of 6 dB per doubling of the distance.

Atmospheric absorption also influences the sound levels received by the observer. The greater the distance traveled, the greater the influence of the atmosphere and the resultant fluctuations. Atmospheric absorption becomes important at distances of greater than about 1,000 feet. The degree of absorption varies depending on the frequency of the sound, as well as the humidity and temperature of the air. For example, atmospheric absorption is lowest (i.e., sound carries farther) at high humidity and high temperatures. Absorption effects in the atmosphere vary with frequency. Higher frequencies are more readily absorbed than lower frequencies. Over large distances, lower frequencies become the dominant sound as the higher frequencies are attenuated. Turbulence and gradients of wind, temperature, and humidity also play a significant role in determining the degree of attenuation. Certain conditions, such as inversions, can channel or focus the sound waves resulting in higher noise levels than would result from simple spherical spreading. The effects of meteorological conditions on sound levels are illustrated in **Exhibit 1-2, The Effects of Weather on Sound Propagation**.

Exhibit 1-2
The Effects of Weather on Sound Propagation



Source: Adapted from Vancouver International Airport, Noise Management Report.

Duration of Sound. Duration of a noise event is an important factor in describing sound in a community setting. The longer the noise event, the more annoying it is. The duration of a sound starts when a sound rises above the background sound level and ends when it drops back below the background level.

This relationship between duration and noise level forms the basis of the equivalent energy principal of sound exposure. Reducing the acoustic energy of a sound by one-half results in a 3 dB reduction. Conversely, doubling the duration of the sound event increases the total energy of the event by 3 dB. This equivalent energy principal is based upon the premise that the potential for a noise to impact a person is dependent on the total acoustical energy content of the noise. Noise descriptors explained below (CNEL, LEQ and SEL) are all based upon the equal energy principle.

Change in Noise Levels. The concept of change in sound levels is related to the reaction of the human ear to sound. The human ear detects relative differences between sound levels better than absolute values of levels. Under controlled laboratory conditions, a human listening to a steady unwavering pure tone sound can barely detect a change of approximately one decibel for sound levels in the mid-frequency region. However, when ordinary noises are heard, a young healthy ear can only detect changes of two to three decibels. A five-decibel change is noticeable while a 10-decibel change is judged by the majority of people as a doubling of the loudness of the sound. Therefore it is typical in environmental noise studies to consider a 3 dB change as potentially discernible.

Ground Effects. As sound travels near the ground away from the source, interaction of the sound wave and the ground surface affects sound level. The amount of such ground attenuation depends on the structure and density of trees and plant material as well as the height of both the source and receiver and the frequency of the sound being absorbed. If the source and the receiver of the sound are both located below the average height of the intervening foliage, the ground covering will be most effective. If either the source or the receiver rises above the height of the ground covering, the attenuation becomes less effective. Homes located on a ridge, for example, where there is less ground absorption would experience higher noise levels than what would normally be expected at those distances. Water surface is a reflective surface and therefore absorbs less sound than ground or foliage.

1.3 Factors Influencing Human Response to Sound

Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. This includes not only physical characteristics of the sound but also secondary influences such as sociological and external factors. Molino, in the Handbook of Noise Control, describes human response to sound in terms of both acoustic and non-acoustic factors. These factors are summarized in **Table 1-1, Factors that Affect Individual Annoyance to Noise**.

Table 1-1
Factors that Affect Individual Annoyance to Noise

Primary Acoustic Factors
Sound Level
Frequency
Duration
Secondary Acoustic Factors
Spectral Complexity
Fluctuations in Sound Level
Fluctuations in Frequency
Rise-time of the Noise
Localization of Noise Source
Non-acoustic Factors
Physiology
Adaptation and Past Experience
How the Listener's Activity Affects Annoyance
Predictability of When a Noise will Occur
Is the Noise Necessary
Individual Differences and Personality

Source: C. Harris, 1979

Sound rating scales have been developed to account for how humans respond to sound and how sounds are perceived in the community. Many non-acoustic parameters affect individual response to noise. Background sound, an additional acoustic factor not specifically listed, is important in describing sound in rural settings. Some research on the effects of personal and situational variables on noise annoyance, identified a clear association of reported annoyance and fear of an accident. In particular, there is firm evidence that noise annoyance is associated with : (1) the fear of an aircraft crashing or of danger from nearby surface transportation; (2) the belief that aircraft noise could be prevented or reduced by designers, pilots or authorities related to airlines; and (3) an expressed sensitivity to noise generally. Thus, it is important to recognize that such non-acoustic factors as well as acoustic factors contribute to human response to noise.

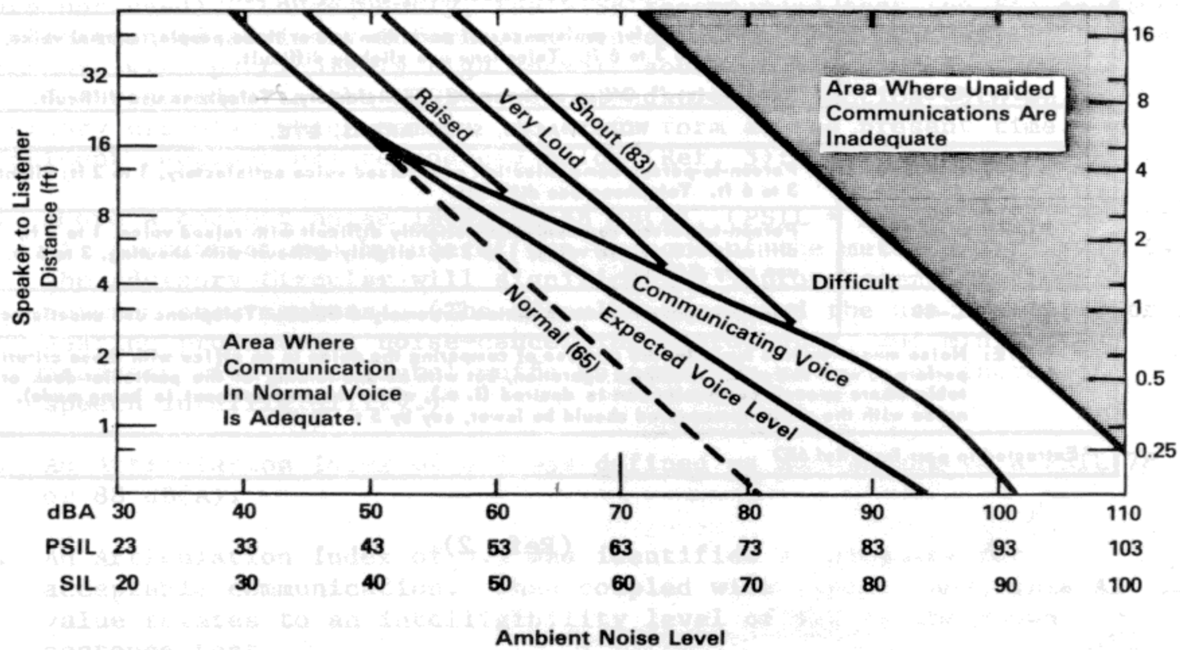
1.4 Health Effects of Noise

Noise, often described as unwanted sound, is known to have several adverse effects on people. From these effects, criteria have been established to help protect the public health and safety and prevent disruption of certain human activities. These criteria are based on effects of noise on people such as hearing loss (not a factor with typical community noise), communication interference, sleep interference, physiological responses and annoyance. Each of these potential noise impacts are briefly discussed below:

- *Hearing Loss* is generally not a concern in community noise problems, even close to a major airport or a freeway. The potential for noise induced hearing loss is more commonly associated with occupational noise exposures in heavy industry, very noisy work environments with long term exposure, or certain very loud recreational activities such as target shooting, motorcycle or car racing, etc. The Occupational Safety and Health Administration (OSHA) identifies a noise exposure limit of 90 dBA for 8 hours per day to protect from hearing loss (higher limits are allowed for shorter duration exposures). Noise levels in neighborhoods, even in very noisy neighborhoods, do not exceed this standard and are not sufficiently loud to cause hearing loss.

- *Communication Interference* is one of the primary concerns in environmental noise problems. Communication interference includes speech interference and interference with activities such as watching television. Normal conversational speech is in the range of 60 to 65 dBA and any noise in this range or louder may interfere with speech. There are specific methods for describing speech interference as a function of the distance between speaker and listener and voice level. **Exhibit 1-3 Speech Interference with Different Background Noise** shows the relationship between the quality of speech communication and various noise levels.

Exhibit 1-3
Speech Interference with Different Background Noise



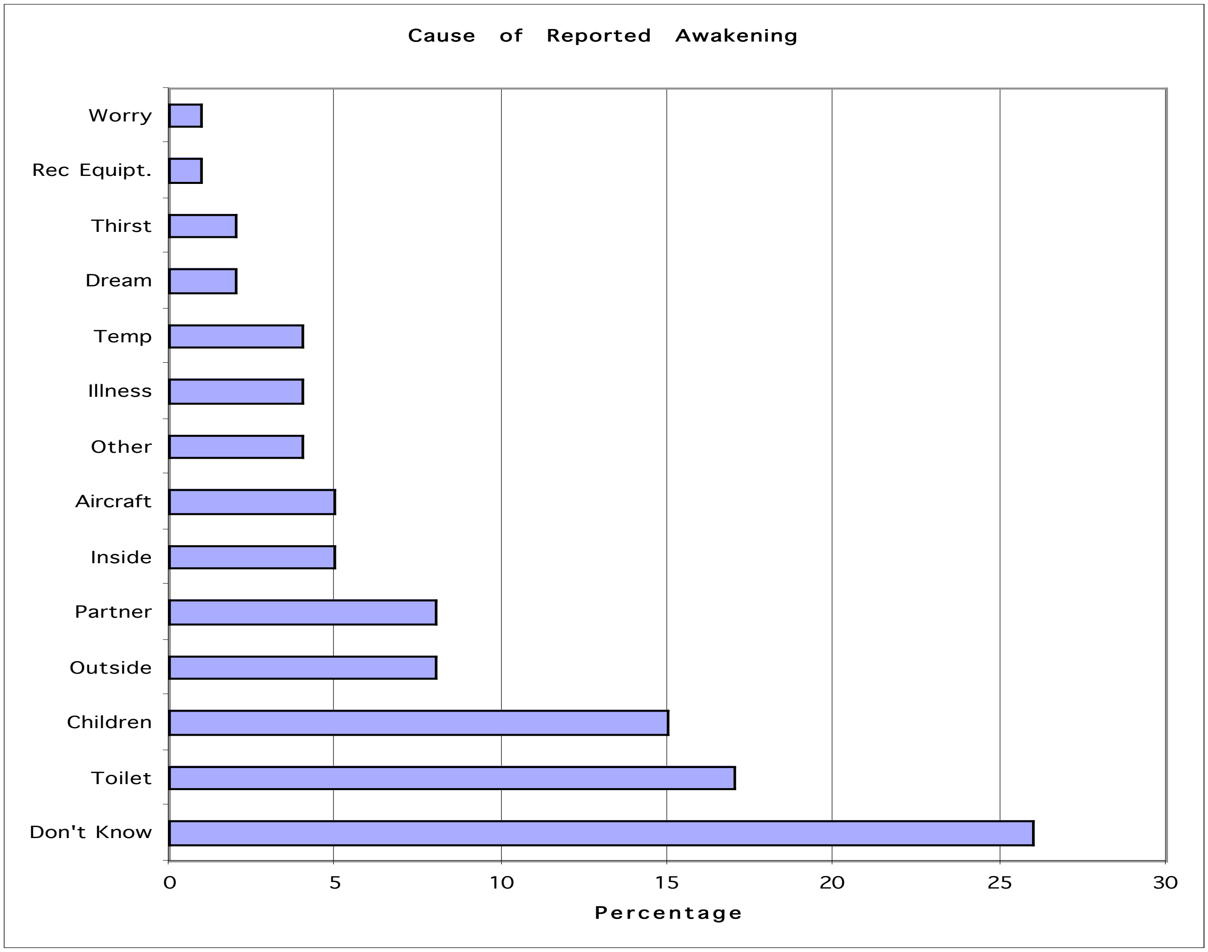
Permissible Distance Between a Speaker and Listeners for Specified Voice Levels and Ambient Noise Levels

(The Levels in Parantheses Refer to Voice Levels Measured One Meter From the Mouth.)

- *Sleep Interference,* particularly during nighttime hours, is a cause of annoyance due to community noise. Noise may make it difficult to fall asleep, create momentary disturbances of natural sleep patterns by causing shifts from deep to lighter stages and may cause awakenings.

  The latest research conducted in the 1990's shows that the probability for sleep disturbance is less than that reported in earlier research. Newer, more sophisticated *field* techniques indicate that awakenings can be expected at a much lower rate than had been expected based on earlier *laboratory* studies. The significant difference in the recent studies is the use of actual in-home sleep disturbance patterns as opposed to laboratory data that had been the historic basis for predicting sleep disturbance. This research showed that once a person was asleep, it is much more unlikely that they will be awakened by a noise. Some of this research has been criticized because it was conducted in areas where subjects had become habituated to aircraft noise. On the other hand, some of the earlier laboratory sleep studies had been criticized because of the extremely small sample sizes and because the laboratory was not necessarily a representative sleep environment. The more recent field studies assessed the effects of nighttime aircraft noise on sleep in 400 people (211 women and 189 men; 20-70 years of age; one per household) habitually living at eight sites adjacent to four U.K. airports, with different levels of night flying. The main finding was that only a minority of aircraft noise events affected sleep, and, for most subjects, that domestic and other non-aircraft factors had much greater effects. As shown in the **Exhibit 1-4, Causes and Prevalence of All Awakenings** aircraft noise was a minor contributor among a host of other factors causing awakening.

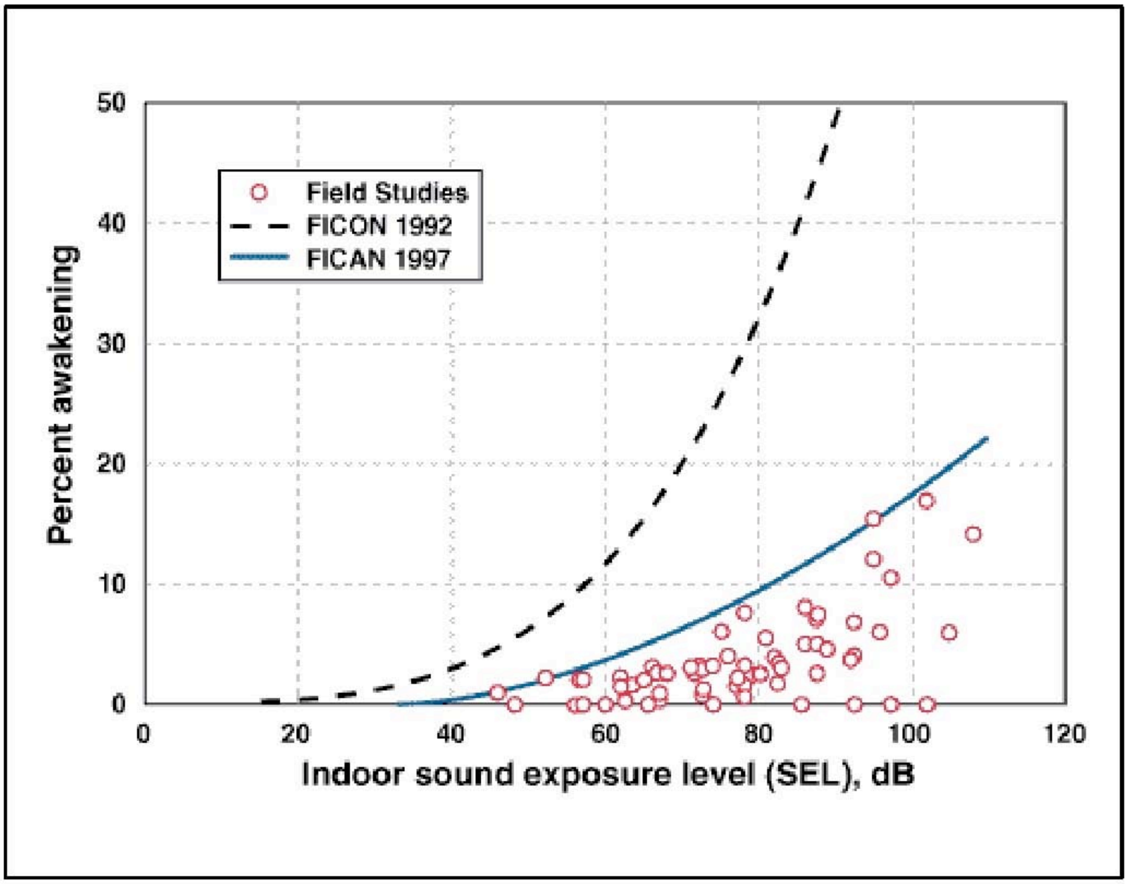
Exhibit 1-4
Causes and Prevalence of All Awakenings



(Total awakenings = 6,457. Each subject could have reported more than one awakening each night.)

In June of 1997, the Federal Interagency Committee on Aviation Noise (FICAN) updated its recommendation using an updated curve based on the more recent in-home sleep disturbance studies. The FICAN recommended a curve based on the upper limit of the data presented and therefore considers the curve to represent the "maximum percent of the exposed population expected to be behaviorally awakened," or the "maximum awakened." The FICAN recommendation is shown on **Exhibit 1-5, Sleep Disturbance Research.** This is a very conservative approach. (The full FICAN report can be found on the internet at www.fican.org.)

Exhibit 1-5
Sleep Disturbance Research



- *Physiological Responses* reflect measurable changes in pulse rate, blood pressure etc. Generally, physiological responses reflect a reaction to a loud short-term noise, such as a rifle shot or a very loud jet over flight. While such effects can be induced and observed, the extent to which these physiological responses cause harm is not known.

- *Annoyance* is the most difficult of all noise responses to describe. Annoyance is an individual characteristic and can vary widely from person to person. What one person considers tolerable may be unbearable to another of equal hearing capability. The level of annoyance also depends on the characteristics of the noise (i.e.; loudness, frequency, time, and duration), and how much activity interference (e.g. speech interference and sleep interference) results from the noise. However, the level of annoyance is also a function of the attitude of the receiver. Personal sensitivity to noise varies widely. It has been estimated that 2 to 10 percent of the population is highly susceptible to annoyance from noise not of their own making, while approximately 20 percent are unaffected by noise. Attitudes are affected by the relationship between the listener and the noise source. (Is it our dog barking or the neighbor's dog?) Whether we believe that someone is trying to abate the noise will also affect our level of annoyance.

1.5 Sound Rating Scales

The description, analysis, and reporting of community sound levels is made difficult by the complexity of human response to sound and the myriad of sound-rating scales and metrics that have been developed for describing acoustic effects. Various rating scales have been devised to approximate the human subjective assessment of "loudness" or "noisiness" of a sound.

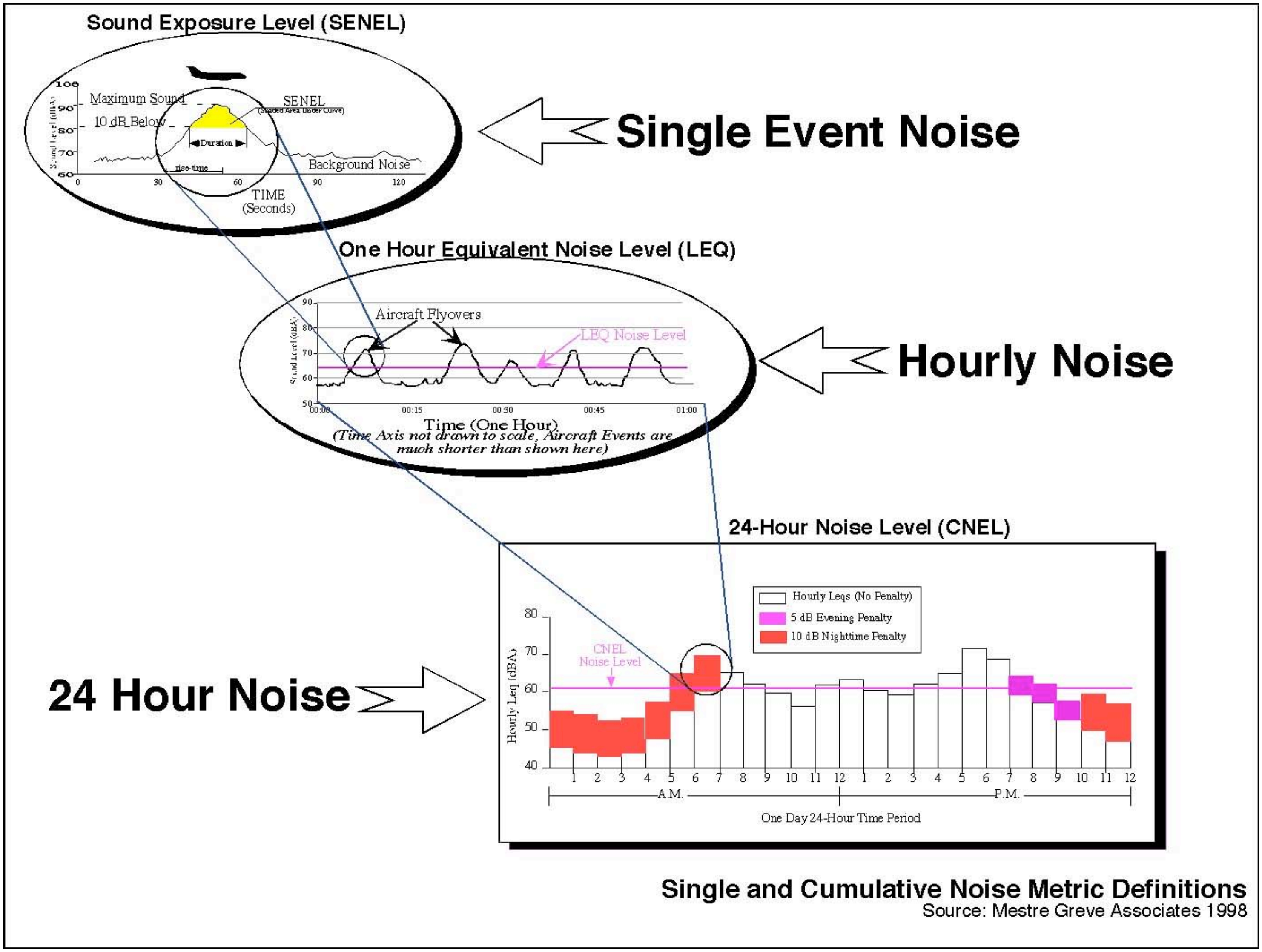
Noise metrics can be categorized as single event metrics and cumulative metrics. Single event metrics describe the noise from individual events, such as an aircraft flyover. Cumulative metrics describe the noise in terms of the total noise exposure throughout the day, year or other time period. The noise metrics used in this study are summarized below:

1.5.1 Single Event Metrics

- *Maximum Noise Level*. The highest noise level reached during a noise event is called the "Maximum Noise Level," or Lmax. For example, as an aircraft approaches, the sound of the aircraft begins to rise above ambient noise levels. The closer the aircraft gets, the louder it is until the aircraft is at its closest point directly overhead. As the aircraft passes, the noise level decreases until the sound level settles to ambient levels. This is plotted at the top of **Exhibit 1-6, Single and Cumulative Noise Metric Definitions**. It is this metric to which people generally respond when an aircraft flyover occurs.

- *Sound Exposure Level (SEL*). The SEL is another metric reported for aircraft flyovers. It is computed from dBA sound levels within 10 dB of the maximum noise level (referring to the shaded area at the top of **Exhibit 1-6**). The SEL value is the integration of all the acoustic energy contained within the event. Speech and sleep interference research can be assessed relative to SEL data. This metric takes into account the maximum noise level of the event and the duration of the event. For aircraft flyovers, the SEL value is typically about 10 dBA higher than the maximum noise level. Single event metrics are a convenient method for describing noise from individual aircraft events. This metric is useful in that airport noise models contain aircraft noise data based upon the SEL metric. In addition, cumulative noise metrics such as LEQ and CNEL can be computed from SEL data.

Exhibit 1-6
Single and Cumulative Noise Metric Definitions



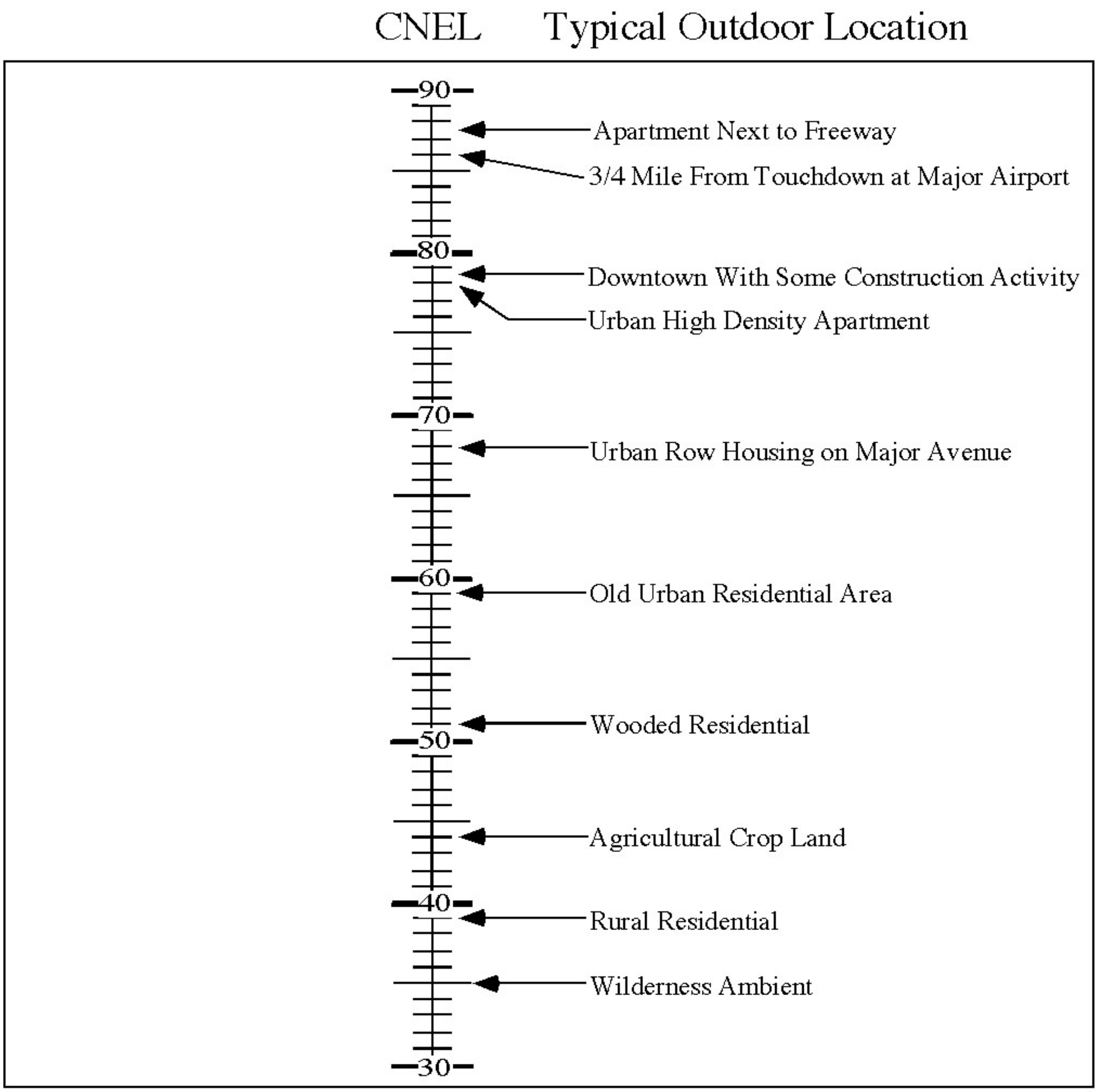
1.5.2 Cumulative Metrics

Cumulative noise metrics have been developed to assess community response to noise. They are useful because these scales attempt to include the loudness and duration of the noise, the total number of noise events and the time of day these events occur into one single number rating scale. They are designed to account for the known health effects of noise on people.

- *Equivalent Noise Level (LEQ)*. LEQ is the sound level corresponding to a steady-state A-weighted sound level containing the same total energy as a time-varying signal over a given sample period. LEQ is the "energy" average taken from the sum of all the sound that occurs during a certain time period; however, it is based on the observation that the potential for a noise to impact people is dependent from the total acoustical energy content. This is graphically illustrated in the middle graph of **Exhibit 1-6**. LEQ can be measured for any time period, but is typically measured for 15 minutes, 1 hour or 24-hours. LEQ for one hour is used to develop the *Community Noise Equivalent Level (CNEL)* values for aircraft operations.

- *Community Noise Equivalent Level (CNEL).* The CNEL index is a measure of the overall noise experienced during an entire (24-hour) day; which includes time-weighted energy average noise level based on the A-weighted decibel. Time-weighted refers to the fact that noise that occurs during certain sensitive time periods and is penalized for occurring at these times. In the CNEL scale, noise occurring between the hours of 10 p.m. to 7 a.m. is penalized by 10 dB and 5 dB during the hours of 7 p.m. and 10 p.m. This penalty was selected to account for the higher sensitivity to noise in the evening and nighttime hours and the expected further decrease in background noise levels that typically occur at night. CNEL is specified by the FAA for community and airport noise assessment as well as the Environmental Protection Agency (EPA). CNEL is graphically illustrated in the bottom of **Exhibit 1-6**. Examples of various noise environments in terms of CNEL are presented in **Exhibit 1-7, Typical Outdoors Noise Levels in CNEL**. The CNEL index is used in the state of California. The remaining 49 states use a similar Day-Night Noise Level (DNL) index that excludes the noise penalty between 7 p.m. and 10 p.m.

Exhibit 1-7
Typical Outdoor Noise Levels in Terms of CNEL



Examples of Typical Outdoor CNEL Levels
Source: Adapted from "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety", EPA, 1974

1.6 Noise/Land Use Compatibility Standards and Guidelines

Land use and development regulations often include compatibility standards for various levels of environmental noise. The most common noise/land use compatibility standard or criteria used is 65 dB DNL or CNEL for residential land use with outdoor activity areas. At 65 dB DNL the Schultz curve as shown on **Exhibit 1-8, Examples of Community Reaction to Aircraft Noise** predicts approximately 14% of the exposed population to be highly annoyed. At 60 dB DNL this decreases to approximately 8% of the population highly annoyed. However, there is some uncertainty with the "Schultz curve" and even a higher percentage of residents within these contours may experience annoyance in some cases.

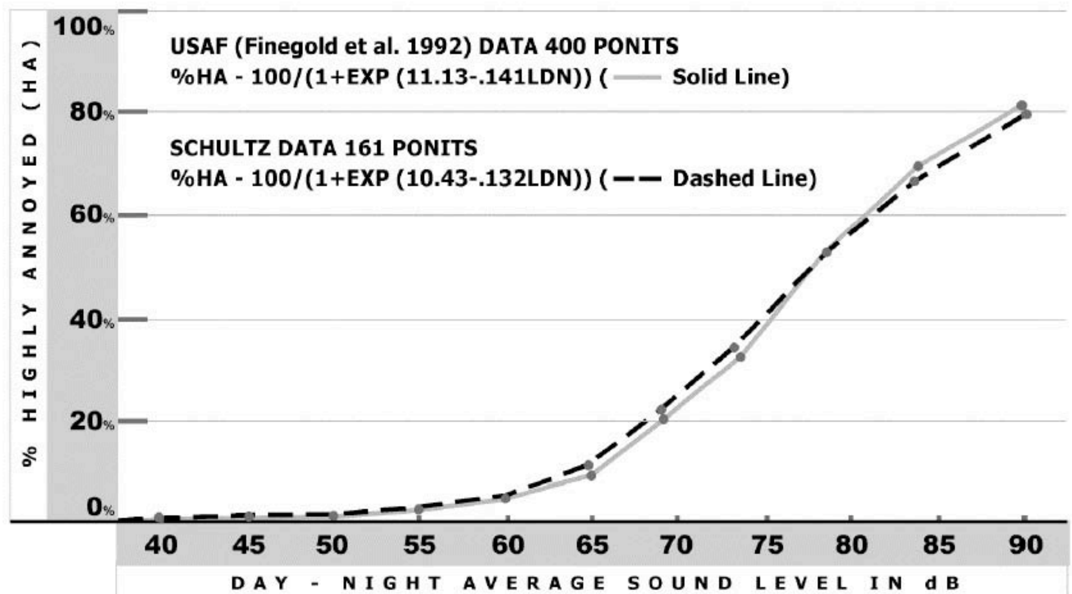
Several agencies have utilized such research on the human response to aircraft noise and developed standards and guidelines for land use within certain areas exposed to aircraft noise. Such community standards also account for trade offs with the economic consequences of achieving noise and land use compatibility criteria. These laws and regulations provide the basis for local development of airport plans, analyses of airport impacts, and the enactment of compatibility policies.

A summary of pertinent regulations and guidelines are presented below:

- *Federal Aviation Regulations, Part 36, "Noise Standards: Aircraft Type and Airworthiness Certification"*

  Originally adopted in 1960, FAR Part 36 prescribes noise standards for issuance of new aircraft type certificates; it also limited noise levels for certification of new types of propeller-driven, small airplanes as well as for transport category, large airplanes. Subsequent amendments extended the standards to certain newly produced aircraft of older type designs. Other amendments extended the required compliance dates. Aircraft may be certificated as Stage 1, Stage 2, or Stage 3 aircraft based on their noise level, weight, number of engines and in some cases number of passengers. Stage 1 aircraft are no longer permitted to operate in the U.S. Stage 2 aircraft were phased out of the U.S. fleet as discussed below under Airport Noise and Capacity Act of 1990. Although aircraft meeting Part 36 standards are noticeably quieter than many of the older aircraft, the regulations make no determination that such aircraft are acceptably quiet for operation at any given airport.

Exhibit 1-8
Example of Community Reaction to Aircraft Noise



USAF	0.40	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81.00

CALCULATED % HIGHLY ANNOYED (HA) POINTS

- *Federal Aviation Regulations, Part 150, "Airport Noise Compatibility Planning"*

  As a means of implementing the Aviation Safety and Noise Abatement Act, the FAA adopted Federal Aviation Regulations Part 150 Airport Noise Compatibility Planning Programs including a noise and land use compatibility chart to be used for land use planning with respect to aircraft noise. An expanded version of this chart appears in FAA Advisory Circular 150/5020-1 (dated August 5, 1983) and is reproduced in **Exhibit 1-9A, FAR Part 150 Noise Compatibility**. These guidelines offer recommendations to local authorities for determining acceptability and compatibility of land uses. The guidelines specify the maximum amount of noise exposure (in terms of the cumulative noise metric DNL or CNEL) that are considered acceptable or compatible to people in living and working areas.

  The State of California Department of Transportation Land Use Compatibility guidelines use noise exposure levels that reflect the use of CNEL. These guidelines are reproduced in **Exhibit 1-9B State of California Department of Transportation Land Use Compatibility with Yearly CNEL Average Sound levels**.

Exhibit 1-9A
FAR Part 150 Noise Compatibility

Land Use	Yearly day-night average sound level (Ldn) in decibels					
	Below 65	65-70	70-75	75-80	80-85	Over 85
RESIDENTIAL						
Residential, other than mobile homes and transient lodging	Y	N(1)	N(1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
PUBLIC USE						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
COMMERCIAL USE						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail--building materials, hardware and farm equipment	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade--general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables and water recreation	Y	Y	25	30	N	N

Numbers in parenthesis refer to notes.

*The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

Key to Table 1

SLUCM Standard Land Use Coding Manual.
Y (YES) Land Use and related structures compatible without restrictions.
N (No) Land Use and related structures are not compatible and should be prohibited.
NLR Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25, 30, or 35 Land use and related structures generally compatible; measures to achieve NLR of 25, 30 or 35 dB must be incorporated into design and construction of structure.

Notes for Table 1

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.
(2) Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.
(3) Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.
(4) Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.
(5) Land use compatible provided special sound reinforcement systems are installed.
(6) Residential buildings require an NLR of 25.
(7) Residential buildings require an NLR of 30.
(8) Residential buildings not permitted.

Source: FAR Part 150

Exhibit 1-9B
State of California Department of Transportation Land Use Compatibility with Yearly CNEL Average Sound Levels

LAND USE	YEARLY CNEL AVERAGE SOUND LEVEL					
	<60	**60-65**	**65-70**	**70-75**	**75-80**	**80-85**
Residential						
Low density residential, resorts, and hotels with extensive outdoor use	Y(a)	N(b)	N	N	N	N
Low density apartment with moderate outdoor use	Y	N(b)	N	N	N	N
High density apartment with limited outdoor use	Y	N(b)	N(b)	N	N	N
Transient lodgings with limited outdoor use	Y	N(b)	N(b)	N	N	N
Public Use						
Schools, day-care centers, libraries, and churches	Y	N(c)	N(c)	N(c)	N	N
Hospitals, nursing homes, clinics, and health facilities	Y	Y(d)	Y(d)	Y(d)	N	N
Indoor auditoriums and concert halls	Y(c)	Y(c)	N	N	N	N
Government service and office buildings serving the general public	Y	Y	Y(d)	Y(d)	N	N
Transportation and parking	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Commercial and Government Use						
Offices - government, business, and professional	Y	Y	Y(d)	Y(d)	N	N
Wholesale and retail - building materials, hardware and heavy equip.	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Airport businesses - car rental, tours, lei stands, ticket offices, etc.	Y	Y	Y(d)	Y(d)	N	N
Retail trade, restaurants, shopping centers, financial institutions, etc.	Y	Y	Y(d)	Y(d)	N	N
Power plants, sewage treatment plants, and base yards	Y	Y	Y(d)	Y(d)	Y(d)	N
Studios without outdoor sets, broadcasting, production facilities, etc.	Y(c)	Y(c)	N	N	N	N
Manufacturing, Production and Storage						
Manufacturing, general	Y	Y	Y(d)	Y(d)	Y(d)	N
Photographic and optical	Y	Y	Y(d)	Y(d)	N	N
Agriculture (except livestock) and forestry	Y	Y(e)	Y(e)	Y(e)	Y(e)	Y(e)
Livestock farming and breeding	Y	Y(e)	Y(e)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y(f)	Y(f)	N	N	N
Outdoor music shells, amphitheaters	Y(f)	N	N	N	N	N
Nature exhibits and zoos, neighborhood parks	Y	Y	Y	N	N	N
Amusements, beach parks, active playground, etc.	Y	Y	Y	Y	N	N
Public golf courses, riding stables, cemeteries, gardens, etc.	Y	Y	N	N	N	N
Professional/resort sport facilities, locations of media events, etc.	Y(f)	N	N	N	N	N
Extensive natural wildlife and recreation areas	Y(f)	N	N	N	N	N

Key to Exhibit 1-9B

Y (Yes) Land Use and related structures compatible without restrictions.
N (No) Land Use and related structures are not compatible and should be prohibited.

(a) A noise level of 60 CNEL does not eliminate all risks of adverse noise impacts from aircraft noise. However, the 60 CNEL planning level has been selected by the State Airports Division as an appropriate compromise between the minimal risk level of 55 CNEL and the significant risk level of 65 CNEL.
(b) Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 CNEL or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure plus air conditioning may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems.
(c) Because the CNEL noise descriptor system represents a 24-hour average of individual aircraft noise events, each of which can be unique in respect to amplitude, duration, and tonal content, the NLR requirements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based solely upon the exterior CNEL exposure level.
(d) Measures to achieve required NLR must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
(e) Residential buildings require NLR. Residential buildings should not be located where noise is greater than 65 CNEL.
(f) Impact of amplitude, duration, frequency, and tonal content of aircraft noise events should be evaluated.

This table has been adapted from the Federal Aviation Administration Land Use Compatibility Table, Advisory Circular 150/5020-1 (dated August 5, 1983). This table is for land use planning purposes only.

- *Federal Aviation Administration Order 5050.4 and Directive 1050.1 for Environmental Analysis of Aircraft Noise Around Airports*

  The FAA issued Order 5050.4A containing guidelines for the environmental analysis of airports. Federal requirements now dictate that increases in noise levels over 1.5 dB CNEL within the 65 dB CNEL contour are considered significant (1050.1D Directive 12.21.83) and require additional analysis. The FAA is primarily concerned with the noise impacts that occur at the 65 dB CNEL or greater.

- *Airport Noise and Capacity Act of 1990*

  The Airport Noise and Capacity Act of 1990 (PL 101-508, 104 Stat. 1388), also known as ANCA or the Noise Act, established two broad directives for the FAA: (1) establish a method to review aircraft noise, and airport use or access restriction, imposed by airport proprietors, and (2) institute a program to phase-out Stage 2 aircraft over 75,000 pounds by December 31, 1999. (Stage 2 aircraft are older, noisier aircraft (B-737-200, B-727 and DC-9); Stage 3 aircraft are newer, quieter aircraft (B-737-300, B-757, MD-80/90).) To implement ANCA, FAA amended Part 91 to address the phase-out of large Stage 2 aircraft and the phase-in of Stage 3 aircraft. In addition, Part 91 states that all Stage 2 aircraft over 75,000 pounds, were to be removed from the domestic fleet by December 31, 1999. There are a few exceptions but only Stage 3 aircraft greater than 75,000 pounds are now in the mainland domestic fleet. Hawaii is exempted from this rule and stage 2 operations are permitted in this state.

  FAR Part 161 was adopted to institute a more stringent review and approval process for implementing use or access restrictions by airport proprietors. Part 161 sets out the requirements and procedures for implementing new airport use and access restrictions by airport proprietors. They must use the CNEL metric to measure noise effects, and the Part 150 land use guideline table, including 65 dB CNEL as the threshold contour to determine compatibility, unless there is a locally adopted standard that is more stringent.

  Part 161 identifies three types of use restrictions and treats each one differently: negotiated restrictions, Stage 2 aircraft restrictions and Stage 3 aircraft restrictions. Generally speaking, any use restriction which affects the number or times of aircraft operations will be considered an access restriction. Even though the Part 91 phase-out does not apply to aircraft under 75,000 pounds, FAA has determined that Part 161 limitations on proprietors' authority also apply to smaller aircraft.

  Negotiated restrictions are more favorable from the FAA's standpoint, but still require complex procedures for approval and implementation. They must be agreed upon by all airlines, and public notice must be given.

Stage 2 restrictions are more difficult, as one of the major reasons for ANCA was to discourage local restrictions more stringent that the ANCA's 1999 phase-out. To comply with the regulation and institute a new Stage 2 restriction, the proprietor must prepare a cost/benefit analysis of the proposed restriction and give proper notice. The cost/benefit analysis is extensive and entails considerable evaluation. Stage 2 restrictions do not require approval by the FAA.

Stage 3 restrictions are especially difficult to implement. A Stage 3 restriction involves considerable additional analysis, justification, evaluation and economic discussion. In addition, a Stage 3 restriction must result in a decrease in noise exposure of the 65 dB CNEL to noise sensitive land uses (residences, schools, churches, parks). The regulation requires both public notice and FAA approval.

ANCA applies to all local noise restrictions that are proposed after October 1990, and to amendments to existing restrictions proposed after October 1990.

- *Federal Interagency Committee on Noise (FICON) Report of 1992*

The use of the CNEL or DNL metric and the 65 dB CNEL or DNL criteria has been criticized by various interest groups concerning its usefulness in assessing aircraft noise impacts. As a result, at the direction of the EPA and the FAA, the Federal Interagency Committee On Noise (FICON) was formed to review specific elements of the assessment on airport noise impacts and to recommend procedures for potential improvements. FICON included representatives from the Departments of Transportation, Defense, Justice, Veterans Affairs, Housing and Urban Development, the Environmental Protection Agency, and the Council on Environmental Quality.

The FICON review focused primarily on the manner in which noise impacts are determined including whether aircraft noise impacts are fundamentally different from other transportation noise impacts; how noise impacts are described; and whether impacts outside of CNEL or DNL 65 decibels (dB) should be reviewed in a National Environmental Policy Act (NEPA) document.

The committee determined there are no new descriptors or metrics of sufficient scientific standing to substitute for the present CNEL or DNL cumulative noise exposure metric. FICON determined that the CNEL or DNL method contains appropriate dose-response relationships to determine the noise impact and is properly used to assess noise impacts at both civil and military airports. The report does support agency discretion in the use of supplemental noise analysis, recommends public understanding of the CNEL or DNL and supplemental methodologies, as well as aircraft noise impacts.

FICON did, however, recommend that if screening analysis shows a 1.5 dB increase within a 65 CNEL or DNL or a 3.0 dB increase within a 60-65 CNEL or DNL, then additional analysis should be conducted.

- *Environmental Protection Agency Noise Assessment Guidelines*

  In March 1974 the EPA published "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety". (EPA 550/9-74-004). In this document, 55 DNL is described as the requisite level with an adequate margin of safety for areas with outdoor uses. This includes residences, and recreational areas. This document does not constitute EPA regulations or standards. Rather, it is intended to "provide State and Local governments as well as the Federal Government and the private sector with an informational point of departure for the purpose of decision-making". Note that these levels were developed for suburban uses. In some urban settings, the noise levels will be significantly above this level, while in some wilderness settings, the noise levels will be well below this level. While this "levels document" does not constitute a standard, specification or regulation, it does identify safe levels of environmental noise exposure without consideration for economic cost for achieving these levels.

1.7 Airport Noise Assessment Methodology

Existing and future aircraft noise environments for airports are typically determined through the use of a computer model. Once reliable computer generated contours are developed for existing conditions, the computer input files are altered to reflect future conditions based on forecasts of future operations and/or proposed noise abatement aircraft operational measures. New computer generated data and contours are then developed to assess those future conditions. The following sections provide the details on this process.

1.7.1 Computer Noise Modeling

Computer noise modeling generates maps or tabular data of an airport’s noise environment expressed in the various metrics described above such as CNEL or DNL. Computer models are most useful developing contours that depict, like elevation contours on a map, areas of equal noise exposure. Accurate noise contours are largely dependent on the use of a reliable, validated, and updated noise model, and collection of accurate aircraft operational data.

The FAA's Integrated Noise Model (INM) models civilian and military aviation operations. The original INM was released in 1977. The latest version, INM Version 6.2a, was released for use in May 2006 and is the state-of-the-art in airport noise modeling. The program includes standard aircraft noise and performance data for over 100 aircraft types that can be tailored to the characteristics of the airport in question. Version 6.2 includes an updated database that includes some newer aircraft, the ability to include run-ups and topography in the computations, and a provision to vary aircraft profiles in an automated fashion. It also includes more comprehensive and flexible contour plotting routines.

Operational data for input to the INM is gathered in a meticulous manner to assure its accuracy, and the data is arranged for input to the model. The INM program requires the input of the physical and operational characteristics of the airport. Physical characteristics include runway coordinates, airport altitude, and temperature and optionally, topographical data. Operational characteristics include aircraft types, flight tracks, departure procedures, arrival procedures and stage lengths (flight distance) that are specific to the operations at the airport. Aircraft data needed to generate noise contours include:

- Number of aircraft operations by type
- Types of aircraft
- Day/Night time distribution by type
- Flight tracks
- Flight track utilization by type
- Flight profiles
- Typical operational procedures
- Average Meteorological Conditions

SECTION 2

COMPUTER NOISE MODELING

As a part of a runway feasibility study performed by Mead & Hunt, the Sonoma County Board of Supervisors identified a potential a project to extend the runways at STS. The alternative selected, Alternative A-1, will accomplish the following runway configurations:

- Extend existing Runway 14-32 and associated parallel taxiway approximately 900 feet to the northwest to a total length of 6,000 feet.
- Extend existing Runway 01-19 approximately 500 feet to the north to a total length of 5,500 feet for takeoff and displace Runway 19 landing threshold 700 feet leaving 4,800 feet for landing.

Two noise modeling cases described in the following tables and exhibits refer to operational conditions for Year 2005 with existing runway configurations and forecast operations conditions for Year 2030 (see Chapter 2, Aviation Activity Forecast, Table 2-12) with Alternative A-1 runway conditions.

Computer noise modeling is used in this study to generate noise contours depicting CNEL values for the aircraft activity at STS. The FAA's Integrated Noise Model (INM) Version 6.2a was used for this purpose as described previously in the Background section. This section first provides the aircraft operational data and describes how it was compiled for input to the computer model and then provides the resulting contours.

The section is divided as follows:

- Aircraft Operations
- Flight Tracks
- Operational Conditions
- Noise Contours

2.1 Aircraft Operations

Annual operations for STS were compiled using data for the twelve-month period extending from January 2005 through December 2005. The STS Airport and FAA Tower Personnel provided the primary database for airport operations, which appears on **Table 2-1, Year 2005 Annual Operations by Aircraft Category**. **Table 2-2, Year 2030 Forecast Annual Operations by Aircraft Category**, was derived from Table 2-12 in Chapter 2, Aviation Activity Forecast.

There were no Air Carrier operations during calendar year 2005. Military flights were predominately performed by the U.S. Coast Guard helicopter and, less frequently, a C-130. General Aviation operations included frequent single-engine and twin-engine propeller aircraft training and itinerant flights, a variety of business jet flights, and daily law enforcement helicopter flights.

Table 2-1
Year 2005 Annual Operations by Aircraft Category

CATEGORY	ANNUAL OPERATIONS
Air Carrier	0
Air Taxi	4,836
General Aviation	111,174
Military	396
TOTAL	**116,406**

Table 2-2
Year 2030 Forecast Annual Operations by Aircraft Category

CATEGORY	ANNUAL OPERATIONS
Air Carrier	6,161
Commuter	3,570
Air Taxi	7,959
General Aviation	166,217
Military	496
TOTAL	**184,403**

A composite of all operations by aircraft type, arrival/departure, and day/night is provided on **Table 2-3 and Table 2-4.**

Table 2-3
Year 2005 Annual Operations by Aircraft Type and Time of Day*

INM Aircraft Name	Total Operations	Day	Evening	Night
General Aviation				
Single-engine, Fixed	45,272	40,744	3,395	1,132
Single-engine, Variable	30,364	27,327	2,277	759
Twin-engine, Piston	16,564	14,908	1,242	414
Twin-engine, Turboprop	3,768	3,392	283	94
Piaggio – Twin-engine prop	1,295	1,165	97	32
Business Jets				
Beech 400	3,698	3,328	277	92
Gulfstream III	211	190	16	5
Gulfstream IV	105	95	8	3
Gulfstream V	105	95	8	3
Falcon 50	105	95	8	3
Falcon 900	211	190	16	5
Hawker H25	421	379	32	11
Cessna 550	3,698	3,328	277	92
Cessna 650	740	666	55	18
Cessna 750	1,479	1,331	111	37
Challenger 600	158	142	12	4
Lear 45	211	190	16	5
Lear 60	211	190	16	5
Helicopters				
B206L	3,698	3,328	277	92
A109	3,698	3,328	277	92
Military				
A109 – Helicopter	396	356	30	10
TOTAL	**116,406**	**104,765**	**8,730**	**2,910**

* Numbers are rounded to reflect full operations.

Table 2-4
Year 2030 Forecast Annual Operations by Aircraft Type and Time of Day*

INM Aircraft Name	Total Operations	Day	Evening	Night
General Aviation				
Single-engine, Fixed	60,690	54,621	4,552	1,517
Single-engine, Variable	39,492	35,543	2,962	987
Twin-engine, Piston	22,350	20,115	1,676	559
Twin-engine, Turboprop	5,455	4,909	409	136
Piaggio – Twin-engine prop	2,816	2,534	211	70
Business Jets				
Beech 400	8,045	7,240	603	201
Gulfstream III	229	206	17	6
Gulfstream IV	229	206	17	6
Gulfstream V	229	206	17	6
Falcon 50	229	206	17	6
Falcon 900	458	413	34	11
Hawker H25	917	825	69	23
Cessna 550	6,033	5,430	453	151
Cessna 650	1,609	1,448	121	40
Cessna 750	3,218	2,896	241	80
Challenger 600	344	309	26	9
Lear 45	458	413	34	11
Lear 60	458	413	34	11
Very Light Jet (VLJ)	12,067	10,860	905	302
Helicopters				
B206L	4,425	3,982	332	111
A109	4,425	3,982	332	111
Military				
A109	496	446	37	12
Commercial				
Boeing 737-700	1,475	1,328	111	37
EMB-170 – Regional Jet (RJ)	1,075	968	81	27
EMB-190 – RJ	1,361	1,225	102	34
CRJ-700 – RJ	1,075	968	81	27
CRJ-900 – RJ	1,175	1,058	88	29
Q-400 – Twin-engine prop	3,570	3,213	268	89
Total	**184,403**	**165,963**	**13,830**	**4,610**

* Numbers are rounded to reflect full operations.

2.2 Flight Tracks

Typical arrival and departure tracks were determined by consulting the STS FAA Tower personnel and reviewing flight tracks produced for the **Airport Comprehensive Land Use Plan for Sonoma County** and the **Sonoma County Airport – Airport Layout Plan Narrative Report and Technical Study**. The INM flight tracks depicted on **Exhibits 2-1** through **Exhibits 2-6** represent general flight tracks within the area that affects the noise contours. There may be turns that occur beyond the noise contours that have not been represented in this study because they do not affect the contours.

Runway 1 is in use approximately 5% of the time. Because the prevailing winds are from the south/southeast, a relatively low number of operations occur on Runway 1. Aircraft arriving on Runway 1 generally establish final approach several miles southwest from the airport.

Runway 19 is in use approximately 23% of the time. When departing to the south, the aircraft continue to fly runway heading. Flights to the southeast make a left turn of approximately 60° after departure. Aircraft arriving on Runway 19 establish final approach approximately 1 to 1.5 miles from the runway. Runway 32 is in use approximately 14% of the time.

Runway 14 is the primary runway and it is in use approximately 51% of the time. Flights to the southeast may continue to fly runway heading or make a left turn after departure. Flights from the northwest establish final approach several miles from the runway. Aircraft arriving from the southeast approach the airport at a 45° angle, make a left base-leg turn and establish final approach approximately 1 mile from the runway. Aircraft arriving from the south approach at a 45° angle, make a right base-leg turn, and establish final approach approximately 1 mile from the runway.

Helicopter operations make up approximately 7% of total operations. Helicopter operations land and take off from helipads located near Taxiway C, south of the Sonoma Jet Center and generally follow established helicopter flight tracks.

Touch and Go (pilot training) operations primarily use Runway 14 and typically remain within a right-hand “box” pattern.

Aircraft operations appearing on **Table 2-3 and Table 2-4** were distributed onto the defined flight tracks.

Exhibit 2-1
Year 2005 Modeled Arrival Flight Tracks

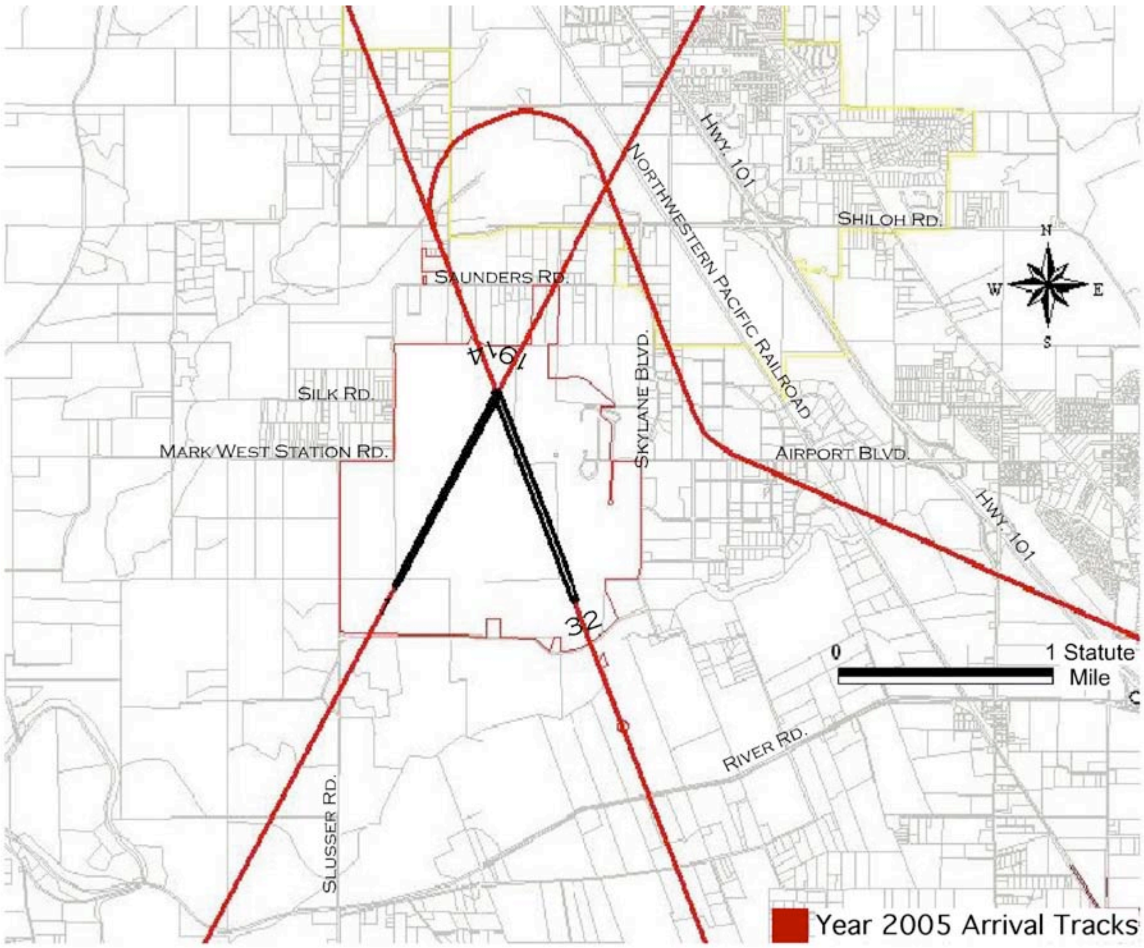


Exhibit 2-1 Year 2005 Modeled Arrival Flight Tracks

Sonoma County Airport - 2007 Master Plan   *Mestre Greve Associates*

Exhibit 2-2
Year 2030 Modeled Arrival Flight Tracks

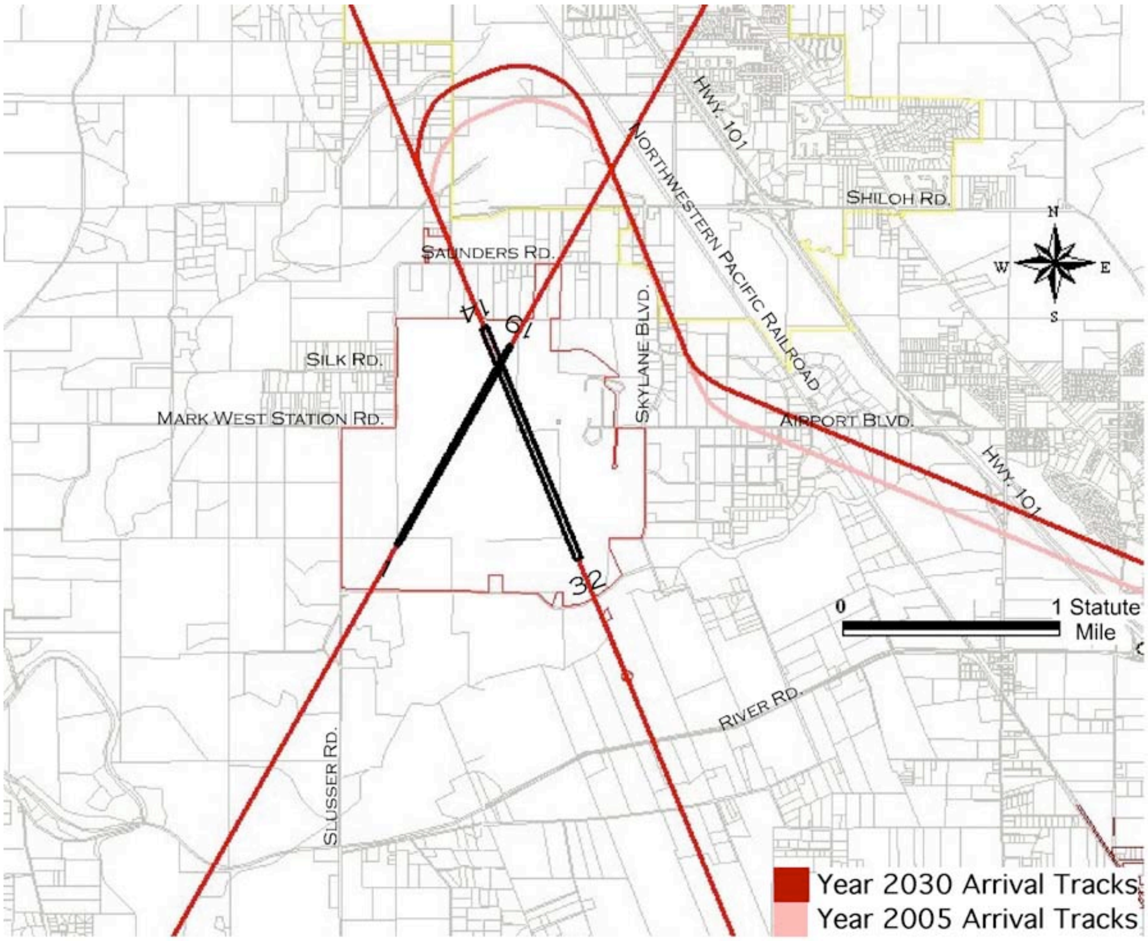


Exhibit 2-2 Year 2030 Modeled Arrival Flight Tracks

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

Exhibit 2-3
Year 2005 Modeled Departure Flight Tracks

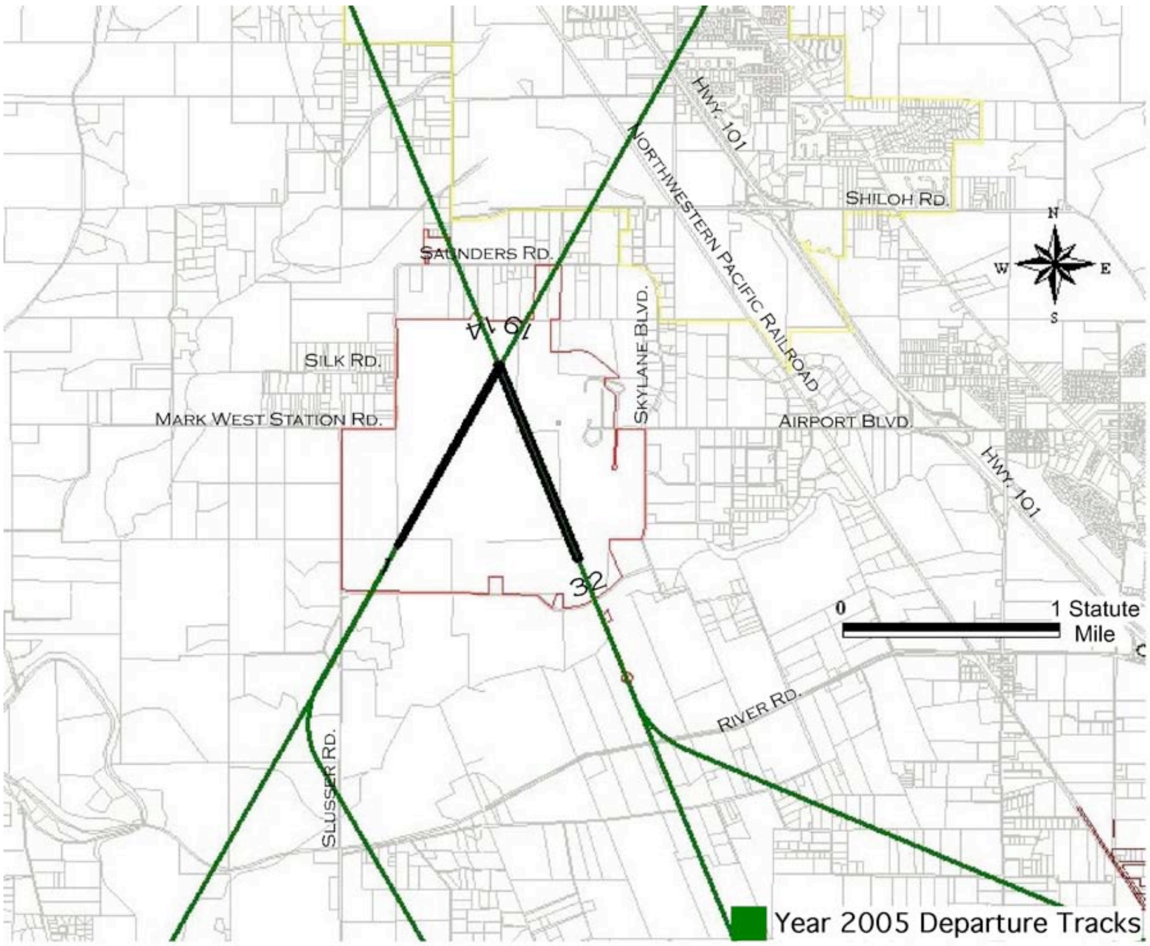


Exhibit 2-3 Year 2005 Modeled Departure Flight Tracks

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

Exhibit 2-4
Year 2030 Modeled Departure Flight Tracks

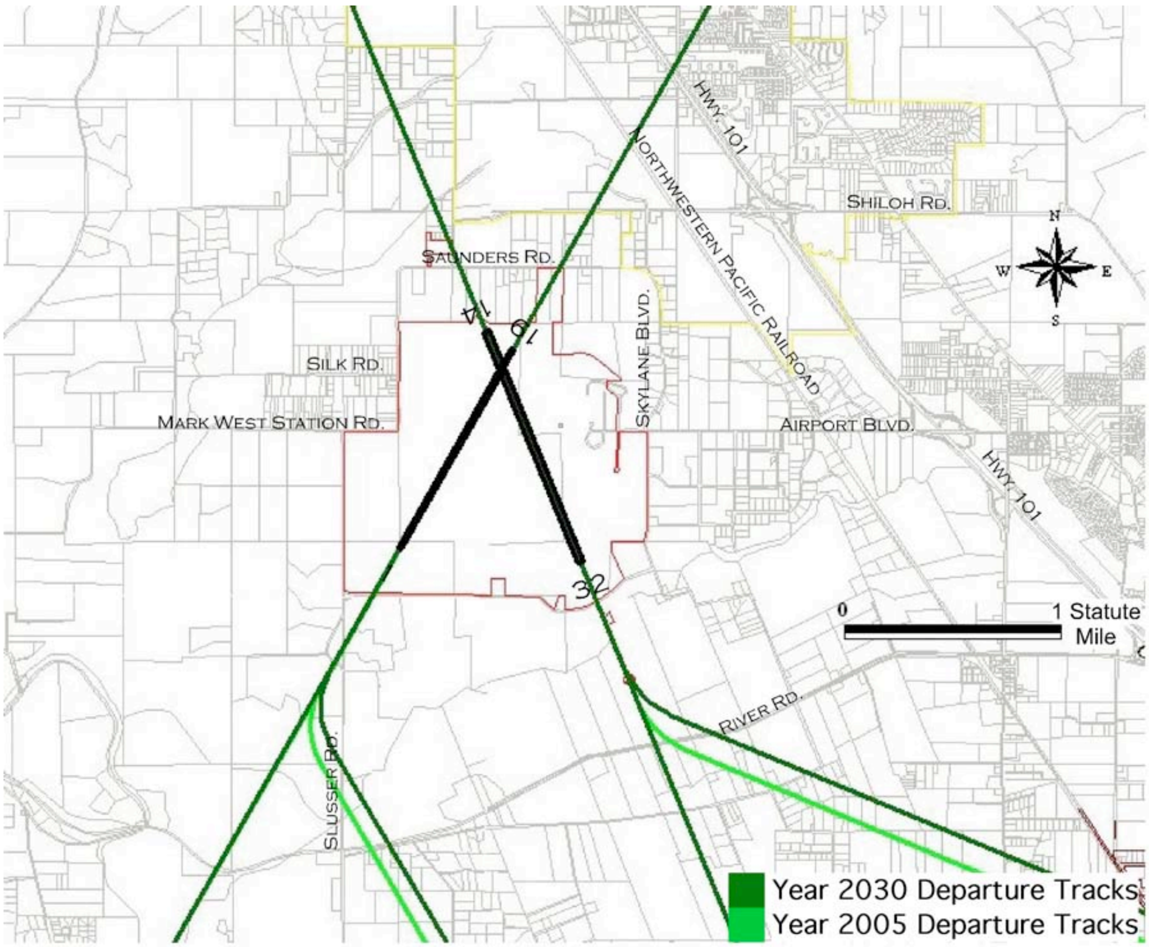


Exhibit 2-4 Year 2030 Modeled Departure Flight Tracks

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

Exhibit 2-5
Year 2005 Modeled Touch and Go Flight Tracks

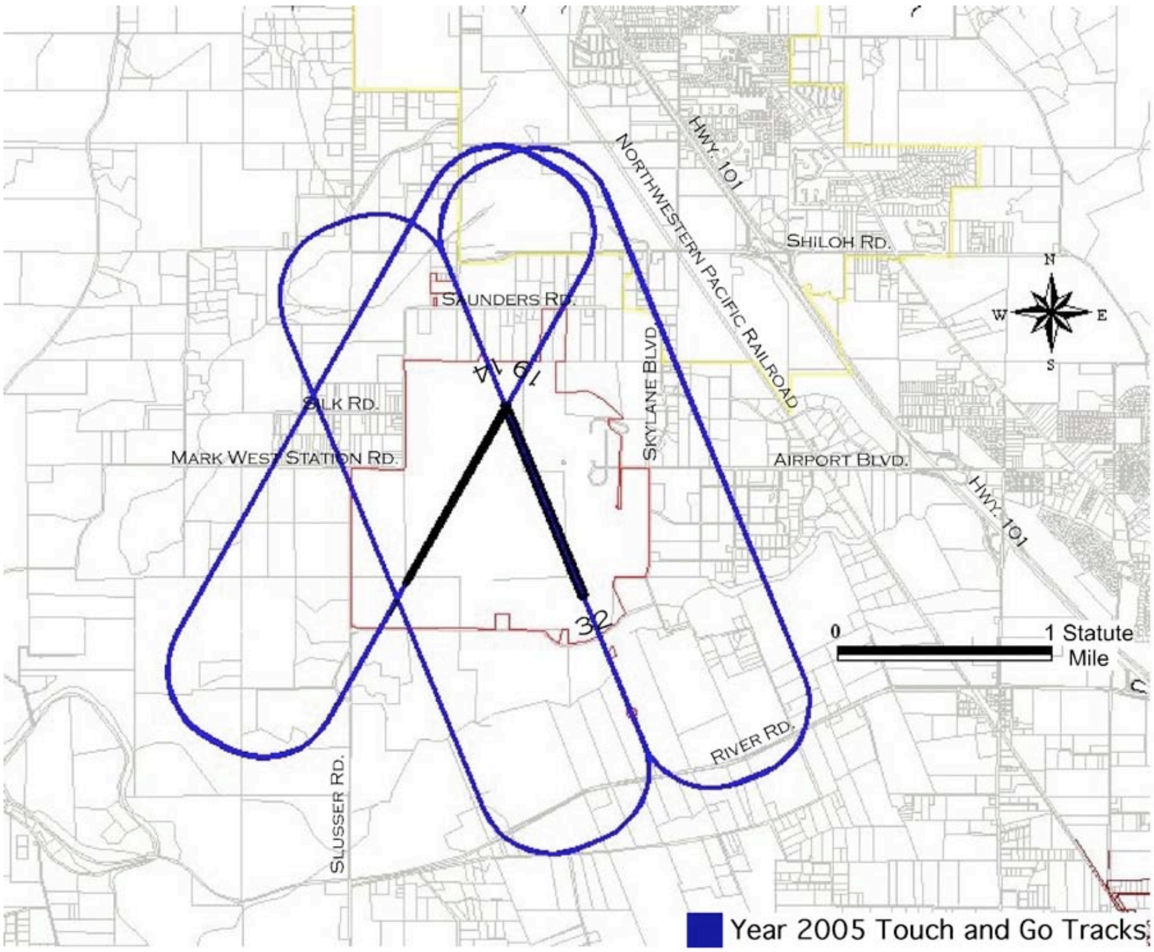


Exhibit 2-5 Year 2005 Modeled Touch and Go Flight Tracks

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

Exhibit 2-6
Year 2030 Modeled Touch and Go Flight Tracks

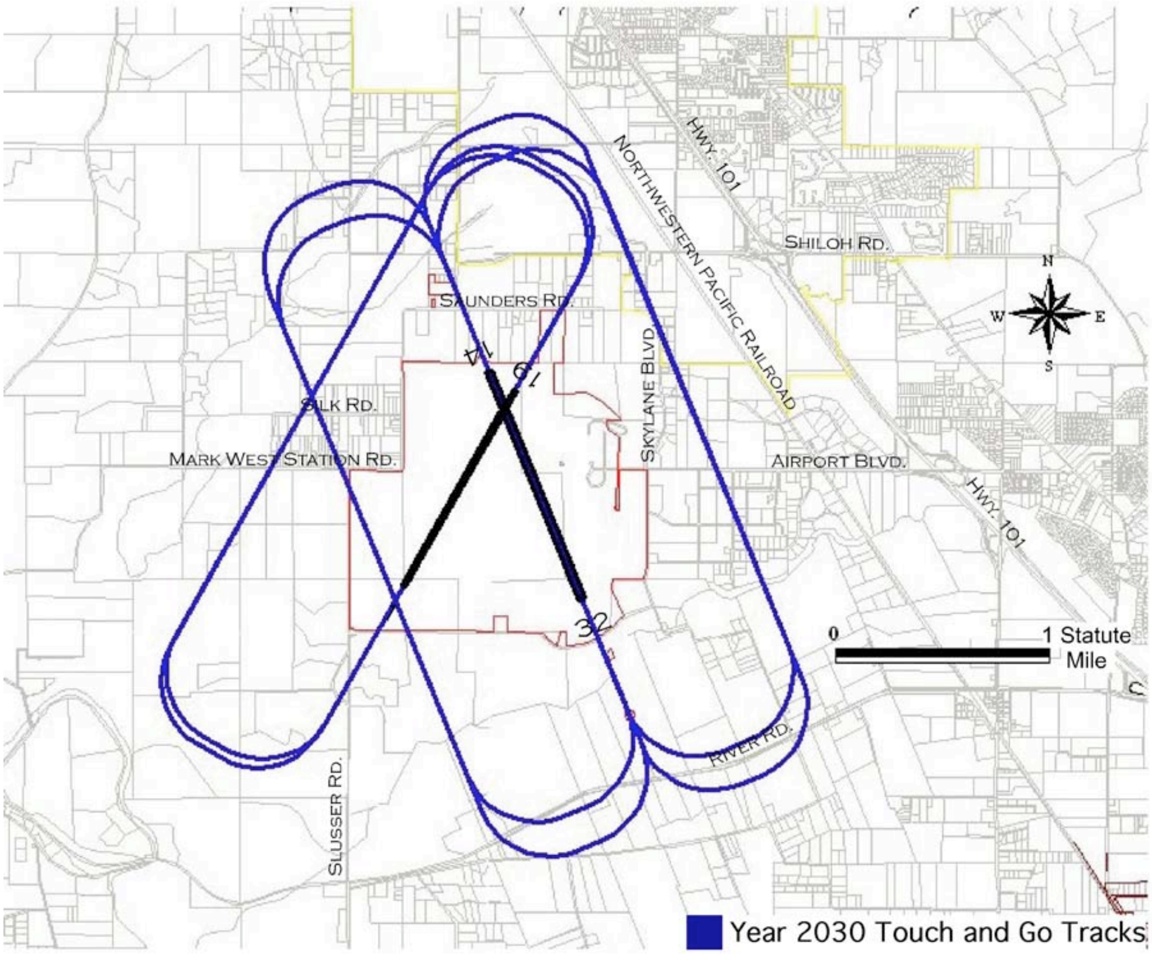


Exhibit 2-6 Year 2030 Modeled Touch and Go Flight Tracks

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

2.3 Operational Conditions

Various physical and operational conditions are required by the INM to accurately describe the airport, the metrological conditions and operating parameters of aircraft. It was assumed that all commercial, general aviation and military aircraft operating out of STS were bound for short range (Stage I) destinations. All aircraft were assumed to utilize a 3° approach for at least the last three miles before touchdown. Note that operational counts originate from Year 2005 operations and Year 2030 forecast operations with runway Alternative A-1.

2.4 Noise Contours

Using the data described above, the INM computer model generated CNEL contours, as explained in the Background section, for STS. The CNEL contours for the existing case were developed for the 60 and 65 dBA levels and are depicted on **Exhibit 2-7, Year 2005 CNEL Contours**. The forecast case noise levels are shown on **Exhibit 2-8, Year 2030 CNEL Contours**. **Exhibit 2-9** compares the **Year 2005 and Year 2030 65dB CNEL Contours**.

Exhibit 2-7
2005 CNEL Noise Contours

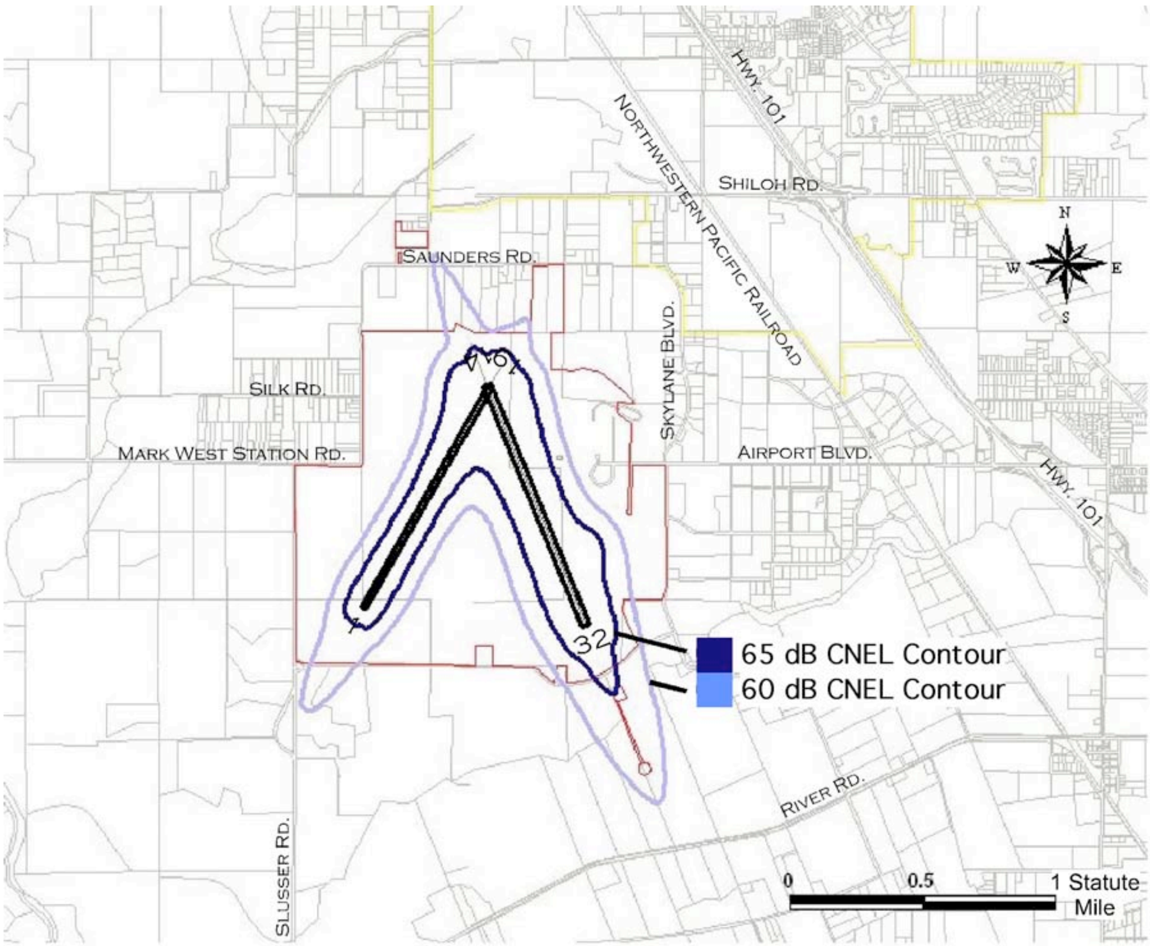


Exhibit 2-7 Year 2005 CNEL Contours

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

Exhibit 2-8
Year 2030 CNEL Noise Contours

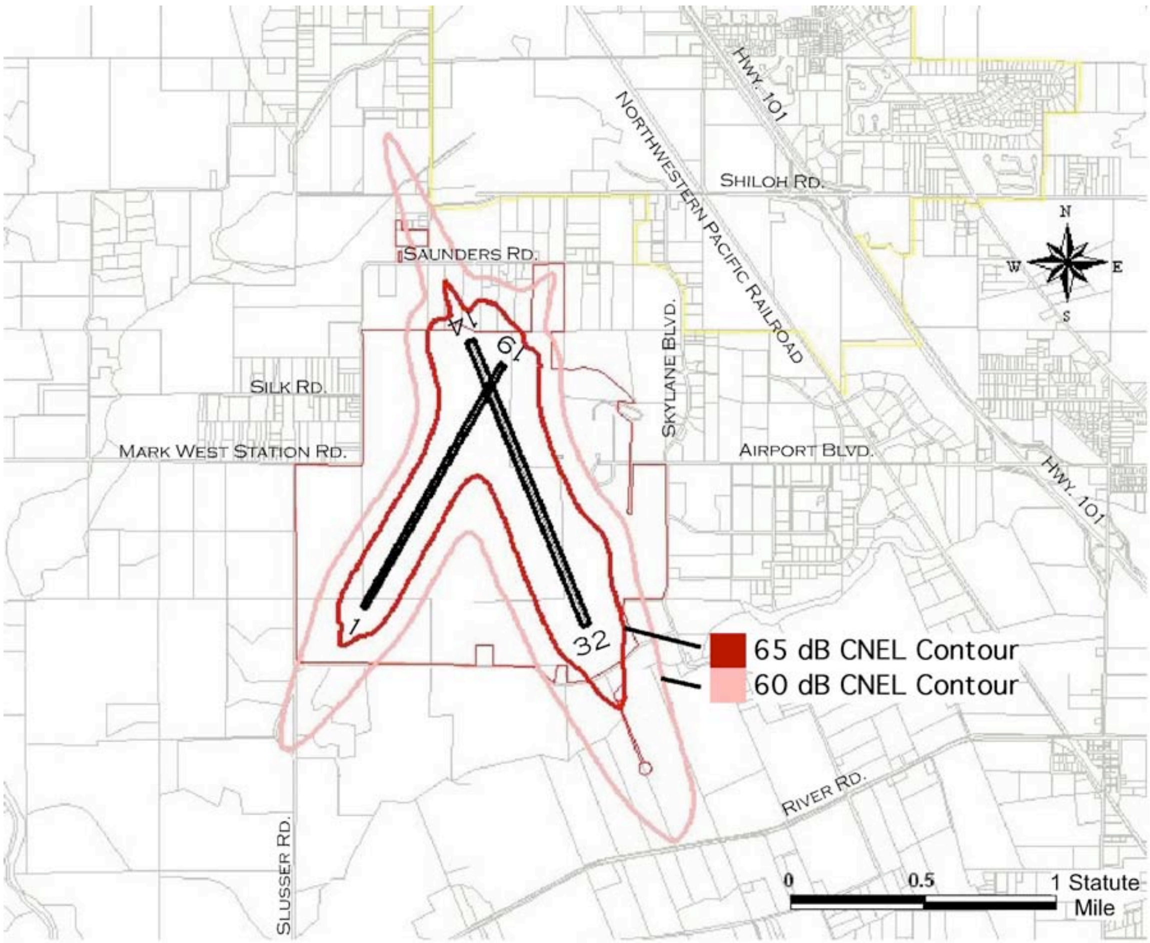


Exhibit 2-8 Year 2030 CNEL Contours

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

Exhibit 2-9
Year 2005 and Year 2030 CNEL Noise Contours

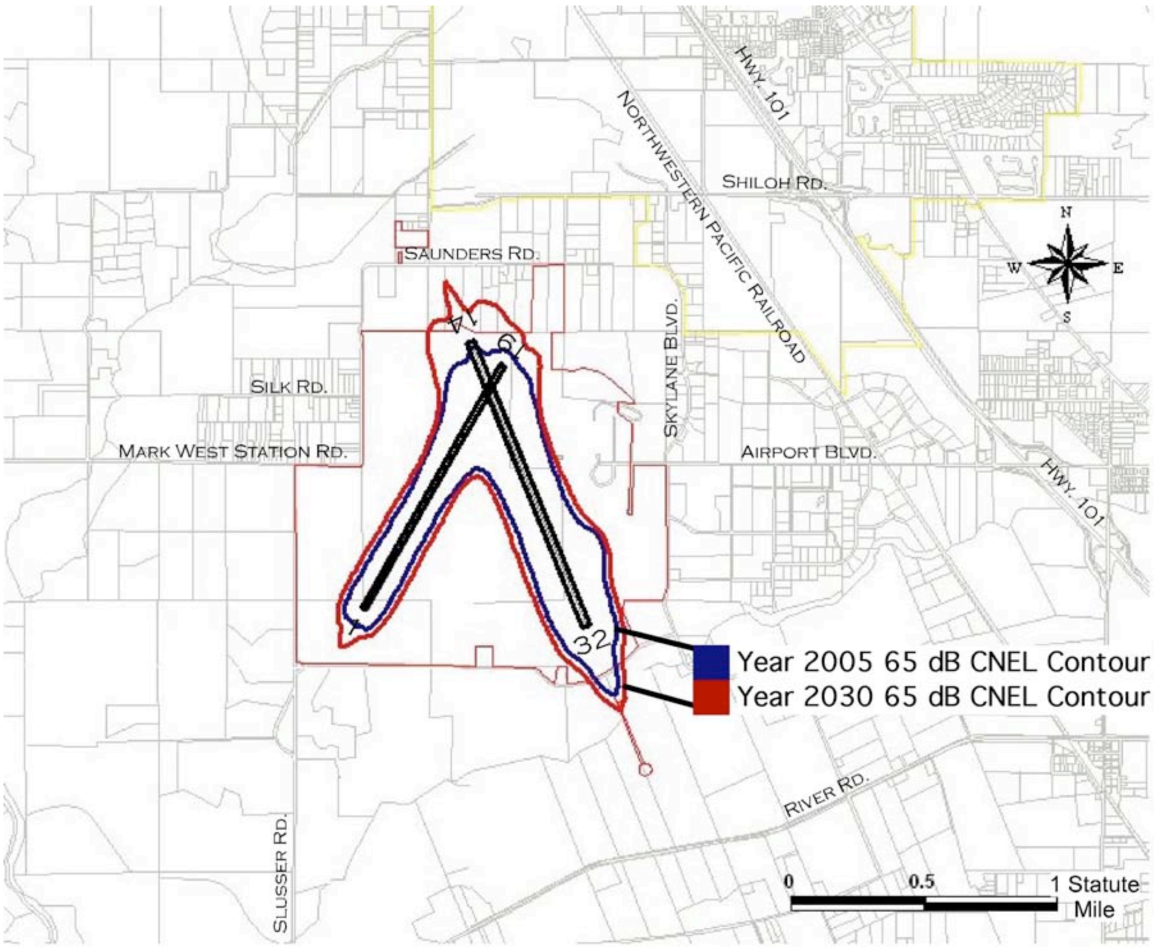


Exhibit 2-9 Year 2005 and Year 2030 65 dB CNEL Contours

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

2.5 Modeled Noise Receptors

The INM is capable of modeling or predicting noise levels and metrics at specifically identified locations. Ten sites were identified as points of interest to represent schools and residential areas near STS. The site names and locations are shown on **Table 2-5, Modeled Noise Receptors**. A map illustrating the site locations is shown on **Exhibit 2-10, Modeled Noise Receptor Sites**. The single event noise level metric used was Lmax. Normal conversational speech is in the range of 60 to 65 dBA. Therefore, the aircraft noise levels listed in **Table 2-7** represent modeled Lmax noise levels above 65 dBA using year 2005 and year 2030 cases. The table includes 2 sub-tables per site that represent the year 2005 runway configuration and designation (Runways 1, 14, etc.) and year 2030 Alternative A-1 extended runway configuration. The prefix "A" has been added to runway designations to represent the Alternative A-1 runway configuration (Runways A1, A14, etc.). Each row lists the modeled noise levels produced by an Aircraft Type during an Operation (arrival, departure, touch and go, or overflight) on a modeled Flight Track.

Table 2-5
Modeled Noise Receptors

Modeled Noise Receptors	Address
Site 1 - Days Private School	4400 Day School Pl, Santa Rosa, CA
Site 2 - Mattie Washburn Elementary	75 Pleasant Ave, Santa Rosa, CA
Site 3 - Windsor Creek Elementary	8955 Conde Ln, Windsor, CA
Site 4 - Windsor High School & Windsor Oaks Academy	8695 Windsor Rd, Windsor, CA
Site 5 - Cali Calmecac Charter	9491 Starr Rd, Windsor, CA
Site 6 - Brooks Elemetary School	750 Natalie Dr, Windsor, CA
Site 7 - Windsor Middle School	9500 Brooks Rd S, Windsor, CA
Site 8 - Skylane Blvd and Golf Course Dr	Residential area near Skylane Blvd and Golf Course Dr, Windsor, CA
Site 9 - Silk Rd and Mark West Station Rd	Residential area near Silk Rd and Mark West Station Rd
Site 10 - Olivet Elementary School	1825 Willowside Rd, Santa Rosa, CA

Exhibit 2-10
Modeled Noise Receptor Sites

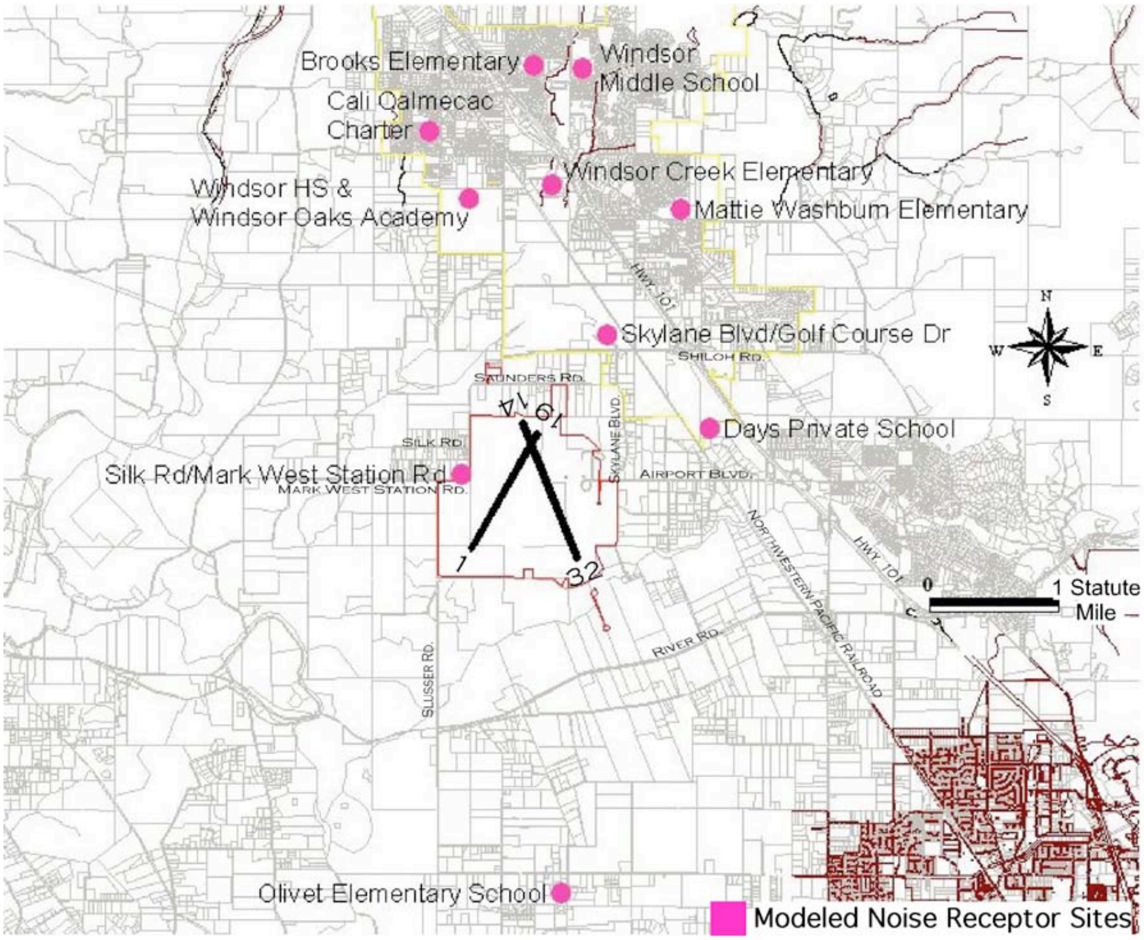


Exhibit 2-10 Modeled Noise Receptor Sites

Sonoma County Airport - 2007 Master Plan *Mestre Greve Associates*

A single aircraft type in the INM software may represent several aircraft types that produce very similar noise levels. **Table 2-6** lists the INM aircraft types used in the study and the actual aircraft types they represent.

Table 2-6
INM Aircraft Type Representation

INM Aircraft Type	STS Aircraft Type
GASEPF	Single Engine (Fixed),
GASEPV	Single Engine (Variable),Piaggio
BEC58P	Twin Engine (Piston)
CNA441	Twin Engine (Turbo)
LEAR35	Beech 400, Falcon 50, Falcon 900, Hawker H25, Lear 45, Lear 60
GIIB	Gulfstream III
GIV	Gulfstream IV
GV	Gulfstream V, EMB-170, EMB-190
CNA55B	Cessna 550
CIT3	Cessna 650
CNA750	Cessna 750
CL600	Challenger 600
CNA500	Very Light Jet (VLJ)
B206L	B206 (Bell Ranger)
A109	A109 (Agusta-109)
737700	Boeing 737-700
CL601	CRJ-700, CRJ-900
DHC8	Q-400

Table 2-7
Receptor Site Noise Levels

Year 2005 Site 1 - Days Private School				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	1	NE1	67.6
GIIB	Departure	19	SW4	65.9
GIIB	Departure	19	SW1	65.9
GIIB	Departure	14	SE5	65.0
GIIB	Departure	14	SE1	65.0

Year 2030 Site 1 - Days Private School				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
737700	Arrival	A14	NW6	68.6
GIIB	Departure	A1	NE1	67.7
GIIB	Departure	A19	SW4	66.4
GIIB	Departure	A19	SW1	66.4

Year 2005 Site 2 - Mattie Washburn Elementary				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	1	NE1	86.2
LEAR35	Departure	1	NE1	77.5
CIT3	Departure	1	NE1	76.7
GIIB	Arrival	19	NE3	76.1
CL600	Departure	1	NE1	75.1
GV	Departure	1	NE1	73.9
CNA55B	Arrival	19	NE3	72.9
CNA55B	Departure	1	NE1	72.2
GIV	Arrival	19	NE3	72.1
GV	Arrival	19	NE3	71.7
GIV	Departure	1	NE1	71.5
BEC58P	Departure	1	NE1	71.3
CL600	Arrival	19	NE3	71.2
LEAR35	Arrival	19	NE3	71.1
CNA750	Arrival	19	NE3	70.9
BEC58P	Arrival	19	NE3	70.7
CNA750	Departure	1	NE1	70.5
CNA441	Arrival	19	NE3	69.8
GASEPV	Departure	1	NE1	69.2
GASEPV	Arrival	19	NE3	68.7
CIT3	Arrival	19	NE3	67.2
CNA441	Departure	1	NE1	65.5

Year 2030 Site 2 - Mattie Washburn Elementary				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A1	NE1	86.3
737700	Arrival	A19	NE3	78.1
LEAR35	Departure	A1	NE1	77.7
737700	Departure	A1	NE1	77.0
CIT3	Departure	A1	NE1	76.7
GIIB	Arrival	A19	NE3	76.0
CNA500	Departure	A1	NE1	75.8
CL600	Departure	A1	NE1	75.2
CL601	Departure	A1	NE1	74.3
GV	Departure	A1	NE1	74.0
CNA55B	Arrival	A19	NE3	72.8
CNA55B	Departure	A1	NE1	72.2
GIV	Arrival	A19	NE3	72.0
GV	Arrival	A19	NE3	71.6
GIV	Departure	A1	NE1	71.5
BEC58P	Departure	A1	NE1	71.3
CL600	Arrival	A19	NE3	71.2
LEAR35	Arrival	A19	NE3	71.0
CL601	Arrival	A19	NE3	70.9
CNA750	Arrival	A19	NE3	70.8
CNA750	Departure	A1	NE1	70.6
BEC58P	Arrival	A19	NE3	70.6
CNA441	Arrival	A19	NE3	69.7
CNA500	Arrival	A19	NE3	69.4
GASEPV	Departure	A1	NE1	69.2
GASEPV	Arrival	A19	NE3	68.7
CIT3	Arrival	A19	NE3	67.2
DHC8	Arrival	A19	NE3	66.2
CNA441	Departure	A1	NE1	65.6

Year 2005 Site 3 - Windsor Creek Elementary				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	1	NE1	69.7
GIIB	Departure	32	NW1	67.6
LEAR35	Departure	1	NE1	65.3

Year 2030 Site 3 - Windsor Creek Elementary				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A1	NE1	69.7
GIIB	Departure	A32	NW1	67.6
737700	Departure	A1	NE1	66.7
LEAR35	Departure	A1	NE1	65.3

Year 2005 Site 4 - Windsor High & Windsor Oaks Academy				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	32	NW1	82.6
LEAR35	Departure	32	NW1	77.8
CIT3	Departure	32	NW1	74.3
CL600	Departure	32	NW1	73.0
GV	Departure	32	NW1	73.0
GIV	Departure	32	NW1	71.0
CNA55B	Departure	32	NW1	69.7
BEC58P	Departure	32	NW1	69.4
GIIB	Arrival	14	NW3	69.1
GASEPV	Departure	32	NW1	67.6
CNA750	Departure	32	NW1	67.5

Year 2030 Site 4 - Windsor High & Windsor Oaks Academy

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A32	NW1	82.6
LEAR35	Departure	A32	NW1	77.8
737700	Departure	A32	NW1	76.4
CIT3	Departure	A32	NW1	74.3
CNA500	Departure	A32	NW1	73.3
CL600	Departure	A32	NW1	73.0
GV	Departure	A32	NW1	73.0
CL601	Departure	A32	NW1	71.7
GIV	Departure	A32	NW1	71.0
737700	Arrival	A14	NW3	70.0
CNA55B	Departure	A32	NW1	69.8
BEC58P	Departure	A32	NW1	69.4
GIIB	Arrival	A14	NW3	69.3
GASEPV	Departure	A32	NW1	67.6
CNA750	Departure	A32	NW1	67.5

Year 2005 Site 5 - Cali Calmecac Charter

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	32	NW1	83.8
LEAR35	Departure	32	NW1	74.8
CL600	Departure	32	NW1	73.1
CIT3	Departure	32	NW1	72.8
GIIB	Arrival	14	NW3	71.8
GV	Departure	32	NW1	71.7
CNA55B	Departure	32	NW1	70.0
GIV	Departure	32	NW1	69.9
BEC58P	Departure	32	NW1	69.7
CNA55B	Arrival	14	NW3	68.5
GIV	Arrival	14	NW3	68.3
CNA750	Departure	32	NW1	68.3
BEC58P	Arrival	14	NW3	67.7
GV	Arrival	14	NW3	67.6
GASEPV	Departure	32	NW1	67.6
CL600	Arrival	14	NW3	67.0
CNA441	Arrival	14	NW3	66.8
LEAR35	Arrival	14	NW3	66.8
CNA750	Arrival	14	NW3	66.6
GASEPV	Arrival	14	NW3	65.7

Year 2030 Site 5 - Cali Calmecac Charter

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A32	NW1	83.8
737700	Arrival	A14	NW3	74.9
LEAR35	Departure	A32	NW1	74.8
737700	Departure	A32	NW1	74.7
CNA500	Departure	A32	NW1	74.1
CL600	Departure	A32	NW1	73.1
CIT3	Departure	A32	NW1	73.0
GIIB	Arrival	A14	NW3	72.2
CL601	Departure	A32	NW1	71.9
GV	Departure	A32	NW1	71.7
CNA55B	Departure	A32	NW1	70.0
GIV	Departure	A32	NW1	69.9
BEC58P	Departure	A32	NW1	69.7
CNA55B	Arrival	A14	NW3	68.7
GIV	Arrival	A14	NW3	68.4
CNA750	Departure	A32	NW1	68.3
BEC58P	Arrival	A14	NW3	67.9
GV	Arrival	A14	NW3	67.7
GASEPV	Departure	A32	NW1	67.6
CL600	Arrival	A14	NW3	67.1
CL601	Arrival	A14	NW3	67.1
CNA441	Arrival	A14	NW3	67.0
LEAR35	Arrival	A14	NW3	67.0
CNA750	Arrival	A14	NW3	66.8
GASEPV	Arrival	A14	NW3	65.9
CNA500	Arrival	A14	NW3	65.6

Year 2005 Site 6 - Brooks Elemetary

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	32	NW1	65.5

Year 2030 Site 6 - Brooks Elemetary

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A32	NW1	65.5

Year 2005 Site 7 - Windsor Middle School

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	1	NE1	66.7

Year 2030 Site 7 - Windsor Middle School

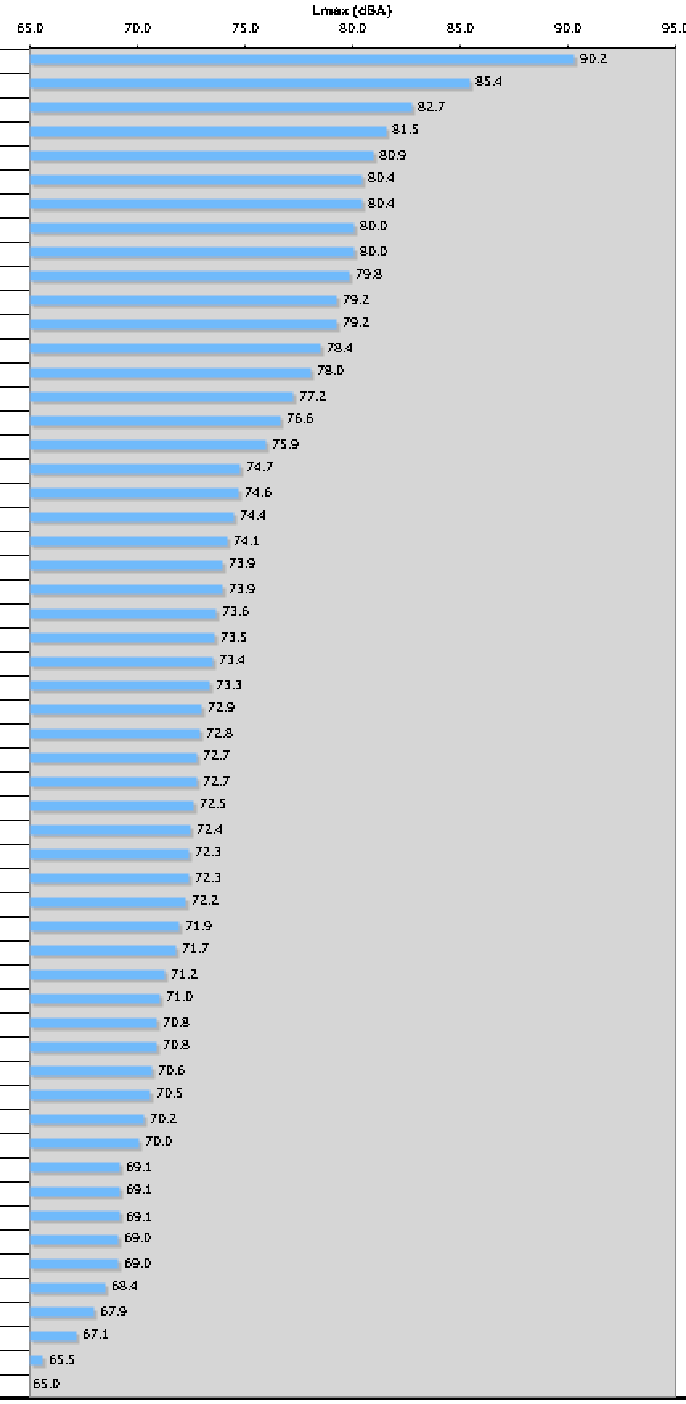
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A1	NE1	66.7

Year 2005 Site 8 - Skylane Dr. and Golf Course Dr

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	1	NE1	90.1
LEAR35	Departure	1	NE1	85.4
CIT3	Departure	1	NE1	81.4
GV	Departure	1	NE1	80.8
CL600	Departure	1	NE1	79.9
GIIB	Arrival	14	NW6	79.2
GIIB	Arrival	19	NE3	79.2
CNA55B	Departure	1	NE1	79.1
BEC58P	Departure	1	NE1	78.0
GIV	Departure	1	NE1	77.1
CNA55B	Arrival	14	NW6	76.6
CNA750	Departure	1	NE1	76.5
GIV	Arrival	14	NW6	75.1
GV	Arrival	14	NW6	75.1
CNA55B	Arrival	19	NE3	74.8
CL600	Arrival	14	NW6	74.7
CNA750	Arrival	14	NW6	74.6
LEAR35	Arrival	14	NW6	74.6
GASEPV	Departure	1	NE1	73.4
GIV	Arrival	19	NE3	73.4
GV	Arrival	19	NE3	73.3
BEC58P	Arrival	14	NW6	73.0
CL600	Arrival	19	NE3	72.9
CNA750	Arrival	19	NE3	72.8
LEAR35	Arrival	19	NE3	72.8
GIIB	Departure	32	NW1	72.6
BEC58P	Touch and Go	14	SE4	72.3
BEC58P	Touch and Go	32	NW4	72.3
CNA441	Arrival	14	NW6	72.2
BEC58P	Arrival	19	NE3	71.9
GASEPV	Arrival	14	NW6	71.2
CNA441	Arrival	19	NE3	71.1
CIT3	Arrival	14	NW6	70.9
CNA441	Departure	1	NE1	70.4
GIIB	Departure	14	SE5	70.1
GIIB	Departure	14	SE1	70.1
GASEPV	Arrival	19	NE3	70.0
GASEPV	Touch and Go	14	SE4	69.1
GASEPV	Touch and Go	32	NW4	69.1
BEC58P	Touch and Go	1	NE2	69.0
GASEPF	Departure	1	NE1	69.0
CIT3	Arrival	19	NE3	69.0
GASEPF	Touch and Go	1	NE2	67.1
GASEPV	Touch and Go	1	NE2	65.5
BEC58P	Touch and Go	19	SW2	65.0

Year 2030 Site 8 - Skylane Dr. and Golf Course Dr

Aircraft Type	Operation	Runway	Flight Track
GIIB	Departure	A1	NE1
LEAR35	Departure	A1	NE1
737700	Departure	A1	NE1
CIT3	Departure	A1	NE1
GV	Departure	A1	NE1
CL601	Departure	A1	NE1
737700	Arrival	A14	NW6
CL600	Departure	A1	NE1
CNA500	Departure	A1	NE1
737700	Arrival	A19	NE3
CNA55B	Departure	A1	NE1
GIIB	Arrival	A19	NE3
GIIB	Arrival	A14	NW6
BEC58P	Departure	A1	NE1
GIV	Departure	A1	NE1
CNA750	Departure	A1	NE1
CNA55B	Arrival	A14	NW6
CNA55B	Arrival	A19	NE3
GIV	Arrival	A14	NW6
GV	Arrival	A14	NW6
CL600	Arrival	A14	NW6
CNA750	Arrival	A14	NW6
LEAR35	Arrival	A14	NW6
CL601	Arrival	A14	NW6
GASEPV	Departure	A1	NE1
GIV	Arrival	A19	NE3
GV	Arrival	A19	NE3
CL600	Arrival	A19	NE3
CNA750	Arrival	A19	NE3
LEAR35	Arrival	A19	NE3
GIIB	Departure	A32	NW1
BEC58P	Arrival	A14	NW6
CL601	Arrival	A19	NE3
BEC58P	Touch and Go	A14	SE4
BEC58P	Touch and Go	A32	NW4
CNA500	Arrival	A14	NW6
BEC58P	Arrival	A19	NE3
CNA441	Arrival	A14	NW6
CNA441	Arrival	A19	NE3
CNA500	Arrival	A19	NE3
GIIB	Departure	A14	SE5
GIIB	Departure	A14	SE1
GASEPV	Arrival	A14	NW6
CNA441	Departure	A1	NE1
CIT3	Arrival	A14	NW6
GASEPV	Arrival	A19	NE3
BEC58P	Touch and Go	A1	NE2
GASEPV	Touch and Go	A14	SE4
GASEPV	Touch and Go	A32	NW4
GASEPF	Departure	A1	NE1
CIT3	Arrival	A19	NE3
DHC8	Arrival	A14	NW6
DHC8	Arrival	A19	NE3
GASEPF	Touch and Go	A1	NE2
GASEPV	Touch and Go	A1	NE2
737700	Departure	A32	NW1



Year 2005 Site 9 - Silk Blvd and Mark West Station Rd				Lmax (dBA)
Aircraft Type	Operation	Runway	Flight Track	
GIIB	Departure	1	NE1	82.6
GIIB	Departure	19	SW4	82.4
GIIB	Departure	19	SW1	82.4
GIIB	Departure	32	NW1	75.5
GIIB	Departure	14	SE5	75.1
GIIB	Departure	14	SE1	75.1
GASEPV	Touch and Go	19	SW2	74.8
GASEPV	Touch and Go	1	NE2	74.0
LEAR35	Departure	19	SW1	73.1
LEAR35	Departure	19	SW4	73.1
LEAR35	Departure	1	NE1	73.0
A109	Overflight	Helipad	COA	72.8
A109	Overflight	Helipad	CO1	72.6
GIV	Departure	1	NE1	70.9
GIV	Departure	19	SW4	70.7
GIV	Departure	19	SW1	70.7
BEC58P	Touch and Go	19	SW2	69.8
BEC58P	Touch and Go	1	NE2	69.6
BEC58P	Departure	19	SW4	69.6
BEC58P	Departure	19	SW1	69.6
BEC58P	Departure	1	NE1	69.5
GV	Departure	19	SW1	68.9
GV	Departure	19	SW4	68.9
GV	Departure	1	NE1	68.8
BEC58P	Touch and Go	14	SE2	68.4
BEC58P	Touch and Go	32	NW2	68.4
B206L	Overflight	Helipad	CO1	68.4
B206L	Overflight	Helipad	COA	68.4
GASEPV	Touch and Go	32	NW4	68.3
GASEPV	Touch and Go	32	NW2	68.3
CIT3	Departure	1	NE1	67.3
GASEPV	Departure	1	NE1	67.1
CIT3	Departure	19	SW4	66.9
CIT3	Departure	19	SW1	66.9
CL600	Departure	1	NE1	66.8
CNA55B	Departure	19	SW1	66.8
CNA55B	Departure	19	SW4	66.8
CL600	Departure	19	SW4	66.6
CL600	Departure	19	SW1	66.6
GIV	Departure	32	NW1	66.4
GASEPV	Departure	19	SW4	66.1
GASEPV	Departure	19	SW1	66.1
GIV	Departure	14	SE5	66.0
GIV	Departure	14	SE1	66.0
CNA55B	Departure	1	NE1	65.6
LEAR35	Departure	32	NW1	65.5
GASEPV	Touch and Go	14	SE2	65.1
LEAR35	Departure	14	SE5	65.0
LEAR35	Departure	14	SE1	65.0

Year 2030 Site 9 - Silk Blvd and Mark West Station Rd

Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A1	NE1	82.6
GIIB	Departure	A19	SW4	81.9
GIIB	Departure	A19	SW1	81.9
GIIB	Departure	A32	NW1	75.4
GIIB	Departure	A14	SE5	74.6
GIIB	Departure	A14	SE1	74.6
LEAR35	Departure	A19	SW4	74.6
LEAR35	Departure	A19	SW1	74.6
GASEPV	Touch and Go	A19	SW2	74.4
GASEPV	Touch and Go	A1	NE2	74.0
LEAR35	Departure	A1	NE1	73.0
A109	Overflight	Helipad	COA	72.8
A109	Overflight	Helipad	CO1	72.6
737700	Departure	A19	SW4	72.2
737700	Departure	A19	SW1	72.2
GIV	Departure	A19	SW4	72.0
GIV	Departure	A19	SW1	72.0
737700	Departure	A1	NE1	71.9
GIV	Departure	A1	NE1	71.0
BEC58P	Departure	A19	SW4	69.8
BEC58P	Departure	A19	SW1	69.8
GV	Departure	A19	SW4	69.8
GV	Departure	A19	SW1	69.8
BEC58P	Touch and Go	A19	SW2	69.7
BEC58P	Touch and Go	A1	NE2	69.6
BEC58P	Departure	A1	NE1	69.4
GV	Departure	A1	NE1	68.8
CNA55B	Departure	A19	SW4	68.7
CNA55B	Departure	A19	SW1	68.7
BEC58P	Touch and Go	A14	SE2	68.4
BEC58P	Touch and Go	A32	NW2	68.4
B206L	Overflight	Helipad	CO1	68.4
B206L	Overflight	Helipad	COA	68.4
GASEPV	Touch and Go	A32	NW2	68.3
GASEPV	Touch and Go	A32	NW4	68.3
CIT3	Departure	A1	NE1	67.4
737700	Departure	A32	NW1	67.4
GASEPV	Departure	A1	NE1	67.2
GASEPV	Departure	A19	SW4	67.0
GASEPV	Departure	A19	SW1	67.0
CL600	Departure	A1	NE1	66.9
CIT3	Departure	A19	SW4	66.8
CIT3	Departure	A19	SW1	66.8
GIV	Departure	A32	NW1	66.4
CL600	Departure	A19	SW4	66.1
CL600	Departure	A19	SW1	66.1
CL601	Departure	A1	NE1	65.5
CNA500	Departure	A1	NE1	65.5
GIV	Departure	A14	SE5	65.4
GIV	Departure	A14	SE1	65.4
CNA500	Departure	A19	SW4	65.4
CNA500	Departure	A19	SW1	65.4
LEAR35	Departure	A32	NW1	65.4
CNA55B	Departure	A1	NE1	65.2
GASEPV	Touch and Go	A14	SE2	65.1

Year 2005 Site 10 - Olivet Elementary School				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	19	SW4	84.1
LEAR35	Departure	19	SW4	73.1
CIT3	Departure	19	SW4	71.2
GV	Departure	19	SW4	70.8
CL600	Departure	19	SW4	70.0
BEC58P	Departure	19	SW4	69.9
CNA55B	Departure	19	SW4	69.5
GIV	Departure	19	SW4	69.3
CNA750	Departure	19	SW4	68.4
GASEPV	Departure	19	SW4	67.3
GIIB	Departure	14	SE1	65.4

Year 2030 Site 10 - Olivet Elementary School				
Aircraft Type	Operation	Runway	Flight Track	Lmax (dBA)
GIIB	Departure	A19	SW4	83.8
CNA500	Departure	A19	SW4	74.0
737700	Departure	A19	SW4	73.3
LEAR35	Departure	A19	SW4	72.8
CIT3	Departure	A19	SW4	70.9
GV	Departure	A19	SW4	70.6
BEC58P	Departure	A19	SW4	69.7
CL600	Departure	A19	SW4	69.6
CNA55B	Departure	A19	SW4	69.2
GIV	Departure	A19	SW4	69.2
CL601	Departure	A19	SW4	69.0
CNA750	Departure	A19	SW4	68.0
GASEPV	Departure	A19	SW4	67.1
GIIB	Departure	A14	SE1	65.5

SECTION 3

REFERENCES

[1] Environmental Protection Agency, "Information on Levels on Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." U.S. Environmental Protection Agency, Office of Noise Abatement and Control, March 1974.

[2] Harris, Cyril M., "Handbook of Noise Control," Second Edition, McGraw-Hill Book Co., 1979.

Federal Aviation Administration, "Integrated Noise Model User's Guide," version 6.0 and 6.2a, Federal Aviation Administration, Office of Environment and Energy, 2006.