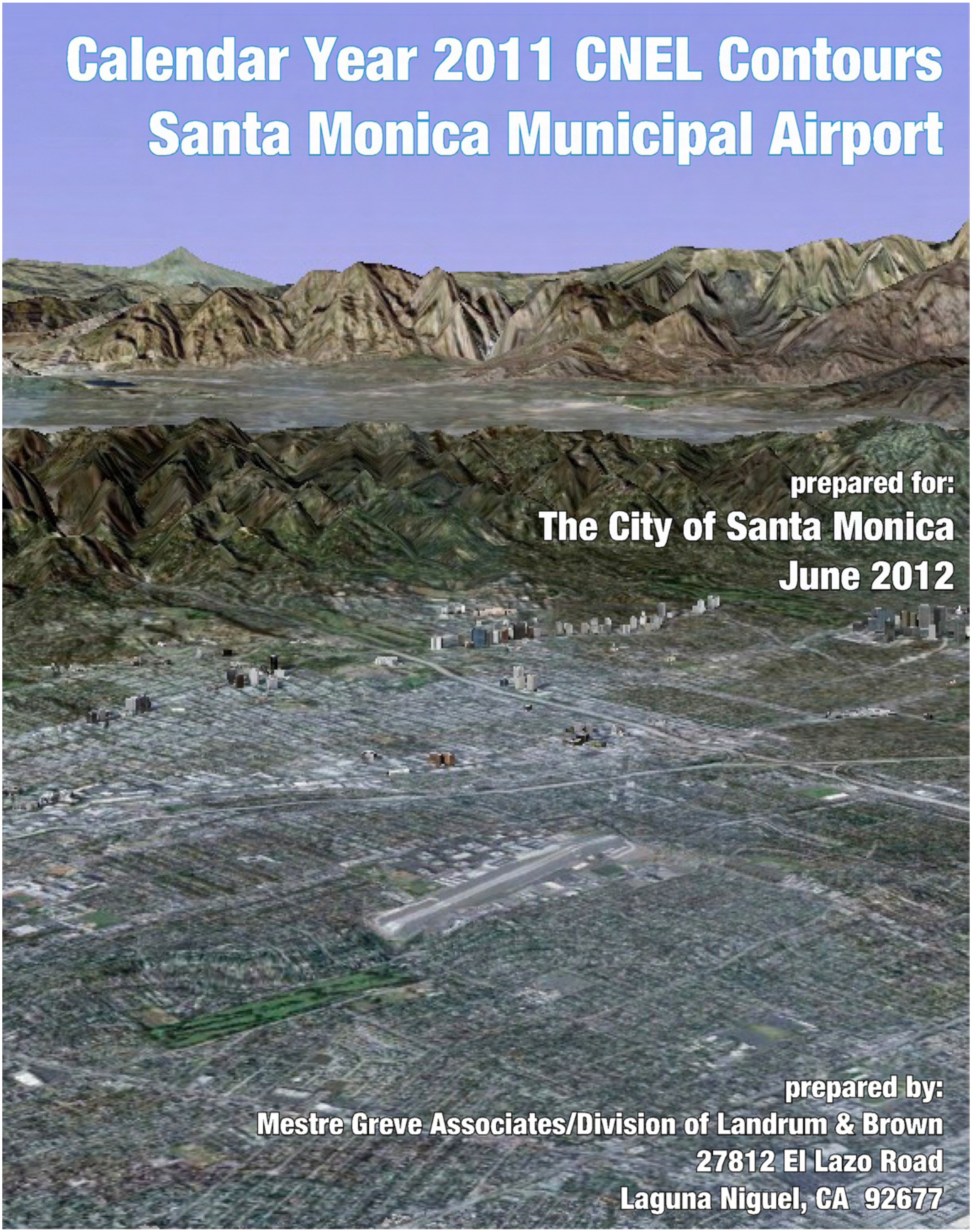
Calendar Year 2011 CNEL Contours
Santa Monica Municipal Airport



prepared for:

The City of Santa Monica

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prepared by:

Mestre Greve Associates/Division of Landrum & Brown
27812 El Lazo Road
Laguna Niguel, CA 92677

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Table of Contents

1.0 OUTLINE OF NOISE ANALYSIS

Year 2011 CNEL contours were developed using the calendar year 2011 operations and noise measurement data for the airport. The methodology used for the year 2011 CNEL contours has been updated to reflect current noise measurement data and an update in the FAA noise model.

This report contains 3 major sections including this introduction. Section 2 describes the methodology used for this study. Section 3 describes the existing noise in the environs of Santa Monica Municipal Airport including the 2011 CNEL contours. Section 4 presents historical CNEL measurement data for the airport.

2.0 METHODOLOGY

2.1 BACKGROUND

The methods used here for describing the existing noise environment in terms of CNEL rely heavily on noise measurements made by the airport's permanent noise monitoring system and computer noise modeling. The noise environment is commonly depicted in terms of lines of equal noise levels, or noise contours. These noise contours are supplemented here with specific noise data for selected points on the ground. The computer noise model used here is described in the following below.

2.2 COMPUTER MODELING

Noise contour modeling is a very key element of creating noise contours. Generating accurate noise contours is largely dependent on the use of a reliable, validated, and updated noise model. It is imperative that these contours be accurate for the meaningful analysis of airport noise.

Airport noise contours were generated using the INM Version 7.0b. [1] The original INM was released in 1977. This version, INM Version 7.0b, was released for use in September 2008 and is the state-of-the-art in airport noise modeling. The INM is a large computer program developed to plot noise contours for airports. The program is provided with standard aircraft noise and performance data for over 100 civilian aircraft types that can be tailored to the characteristics of the airport in question, as well as a database of military aircraft types. Version 7.0b represents a minor revision to the computational algorithms used in the model and an updated aircraft noise database.

One of the most important factors in generating accurate noise contours is the collection of accurate operational data. 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 optional topographical data. Operational characteristics include various types of aircraft data. This includes not only the aircraft types and flight tracks, but also departure and arrival procedures 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/Evening/Night time distribution by type
- Flight tracks
- Flight track utilization by type
- Flight profiles
- Typical operational procedures
- Average Meteorological Conditions

3.0 EXISTING NOISE ENVIRONMENT

3.1 EXISTING SANTA MONICA MUNICIPAL AIRPORT NOISE

3.1.1 SANTA MONICA BACKGROUND

Santa Monica Municipal Airport serves as a general aviation airport. The use of Santa Monica Municipal Airport is heavily regulated as a result of its limited area and facilities, environmental sensitivity of the local area, and because of a long history of airport related litigation extending back at least to the 1960's. The operation of Santa Monica Municipal Airport is regulated by Federal, State, and local laws and regulations including the 1984 Settlement Agreement.

Santa Monica Municipal Airport has a long history of noise analyses and was one of the very early airports to install a permanent noise monitoring system. Extensive data from its noise monitoring system enables accurate modeling and prediction of noise levels. Both CNEL and SENEL are monitored and calculated for each day and each aircraft operated at the airport. CNEL data are collected at each of the 6 permanent noise monitoring sites. These sites are shown in Exhibit 3-1.

The emphasis of the Santa Monica Municipal Airport noise control program, as agreed to in the 1984 Settlement Agreement, is on regulating and limiting single event noise. This is in response to residents concerns about high noise levels associated with some aircraft operations at the airport. Santa Monica is one of the very few airports that limit aircraft single event noise. Other airports that limit single event noise include John Wayne Airport, Long Beach Municipal Airport, Torrance Municipal Airport, and Hayward Air Terminal. Of these airports the noise limits vary and are difficult to compare because the location of the enforcement microphones at the various airports are not located in similar positions to the microphones at Santa Monica. Estimating the noise limits at all these airports using a common microphone location indicates that the John Wayne Airport and Long Beach Municipal Airport are much less stringent than Santa Monica (both include jet air carrier operations), Hayward Air Terminal is about 3 dB less stringent than Santa Monica and Torrance Municipal Airport noise limits are about the same as Santa Monica. No airport has limits more stringent than Santa Monica Municipal Airport.

3.1.2 EXISTING SANTA MONICA MUNICIPAL AIRPORT OPERATIONS DATA

Existing year 2011 aircraft operations at Santa Monica Municipal Airport totaled 110,694 of which some 13,180 are jet aircraft operations. These data were obtained from traffic counts kept by the FAA Air Traffic Control Tower and Santa Monica Airport staff. Note that an operation is defined as a takeoff or a landing. Therefore, 110,694 operations translate into 55,347 takeoffs and 55,347 landings during the year. The total operations represent an increase in operations from the year 2010 of approximately 5%. The jet operations represent an increase of approximately 2% relative to the year 2010. Of the total operations, 69,764 were itinerant operations and 40,930 were local operations. “Local traffic” is defined as an aircraft that stayed within the Airport’s Class D controlled airspace, generally within 5 nautical miles of the airport or within the airport traffic pattern. When counting local operations, the departure part of the touch and go is counted as one operation and the landing part is counted as another operation.

Exhibit 3-1
Noise Monitor Locations at Santa Monica Airport
Santa Monica Municipal Airport CNEL Contour Study

3.1.3 EXISTING SANTA MONICA MUNICIPAL AIRPORT FLEET MIX DATA

The type of aircraft using Santa Monica Municipal Airport were determined using the year 2006 flight information data from the airports noise monitoring system that is known as Airscene (2006 was the latest year in which a noise event to aircraft type analysis was completed). All aircraft noise events for all of the year 2006 were downloaded and analyzed by aircraft type, operation, and runway used. Not all of the aircraft types that fly at Santa Monica are represented in the INM. The INM uses substitute aircraft to represent similar aircraft types. Table 3-1 lists the jet aircraft types that were recorded at Santa Monica and the INM substitution used to model that aircraft.

Table 3-1
Jet Aircraft Flown At Santa Monica and the INM Substitution

Aircraft	INM substitution
ASTR	IA1125
BE40	MU3001
C25A	CNA500
C25B	CNA500
C500	CNA500
C501	CNA500
C550	MU3001
C551	MU3001
C560	MU3001
C650	CIT3
C750	CNA750
CL60	CL600
E135	EMB145
F900	LEAR35
FA10	LEAR35
FA20	FAL20
FA50	FAL20
G150	IA1125
GLF4	GIV
H25B	LEAR35
LJ31	LEAR35
LJ35	LEAR35
LJ45	LEAR35
LJ55	LEAR35
MU30	MU3001
WW24	IA1125

Note: Aircraft names are shown using Santa Monica/Air Traffic Control 4 letter code and the INM Substitution name is the INM aircraft naming convention.

The annual operations data were then summarized by aircraft type using the INM aircraft types available. Single Engine propeller aircraft were divided into high performance singles (GASEPV) for aircraft such as the Bonanza, C210 and Cirrus 22 aircraft and low performance (GASEPF) for aircraft such as the C150 and C172. Table 3-2 presents a summary of the annual operations by aircraft type used in the noise modeling. Note that the airport noise monitoring system does not record all flights and some flights are labeled as 'unknown' if the aircraft is flying under visual flight rules (VFR) and does not broadcast its identification. The single engine propeller aircraft operations were adjusted to increase these operations in order to replicate the total operations as reported by the FAA Tower in its annual operations report.

Table 3-2
Summary of 2011 Annual Operations By Aircraft Type

Itinerant:		
	GASEPV	4,640
	GASEPF [itinerant]	46,852
	BEC58	3,112
	CNA441	1,980
	CIT3	201
	CL600	768
	CNA500	1,024
	CNA750	1,288
	EMB145	359
	FAL20	237
	GIV	1,549
	IA1125	231
	LEAR35	3,150
	MU3001	4,372
Local:		
	GASEPF	40,930
Total:		110,694

3.1.4 SANTA MONICA MUNICIPAL AIRPORT RUNWAY AND FLIGHT TRACK UTILIZATION

The flight tracks at Santa Monica Municipal Airport are well established to take advantage of the runway configuration and prevailing wind conditions. Runway 3/21 is approximately 5,000 feet long and is the only runway at the airport. With winds predominantly coming from the ocean, aircraft typically depart to the west and arrive from the east on Runway 21. Only during Santa Ana wind conditions or other winds that move toward the ocean does the flow reverse with departures to the east and arrivals from the west. East flow occurred approximately 4 percent of the time in 2011.

Departures to the west are grouped into 2 major tracks. Small aircraft doing visual departures follow a track that proceeds over the golf course and pilots are instructed to not turn prior to Lincoln Boulevard to the south and the shoreline to the north or east. Larger aircraft doing instrument departures proceed straight along the extended runway centerline. All twins, turboprops, and business jets were modeled on the straight out departure. These aircraft are generally doing an Instrument Flight Rules (IFR) departure and are instructed to fly runway heading departures. Arrivals are from the east and are on a straight in track by the time they get within the airport environs. The local pattern is a left hand pattern. INM flight tracks are shown on Exhibit 3-2 and a sample of radar flight tracks are shown in the attachment. The tracks were refined using radar data collected from the airport's Airscene system. Sample radar tracks are attached to this report. When winds dictate flow to the east, the aircraft are assumed to operate on straight in and straight out flight tracks.

The day/evening/night distribution of operations was derived from noise monitoring system data for the year 2007 (the last year in which a day/evening/night database was compiled). The data logs show 90.8 percent of the operations during daytime hours (7 am to 7 pm), 7.8 percent during the evening hours (7 pm to 10 pm), and 1.4 percent of the operations during the night hours (10 pm to 7 am).

3.1.5 SANTA MONICA MUNICIPAL AIRPORT NOISE MONITORING DATA

The remote monitoring sites were shown in Exhibit 3-1. The CNEL measured at each of these sites during calendar year 2011 are shown in Table 3-3.

Table 3-3
CNEL Measured During Calendar Year 2011

Site	2011 CNEL, dB
1	56.8
2	53.5
3	56.5
4	58.5
5	60.8
6	57.3

Note that in 2011 the noise monitoring system parameters were modified. The system uses a fixed threshold to determine noise events which are then correlated to radar flight tracks to determine which noise events are aircraft versus non-aircraft noise events. This resulted in more noise events being captured and the noise levels increased at all of the sites except site 6 as a result of this refinement in aircraft noise identification. Further evaluation of the aircraft identification parameters should be considered for next year to refine the system ability to separate aircraft from non-aircraft noise. Such an evaluation would examine the noise event to aircraft radar track matching parameters in the system.

The noise monitoring system data were reviewed by aircraft type to determine the single event noise levels associated with each aircraft type. This was done in 2006 (since the aircraft types have not changed significantly, this is the latest year that analysis was completed) in order to develop aircraft flight profiles needed to use in the INM in order to get noise model results to match noise measurement results. Because of the strict noise limits at Santa Monica Airport, aircraft generally use procedures that are not represented by the typical aircraft flight procedures that are contained in the INM. Exhibit 3-3 shows the results of the SENEL analysis by aircraft type for noise measurements made at site RMS 1 for aircraft departures and site RMS 2 for aircraft arrivals. Note that the quantity shown is the energy average SENEL. Energy average is a form of averaging used for logarithmic data such as decibels. The energy average is biased towards the higher values in the distribution. For example, the more typical arithmetic average of the 2 numbers 50 and 100 is a value of 75. But the energy average of the decibel values 50 and 100 results in an energy average of 97 decibels. Note also that in computing the averages, the number used for the sample size was the actual number of measured noise events plus the number of noise flights that were tracked but did not generate a noise event. For the flights that did not generate a noise event and assumed SENEL was included that was based on the loudest an aircraft could be without triggering a noise event in the noise monitoring system. Note also that aircraft types shown in Exhibit 3-3 represent the aircraft indicated plus all the aircraft for which this aircraft was the INM substitute. For example, the noise level for the aircraft shown as the MU3001 included the Beechjet 400, C550, C551, and the C560 aircraft.

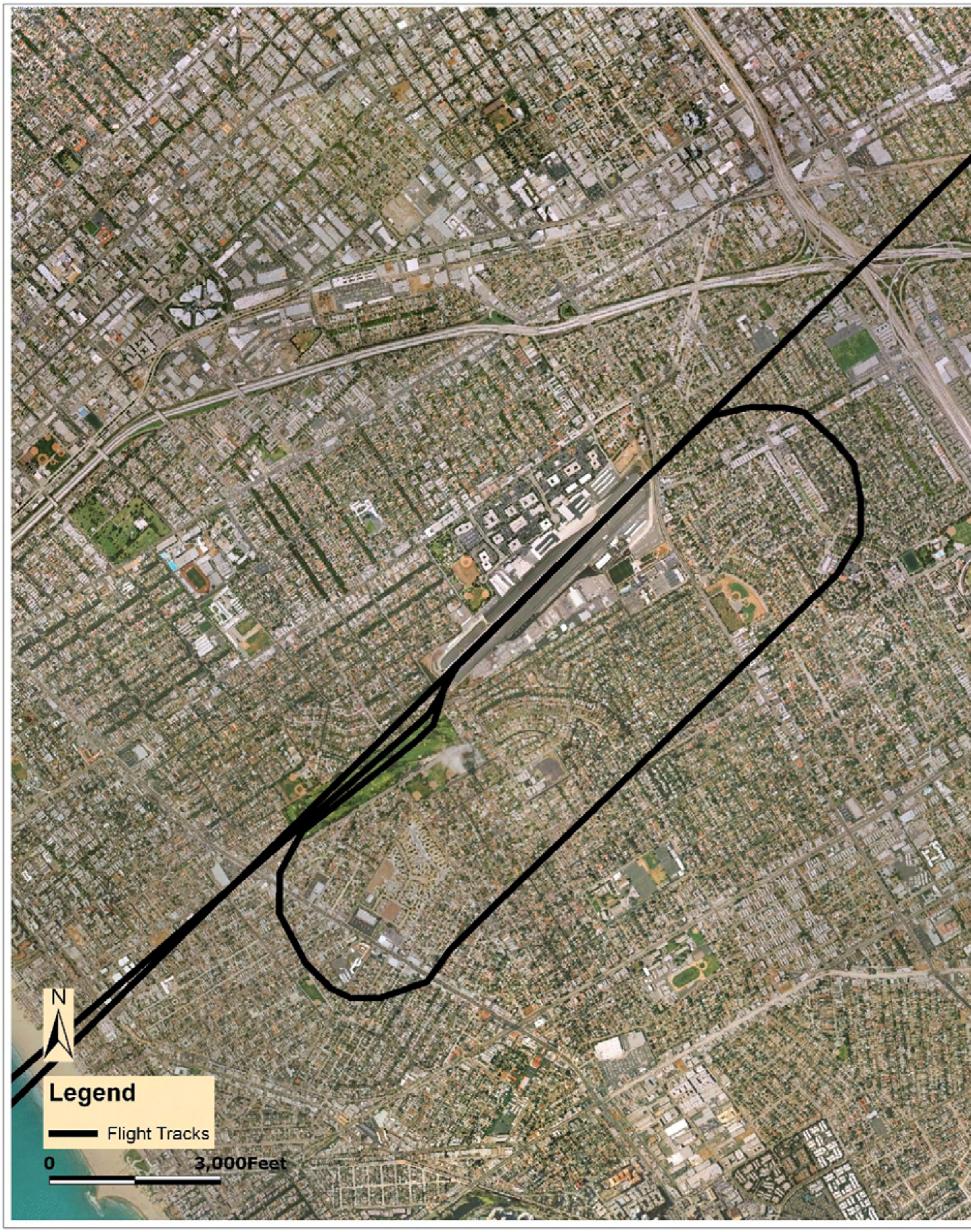
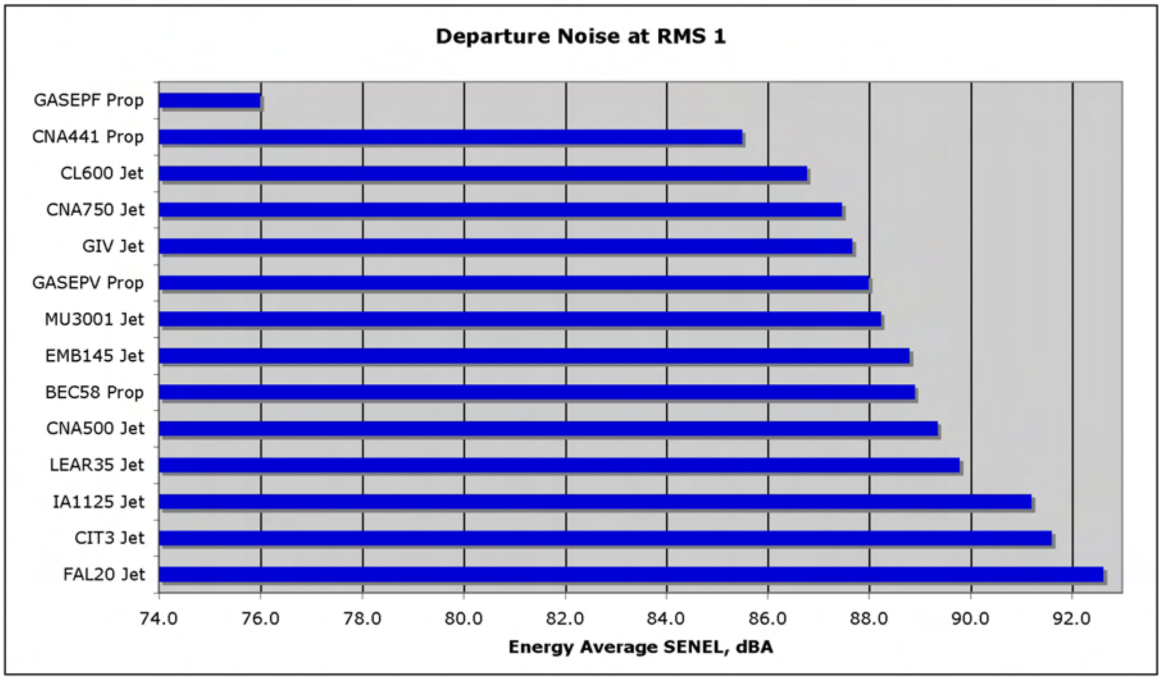


Exhibit 3-2
Flight Tracks Used For INM Modeling at Santa Monica Airport
Santa Monica Municipal Airport CNEL Contour Study



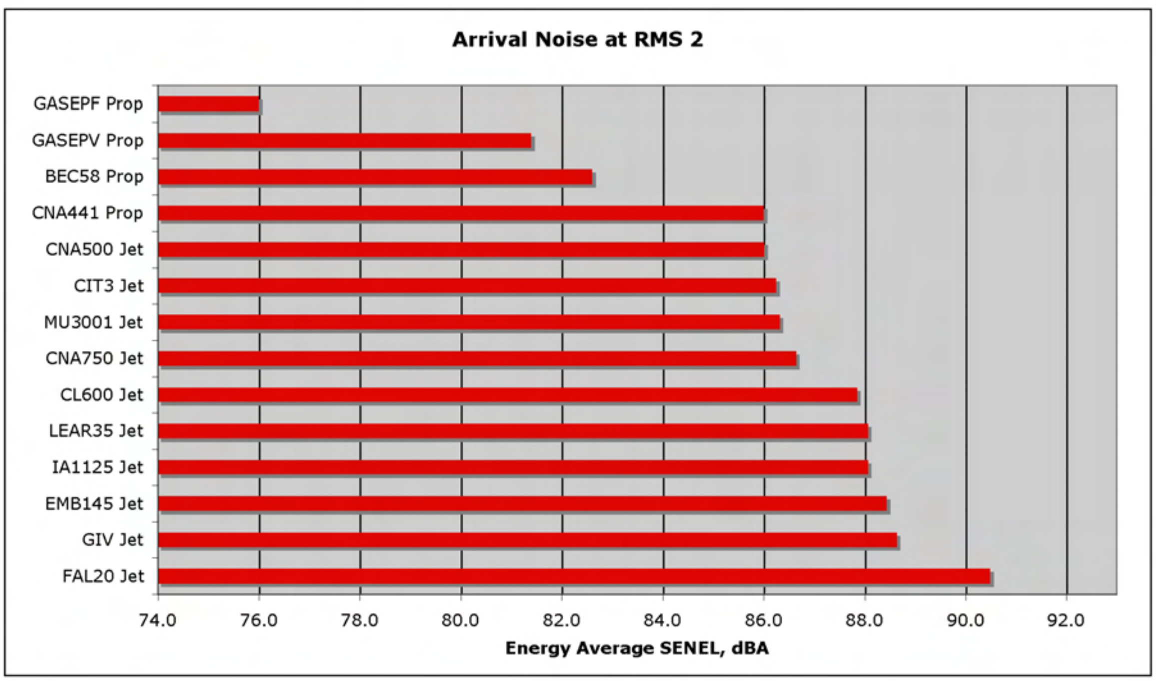


Exhibit 3-3
Energy Average SENEL By Aircraft Type
Santa Monica Municipal Airport CNEL Contour Study

3.1.6 Santa Monica Municipal Airport Year 2011 CNEL Contours

The CNEL contours used to depict existing noise exposure at Santa Monica Municipal Airport were developed using the INM Version 7.0b. The 60, 65 and 70 dB CNEL contours are depicted on Exhibit 3-4. Table 3-4 compares the measured CNEL with the CNEL predicted by the INM model at the 6 measurement sites.

Table 3-4
Comparison of Measured CNEL with Modeled CNEL

Site	Measured CNEL	Modeled CNEL
1	56.8	55.6
2	53.5	53.0
3	56.5	53.7
4	58.5	53.2
5	60.8	60.2
6	57.3	62.3

The comparison of measured versus modeled results is complicated by the recent resetting of the noise event thresholds at the monitors. Site 1 noise increased by 2 dBA as a result of that change, while Site 2 only changed by 0.5 dBA. The match at Site 1 is still good, but not as good as Site 2. Note that a noise monitoring system is expected to provide an overall end-to-end accuracy of at least plus or minus 1.5 dB CNEL. The measurement system, while very good, cannot match the human ear and brain for identifying sound sources. Computers, with appropriately connected microphones, can measure sound level accurately, but cannot identify the sound source precisely. Near the airport the aircraft sound can be more successfully classified than at more remote sites where ambient noise can confuse the system. These data should be reviewed again in the future and further refinement may be necessary.

Some caution is warranted when reviewing the noise contours. The noise contours at the east end of the airport are shaped by 2 types of operations, arrivals to Runway 21 and noise aft of the aircraft generated during departure on Runway 21. The noise generated aft of the aircraft during pre-takeoff engine run and takeoff roll is modeled in the INM using a generic aircraft directional pattern that may or may not be representative of the aircraft that operate at Santa Monica Municipal Airport.

CNEL tends to be more influenced by the noise levels associated with the most frequently flown aircraft as opposed to the noise associated with a few very loud aircraft. Historically, jet aircraft tend to produce the highest single event noise but the CNEL was dominated by the more frequently flown high performance single engine propeller aircraft. As the number of propeller aircraft operations at the airport has dropped and the number of jets has increased, there is no clearly dominate aircraft type at Santa Monica.

Exhibit 3-4
Year 2011 CNEL Contours Santa Monica Airport
Santa Monica Municipal Airport CNEL Contour Study

4.0 HISTORICAL NOISE MONITORING DATA

4.1 HISTORY OF CNEL MEASUREMENT DATA, 1988 TO 2011

The original noise monitoring system was installed in the 1970's and replaced in 1988. The present noise monitoring system has been in operation since 1988 and a major system software upgrade completed in 2004. The historical CNEL data from the existing system are plotted in Exhibit 4-1. Note that the apparent increase in noise level for 2011 is due to both an increase in jet and propeller operations from the year 2010 to 2011 as well as retuning of the noise event filter in the noise monitoring system.

CNEL measurements recorded prior to 1988 are available and were reported occasionally. Data for the years 1982, 1983, 1985 and 1987 were found for Site 1. These are listed in Table 4-1.

Table 4-1
Pre-1988 CNEL Measurement Data for Site 1

Year	CNEL
1982	62.1
1983	61.5
1985	58.8
1987	57.9

5.0 REFERENCES

1. U.S. Department of Transportation, Federal Aviation Administration, "Integrated Noise Model (INM) Version 7.0 User's Guide," April, 2007.

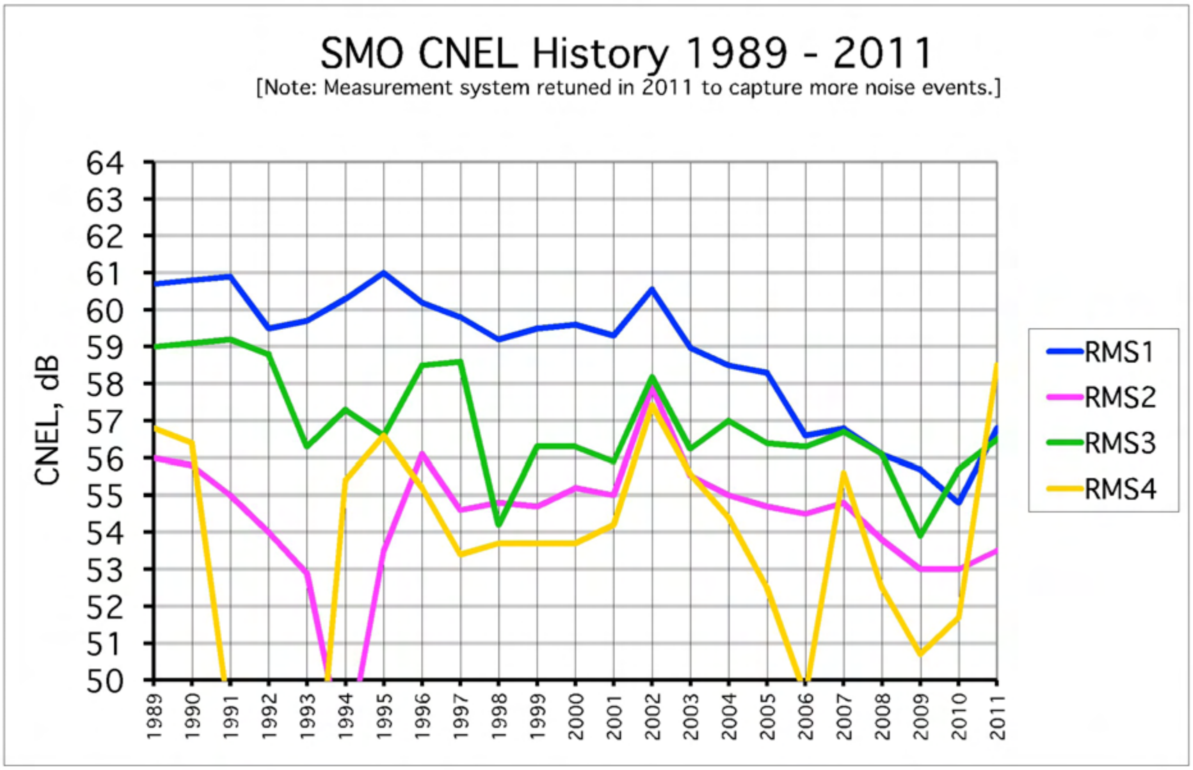
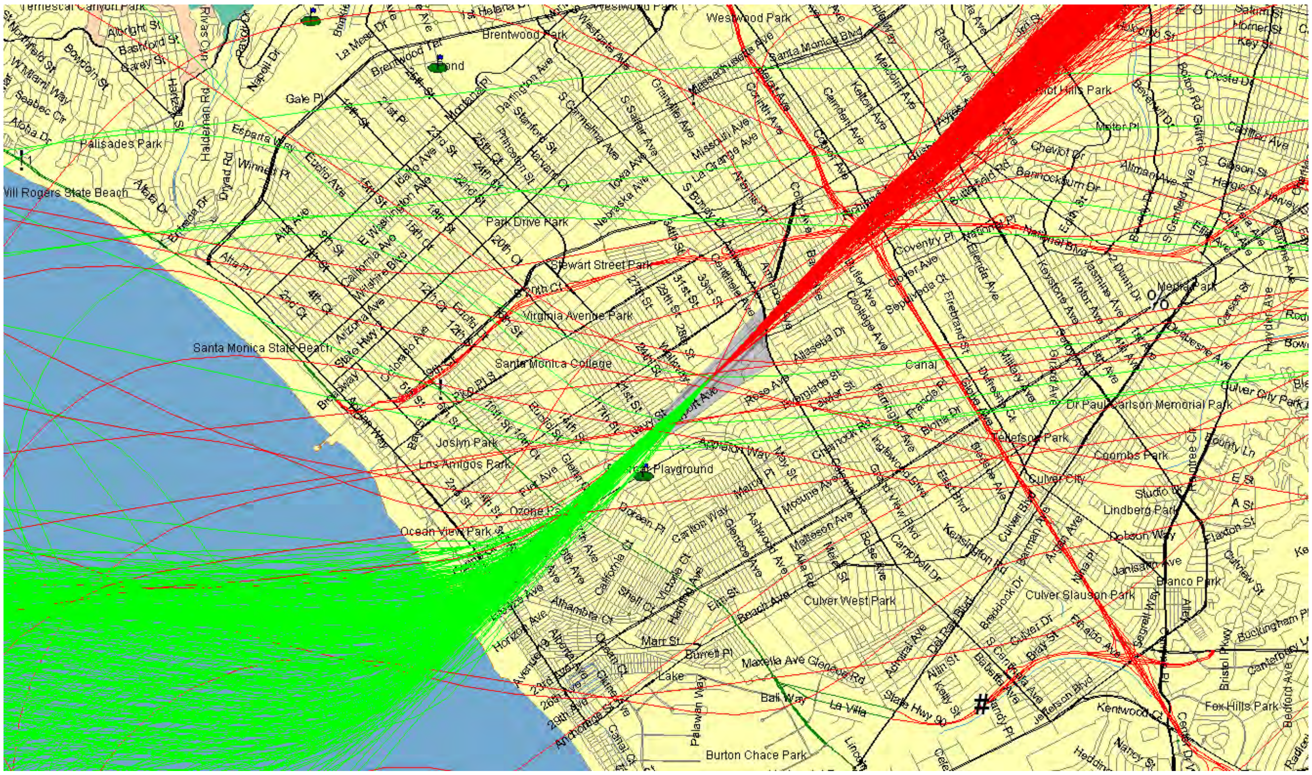


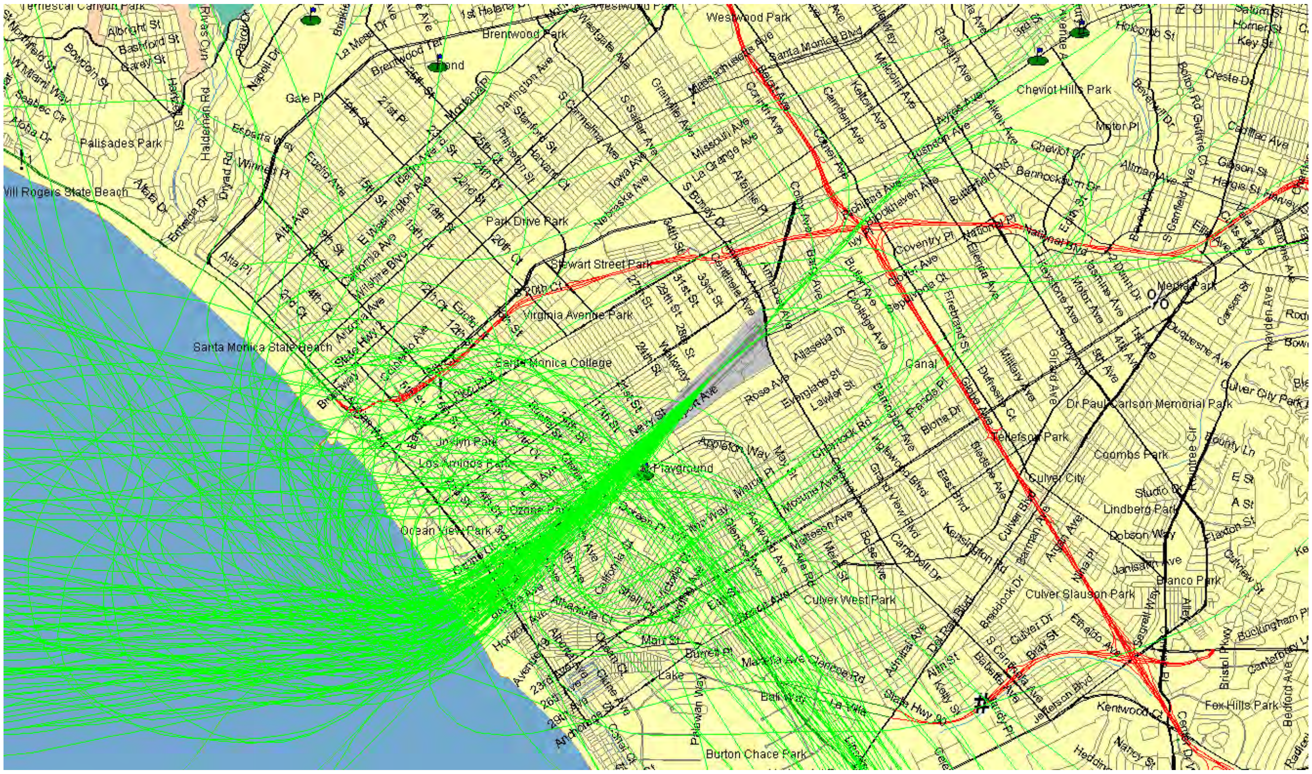
Exhibit 4-1
History of CNEL, Sites 1 - 4, 1989 - 2011
Santa Monica Municipal Airport CNEL Contour Study

Attachment

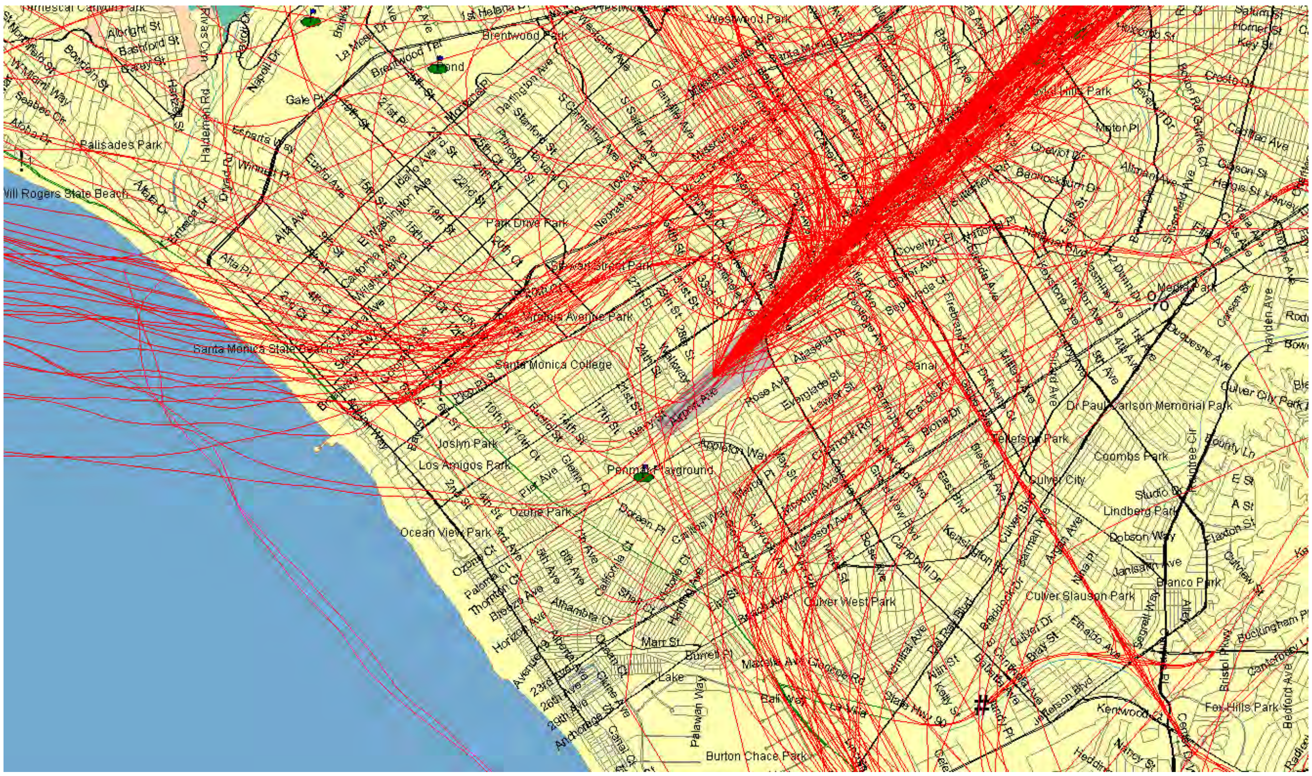
Sample Radar Tracks From Airscene



Sample of Jet Operations (August 11 – 31, 2011)
[green = departures, red = arrivals]



Sample of Propeller Departures (August 1 – 8, 2011)
[green = departures]



Sample of Propeller Arrivals (August 1 – 8, 2011)
[red = arrivals]