AIRCRAFT NOISE ASSESSMENT
WATSONVILLE MUNICIPAL AIRPORT
WATSONVILLE, CALIFORNIA

BBA Report No. 12-033

PREPARED FOR

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INTRODUCTION

This report presents the findings of an aircraft noise analysis conducted by Brown-Buntin Associates, Inc. (BBA) for the Watsonville Municipal Airport in Watsonville, California. The study included aircraft noise monitoring over a week-long period in May of 2013 and the preparation of aircraft noise exposure maps for existing (2012) and forecast future (2032) conditions using the Federal Aviation Administration (FAA) Integrated Noise Model (INM). Aircraft operations data utilized for noise modeling was provided by the City of Watsonville and the airport engineer (Reinard W. Brandley, Consulting Engineer).

The noise level descriptors used in this analysis are described in Appendix A. The primary descriptor utilized is the Community Noise Equivalent Level (CNEL), which is the energy average sound level for a 24-hour period determined after addition of penalties of 10 dB for aircraft operations at night between the hours 10:00 p.m. and 7:00 a.m. and 4.8 dB for operations during the evening between the hours of 7:00 p.m. and 10:00 p.m. The CNEL is calculated based upon the sound energy generated by individual aircraft events, the number of events occurring during a 24-hour period and the time of day in which the events occur.

As applied to the assessment of long-term (or cumulative) exposure to aircraft noise, the CNEL represents annual average noise exposure. This means that the noise exposure on a particular day is likely to be either higher or lower than the annual average for a given location. The State of California requires use of the annual average CNEL for the analysis of potential noise impacts associated with airport improvement projects.

Appendix B provides examples of noise levels from a variety of familiar sources along with a ranking of subjective loudness. The chart is useful when making a relative comparison of the noise levels reported by this analysis for maximum noise levels during aircraft single events to noise generated by other common sources within a developed area.

II. AIRCRAFT NOISE MEASUREMENT PROGRAM

Continuous measurements of noise from aircraft and other sources were conducted during the seven-day period of May 7-13, 2013 at four (4) locations using automated noise monitoring equipment. The noise monitoring sites were selected by BBA and the City of Watsonville to represent areas of the community potentially impacted by aircraft noise or where noise complaints had been received. Short-term measurements of aircraft single event noise levels were also conducted at the sites.

Weather conditions during the noise measurement period consisted of mostly cloudy and overcast skies in the morning hours, often becoming clear and sunny in the afternoon hours. Temperatures ranged from approximately 50°F during the early morning hours to approximately 75°F during the mid-afternoon. Winds were light to moderate with speeds of 5-10 miles per hour during most of the monitoring period, and humidity was in the range of 60-80%.

Noise Monitoring Locations:

Noise monitoring sites are described below. Site locations relative to the airport are shown in Figure 1.

Site 1 - This site was located in the backyard of a residence at 46 Buena Vista Drive, north of the airport. The site is exposed to aircraft noise from arrivals on Runway 20 and departures on Runway 02. The site is also exposed to vehicular traffic noise from Buena Vista Drive and Freedom Boulevard.

Site 2 - This site was located within a city-owned water tank property adjacent to the airport boundary. The site was located north of the approach to Runway 26. The site is exposed to noise from aircraft arrivals and departures on Runway 26 and aircraft making a downwind approach to Runway 20.

Site 3 - This site was located at a city-owned driving range south of the airport, and is surrounded by agricultural uses and open space. The site is exposed to noise from aircraft departures on Runway 20 and aircraft arrivals on Runway 02. The site is also exposed to noise from driving range maintenance activities, including pumping equipment near where the monitor was located.

Site 4 - This site was located west of the airport at a rural residential property located at 200 Grizzly Oaks Lane. The site is exposed to periodic aircraft and helicopter over-flights.

Noise Monitoring Equipment:

Noise monitoring equipment consisted of Larson-Davis Laboratories Model LDL 820 sound level analyzers equipped with Bruel & Kjaer (B&K) Type 4176 ½" microphones. The monitors were calibrated with B&K Type 4230 acoustical calibrators to ensure the accuracy of the measurements. Microphones were located on tripods or booms at approximately 5-10 feet above the ground. Microphones were situated so that they had an unobstructed view of the aircraft noise source and were as far as possible from reflective surfaces.

The LDL Model 820 sound level analyzers have the capability of measuring noise continuously for extended periods of time. The analyzers are programmed to distinguish between aircraft noise and noise from other sources using sound level and event duration thresholds. Typical noise measurement threshold settings for this study were 60-65 dBA for a minimum of 5 seconds. This means that the noise level had to equal or exceed the selected noise level threshold for at least 5 seconds in order for the noise event to be considered aircraft-related. The LDL Model 820 analyzers are effective in discriminating between aircraft noise events and noise from other sources provided monitoring sites are carefully chosen and measurement thresholds are appropriate for the monitoring sites.

Cumulative Aircraft Noise Exposure:

Table I provides a summary of measured aircraft noise exposure at the noise monitoring sites as defined by the CNEL metric. Shown by Table I is the energy average aircraft CNEL values for the entire noise monitoring period and the range of daily CNEL values measured during the monitoring period.

The aircraft noise exposure values reported by Table I were determined from the noise event data collected by the LDL 820 sound level analyzers using the pre-programmed event noise level and duration thresholds. The noise event data collected by the instrumentation were further analyzed to remove noise level data that were clearly not aircraft-related. This procedure may be relied upon to define aircraft noise exposure at locations where there is a clear distinction between the noise levels caused by aircraft operations and the noise levels caused by other sources such as roadway traffic or commercial and/or construction activities.

Appendix C contains bar charts showing the *aircraft* and *community* (non-aircraft) CNEL values for each measurement day at the noise monitoring sites. Also shown by the bar charts are the *total* CNEL values for the measurement days. Community noise levels are determined by subtracting the aircraft CNEL from the total CNEL for a particular noise measurement day. As noted above, overall noise levels at Site 3 were affected by nearby pumping equipment that operated several hours per night during the noise measurement period. This resulted in there being a relatively large difference between daily community and aircraft CNEL values at that site.

TABLE I

SUMMARY OF MEASURED AIRCRAFT CNEL VALUES
WATSONVILLE MUNICIPAL AIRPORT

Site	Description	Dates	Measured Aircraft CNEL, dB[1]	
			Range	Mean
1	46 Buena Vista Drive	5/7/13-5/13/13	49.2-57.6	52.5
2	City-owned water tank property	5/7/13-5/13/13	42.1-55.1	49.7
3	City-owned driving range	5/7/13-5/13/13	53.9-59.2	57.1
4	200 Grizzly Oaks Lane	5/7/13-5/13/13	51.0-54.0	50.9

[1]Shown are the range of daily aircraft CNEL values and the average aircraft CNEL for the entire noise measurement period.

Source: Brown-Buntin Associates, Inc.

<u>Single Event Noise Level Measurements</u>:

Appendix D summarizes the results of detailed single event noise level measurements at the noise monitoring sites. Detailed single event monitoring consisted of placing a trained observer at each site for approximately four (4) hours to record the type of aircraft, type of operation (arrival or departure), runway used, maximum noise level (L_{max}), sound exposure level (SEL) and azimuth for each observed flight. The azimuth is the angle between the aircraft flight path and the microphone at the point where the aircraft is closest to the microphone. An azimuth of 90º means the aircraft passed directly over the microphone.

The mean (L_{max}) values shown in Appendix D were determined by arithmetic averaging whereas the mean SEL values were determined by logarithmic (energy) averaging. The SEL for a particular aircraft noise event is a numerically higher number than the (L_{max}) for the same event because the SEL consolidates the energy of the entire noise event into a reference duration of one second. The SEL is not "heard", but is a derived value used for calculation of cumulative aircraft noise exposure as defined by the CNEL.

PREPARATION OF CNEL CONTOURS

Aircraft noise exposure contours were prepared for the Watsonville Municipal Airport using the FAA Integrated Noise Model (INM) and aircraft operations data provided by the City of Watsonville and the airport engineer. As required by the State of California, contours were prepared in terms of the annual average CNEL. CNEL contours were prepared for existing conditions (2012) and forecast future (2032) conditions.

<u>The Integrated Noise Model</u>:

The INM was developed for the FAA and represents the federally sanctioned and required method for quantifying aircraft noise exposure for noise compatibility planning purposes. Version 7.0c is the current version of the INM.

The INM calculates aircraft noise exposure by mathematically combining aircraft noise levels and airport operations factors at a series of points within a cartesian coordinate system which defines the locations of airport runways and generalized aircraft flight tracks. The model then interpolates between points to plot contours of equal noise exposure. User inputs to the INM include the following:

- Runway configuration
- Aircraft flight track definitions
- Distribution of aircraft to flight tracks
- Aircraft traffic volume and fleet mix
- Temporal distribution of flights (day, evening or night)

The INM database includes aircraft performance parameters and noise level data that may be used to model noise from operations by most of the civilian fixed-wing aircraft and helicopters presently in service at U.S. airports. When a user specifies an aircraft type from the INM database, the model provides the necessary inputs concerning aircraft power settings, speed, departure profiles and noise levels. In its present form, the INM accounts for changes in the distance from a receptor to an aircraft noise source (slant range distance) due to variations in local terrain. The INM does *not* take into account reflections from nearby buildings or acoustical shielding caused by buildings or vegetation that may surround an airport.

Noise Modeling Assumptions:

Table II summarizes the airport operations data utilized to prepare CNEL contours for existing (2012) and forecast future (2032) conditions and the INM aircraft types selected by BBA from the INM Version 7.0c database. The annual number of aircraft operations and generalized aircraft fleet mix for 2012 and 2032 were provided by the airport engineer. Military and commercial aircraft operations are included in the multi-engine propeller and turboprop groups of aircraft. The INM aircraft types selected include the GASEPV and GASEPF (for variable- and fixed-pitch single propeller aircraft, respectively), BEC58P (for twin propeller-driven aircraft), CNA441 (for twin turboprop aircraft), the CNA500 and MU3001 (for turbine-powered aircraft), and the R22 (for helicopters).

TABLE II

ASSUMED ANNUAL AIRCRAFT OPERATIONS
WATSONVILLE MUNICIPAL AIRPORT

Aircraft Category	INM Aircraft Type	Year	
		2012	2032
Single engine propeller	GASEPF/GASEPV	91,890	104,400
Multi-engine propeller	BEC58P	10,075	11,765
Helicopter	R22	10,800	14,400
Turboprop	CNA441	5,425	6,335
Turbine (Jet)	CNA500/MU3001	700	1,500
Totals		**118,890**	**138,400**

Sources: City of Watsonville
Reinard W. Brandley, Consulting Engineer
Brown-Buntin Associates, Inc.

Annual average runway use is summarized in Table III. On an annual average basis, most flights take off and land in a southerly direction on Runway 20. High performance turbine-powered aircraft use Runway 02 for landings more frequently than other types of aircraft since the instrument landing system (ILS) for the airport is located at the end of that runway. The crosswind runway (08-26) is used only by smaller propeller-driven aircraft.

TABLE III

ANNUAL AVERAGE RUNWAY USE ASSUMPTIONS
WATSONVILLE MUNICPAL AIRPORT

	Takeoffs		Landings		Touch-and-Go
Runway	**Jet/ Turboprop**	**Propeller/ Helicopters**	**Jet/ Turboprop**	**Propeller/ Helicopters**	**Single-Eng. Prop.**
02	10%	1.8%	20%	1.8%	-0-
20	90%	86.2%	80%	86.2%	90%
08	-0-	0.2%	-0-	0.2%	-0-
26	-0-	11.8%	-0-	11.8%	10%

Sources: City of Watsonville
Reinard W. Brandley, Consulting Engineer
Brown-Buntin Associates, Inc.

The temporal distribution of aircraft operations assumed for noise modeling is summarized in Table IV. The temporal distribution of flights is an important factor in the determination of the CNEL since evening and nighttime flights are weighted to account for increased sensitivity to noise during those hours of the day.

TABLE IV

TEMPORAL DISTRIBUTION OF FLIGHTS
WATSONVILLE MUNICIPAL AIRPORT

Aircraft Type	Time of Day		
	Day (7a-7p)	**Evening (7p-10p)**	**Night (10p-7a)**
Fixed-wing aircraft (except touch-and-go)	94%	4%	1%
Touch-and-go	95%	5%	0
Helicopter	95%	5%	0

Sources: City of Watsonville
Reinard W. Brandley, Consulting Engineer
Brown-Buntin Associates, Inc.

Generalized aircraft flight tracks were developed by BBA for noise modeling purposes based upon field observations and information provided by airport staff and the airport engineer. Figure 2 shows generalized departure tracks and Figure 3 shows generalized arrival and touch-and-go tracks. Generalized flight tracks do not represent all areas around the airport where over-flights could occur but rather the areas with the highest concentrations of aircraft over-flights.

CNEL Contours:

The operations data summarized above were used to calculate the location of annual average CNEL contours using the INM. Figure 4 shows CNEL contours of 60-75 dB for aircraft operations during the 2012 calendar year. Figure 5 depicts CNEL contours of 60-75 dB for aircraft operations forecast for the year 2032. CNEL contour areas are summarized in Table V. The 60 dB CNEL contour is reported for informational purposes. The State of California and the FAA consider areas outside the CNEL 65 dB contour to have an acceptable aircraft noise exposure under normal conditions for noise compatibility planning purposes. However, areas within the 60 dB CNEL contour are exposed to aircraft over-flights and single event noise that may be clearly audible above other sources of ambient noise.

TABLE V

CNEL CONTOUR AREAS (SQUARE MILES/ACRES)
WATSONVILLE MUNICIPAL AIRPORT

Contour	2012	2032
CNEL 60	0.542/347	0.619/396
CNEL 65	0.233/149	0.260/166
CNEL 70	0.103/66	0.112/72
CNEL 75	0.036/23	0.041/26

Source: Brown-Buntin Associates, Inc.

Figure 1: Aircraft Noise Monitoring Sites

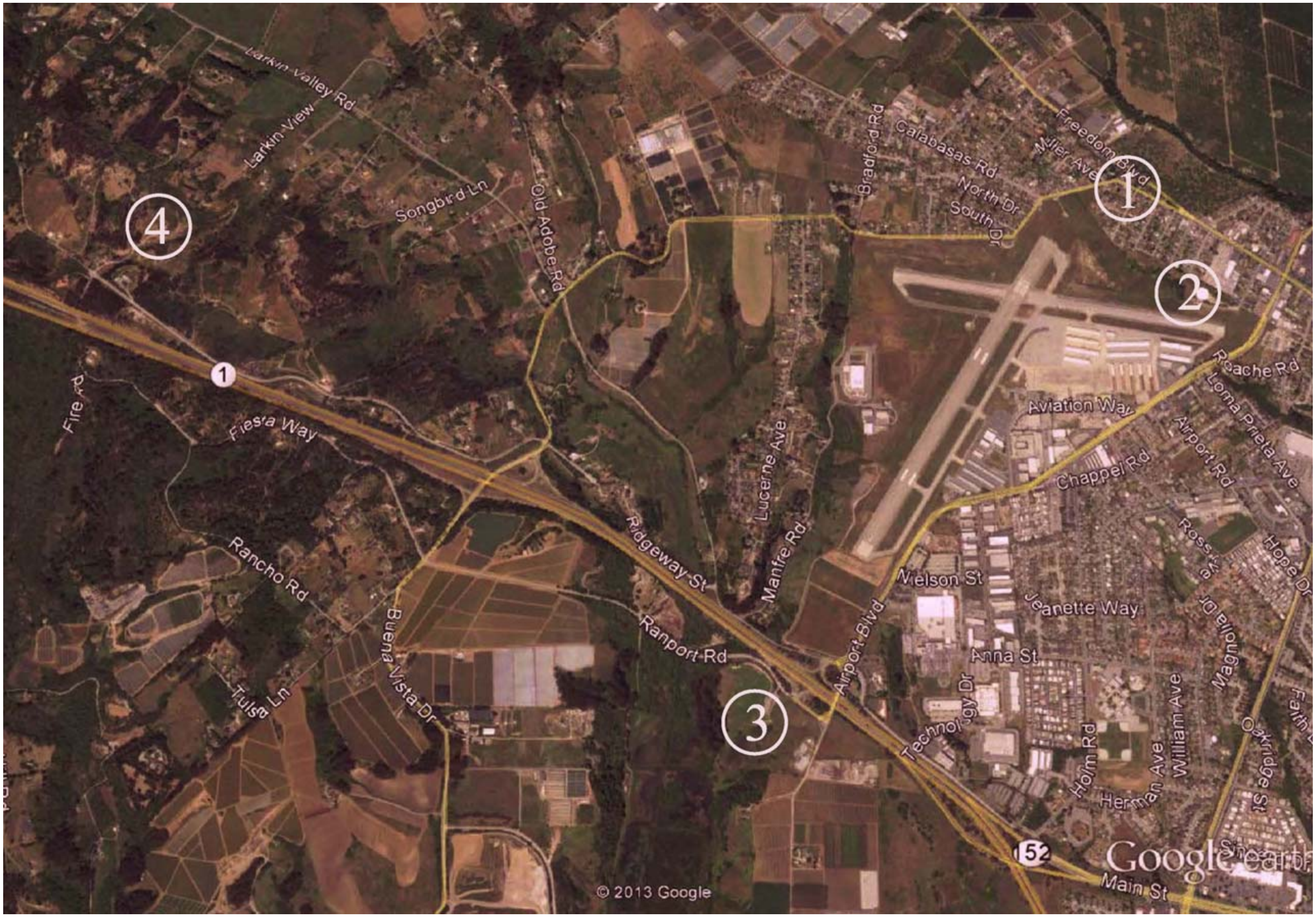


Figure 2: Generalized Departure Tracks

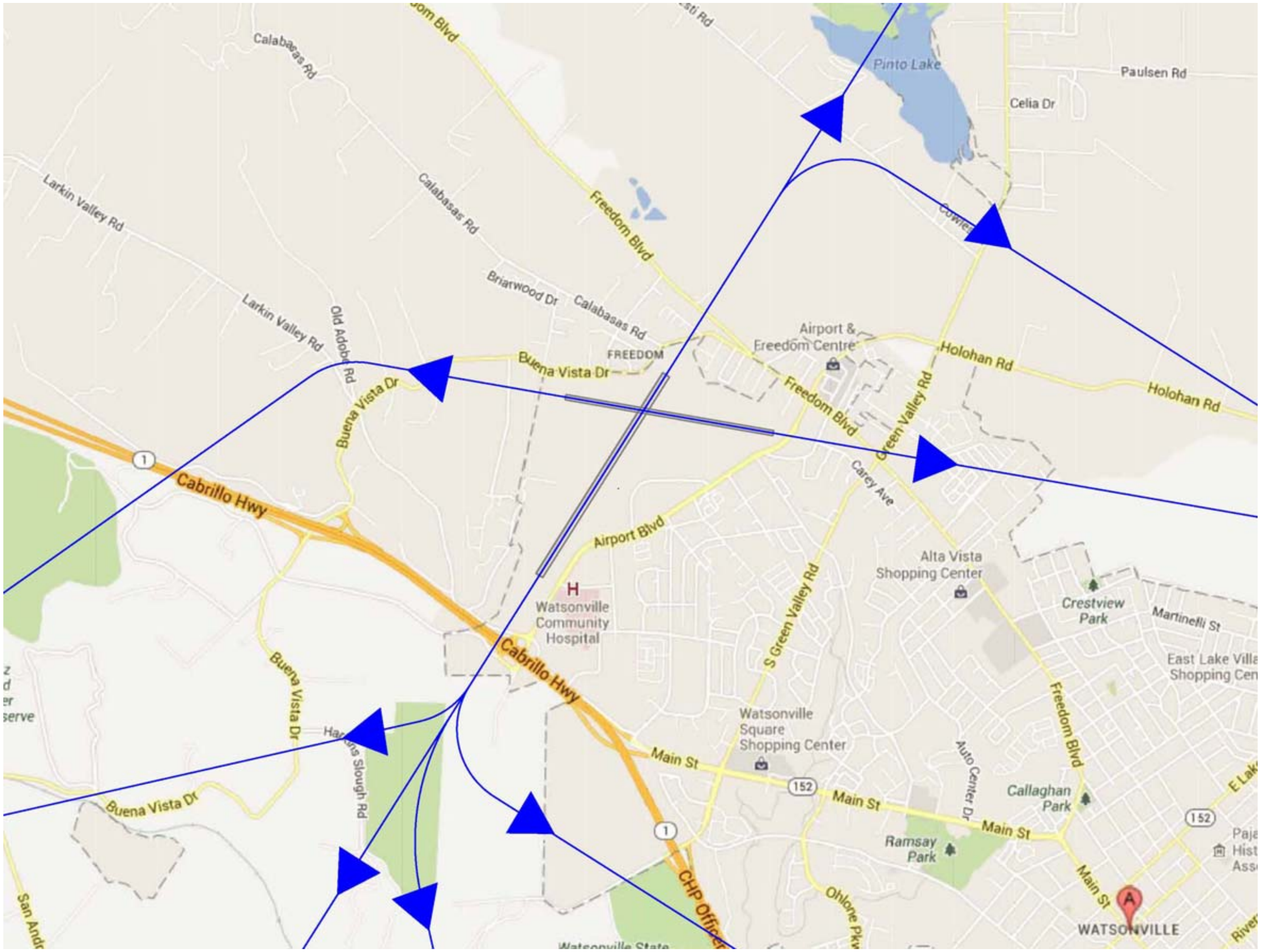


Figure 3: Generalized Arrival and Touch-and-Go Tracks

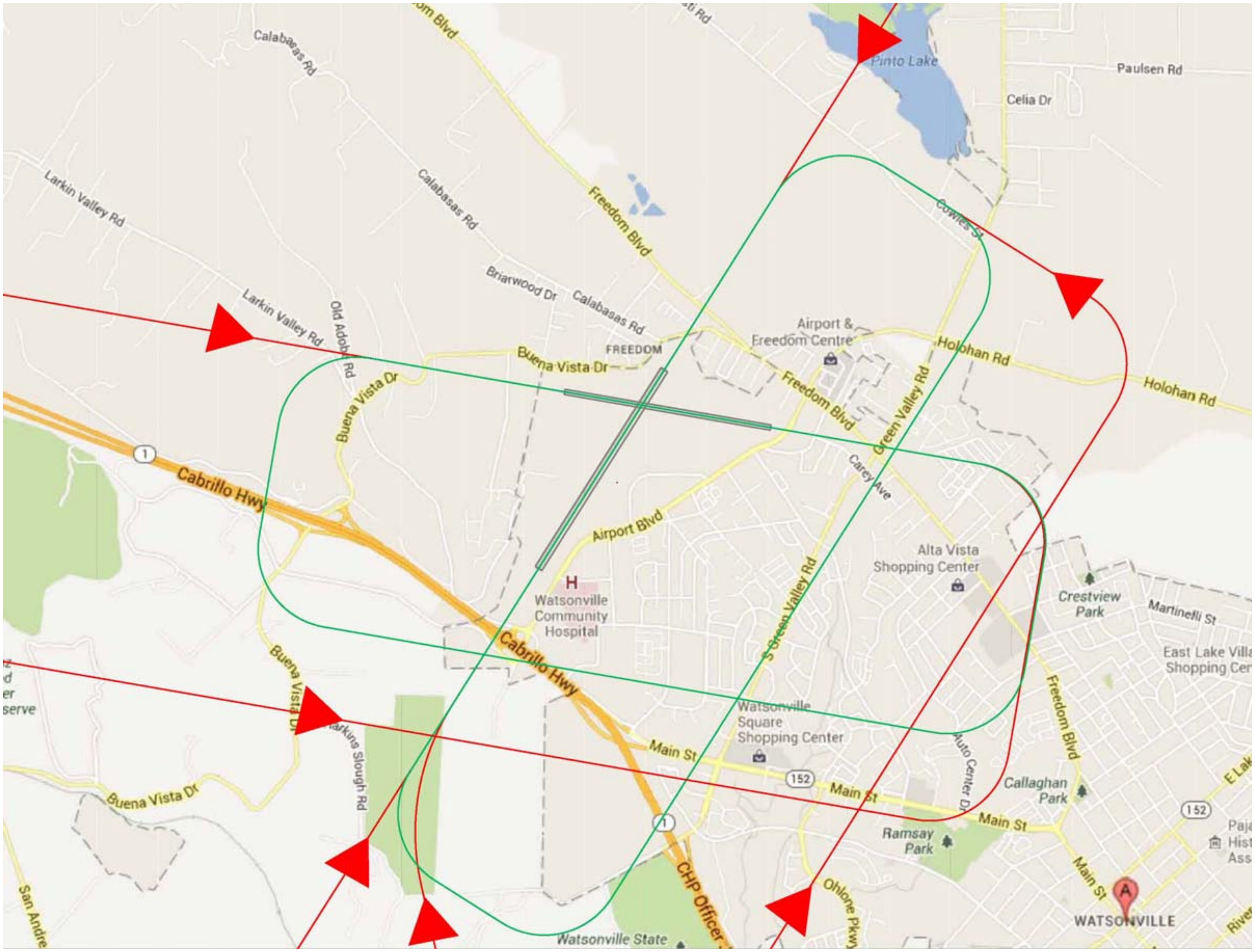


Figure 4: 2012 CNEL Contours

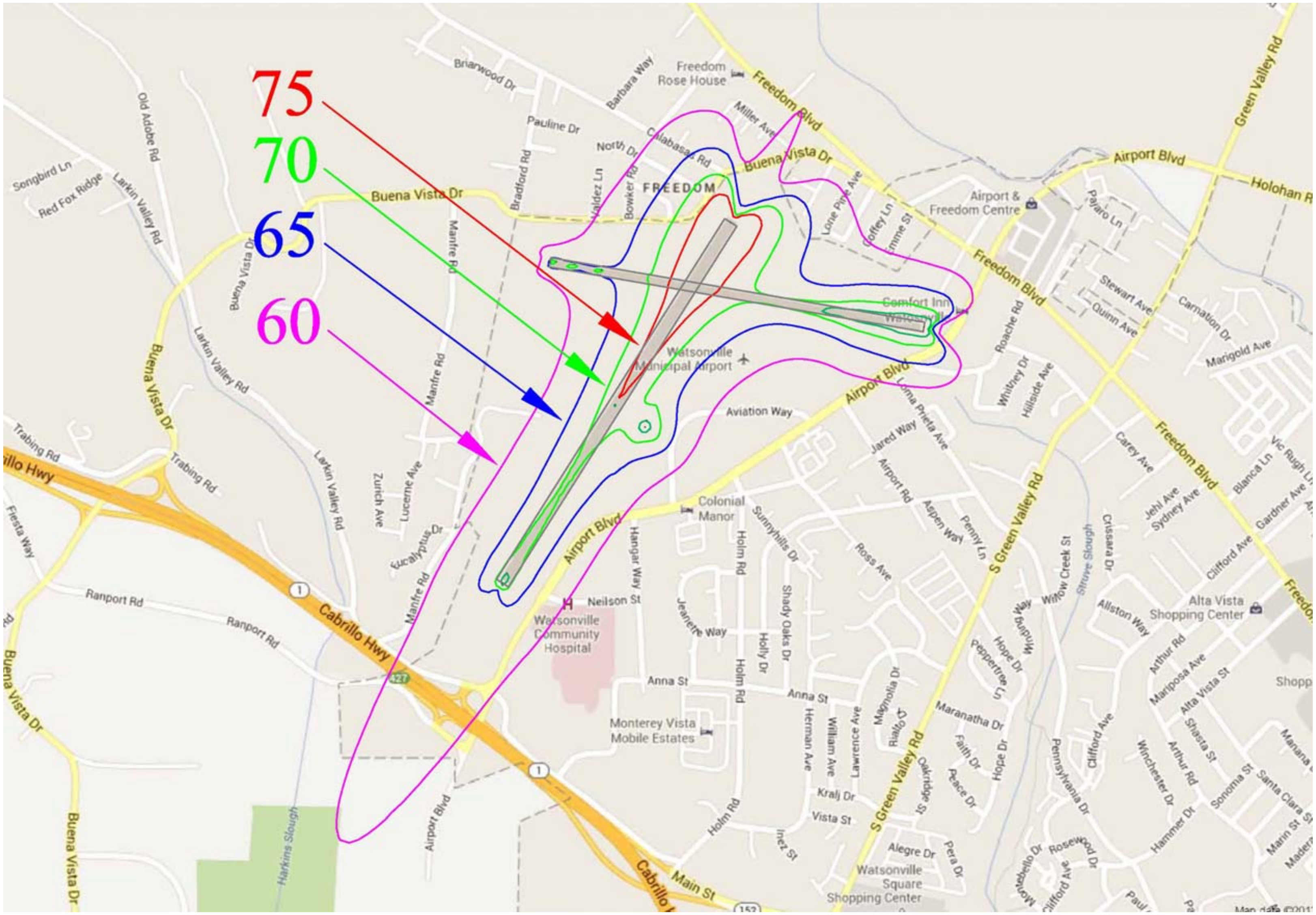
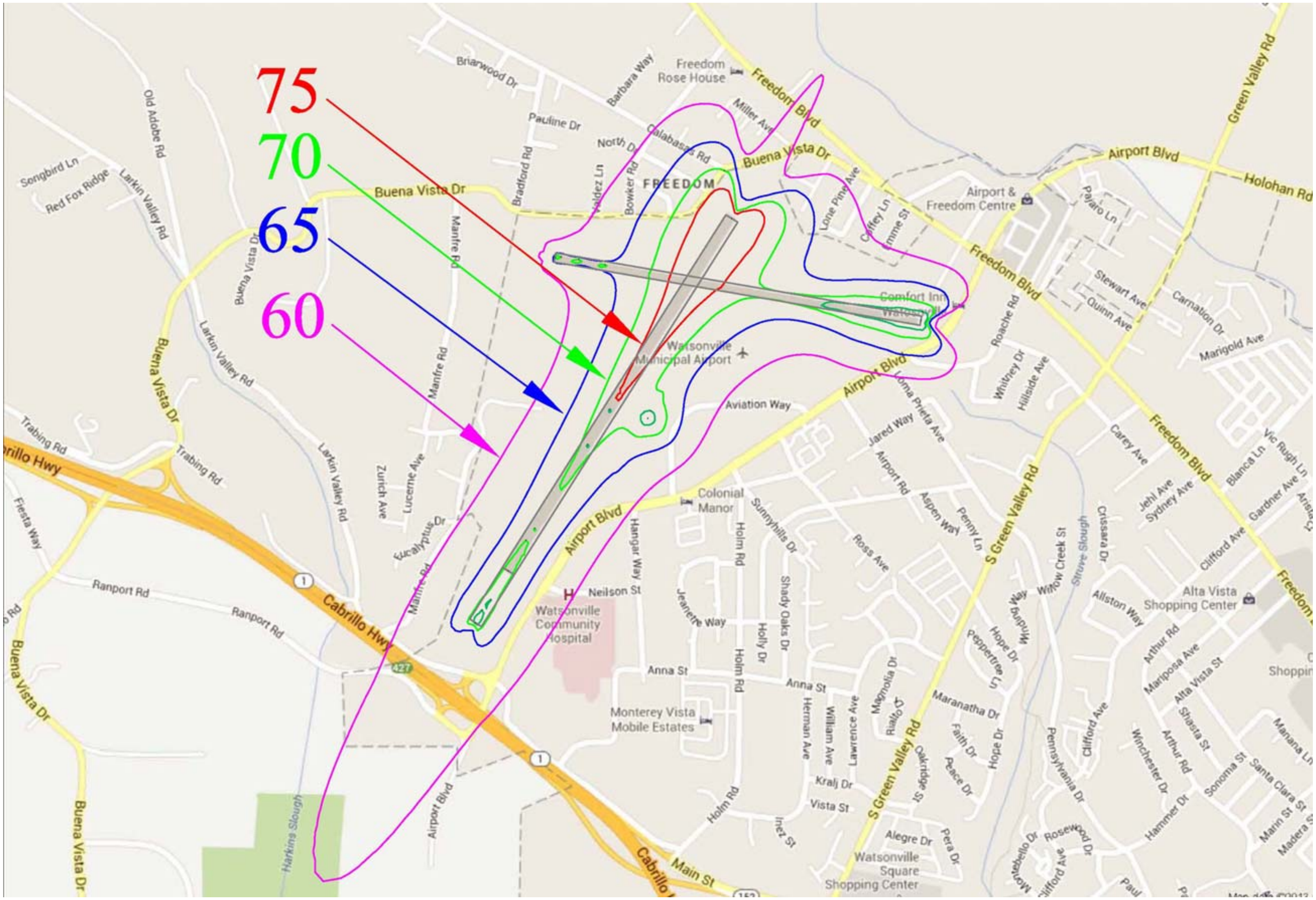


Figure 5: 2032 CNEL Contours



APPENDIX A

ACOUSTICAL TERMINOLOGY

APPENDIX A-1
ACOUSTICAL TERMINOLOGY

AMBIENT NOISE LEVEL: The composite of noise from all sources near and far. In this context, the ambient noise level constitutes the normal or existing level of environmental noise at a given location.

DECIBEL, dB: A unit for describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).

CNEL: Community Noise Equivalent Level. The average equivalent sound level during a 24-hour day, obtained after addition of five decibels to sound levels in the evening from 7:00 p.m. to 10:00 p.m. and ten decibels to sound levels in the night from 10:00 p.m. to 7:00 a.m.

L_{eq}: Equivalent Sound Level. The sound level containing the same total energy as a time varying signal over a given sample period. L_{eq} is typically computed over 1, 8 and 24-hour sample periods.

NOTE: *The CNEL represents daily levels of noise exposure averaged on an annual basis, while the L_{eq} represents the average noise exposure for a shorter time period, typically one hour.*

L_{max}: The maximum noise level recorded during a noise event.

L_n: The sound level exceeded "n" percent of the time during a sample interval (L_{90}, L_{50}, L_{10}, etc.). For example, L_{10} equals the level exceeded 10 percent of the time.

NOISE EXPOSURE CONTOURS: Lines drawn about a noise source indicating equal levels of noise exposure. CNEL contours are frequently utilized to describe community exposure to noise for noise compatibility planning.

APPENDIX A-2
ACOUSTICAL TERMINOLOGY

SEL or SENEL: Sound Exposure Level or Single Event Noise Exposure Level. The level of noise accumulated during a single noise event, such as an aircraft overflight, with reference to a duration of one second. More specifically, it is the time-integrated A-weighted squared sound pressure for a stated time interval or event, based on a reference pressure of 20 micropascals and a reference duration of one second.

SOUND LEVEL: The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear and gives good correlation with subjective reactions to noise.

APPENDIX B

EXAMPLES OF SOUND LEVELS

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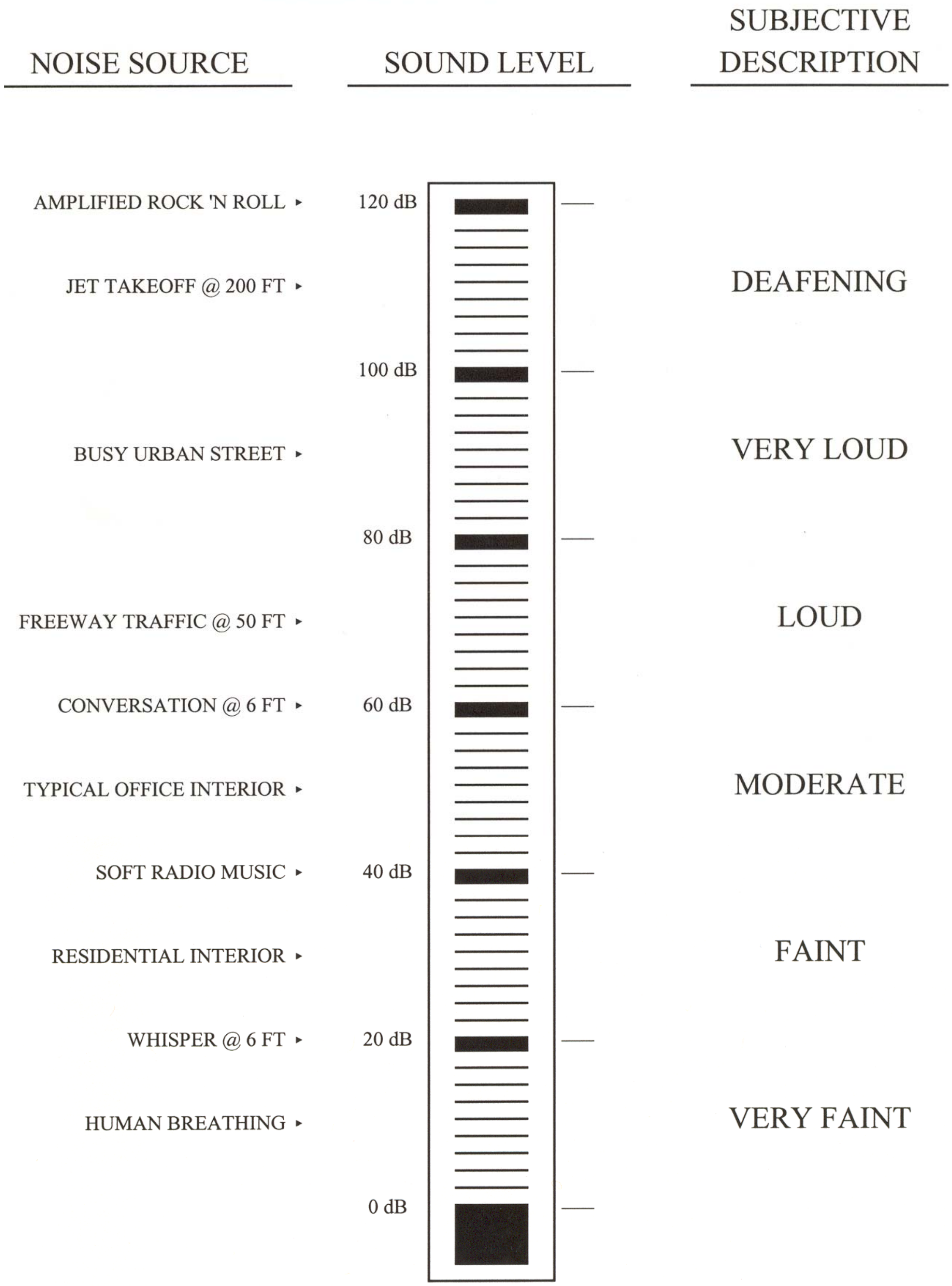
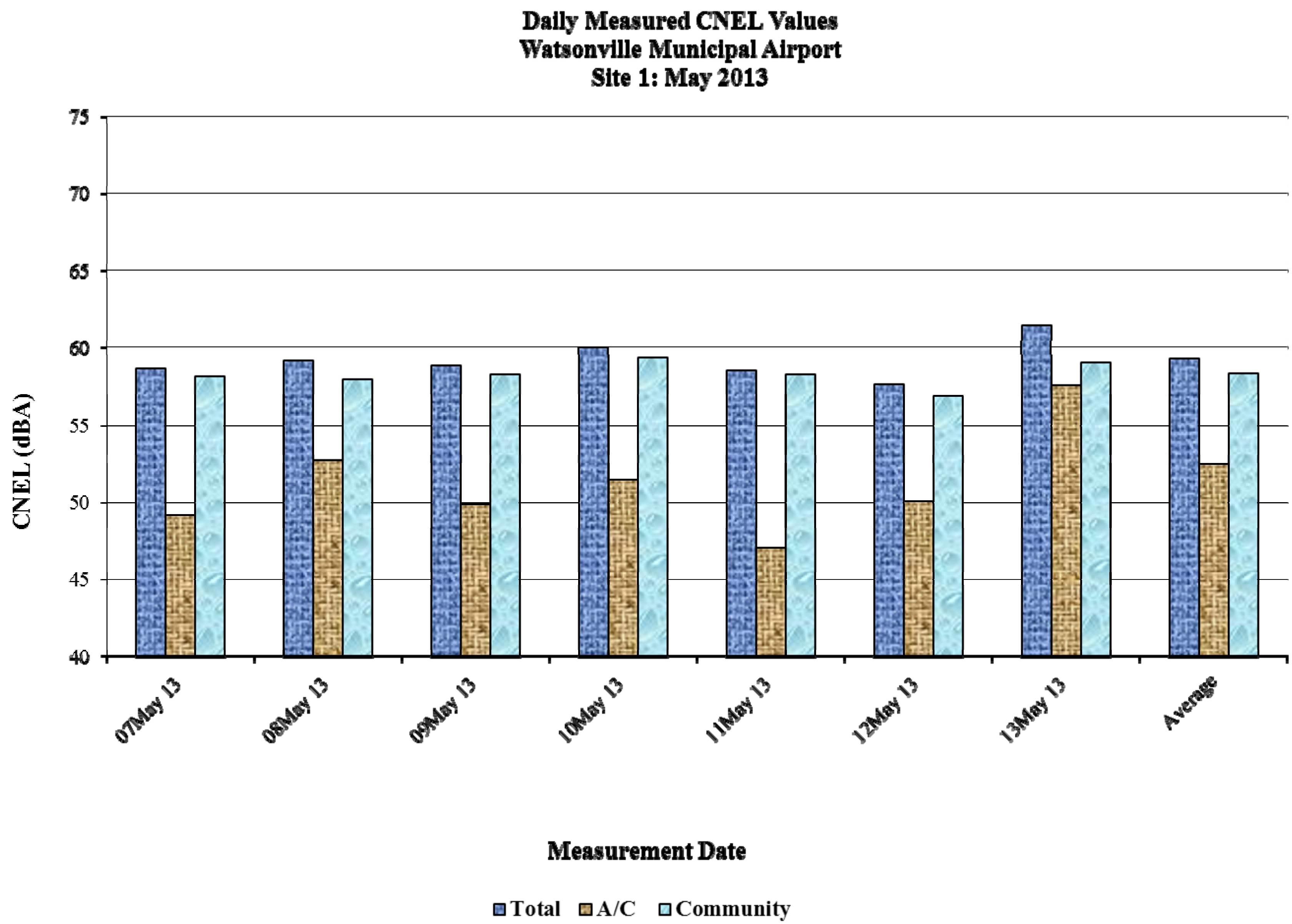
EXAMPLES OF SOUND LEVELS

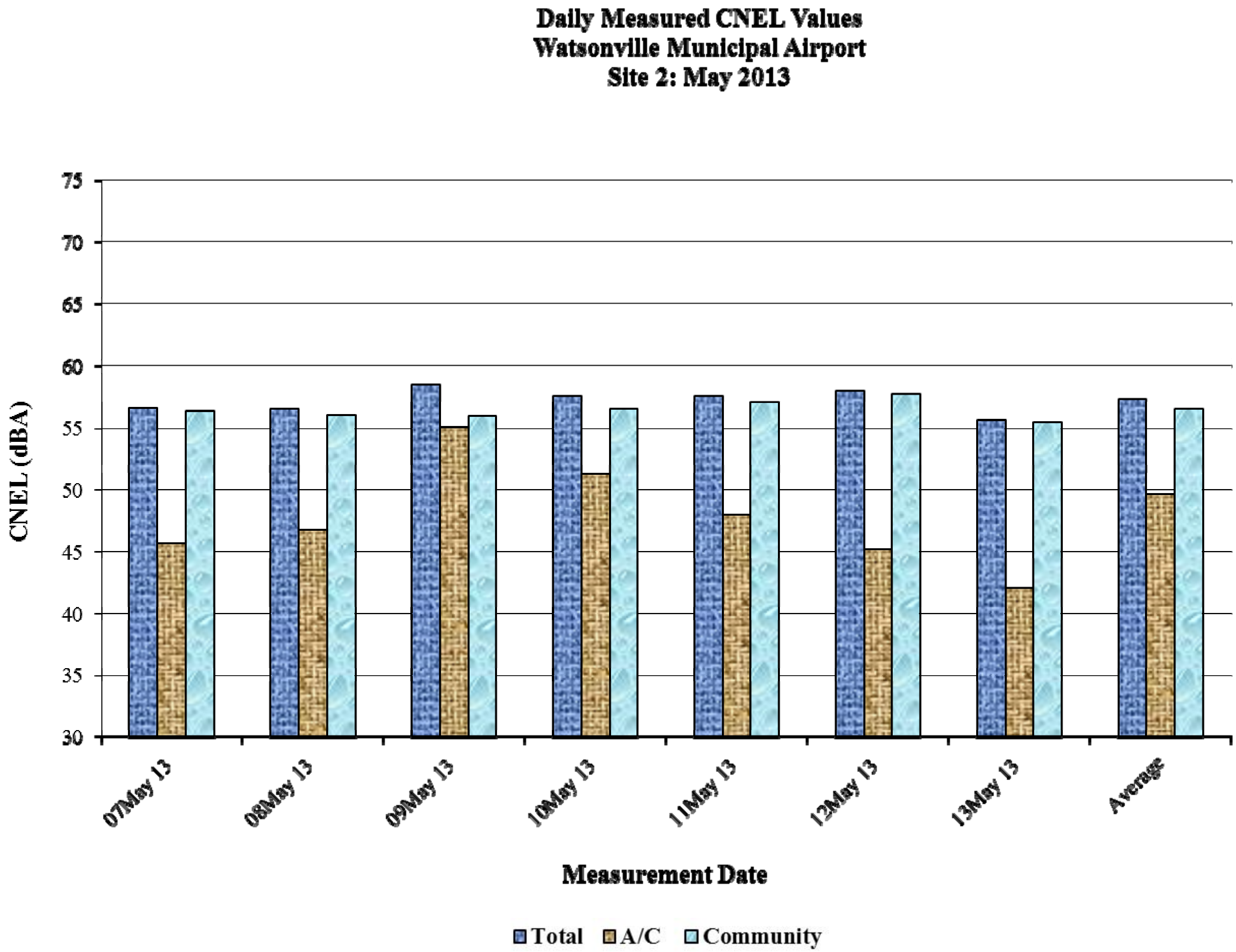


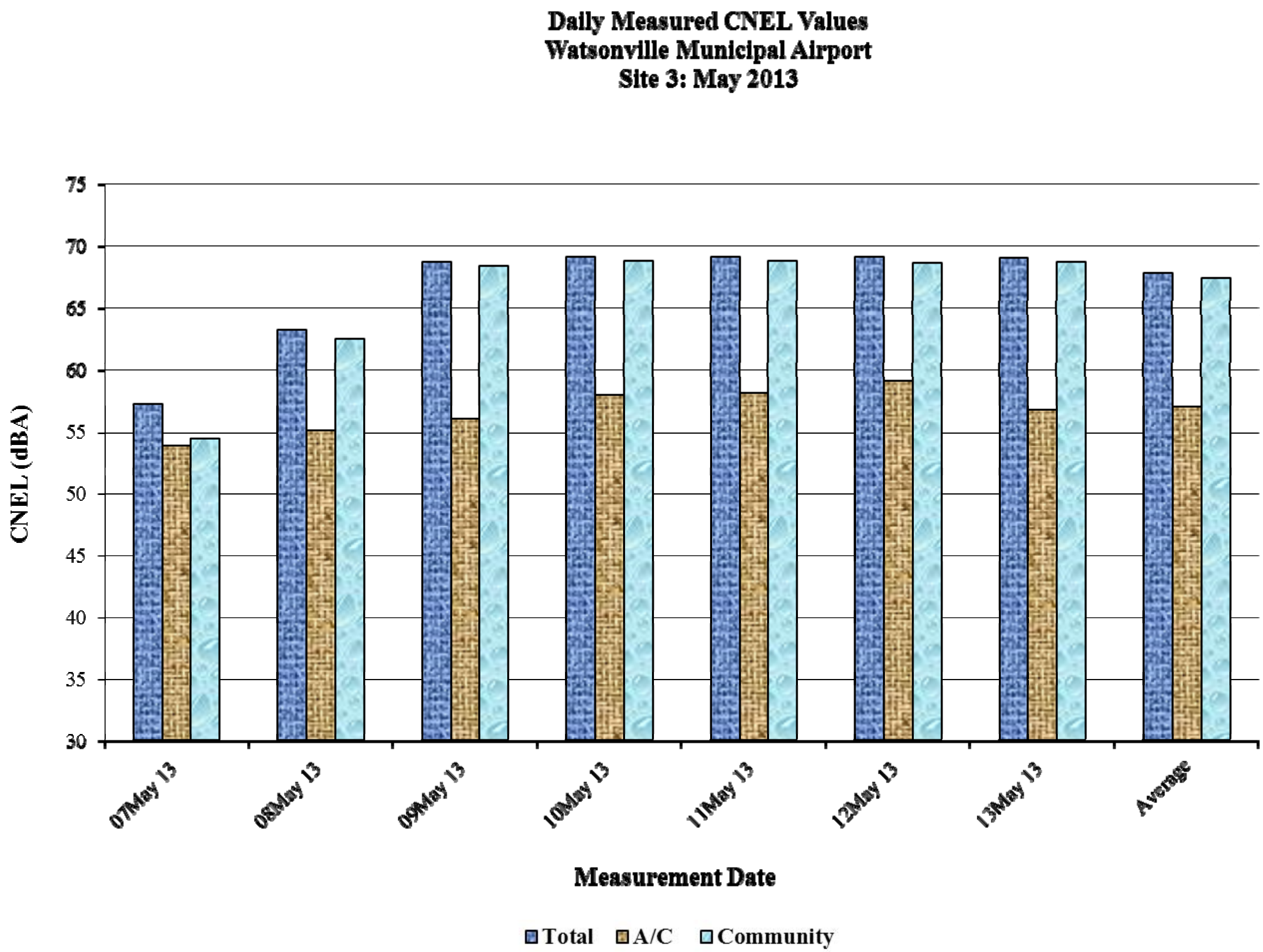
APPENDIX C

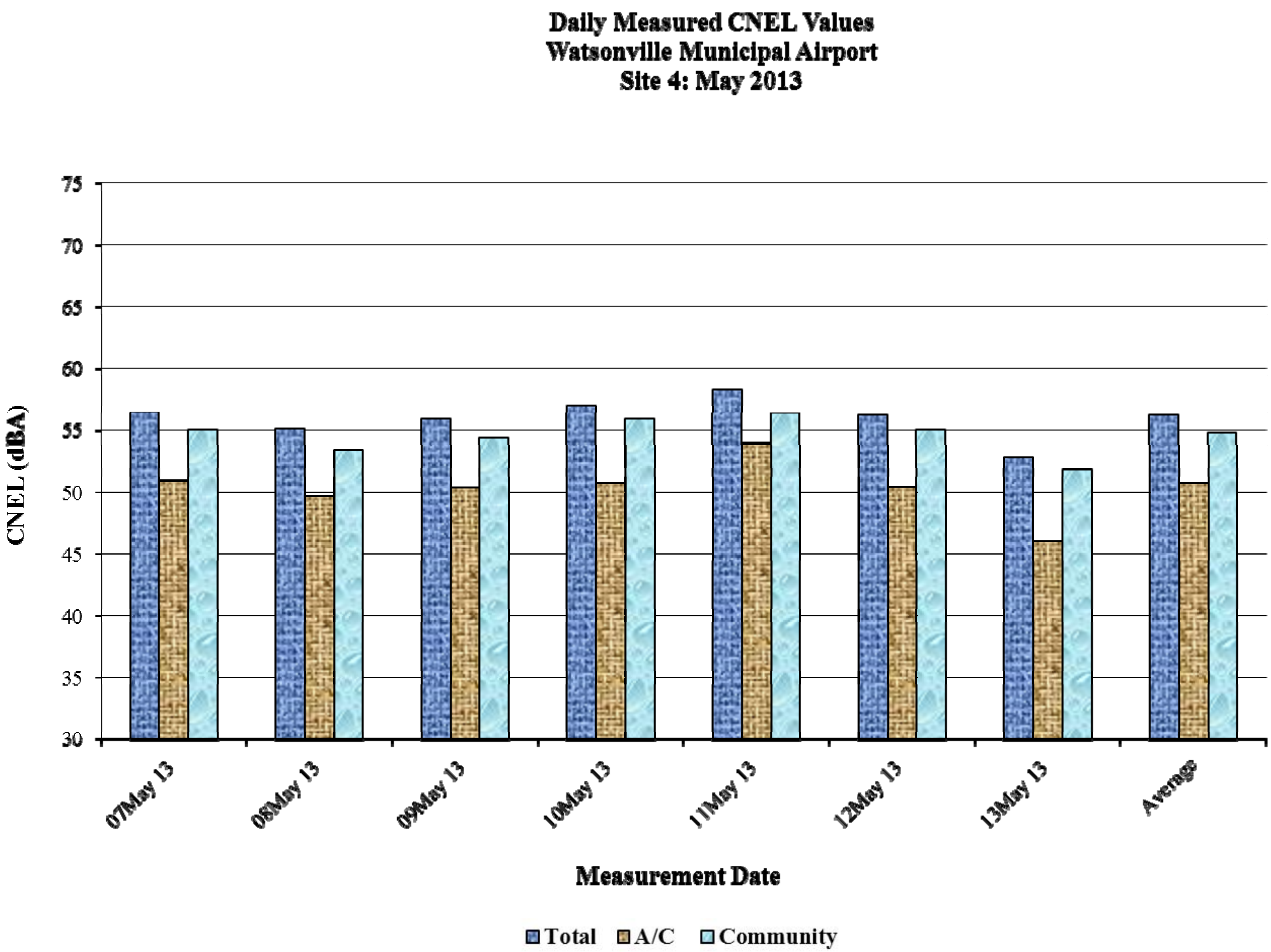
DAILY MEASURED CNEL VALUES



Daily Measured CNEL Values
Watsonville Municipal Airport
Site 1: May 2013
75
70
65
60
55
50
45
40
CNEL (dBA)
07May 13
08May 13
09May 13
10May 13
11May 13
12May 13
13May 13
Average
Measurement Date
Total
A/C
Community


Daily Measured CNEL Values
Watsonville Municipal Airport
Site 2: May 2013
75
70
65
60
55
50
45
40
35
30
CNEL (dBA)
07May 13
08May 13
09May 13
10May 13
11May 13
12May 13
13May 13
Average
Measurement Date
Total
A/C
Community


Daily Measured CNEL Values
Watsonville Municipal Airport
Site 3: May 2013
75
70
65
60
55
50
45
40
35
30
CNEL (dBA)
07May 13
08May 13
09May 13
10May 13
11May 13
12May 13
13May 13
Average
Measurement Date
Total
A/C
Community


Daily Measured CNEL Values
Watsonville Municipal Airport
Site 4: May 2013
75
70
65
60
55
50
45
40
35
30
CNEL (dBA)
07May 13
08May 13
09May 13
10May 13
11May 13
12May 13
13May 13
Average
Measurement Date
Total
A/C
Community

APPENDIX D

SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS

APPENDIX D

SUMMARY OF SINGLE EVENT NOISE LEVEL MEASUREMENTS
WATSONVILLE MUNICIPAL AIRPORT
MAY 2013

Aircraft Type	Number Sampled	SEL, dBA Mean (Range)	Lmax, dBA Mean (Range)	Azimuth
Site 1 - Arrivals on Runway 20 (5/7/13 and 5/14/13)				
Single Engine Prop.	15	68.5 (62.6-72.2)	61.0 (56.0-65.2)	15°NW-30°NW
Site 2 - Arrivals on Runway 20 (5/7/13)				
Single Engine Prop.	8	66.0 (60.5-70.2)	55.2 (49.9-59.3)	45°S
Twin Turboprop	1	70.8	63.4	45°S
Site 3 - Departures on Runway 20 (5/7/13 and 5/14/13)				
Bizjet	1	94.1	88.7	90°
Single Engine Prop.	7	84.7 (74.5-87.7)	73.7 (66.0-81.1)	90°
Twin Engine Prop	1	87.1	80.1	90°
Twin Turboprop	1	82.1	74.5	90°
Site 3 – Arrivals on Runway 02 (5/7/13 and 5/14/13)				
Single Engine Prop.	3	76.4 (	66.8	90°
Twin Turboprop	1	83.8	78.5	90°
Site 4 – Overflights (5/7/13 and 5/13/13)				
Single Engine Prop.	3	76.4 (61.0-81.1)	65.8 (61.0-72.8)	30°E-90°
Helicopter	1	64.0	54.5	30°W
Source: Brown-Buntin Associates, Inc.				