CHAPTER 6

AIRCRAFT NOISE ANALYSIS

6.0 INTRODCUTION

Aircraft noise contours were developed to help visualize sound generated by aircraft operations as part of the Airport Master Plan. Aircraft noise contours are used to support land use compatibility measures and to analyze how the Airport influences nearby properties. The noise contours will identify and quantify the potential land use incompatibilities associated with existing and future operations on the existing runway layout, and ultimate operations following implementation of a new Runway 3L/21R.

Noise contours are presented in three scenarios and data used to generate the contours is included. Also included is a discussion on the effects airport noise has on a population and how metrics are used to help quantify aircraft noise.

6.1 AIRCRAFT NOISE

Aircraft noise is one of the more noticeable attributes associated with living and working near an airport. To understand aircraft noise and its effect on people, it is important to understand the physics of sound. Sound is a type of energy which travels in the form of a wave. Sound waves create minute pressure differences in the air which are recognized by receptors including the human ear and microphones. Sound waves can be measured using decibels (dB) to measure the amplitude or strength of the wave and Hertz (Hz) which measures the frequency or pitch of the wave.

The strength, or loudness, of a sound wave is measured using decibels on a logarithmic scale. The range of audibility of a human ear is 0 dB (threshold of hearing) to 125 dB (pain begins). The use of a logarithmic scale often confuses people because it does not directly correspond to the perception of relative loudness. A common misconception is that if two noise events occur at the same time, the result will be twice as loud. In reality, the event will double the sound energy, but only result in a 3 dB increase in magnitude. For a sound event to be twice as loud as another, it must be 10 dB higher.

Scientific studies have shown that people do not interpret sound the same way a microphone does. For example, humans are bias and sensitive to tones within a certain frequency range. The A-weighted decibel scale was developed to correlate sound tones with the sensitivity of the human ear. The A-weighted decibel is a "frequency dependent" rating scale which emphasizes the sound components within the frequency range where most speech occurs. This scale is illustrated in **Figure 6-1**, Approximate Decibel Level of Common Sound Sources, which lists typical sound levels of common indoor and outdoor sound sources.

When sound becomes annoying to people, it is generally referred to as noise. A common definition of noise is unwanted sound. One person may find higher levels of noise bearable while others do not. Studies have also shown that a person will react differently to the same noise depending on that person's activity at the time the noise is recognized, e.g., when that person is sleeping.

6.1.1 Day-Night Noise Level (DNL)

While the A-weighted decibel scale measures human perception of loudness, it does not account for the degree of annoyance based on the duration of a noise event or the differences in sensitivity associated with a person's activity during a noise event.

Noise generated by the operation of aircraft to, from, and around an airport is generally measured in terms of cumulative noise levels of all aircraft operations. Cumulative noise level metrics provide a single measure of the average sound levels in decibels for any point near an airport when exposed over the course of a day. A variety of cumulative noise level metrics have been formulated to provide a single measure of continuous or multiple noise events over an extended period of time. The standard metric used to measure noise from aircraft is the Day-Night Noise Level, or DNL.

The DNL penalizes any activity which takes place in the nighttime (10:00 PM – 7:00 AM) by increasing the decibel level by 10 dB. Since the decibel scale uses a base-10 logarithm, each nighttime operation is equivalent to 10 daytime operations. The rationale for this adjustment is based on the reduced ambient noise at these times, and thus the increase in sensitivity to the human ear. This increase in sensitivity creates a perceived notion that aircraft are louder and more disruptive at night. A summary of effects that noise has on people was developed by the Federal Interagency Committee on Noise in 1992. This is presented in **Figure 6-2**, Summary of Noise Effects, which gives a better understanding of what type of noise exposure is expected at each decibel level.

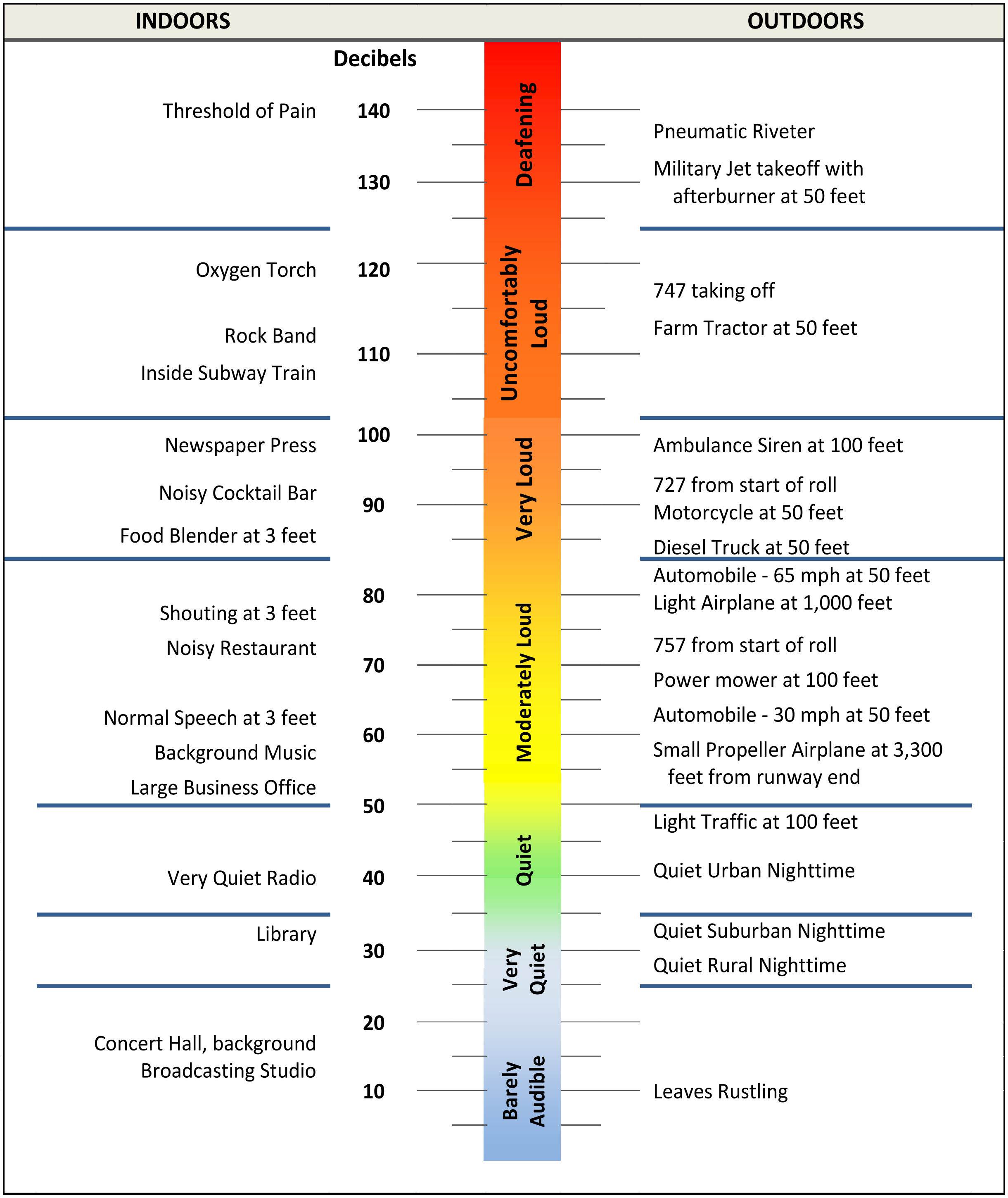


FIGURE 6-1

Approximate Decibel Level of Common Sound Sources

Source: Adapted from CALTRANS Airport Land Use Compatibility Guidebook

Day-Night Average Sound Level (Decibels)	Effects[1]			
	Hearing Loss (Qualitative Description)	Annoyance[2] (Percentage of Population Highly Annoyed)[3]	Average Community Reaction[4]	General Community Attitude Toward Area
>75	May begin to occur	37%	Very severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will not likely occur	22%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will not occur	12%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will not occur	7%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
<55	Will not occur	3%		Noise considered no more important than various other environmental factors.

[1] All data is drawn from National Academy of Science 1977 report Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise.

[2] A summary measure of the general adverse reaction of people to living in noisy environments that cause speech interference; sleep disturbance; desire for tranquil environment; and the inability to use the telephone, radio or television satisfactorily.

[3] The percentage of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time. USAF Update with 400 points (Finegold et al. 1992)

[4] Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE:
Research implicates noise as a factor producing stress-related health effects such as heart disease, high blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been conclusively demonstrated. (Thompson 1981; Thompson et al. 1989; CHABA 1981; CHABA 1982; Hattis et al. 1980; and U.S. EPA 1981)

Source: Federal Interagency Committee on Noise (1992)

FIGURE 6-2

Summary of Noise Effects

6.2 CONTOURS

Noise contours for Spokane International Airport were generated for three operating scenarios:

- Base Year (2010) Scenario – this includes existing annual operations (79,120) using 2010 data on the existing runway layout. These contours are illustrated in **Figure 6-3**.
- Future (2030) Scenario – this scenario uses annual operations as presented in the Forecast Chapter of this Master Plan for 2030 (120,827) on the existing runway layout. Future (2030) Scenario contours are presented in **Figure 6-4**.
- Ultimate (Capacity) Scenario – this scenario illustrates noise on the ultimate runway configuration, which includes the new runway (3L/21R) plus a 1,000 foot extension to the approach end of Runway 3R. Operations equal the calculated annual service volume capacity with this runway configuration (215,000). The Ultimate Scenario contours are shown in **Figure 6-5**.

The noise contours represent noise exposure over a 24-hour period based on average day conditions at GEG. The weighted DNL metric is used to statistically predict the amount of annoyance that cumulative noise exposure would have on a typical population. Lands outside the Airport property and under the influence of the 60 and 65 dB contours are quantified in **Table 6-1** below.

TABLE 6-1: Acres of Land Affected By Noise – Not Under Airport Control

Scenario	Area Affected	60-65 dB DNL	+65 dB DNL
Base Year (2010)	Area North of Runway 21	167 acres	15 acres
	Area South of Runway 3	191 acres	3 acres
	Total Acres	**358**	**18**
Future (2030) Scenario	Area North of Runway 21	274 acres	38 acres
	Area South of Runway 3	464 acres	33 acres
	Total Acres	**738**	**71**
Ultimate Scenario	Area North of Runway 21R & 21L	680 acres	108 acres
	Area South of Runways 3L & 3R	1,174 acres	113 acres
	Area East of Runway 25	18 acres	—
	Total Acres	**1,872**	**221**

6.2.1 Noise Model Inputs

The Integrated Noise Model (INM) 7.0b was used to generate the DNL noise contours for each scenario. The INM is developed by the FAA and is the standard model for computer analysis of aircraft noise. Detailed operational data is required for input into the INM for the program to generate the contours. This data includes specific aircraft fleet mix and number of operations for each, time of day that aircraft operate, runway use percentages, and the dispersal of flight tracks - the paths aircraft use when approaching or departing a particular runway.

To accurately portray average noise exposure at GEG, aircraft operational data was obtained from multiple sources. These include, but are not limited to: airport management and air traffic control tower staff, the FAA's Enhanced Traffic Management System Counts (ETMSC), apgDat airport data, and previous studies.

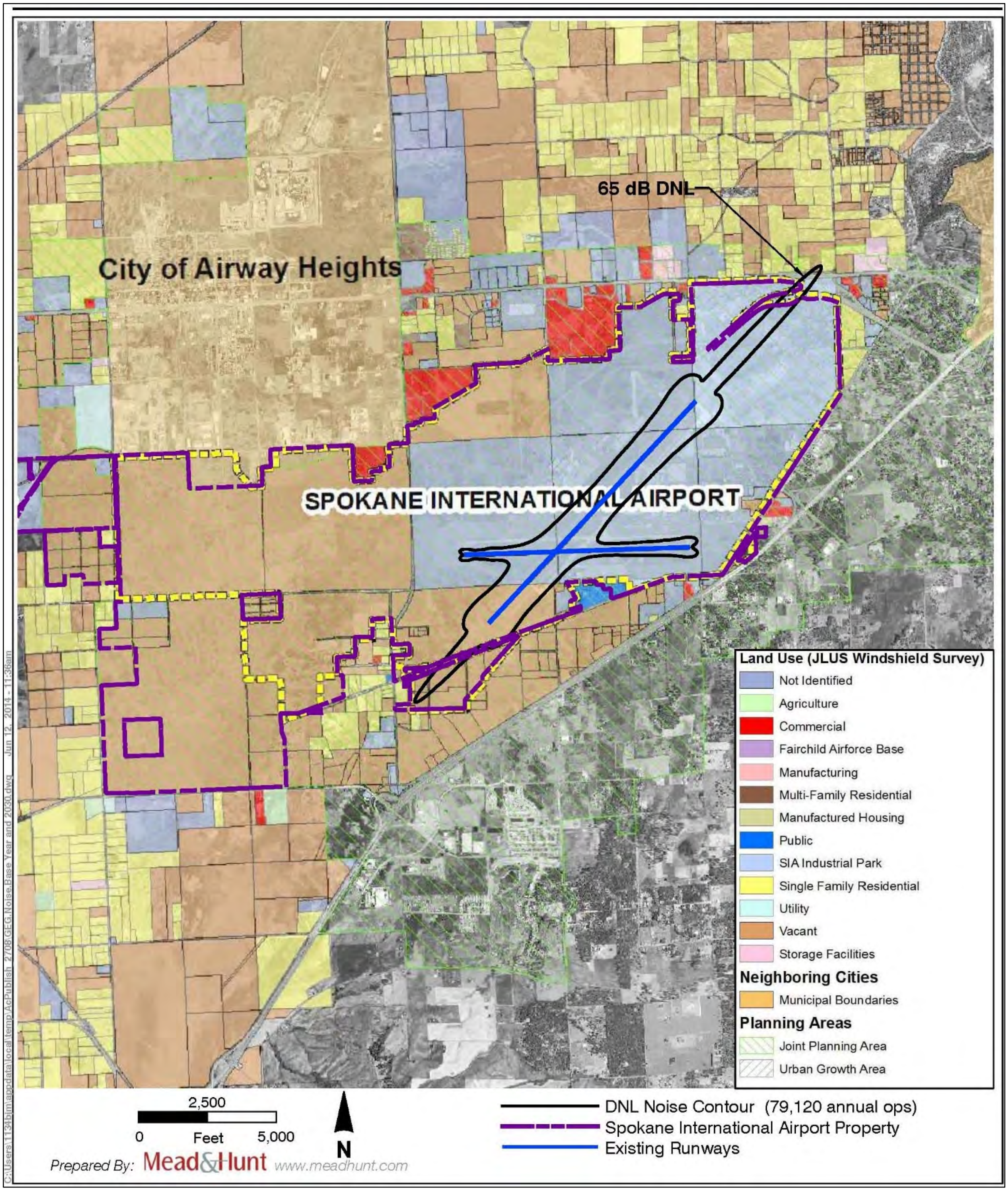


FIGURE 6-3

Base Year (2010) Noise Contours

Spokane International Airport

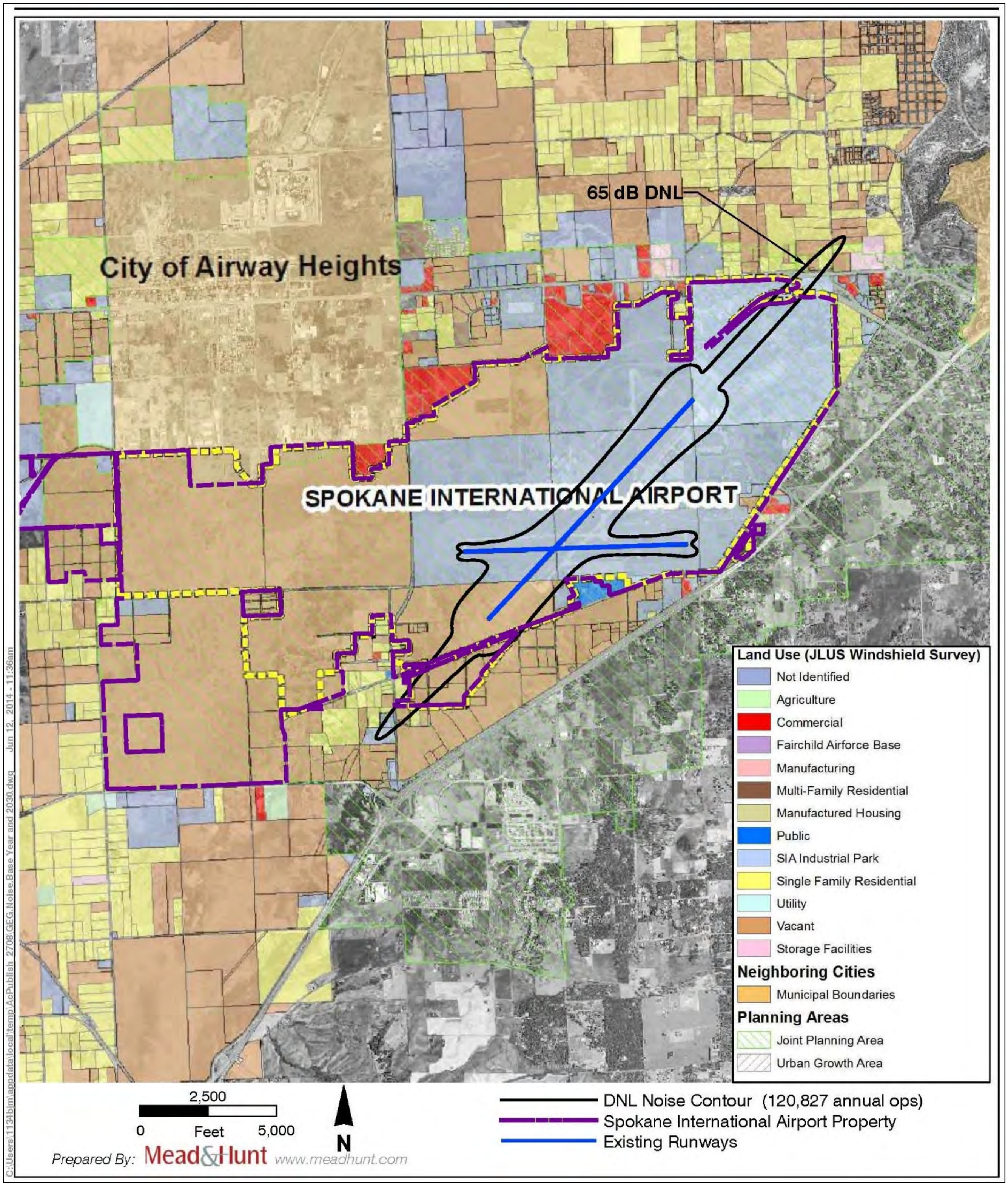


FIGURE 6-4

Future Scenario (2030) Noise Contours

Spokane International Airport

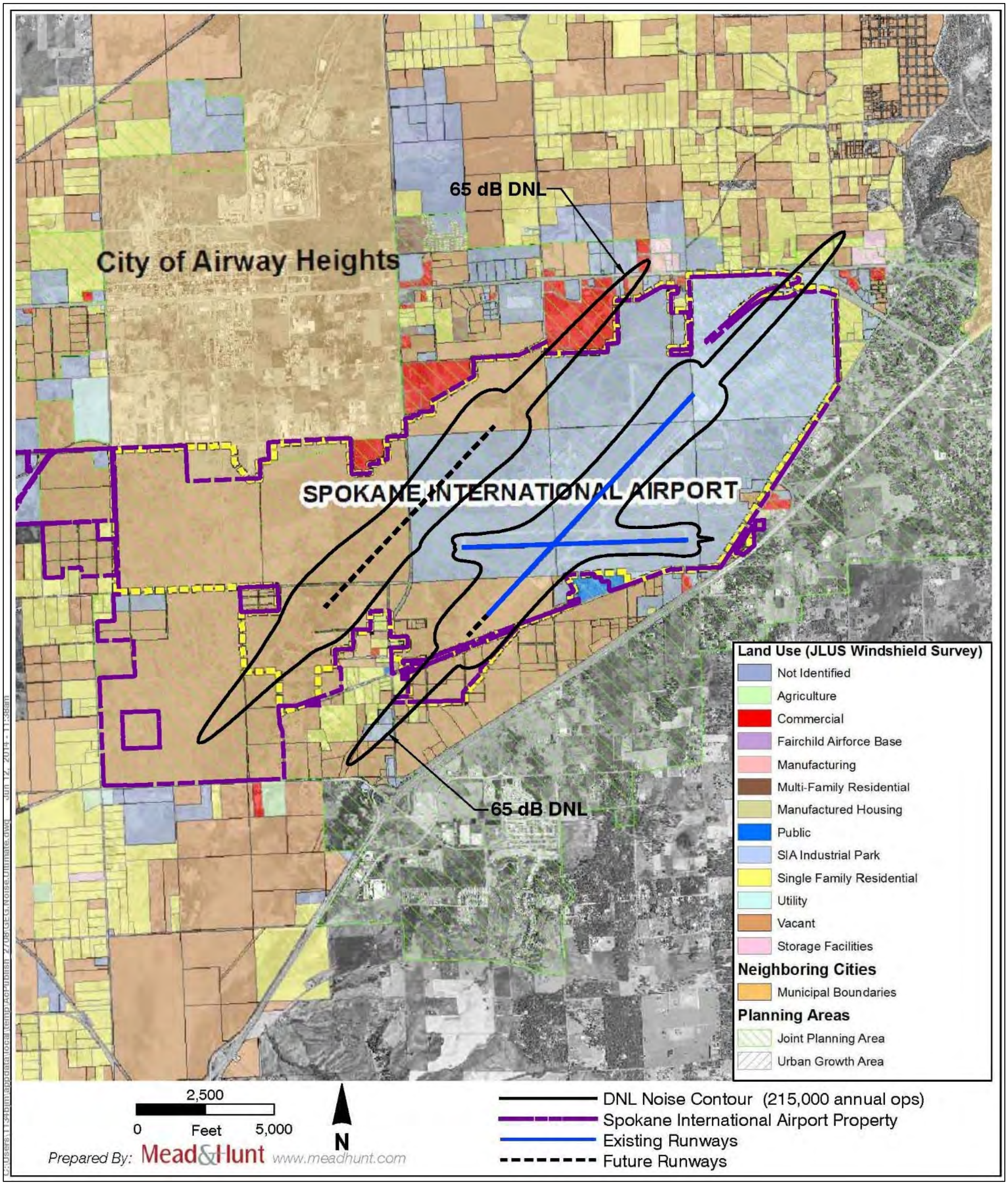


FIGURE 6-5

Ultimate Scenario (Capacity) Noise Contours

Spokane International Airport

6.2.2 Aircraft Operations and Fleet Mix

Base Year Scenario operations were derived from multiple sources. The FAA's Enhanced Traffic Management System Counts (ETMSC), apgDat airport data, and 2010 data from the Forecast Chapter were used to derive a fleet mix and assign operation totals to specific aircraft. Total operations for air carrier, air taxi, general aviation and military aircraft from the Forecast Chapter were retained for each scenario. While Chapter 2 did provide some specific aircraft types, it does not include the detail needed for the INM. ETMSC and apgDat data was used to supplement what is presented in the Forecast Chapter and formulate a reasonable fleet mix.

The ETMSC data includes specific aircraft counts for itinerant aircraft that file flight plans. However, the ETMSC also contains lapses in data and does not include local operations. The apgDat data provided specific aircraft types for scheduled passenger aircraft for March and July 2011, but only includes scheduled operations. A fleet mix for the Base Year Scenario was derived using the sources above. Assumptions were made on some specific aircraft types, supported by conversations with airport and tower staff. The fleet mix with annual operations by type is provided in **Table 6-2**.

Future (2030) Scenario operation totals are based on the totals presented in the Forecast Chapter for 2030. Figures for air carrier, air taxi, cargo, general aviation, and military aircraft match what is in Chapter 2. Specific aircraft types for 2030 are given for air carrier and cargo operations and these were used in this Scenario. Other specific aircraft types for air taxi and general aviation were derived from the ETMSC data for 2010. Future (2030) operation totals are presented in **Table 6-3**.

Ultimate Scenario operation figures are based on the annual service volume capacity of the Airport of 215,000 operations. Air carrier, cargo, air taxi and general aviation operations for this scenario are proportionately the same as the Future Scenario. For instance, air carrier operations are about 60% of total operations in the Future scenario. This percentage remains constant in the Ultimate Scenario. Some additional aircraft were added to the Ultimate Scenario which represent aircraft using the airport for maintenance, repair or overhaul facilities as proposed in the Alternative section, and are discussed below. Aircraft totals for the Ultimate Scenario are documented in **Table 6-4**.

6.2.3 Aircraft Substitutions

A limitation of the INM is that only certain aircraft are programmed into its database. Since aircraft of similar make produce similar noise levels, the INM provides a substitution list for aircraft that are not included. The specific types of aircraft used in each Scenario are detailed under the INM Aircraft Type heading in Tables 6-2 through 6-4.

An important part of this study was to carefully select the types of aircraft INM offers for modeling purposes for this study. Common substitution aircraft for single-engine, multi-engine, turboprops and jets used for this study are shown in **Table 6-5**. For example, the GV INM aircraft type represents the Gulfstream V. This aircraft is also a substitution aircraft for the Bombardier CRJ 700 and CRJ 900 which are scheduled passenger aircraft that operate at GEG. Therefore, the operation total for the GV includes operations by the CRJ 700 and CRJ 900.

TABLE 6-2: Base Year (2010) Scenario Operations

Commercial Aircraft Group

INM Aircraft Type	Operations			Daytime Departures		Daytime Arrivals		
	Annual	% of Total	Daily Average	Scheduled Air Carrier	Other	Scheduled Air Carrier	Cargo	Other
A300 – 622R	652	1.0%	1.8	n/a	99/1%	n/a	0%	99/1%
A310-304	1,698	2.5%	4.7	n/a	99/1%	n/a	50/50%	99/1%
A319-131	3,536	5.2%	9.7	80/20%	99/1%	80/20%	n/a	99/1%
A320-211	2,756	4.0%	7.6	50/50%	99/1%	75/25%	n/a	99/1%
727EM2	50	0.1%	0.1	n/a	99/1%	n/a	n/a	99/1%
737300	6,136	9.0%	16.8	88/12%	99/1%	88/12%	n/a	99/1%
737400	2,080	3.0%	5.7	100/0%	99/1%	35/65%	n/a	99/1%
737500	104	0.2%	0.3	100/0%	99/1%	100/0%	n/a	99/1%
737700	4,730	6.9%	13.0	87/13%	99/1%	83/17%	n/a	99/1%
737800	200	0.3%	0.5	n/a	99/1%	n/a	n/a	99/1%
757300	1,484	2.2%	4.1	100/0%	99/1%	100/0%	25/75%	99/1%
767300	442	0.6%	1.2	n/a	99/1%	n/a	0%	99/1%
CRJ9-ER	2,300	3.4%	6.3	100/0%	99/1%	76/24%	n/a	99/1%
CL601	3,860	5.7%	10.6	75/25%	99/1%	75/25%	n/a	99/1%
DO328	12,688	18.6%	34.8	85/15%	99/1%	92/8%	n/a	99/1%
MD9025	500	0.7%	1.4	n/a	99/1%	n/a	n/a	99/1%

Business Jet/Turboprop Group

INM Aircraft Type	Operations			Daytime Departures		Daytime Arrivals		
	Annual	% of Total	Daily Average	Scheduled Air Carrier	Other	Scheduled Air Carrier	Cargo	Other
1900D	100	0.1%	0.3	n/a	99/1%	n/a	n/a	99/1%
CIT3	313	0.5%	0.9	n/a	99/1%	n/a	n/a	99/1%
CNA208	5,907	8.7%	16.2	n/a	99/1%	n/a	50/50%	99/1%
CNA441	567	0.8%	1.6	n/a	99/1%	n/a	n/a	99/1%
CNA500	383	0.6%	1.0	n/a	99/1%	n/a	n/a	99/1%
CNA55B	187	0.3%	0.5	n/a	99/1%	n/a	n/a	99/1%
CNA750	109	0.2%	0.3	n/a	99/1%	n/a	n/a	99/1%
DHC6	1,500	2.2%	4.1	n/a	99/1%	n/a	n/a	99/1%
DHC8	454	0.7%	1.2	n/a	99/1%	n/a	50/50%	99/1%
EMB120	1,472	2.2%	4.0	n/a	99/1%	n/a	n/a	99/1%
GII	32	<0.1%	0.1	n/a	99/1%	n/a	n/a	99/1%
GIIB	14	<0.1%	0.0	n/a	99/1%	n/a	n/a	99/1%
GIV	82	0.1%	0.2	n/a	99/1%	n/a	n/a	99/1%
GV	1,036	1.5%	2.8	90/10%	99/1%	95/5%	n/a	99/1%
HS748A	318	0.5%	0.9	n/a	99/1%	n/a	n/a	99/1%
IA1125	19	<0.1%	0.1	n/a	99/1%	n/a	n/a	99/1%
LEAR35	1,145	1.7%	3.1	n/a	99/1%	n/a	n/a	99/1%
MU3001	503	0.7%	1.4	n/a	99/1%	n/a	n/a	99/1%
PA31	1,349	2.0%	3.7	n/a	99/1%	n/a	n/a	99/1%

General Aviation – Propeller Group

INM Aircraft Type	Total Operations		Itinerant Operations		Daytime Departures	Daytime Arrivals		Local Operations	
	Annual	% of Total	Annual	Daily Average	All	Cargo	Other	Annual	Daily Average
BEC58P	6,239	4.3%	2,959	8.1	99/1%	50%	99/1%	3,280	9.0
CNA172	4,250	2.2%	1,500	4.1	99/1%	n/a	99/1%	2,750	7.5
CNA206	4,250	2.2%	1,500	4.1	99/1%	n/a	99/1%	2,750	7.5
GASEPV	4,057	2.9%	2,000	5.5	99/1%	n/a	99/1%	2,057	5.6

Military Group

INM Aircraft Type	Operations			Day/Nighttime Departures	Day/Nighttime Arrivals
	Annual	% of Total	Daily Average		
KC135R	1,294	0.6%	3.5	99/1%	99/1%
P3C	162	0.1%	0.4	99/1%	99/1%
C130	81	<0.1%	0.2	99/1%	99/1%
UH1	81	<0.1%	0.2	99/1%	99/1%

Note: Military Group operations remain constant in each Scenario

TABLE 6-3: Future (2030) Scenario Operations

Commercial Aircraft Group

INM Aircraft Type	Operations			Day/Nighttime Departures		Day/Nighttime Arrivals		
	Annual	% of Total	Daily Average	Scheduled Air Carrier	Other	Scheduled Air Carrier	Cargo	Other
A300 – 622R	981	0.8%	2.7	n/a	99/1%	n/a	0%	99/1%
A310-304	2,555	2.1%	7.0	n/a	99/1%	n/a	50/50%	99/1%
A319-131	1,645	1.4%	4.5	83/17%	99/1%	86/14%	n/a	99/1%
A320-211	14,588	12.1%	40.0	83/17%	99/1%	86/14%	n/a	99/1%
717200	1,520	1.3%	4.2	83/17%	99/1%	86/14%	n/a	99/1%
737300	200	0.0%	0.5	n/a	99/1%	n/a	n/a	99/1%
737400	200	0.2%	0.5	n/a	99/1%	n/a	n/a	99/1%
737500	14,588	0.2%	40.0	83/17%	99/1%	86/14%	n/a	99/1%
737700	1,785	12.1%	4.9	83/17%	99/1%	86/14%	n/a	99/1%
737800	1,785	1.5%	4.9	83/17%	99/1%	86/14%	n/a	99/1%
757300	1,927	1.5%	5.3	83/17%	99/1%	86/14%	25/75%	99/1%
767300	514	1.6%	1.4	n/a	99/1%	n/a	0%	99/1%
CRJ9-ER	14,299	0.4%	39.2	83/17%	99/1%	86/14%	n/a	99/1%
CL601	903	11.8%	2.5	83/17%	99/1%	86/14%	n/a	99/1%
DO328	452	0.7%	1.2	83/17%	99/1%	86/14%	n/a	99/1%
EMB145	1,355	0.4%	3.7	83/17%	99/1%	86/14%	n/a	99/1%

Business Jet/Turboprop Group

INM Aircraft Type	Operations			Day/Nighttime Departures		Day/Nighttime Arrivals		
	Annual	% of Total	Daily Average	Scheduled Air Carrier	Other	Scheduled Air Carrier	Cargo	Other
1900D	451	0.4%	1.2	83/17%	99/1%	86/14%	n/a	99/1%
CIT3	500	0.4%	1.4	n/a	99/1%	n/a	n/a	99/1%
CNA208	8,887	7.4%	24.3	n/a	99/1%	n/a	50/50%	99/1%
CNA441	500	0.4%	1.4	n/a	99/1%	n/a	n/a	99/1%
CNA500	500	0.4%	1.4	n/a	99/1%	n/a	n/a	99/1%
CNA55B	500	0.4%	1.4	n/a	99/1%	n/a	n/a	99/1%
CNA750	500	0.4%	1.4	n/a	99/1%	n/a	n/a	99/1%
DHC6	1,750	1.4%	4.8	n/a	99/1%	n/a	n/a	99/1%
DHC8	682	0.6%	1.9	n/a	99/1%	n/a	50/50%	99/1%
EMB120	751	0.6%	2.1	83/17%	99/1%	86/14%	n/a	99/1%
GII	50	0.0%	0.1	n/a	99/1%	n/a	n/a	99/1%
GIV	291	0.2%	0.8	n/a	99/1%	n/a	n/a	99/1%
GV	17,438	14.4%	47.8	83/17%	99/1%	86/14%	n/a	99/1%
IA1125	100	0.1%	0.3	n/a	99/1%	n/a	n/a	99/1%
LEAR35	1,500	1.2%	4.1	n/a	99/1%	n/a	n/a	99/1%
MU3001	600	0.5%	1.6	n/a	99/1%	n/a	n/a	99/1%
PA31	1,600	1.3%	4.4	n/a	99/1%	n/a	n/a	99/1%

General Aviation – Propeller Group

INM Aircraft Type	Total Operations		Itinerant Operations		Day/Nighttime Departures	Day/Nighttime Arrivals		Local Operations	
	Annual	% of Total	Annual	Daily Average	All	Cargo	Other	Annu al	Daily Average
BEC58P	6,307	5.2%	3,691	10.1	99/1%	50/50%	99/1%	2,616	7.2
CNA172	7,005	5.8%	2,000	5.5	99/1%	n/a	99/1%	5,005	13.7
CNA206	5,000	4.1%	2,000	5.5	99/1%	n/a	99/1%	3,000	8.2
GASEPV	5,000	4.1%	2,000	5.5	99/1%	n/a	99/1%	3,000	8.2

Note: Military Group operations remain constant from Base Year Scenario

TABLE 6-4: Ultimate Scenario Operations

Commercial Aircraft Group

INM Aircraft Type	Operations			Day/Nighttime Departures		Day/Nighttime Arrivals		
	Annual	% of Total	Daily Average	Scheduled Air Carrier	Other	Scheduled Air Carrier	Cargo	Other
A300-622R	2,600	1.2%	7.1	n/a	99/1%	n/a	0%	99/1%
A310-304	7,100	3.3%	19.5	n/a	99/1%	n/a	50/50%	99/1%
A319-131	2,686	1.2%	7.4	83/17%	99/1%	86/14%	n/a	99/1%
A320-211	26,212	12.2%	71.8	83/17%	99/1%	86/14%	n/a	99/1%
A340-642	200	0.1%	0.5	n/a	99/1%	n/a	n/a	99/1%
717200	2,686	1.2%	7.4	83/17%	99/1%	86/14%	n/a	99/1%
727EM2	100	<0.1%	0.3	n/a	99/1%	n/a	n/a	99/1%
737300	100	<0.1%	0.3	n/a	99/1%	n/a	n/a	99/1%
737400	100	<0.1%	0.3	n/a	99/1%	n/a	n/a	99/1%
737500	26,212	12.2%	71.8	83/17%	99/1%	86/14%	n/a	99/1%
737700	3,116	1.4%	8.5	83/17%	99/1%	86/14%	n/a	99/1%
737800	3,232	1.5%	8.9	83/17%	99/1%	86/14%	n/a	99/1%
747400	200	0.1%	0.5	n/a	99/1%	n/a	n/a	99/1%
757300	3,116	1.4%	8.5	83/17%	99/1%	86/14%	n/a	99/1%
757PW	600	0.3%	1.6	n/a	99/1%	n/a	25/75%	99/1%
767300	2,200	1.0%	6.0	n/a	99/1%	n/a	0%	99/1%
767400	200	0.1%	0.5	n/a	99/1%	n/a	n/a	99/1%
777200	200	0.1%	0.5	n/a	99/1%	n/a	n/a	99/1%
777300	200	0.1%	0.5	n/a	99/1%	n/a	n/a	99/1%
CRJ9-ER	25,595	11.9%	70.1	83/17%	99/1%	86/14%	n/a	99/1%
CL601	1,616	0.8%	4.4	83/17%	99/1%	86/14%	n/a	99/1%
DO328	809	0.4%	2.2	83/17%	99/1%	86/14%	n/a	99/1%
EMB145	2,425	1.1%	6.6	83/17%	99/1%	86/14%	n/a	99/1%

Business Jet/Turboprop Group

INM Aircraft Type	Operations			Day/Nighttime Departures		Day/Nighttime Arrivals		
	Annual	% of Total	Daily Average	Scheduled Air Carrier	Other	Scheduled Air Carrier	Cargo	Other
1900D	807	0.4%	2.2	83/14%	99/1%	86/14%	n/a	99/1%
CIT3	895	0.4%	2.5	n/a	99/1%	n/a	n/a	99/1%
CNA208	12,000	5.6%	32.9	n/a	99/1%	n/a	50/50 %	99/1%
CNA441	895	0.4%	2.5	n/a	99/1%	n/a	n/a	99/1%
CNA500	895	0.4%	2.5	n/a	99/1%	n/a	n/a	99/1%
CNA55B	895	0.4%	2.5	n/a	99/1%	n/a	n/a	99/1%
CNA750	895	0.4%	2.5	n/a	99/1%	n/a	n/a	99/1%
DHC6	3,132	1.5%	8.6	n/a	99/1%	n/a	n/a	99/1%
EMB120	1,345	0.6%	3.7	83/14%	99/1%	86/14%	n/a	99/1%
GIV	521	0.2%	1.4	n/a	99/1%	n/a	n/a	99/1%
GV	31,302	14.6%	85.8	83/14%	99/1%	86/14%	n/a	99/1%
IA1125	179	0.1%	0.5	n/a	99/1%	n/a	n/a	99/1%
LEAR35	2,685	1.2%	7.4	n/a	99/1%	n/a	n/a	99/1%
MU3001	1,074	0.5%	2.9	n/a	99/1%	n/a	n/a	99/1%
PA31	2,864	1.3%	7.8	n/a	99/1%	n/a	n/a	99/1%

General Aviation – Propeller Group

INM Aircraft Type	Total Operations		Itinerant Operations		Day/Nighttime Departures	Day/Nighttime Arrivals		Local Operations	
	Annual	% of Total	Annual	Daily Average	All	Cargo	Other	Annual	Daily Average
BEC58P	11,053	5.1%	5,370	30.3	99/1%	50%	99/1%	4,683	12.8
CNA172	12,539	5.8%	3,580	34.4	99/1%	n/a	99/1%	8,959	24.5
CNA206	8,950	4.2%	3,580	24.5	99/1%	n/a	99/1%	5,370	14.7
GASEPV	8,950	4.2%	3,580	24.5	99/1%	n/a	99/1%	5,370	14.7

Note: Military Group operations remain constant from Base Year Scenario

TABLE 6-5. Common General Aviation Aircraft Substitutions in INM

Aircraft Type	Substitution Aircraft	Aircraft represented by Substitute aircraft
Single-Engine	Cessna 172	Cessna 150, 152, 170, 172
	Cessna 206	Cessna 180, 182, 185, 206, 210
	GA, Pitch Variable	Beech 33, 35 Bonanza; Piper 24, 28, 32, 46; Mooney M20 Series
	GA, Pitch Fixed	Cessna 140, 208, Columbia 400; Cirrus SR22; Pilatus PC12
Twins and Turboprops	Cessna 441	King Air C90; Cessna 441; Cheyenne 31,42; Merlin II, III
	Beech Baron 58	Beech Baron 55, 58; Cessna 300 and 400 Series; Piper 34, 44
	DeHavilland Dash 6	Beechcraft Super King Air Series 200-350; Swearingen Merlin IV
Business Jet	Learjet 35	Lear Jet Series 35-60; Falcon 10, 200
	Bombardier CL 601	CL-601; Falcon 900, Falcon 2000
	Mitsubishi MU-300	Beechjet 400; Citation II, V
	Cessna Citation 550	Citation I, Citation Jet
	Cessna Citation X	Citation X
	Gulfstream IV	Gulfstream 300 and 400 Series
	Gulfstream V	Embraer 170, 190, CRJ 701 and 901

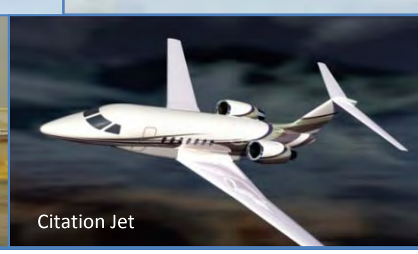
No substitution aircraft exist in the INM for military and helicopter aircraft.

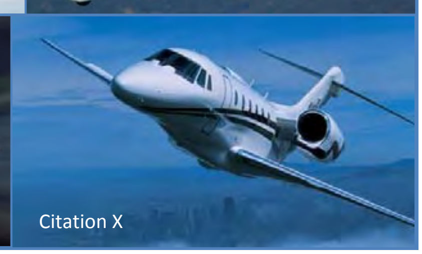

Mooney M20


Cessna 206


Cirrus SR22


Beechcraft Super King Air


Citation Jet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There is uncertainty regarding forecasting which aircraft types will be operating in the long-term. The INM database includes existing aircraft and estimating what will be in service in 30 years relies on using the best information available at this time. Assumptions made for the Future and Ultimate Scenario's fleet mixes are disclosed below.

Aircraft types modeled in the Ultimate Scenario that are not in the Base Year and Future Scenarios include the A340, 747-400, 777-200 and 777-300. These aircraft were added with the assumption that maintenance, repair and overhaul business will increase at the Airport, as described in the Airside Facilities Chapter.

6.2.4 Aircraft Groups

To help simplify data input into the INM, aircraft were placed into four groups: Commercial, Business Jet/Turboprop, General Aviation – Propeller, and Military. Aircraft in the same group are distributed similarly over each flight track (see Flight Tracks information and tables below).

The groups should not be confused with air carrier, cargo, and air taxi. The aircraft used for air carrier, cargo, and air taxi are primarily in the commercial group. Some exceptions include the GV which represents some air carrier activity but is in the Business jet/turboprop group and the CNA208 and DHC8 which represent some cargo activity.

6.2.5 Day/Night Split

The DNL metric 'penalizes' aircraft activity that occurs after 10:00 PM and before 7:00 AM by applying a 10 dB penalty for each operation. Therefore it is important to obtain accurate night data and separate these operations from those that occur during the day. Arrival and departure percentages for daytime operations are included in Tables 2 through 4.

For the Base Year Scenario, scheduled arrival and departure times for air carrier aircraft were provided in the apgDat report. The data allow aircraft types to be modeled with accurate day and night percentages. It was assumed that 99 percent of other aircraft operations occur during daytime hours. This number was used in previous noise studies and was confirmed by tower staff.

For air carrier operations in the Future and Ultimate scenarios, an average of all air carrier arrivals and departures was calculated from the 2010 apgDat data. This was done because at the time of this analysis, it is unknown which aircraft will be operating at specific times in these scenarios. Time of Day splits for cargo and other operations for the Future and Ultimate scenarios remain the same as the Base Year Scenario.

6.2.6 Flight Tracks

Aircraft arriving and departing GEG normally follow similar flight paths, or tracks. The tracks are not finite but over the course of time an average position of the tracks can be observed. Different aircraft will use different tracks based on various factors. The size of the aircraft may determine how soon after departure (or prior to arrival) that aircraft deviate from runway heading. Larger aircraft require more time to climb (and descend) and will usually turn at points farther from the runway end. The origin or destination of the aircraft also helps determine which way aircraft travel to and from the runway. During instrument flight rules conditions, aircraft may be directed by air traffic control on different routes that same aircraft would take during visual flight rules conditions.

Radar data acquired from the control tower along with conversations with tower staff helped establish the location of average flight tracks. The flight tracks modeled are illustrated in **Figure 6-6** for existing Runway 3-21, **Figure 6-7** for Runway 7-25 and **Figure 6.-8** for the ultimate Runway 3L/21R. The percentage splits on each flight track for the aircraft groups are documented in **Table 6-6** for the Base Year and Future Scenarios and in **Table 6-7** for the Ultimate Scenario.

The locations of the flight tracks were based on multiple sources. The radar data acquired represented one day's worth of activity at GEG. While this proved helpful in establishing the tracks, most aircraft activity that day was on Runway 3-21. This left little data to establish tracks on Runway 7-25. To help establish the locations, flight tracks from previous studies were used. The tracks from previous studies were confirmed by control tower staff to be accurate.

Most of the preexisting tracks made turns that were close to the runway ends, which is typical of how smaller aircraft operate. These arrival tracks were named 'visual' in the tables. When observing the radar data, the larger aircraft will start turns farther from the runways, and make wider turns. Additional arrival tracks were created that better represent where larger aircraft travel, and are named "RNP" in the tables.

The RNP (Required Navigation Performance) tracks that were used for larger aircraft are based upon new instrument approaches that mimic visual approaches for large aircraft under IFR conditions. These procedures are new and only being used by select commercial operators; however, their adoption is becoming more wide-spread over time.

Large air carrier, cargo, and military aircraft were modeled to fly on the RNP tracks and make turns further from the runway ends. Business jet operations were also primarily modeled on RNP tracks however some were modeled on the visual tracks. The majority of operations by smaller aircraft such as turboprops and piston aircraft were modeled on the visual flight tracks and a minor amount of operations on the RNP tracks.

Flight tracks modeled for Runway 3R/21L under the Ultimate Scenario are similar to those modeled for Runway 3/21 in the Base Year and Future Scenarios. It was assumed that similar RNP and visual approach and departure procedures would be followed. An extension to Runway 3R in the Ultimate Scenario would cause the flight tracks associated with this runway to shift with the relocated threshold. Flight tracks and associated utilization percentages were developed in coordination with the Spokane airport traffic control tower.

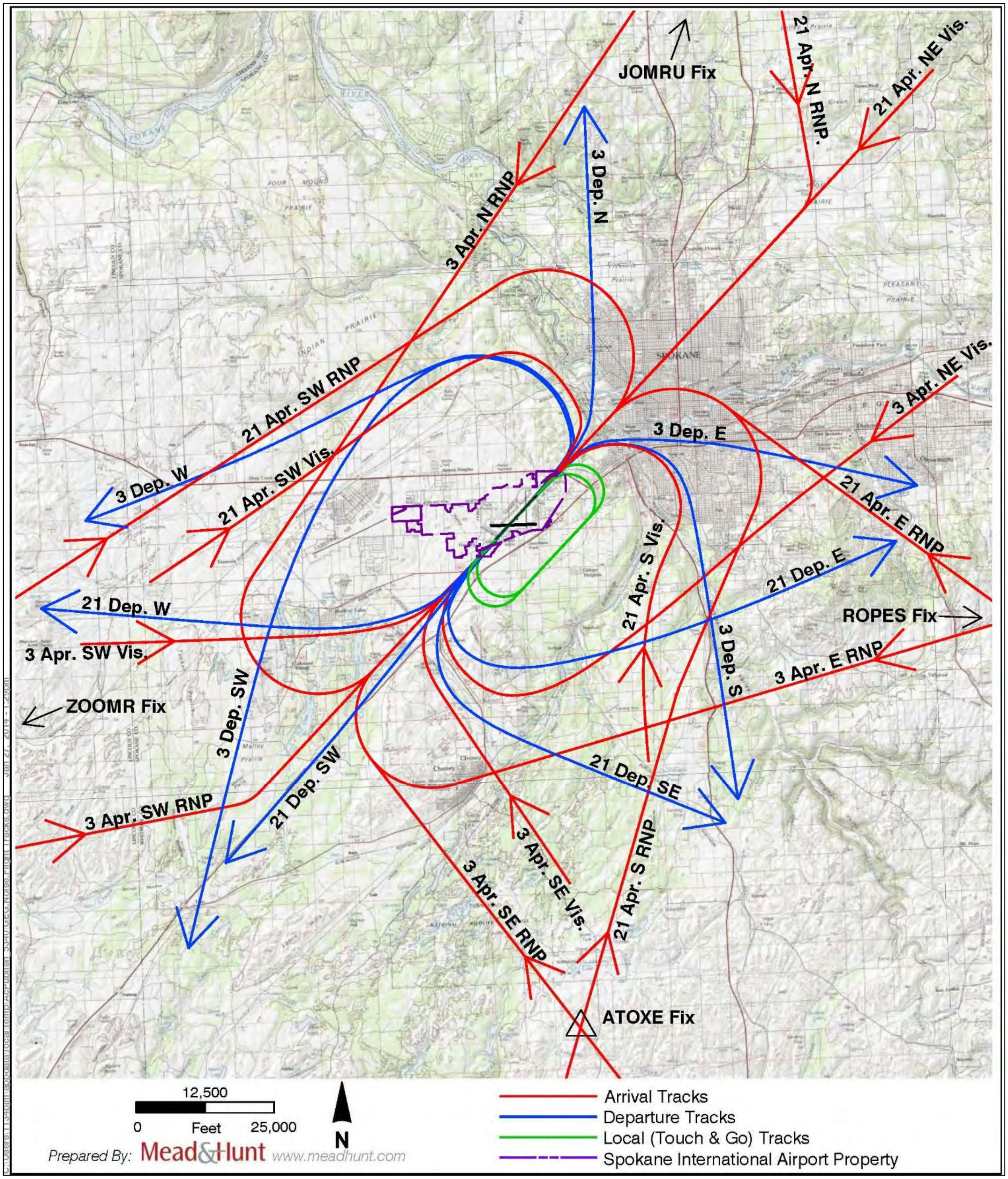

FIGURE 6-6

Runway 3/21 Flight Tracks

Spokane International Airport

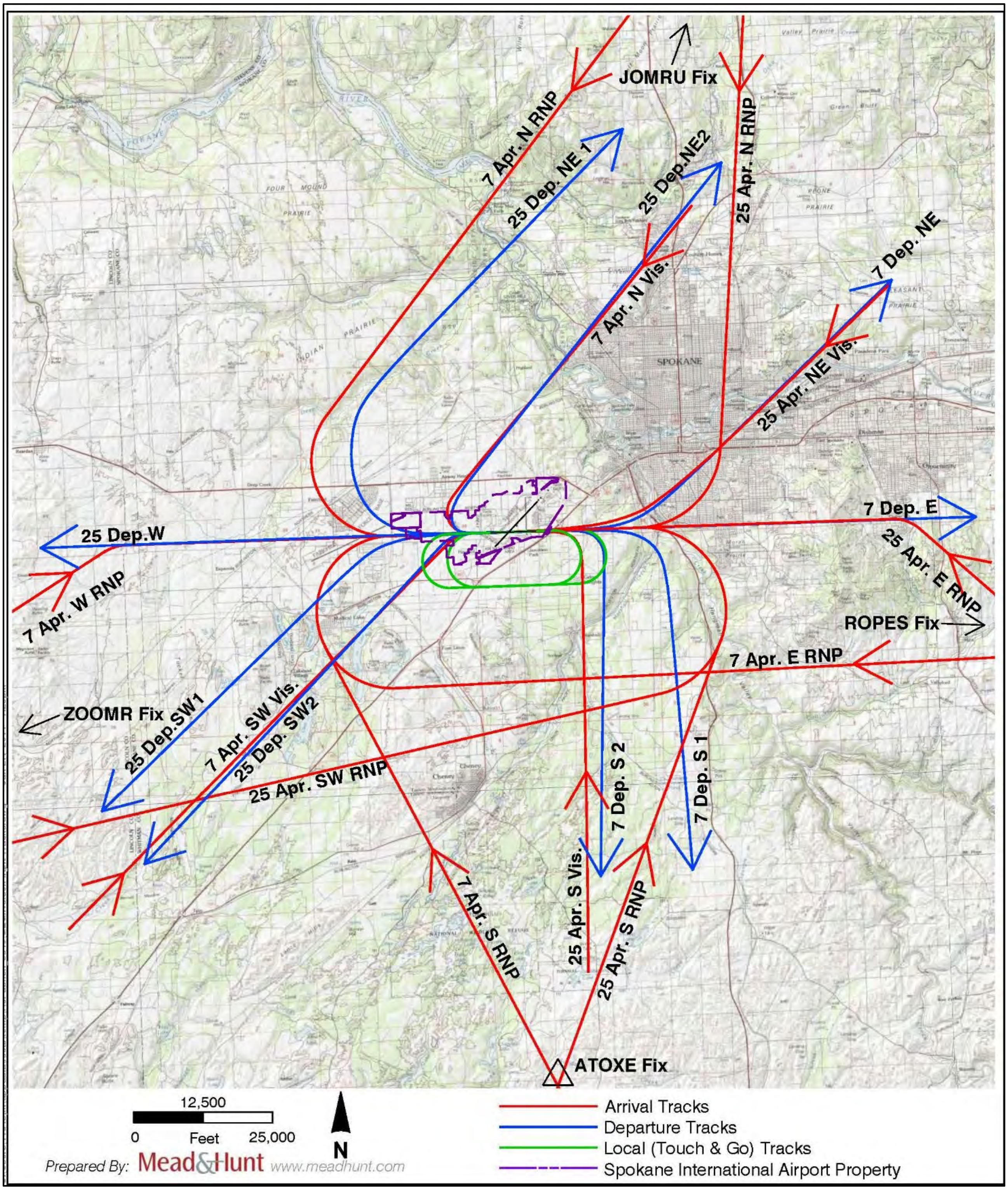

FIGURE 6-7

Runway 7/25 Flight Tracks

Spokane International Airport

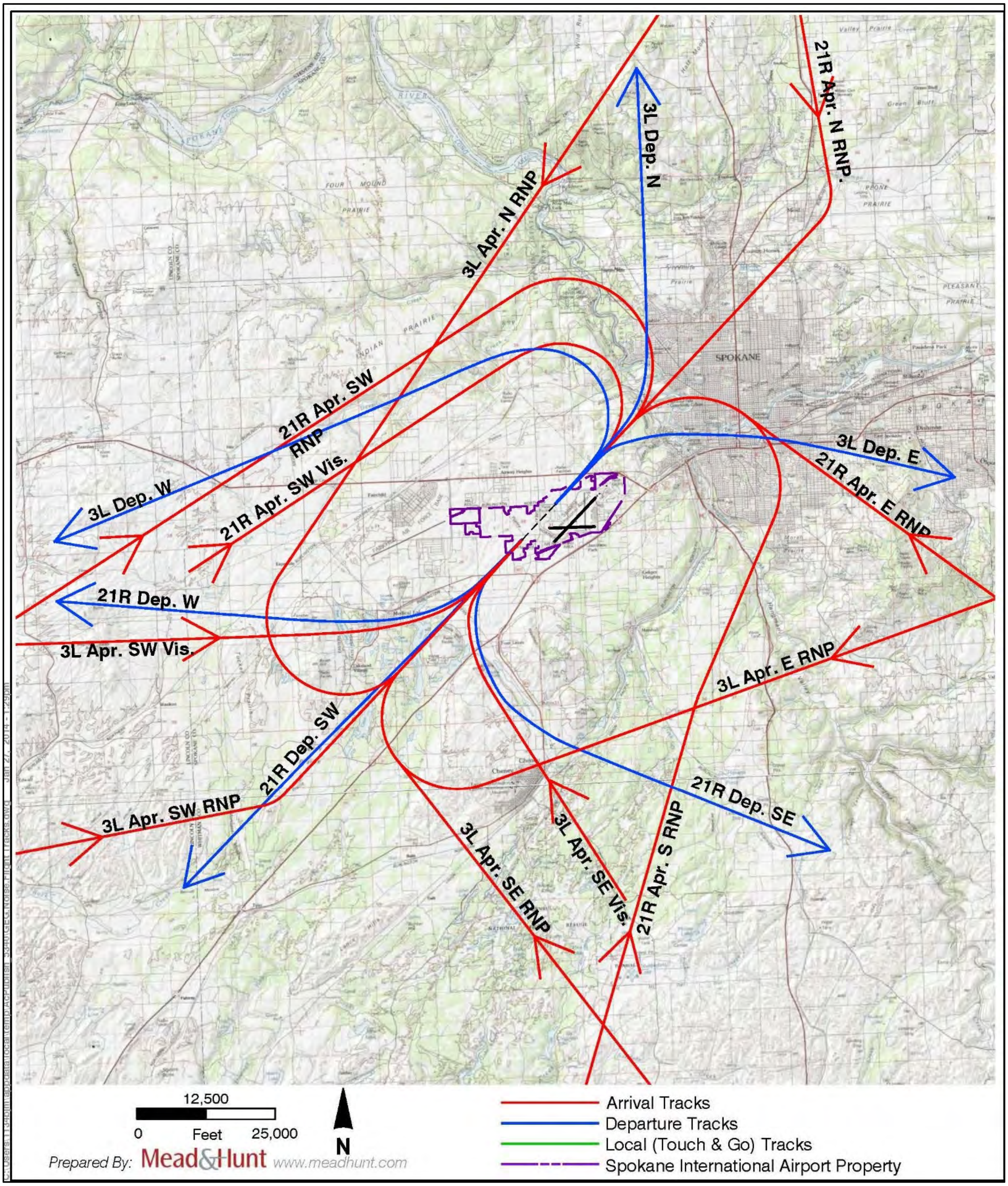

FIGURE 6-8

Ultimate Runway 3L/21R Flight Tracks

Spokane International Airport

TABLE 6-6: Flight Tracks – Base Year and Future Scenarios

ARRIVALS

Runway	Flight Track	Aircraft Group			
		Commercial	Business Jet/Turboprop	General Aviation Propeller	Military
3	North RNP	9.6%	6.4%	1.8%	9.9%
	Southwest RNP	9.6%	6.4%	1.8%	9.9%
	Southeast RNP	5.2%	2.6%	1.0%	5.4%
	East RNP	10.5%	5.2%	2.0%	10.8%
	Southwest Visual	—	6.4%	10.7%	—
	Southeast Visual	—	2.6%	2.9%	—
	Northeast Visual	—	5.2%	5.9%	—
21	North RNP	18.0%	9.0%	6.6%	18.0%
	Southwest RNP	33.0%	16.5%	6.0%	33.0%
	South RNP	4.5%	3.0%	0.8%	4.5%
	East RNP	4.5%	3.0%	0.8%	4.5%
	Northeast Visual	—	9.0%	6.6%	—
	Southwest Visual	—	16.5%	18.1%	—
	South Visual	—	3.0%	5.0%	—
7	North RNP	0.2%	0.1%	0.3%	0.2%
	West RNP	0.2%	0.2%	1.2%	0.2%
	South RNP	0.3%	0.2%	0.5%	0.3%
	East RNP	0.3%	0.2%	0.5%	0.3%
	North Visual	—	0.1%	0.9%	—
	Southwest Visual	—	0.2%	2.7%	—
25	North RNP	0.8%	0.4%	1.2%	0.6%
	Southwest RNP	1.2%	0.8%	1.8%	0.9%
	South RNP	1.2%	0.8%	1.8%	0.9%
	East RNP	0.8%	0.8%	4.8%	0.6%
	Northeast Visual	—	0.4%	3.6%	—
	South Visual	—	0.8%	10.8%	—

Runway 7-25 arrival flight track percentage splits remain constant in the Ultimate Scenario

DEPARTURES

Runway	Flight Track	Aircraft Group			
		Commercial	Business Jet/Turboprop	General Aviation Propeller	Military
3	East	3.2%	3.1%	2.3%	3.2%
	North	0.4%	0.3%	0.3%	0.4%
	South	5.2%	5.3%	3.9%	5.4%
	West	19.3%	19.3%	14.3%	19.8%
	Southwest	7.0%	7.0%	5.2%	7.2%
21	East	6.0%	6.0%	4.4%	6.0%
	Southeast	9.0%	9.0%	6.6%	9.0%
	West	33.0%	33.0%	24.2%	33.0%
	Southwest	12.0%	12.0%	8.8%	12.0%
7	East	0.2%	0.2%	1.2%	0.2%
	Northeast	0.2%	0.2%	1.2%	0.2%
	South 1	0.6%	0.6%	—	0.6%
	South 2	—	—	3.6%	—
25	Northeast 1	0.8%	0.8%	—	0.6%
	Northeast 2	—	—	4.8%	—
	West	0.8%	0.8%	4.8%	0.6%
	Southwest 1	2.4%	2.4%	—	1.8%
	Southwest 2	—	—	14.4%	—

Runway 7-25 departure flight track percentage splits remain constant in the Ultimate Scenario

Note: Tables show percent of all operations per each track. Totals developed in coordination with the Spokane Airport Traffic Control Tower

TABLE 6-7: Flight Tracks – Ultimate Scenario

Arrivals

Runway		Flight Track	Aircraft Group			
			Commercial	Business Jet/Turboprop	General Aviation-Propeller	Military
Existing Runway	3R	North RNP	4.8%	3.2%	0.9%	4.9%
		Southwest RNP	4.8%	3.2%	0.9%	4.9%
		Southeast RNP	2.6%	1.3%	0.5%	2.7%
		East RNP	5.2%	2.6%	1.0%	5.4%
		Southwest Visual	—	3.2%	5.4%	—
		Southeast Visual	—	1.3%	1.5%	—
		Northeast Visual	—	2.6%	2.9%	—
	21L	North RNP	9.0%	4.5%	3.3%	9.0%
		Southwest RNP	16.5%	8.3%	3.0%	16.5%
		South RNP	2.3%	1.5%	0.4%	2.3%
		East RNP	2.3%	1.5%	0.4%	2.3%
		Northeast Visual	—	4.5%	3.3%	—
		Southwest Visual	—	8.3%	9.1%	—
		South Visual	—	1.5%	2.5%	—
Ultimate Runway	3L	Southwest RNP	4.8%	3.2%	0.9%	4.9%
		North RNP	4.8%	3.2%	0.9%	4.9%
		Southeast RNP	2.6%	2.6%	0.7%	2.7%
		East RNP	5.2%	2.6%	0.7%	5.4%
		Southeast Visual	—	2.6%	4.4%	—
		Southwest Visual	—	3.2%	5.4%	—
	21R	North RNP	9.0%	9.0%	6.6%	9.0%
		Southwest RNP	16.5%	8.3%	3.0%	16.5%
		South RNP	2.3%	2.3%	1.7%	2.3%
		East RNP	2.3%	2.3%	1.7%	2.3%
		Southwest Visual	—	8.3%	9.1%	—

Runway 7-25 arrival flight track percentage splits for the Ultimate Scenario are identical to the Base Year values

Departures

Runway		Flight Track	Aircraft Group			
			Commercial	Business Jet/Turboprop	General Aviation-Propeller	Military
Existing Runway	3R	East	1.6%	1.6%	1.2%	1.6%
		North	0.2%	0.2%	0.1%	0.2%
		South	2.6%	2.6%	1.9%	2.7%
		West	9.6%	9.6%	7.1%	9.9%
		Southwest	3.5%	3.5%	2.6%	3.6%
	21L	East	3.0%	3.0%	2.2%	3.0%
		Southeast	4.5%	4.5%	3.3%	4.5%
		West	16.5%	16.5%	12.1%	16.5%
		Southwest	6.0%	6.0%	4.4%	6.0%
Ultimate Runway	3L	East	4.2%	4.2%	3.1%	4.3%
		North	0.2%	0.2%	0.1%	0.2%
		West	13.1%	13.1%	9.7%	13.5%
	21R	Southeast	7.5%	7.5%	5.5%	7.5%
		West	16.5%	16.5%	12.1%	16.5%
		Southwest	6.0%	6.0%	4.4%	6.0%

Runway 7-25 departure flight track percentage splits for the Ultimate Scenario are identical to the Base Case values

Note: Tables show percent of all operations per each track. Totals developed in coordination with the Spokane Airport Traffic Control Tower