SECTION 4.0

NOISE MEASUREMENT RESULTS

Noise measurements were conducted between July 29th, 2000 and September 1st, 2000 at various locations within Juneau. A total of sixteen (16) long term and twenty-one (21) short term sites were monitored. All sites were measured continuously, long term sites for roughly a week and short-term sites for roughly one day. The measurements consisted of: (1) single event noise levels from individual aircraft flyovers, (2) cumulative 24-hour continuous measurements, and (3) ambient non-aircraft noise sources. The survey utilized specialized equipment that recorded and displayed the complete time history of the noise.

The methodology used in the noise measurement program and a description of measurement locations is presented in Section 3.0, **Methodology**. The results of the measurement survey are summarized in the following paragraphs. Additional data with more detailed results for each measurement site is presented in the Appendix.

The measurement results can be divided into the following subsections:

- flightseeing aircraft flight paths
- continuous noise measurement data
- ambient levels
- single event aircraft noise levels
- DNL noise levels
- hourly noise levels
- modified DNL noise levels
- Time Above noise levels
- spectral noise levels
- indoor noise levels

4.2 Flightseeing Aircraft Flight Paths

Flightseeing aircraft flight paths were documented during the survey. These paths were determined based on conversations with the tour operators and field observations during the measurement survey. The flight paths are described in the following figures and paragraphs:

Figure 4-1 presents all of the flight paths of the different Juneau flightseeing operations. This includes operations from Juneau International Airport, the ERA heliport and downtown airpark. These represent general paths, which vary depending upon pilot technique, weather and other traffic in the area.

Figure 4-2 presents primary flight paths for helicopter flightseeing operations that operate to and from Juneau International Airport (JNU). These paths include both good weather and poor weather paths. Although flight paths vary depending upon the type of tour, all paths are those that are flying to the Mendenhall Glacier tour area.

Figure 4-3 presents primary flight paths for floatplane operations to and from the downtown airpark (HAR). Aircraft paths in the immediate area of the airpark will vary depending upon wind conditions. There are times that arrival and departure route will bring the aircraft over the Douglas area. These paths reflect the primary flight area.

Figure 4-4 presents primary flight paths for operations to and from the ERA heliport (5Z1). These paths include both good weather and poor weather paths. The good weather path brings the helicopter route south of Douglas and West Juneau. The poor weather route brings the helicopter route directly down Gastineau Channel.

Figure 4-5 presents primary flight paths for operations from the Juneau International Airport Floatplane area (5Z2), which is used exclusively by floatplanes. These operations include both flightseeing and other business aviation flying. The flight paths are dependent upon the destination and wind speed/wind direction present during the operation.

Figure 4-1
Example flight paths for all types of aircraft
Flightseeing Noise Assessment – City and Borough of Juneau

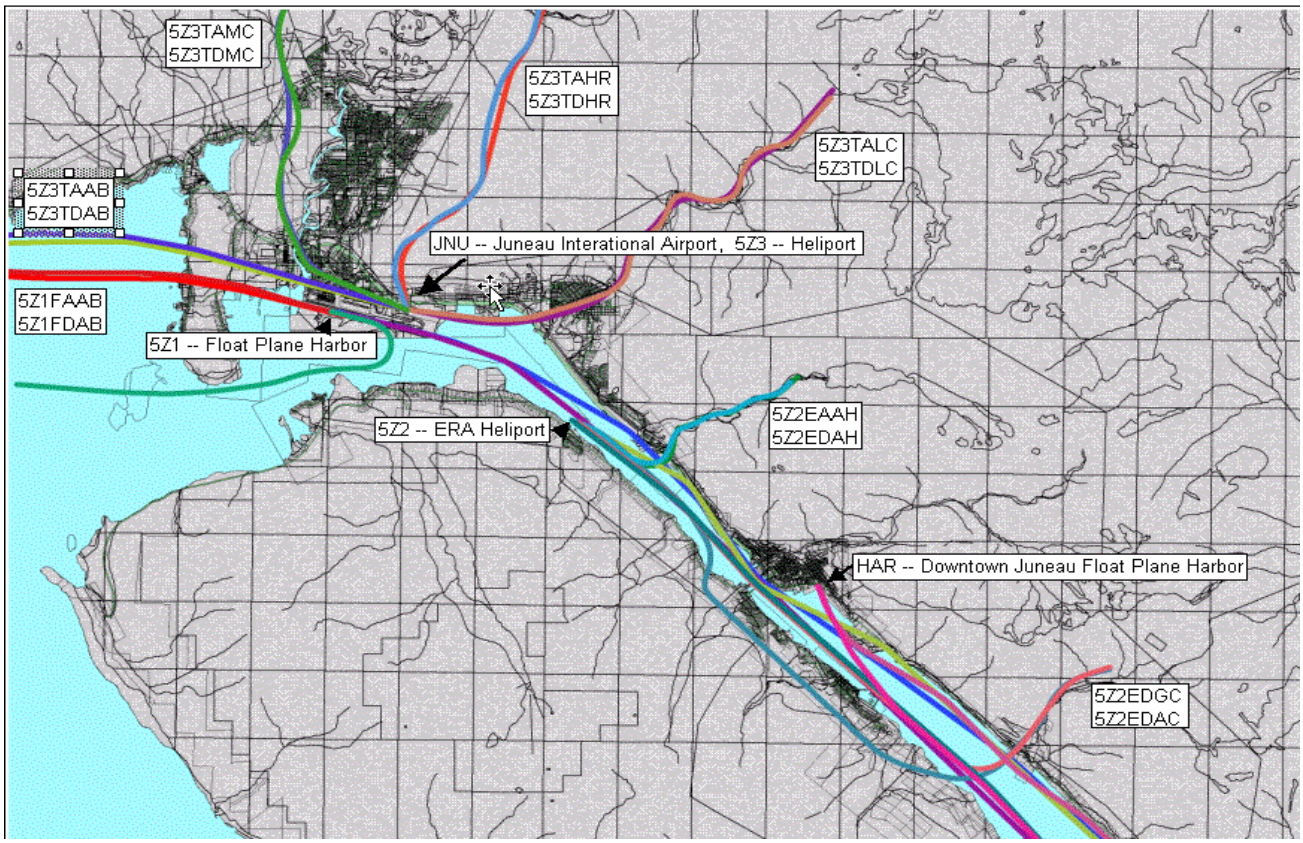


Figure 4-2
Example flight paths for helicopters from Juneau International Airport
Flightseeing Noise Assessment – City and Borough of Juneau

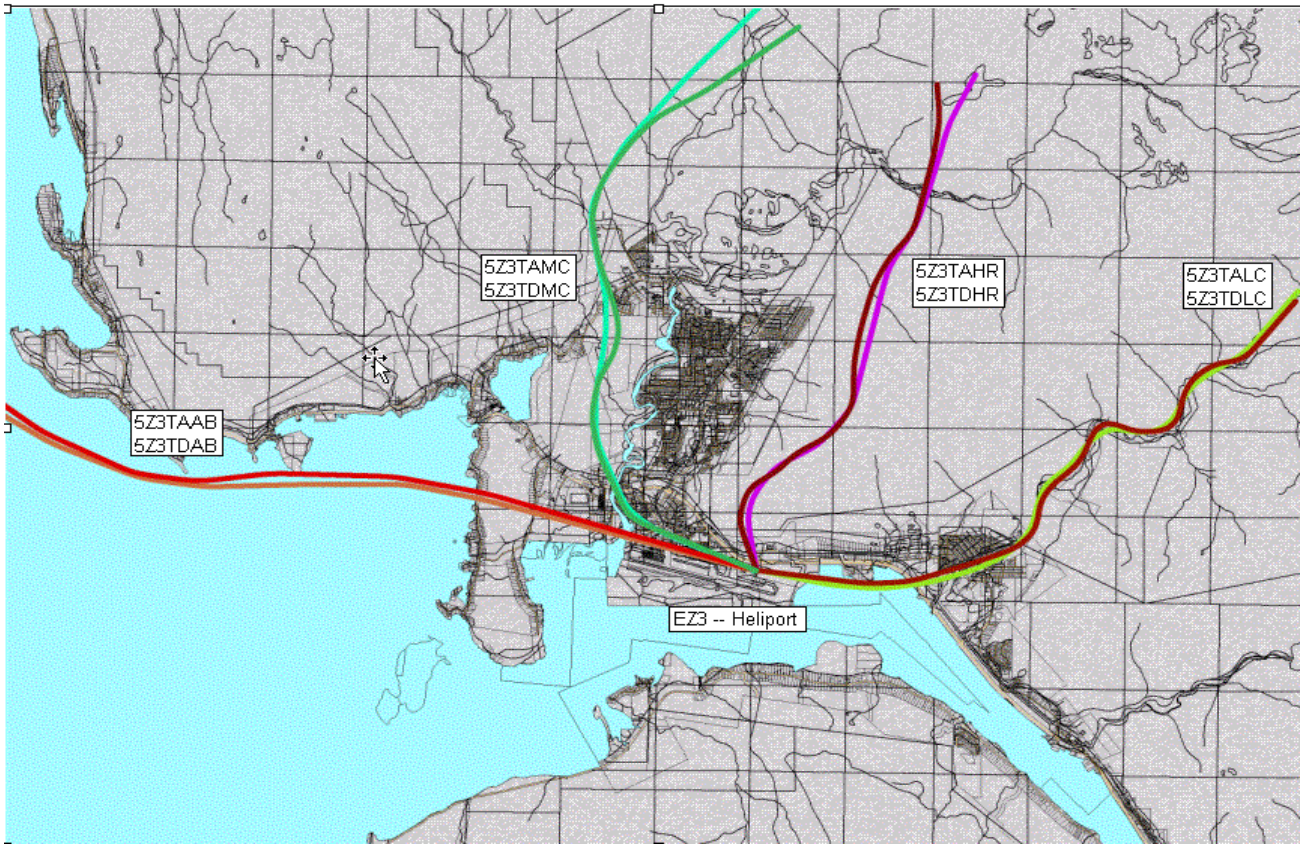


Figure 4-3
Example flight paths for float planes from Juneau harbor front
Flightseeing Noise Assessment – City and Borough of Juneau

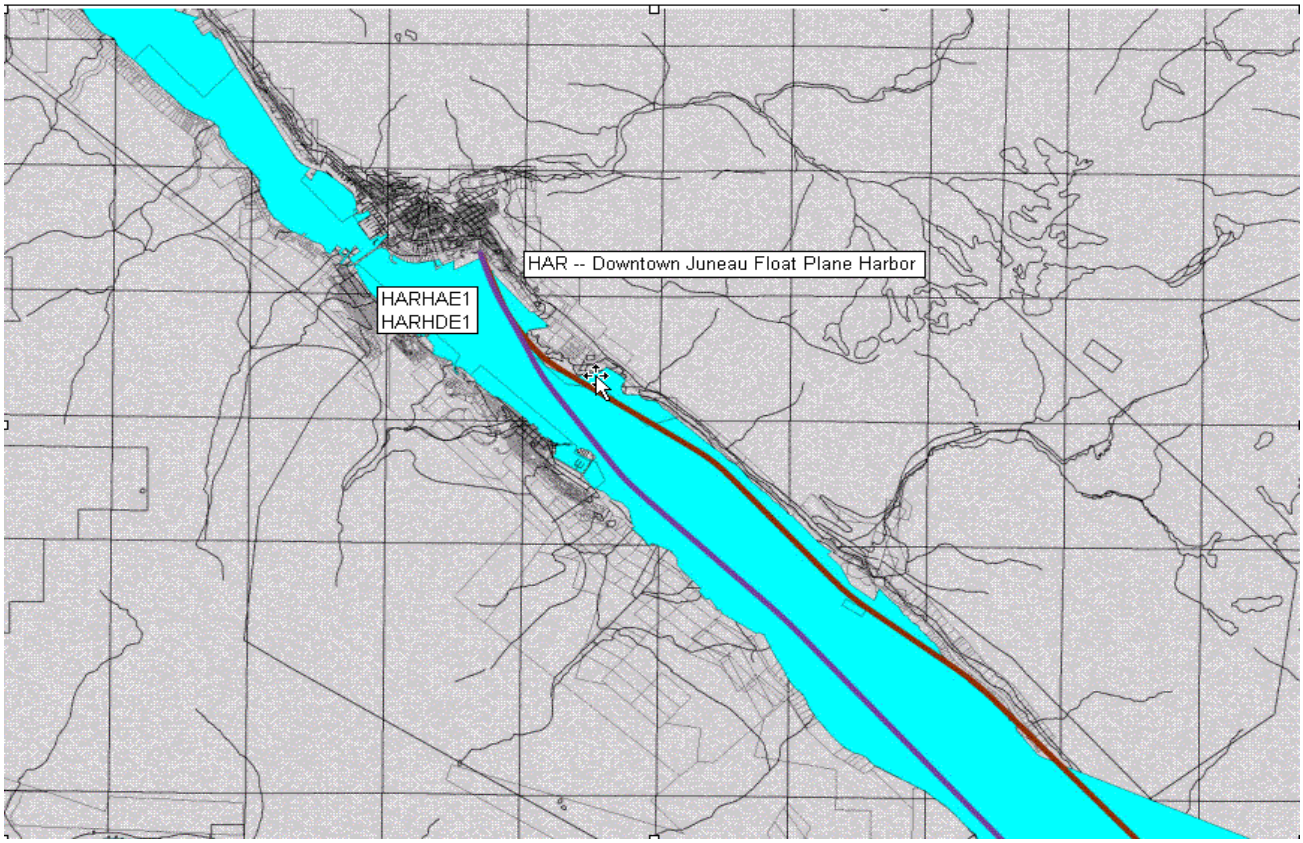


Figure 4-4
Example flight paths for helicopter from ERA Heliport
Flightseeing Noise Assessment – City and Borough of Juneau

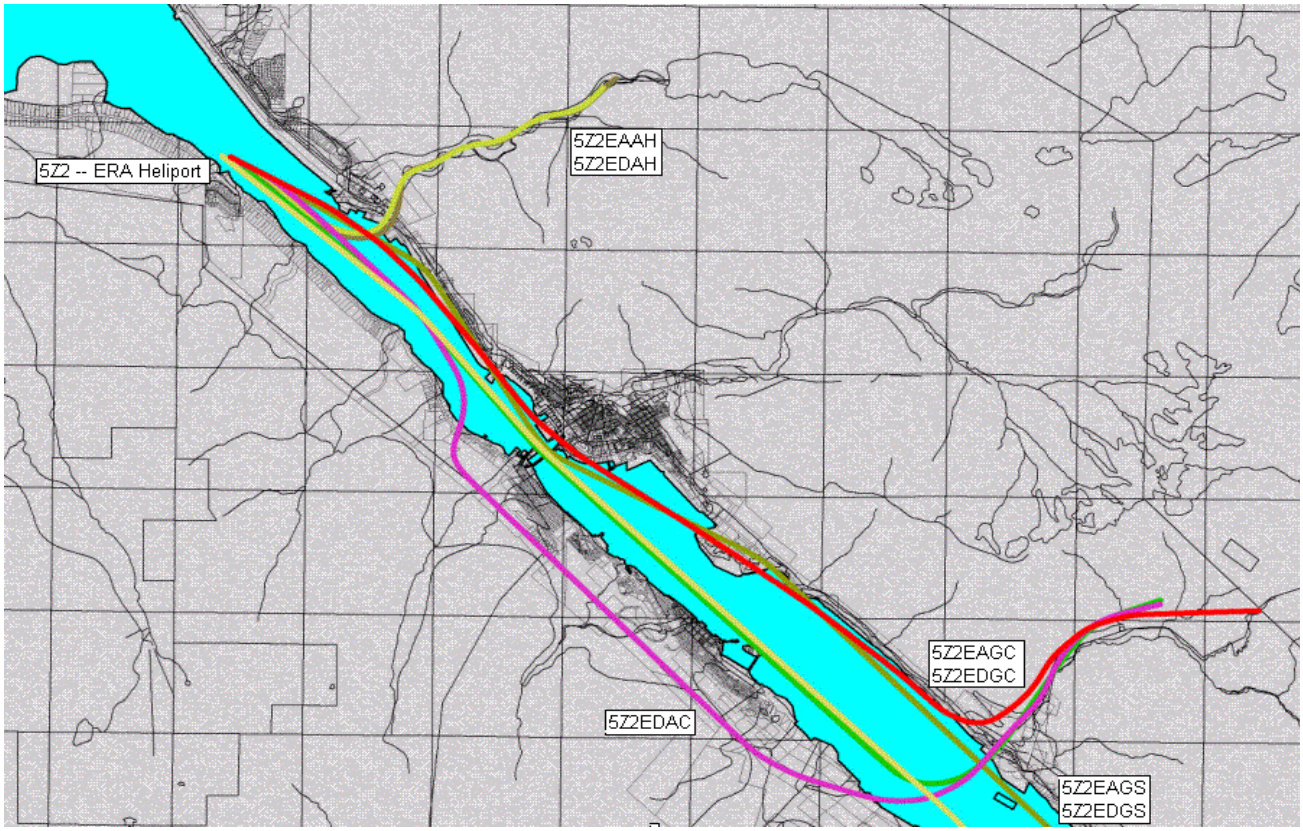
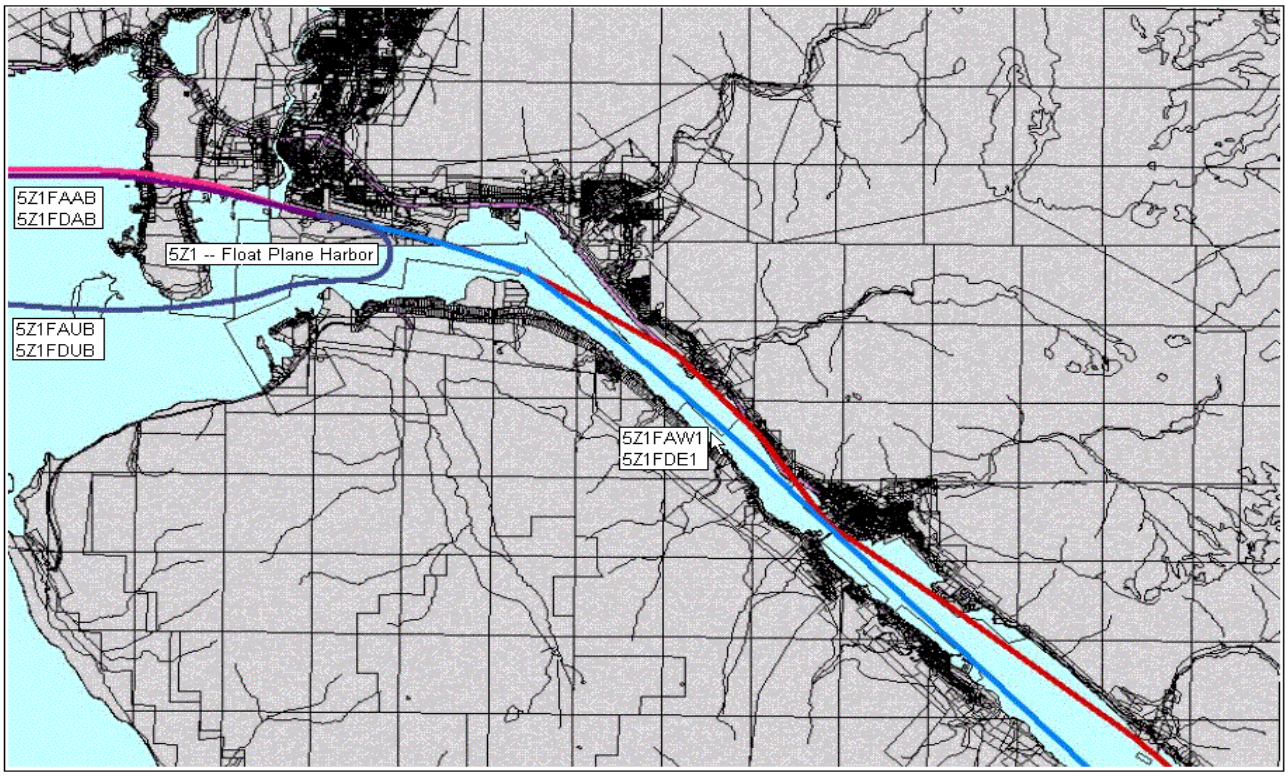


Figure 4-5
Example flight paths for float planes from Juneau International Airport Float Plane Base
Flightseeing Noise Assessment – City and Borough of Juneau



4.3 Continuous One Second Noise Data

Noise levels were continuously recorded at each of the sixteen semi-permanent noise-monitoring sites. In addition to recording the noise events from aircraft, monitors also recorded the ambient noise level of the community surrounding the site. An example of this is presented in **Figure 4-6** where one-half hour of continuous noise data is shown for seven sites. The difference between an aircraft event and the ambient noise can be easily distinguished in this plot. The top portion of the graph plots the data for four sites, while the bottom of the graph plots the data from three sites. The time sequence of each of the noise events is also presented in this data (i.e., the noise events occur in sequence as the

Sample one-half hour noise plots for each of the noise monitoring sites is presented in the Appendix. This includes three days of daytime data (8 am to 8 pm) for each site. The graphics present each of the different groups of noise monitoring sites on one page. The top portion of each graph presents data for four sites. The bottom portion presents data for three to four sites.

4.4 Ambient Noise Measurement Results

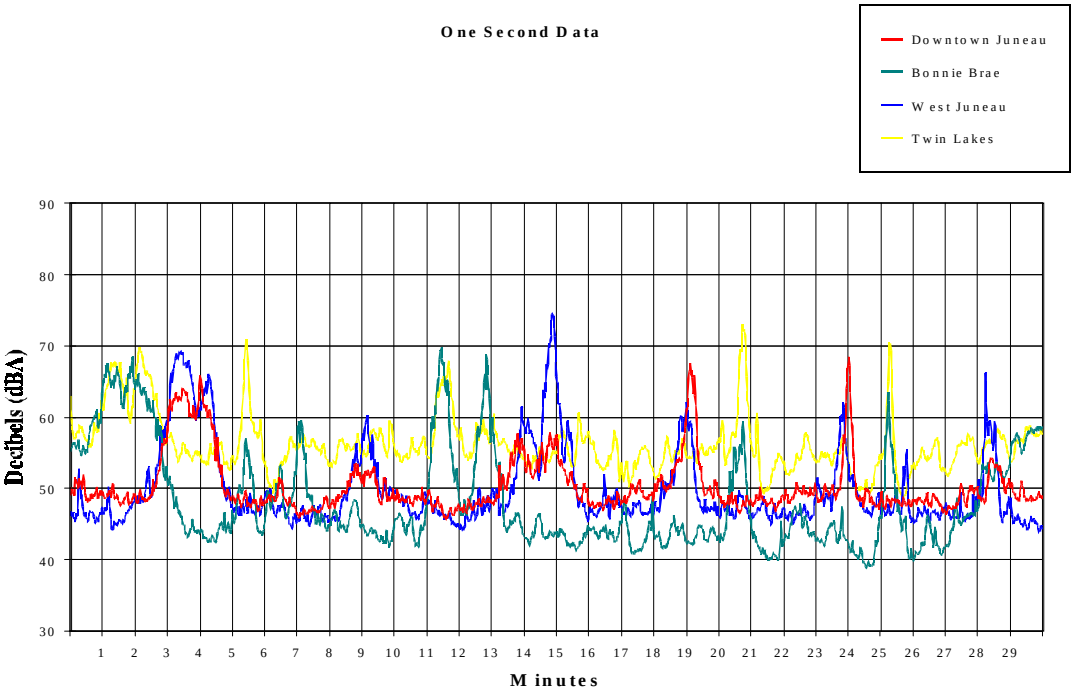
The ambient noise environment was quantified from the noise measurement survey at each of the measurement sites. Ambient noise levels were determined for all sources of noise affecting the sites. The quantities measured were the Percent Noise Levels (Ln). Percent Noise Level is the noise level exceeded different percentages of the time. These metrics were described in greater detail in the background section (Section 2.0). The data helps establish the ambient noise environment for all sources of noise and aids in assessing how intrusive aircraft noise is on the ambient environment. These other sources include noise from roadway, commercial sources and residual background noise.

The results of the ambient noise measurement survey at each measurement site are described in the following figures and tables. **Table 4-1** presents the statistical summary of the ambient measurements for all of the sites in tabular format. This table presents the Ln noise level for the L(min), L90, L50, L10 and L(max)) The L(max) is presented for the peak dBA value that was measured while the L(min) is the lowest dBA value that was measured. This table illustrates the range in noise levels that exist at each site. Note that aircraft noise is included in this data and is typically the source of peak or maximum noise level.

This same information is presented graphically in **Figure 4-7**. The top portion of the figure presents data for the Semi-permanent sites. The bottom portion presents the data for the temporary sites.

Figure 4-6
Example Time History Plot of One Half Hour of Aircraft and Ambient Noise
Flightseeing Noise Assessment -- City and Borough of Juneau
Period: Aug 1, 2000 10:00:00 AM to Aug 1, 2000 10:30:00 AM

Site: PS1 - Downtown Juneau; PS2 - Bonnie Brae; PS4 - West Juneau; PS5 - Twin Lakes



Site: PS3 - Douglas 2nd; PS6 - Douglas 5th; PS7 - Thane; T05 - Orca Point Apartments

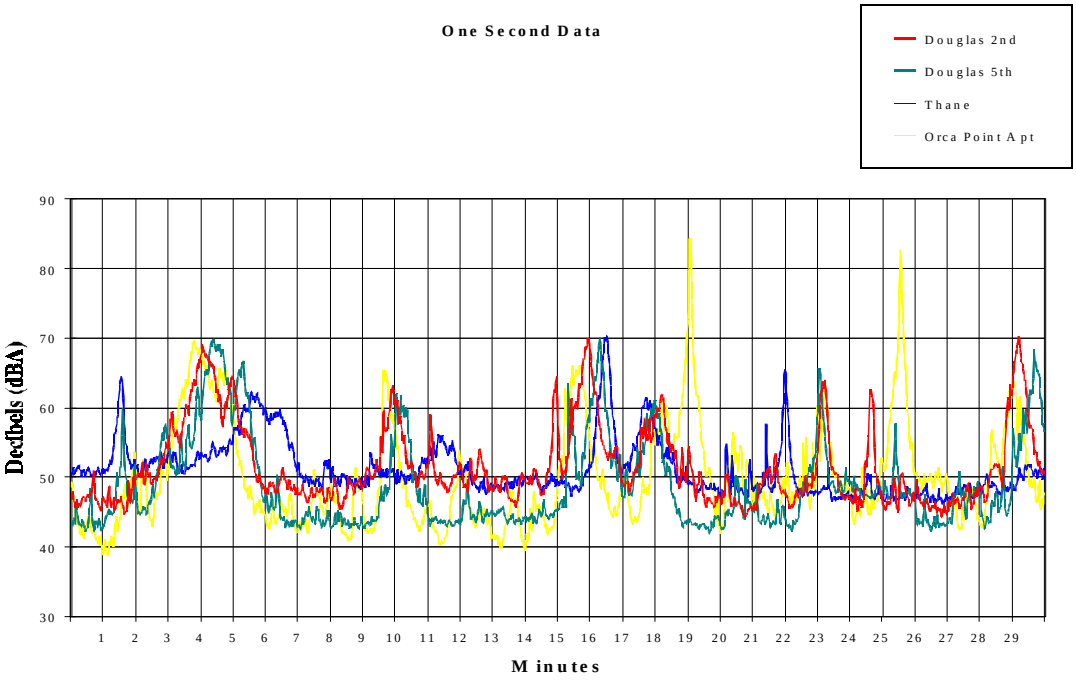
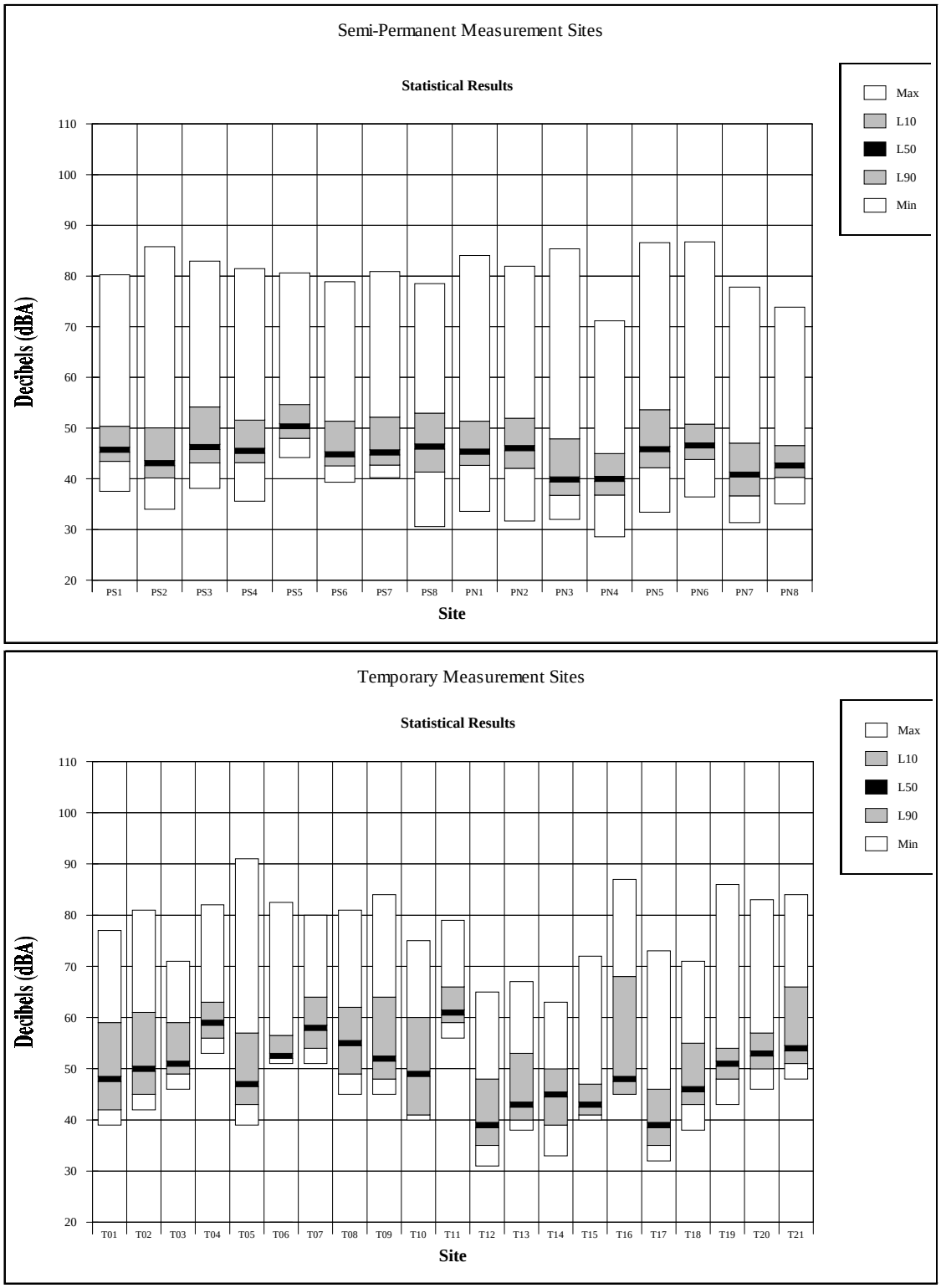


Table 4-1
Ambient Measurement Results for All Sites
Flightseeing Noise Assessment -- City and Borough of Juneau

NMS	Description	Address	Statistical Noise Levels (dBA)				
			Max	L10	L50	L90	Min
Semi-Permanent Sites							
PS1	Downtown Juneau	1544 Pine St.	80	50	46	43	38
PS2	Bonnie Brae	6736 Margurite	86	50	43	40	34
PS3	Douglas 2nd	1208 2nd St.	83	54	46	43	38
PS4	West Juneau	3220 Foster	81	52	46	43	36
PS5	Twin Lakes	4111 Blackerby	81	55	50	48	44
PS6	Douglas 5th	400 5th St.	79	51	45	43	39
PS7	Thane	4990 Thane Rd	81	52	45	43	40
PS8	Thane Sheep Creek	4545 Thane Rd.	78	53	46	41	31
PN1	Lower Mendenhall	2395 Aurora Ct.	84	51	45	43	34
PN2	Brotherhood Park	3110 Wild Meadow	82	52	46	42	32
PN3	Fritz Cove Rd	2180 Fritz Cove Rd.	85	48	40	37	32
PN4	Mendenhaven	4396 Taku Blvd.	71	45	40	37	29
PN5	North Douglas	10624 Starlight Court	87	54	46	42	33
PN6	Lemon Creek	5140 Glacier Highway	87	51	47	44	36
PN7	Upper Mendenhall	8298 Garnet	78	47	41	37	31
PN8	West Mendenhall	9688 Moraine Way	74	47	43	40	35
Temporary Sites							
T01	Douglas	Savikko Recreation Area	77	59	48	42	39
T02	West Juneau	Upper Pioneer	81	61	50	45	42
T03	Downtown Juneau	Wickersham House 7th/Franklin	71	59	51	49	46
T04	Downtown Juneau	Marine Park	82	63	59	56	53
T05	Douglas	Orca Point Apartments	91	57	47	43	39
T06	Downtown Juneau	10th & Bst	82	56	52	52	51
T07	Juneau	Bartlett Memorial Hospital	80	64	58	54	51
T08	Downtown Juneau	Juneau Douglas High School	81	62	55	49	45
T09	Douglas	2616 Edgewater Place	84	64	52	48	45
T10	Douglas	Alaska Belle Ct.	75	60	49	41	40
T11	Douglas	2374 Lawson Creek Rd.	79	66	61	59	56
T12	Upper East Valley	8437 Canyon Drive	65	48	39	35	31
T13	Lower East Valley	3001 Tongass Blvd.	67	53	43	40	38
T14	West Valley	9992 Silver Street	63	50	45	39	33
T15	Lower West Valley	9347 Betty Court	72	47	43	41	40
T16	Tee Harbor	Milepost 19	87	68	48	45	45
T17	Middle Valley	8573 Duran Court	73	46	39	35	32
T18	Indian Point	14185 Otter Way	71	55	46	43	38
T19	Lemon Creek	6044 Pine St.	86	54	51	48	43
T20	Lemon Creek	Lemon Creek Manor Mobile HP	83	57	53	50	46
T21	Airport	Juneau Ranger District	84	66	54	51	48

Figure 4-7
Graphic of Ambient Measurement Results For All Sites
Flightseeing Noise Assessment -- City and Borough of Juneau



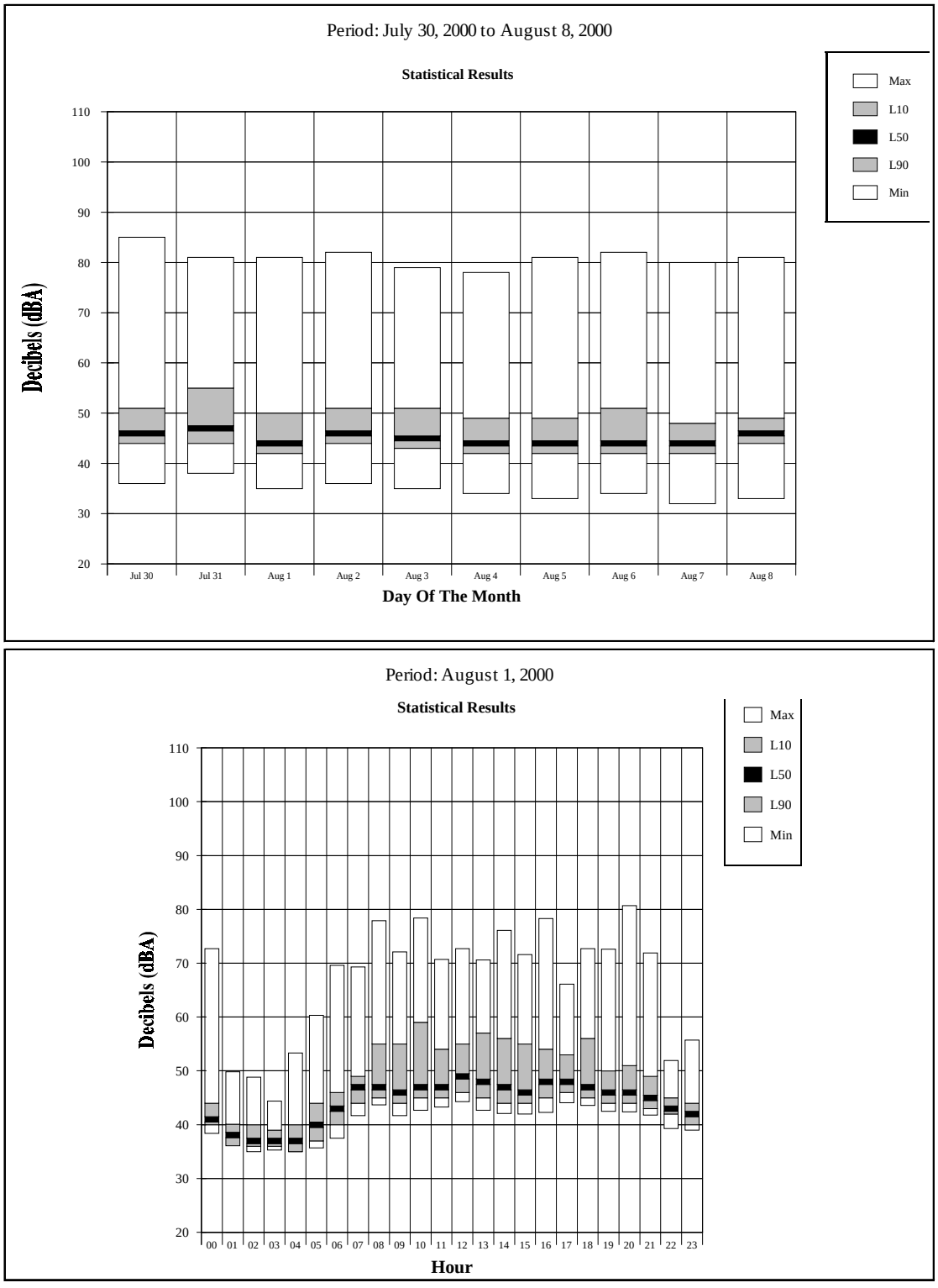
The L90 noise is a good representation of the background noise level. It represents the level that is exceeded 90 percent of the time. Therefore it is commonly referred to as the residual noise when other sources of noise are not present. It is the level above which noise events occur, such as aircraft overflights. Aircraft noise would have very little if any contribution to this noise level. The L50 noise level is the median noise level. Half the time the noise is below this level; half the time it is above this level. During peak hours of aircraft activity, the L50 noise level would be influenced by the aircraft noise, but on a 24-hour basis, this level is generally reflective of ambient noise levels.

The results of the measurements from the permanent sites showed that background L90 noise levels ranged from a low of 37 dBA to a high of 48 dBA. Most sites had background L90 noise levels in the low 40s dBA. The majority of these sites were located in relatively quiet noise environments that were not exposed to noise sources, such as highways. Some temporary sites were located in areas with higher background noise levels. These sites, such as Bartlett Memorial Hospital had background L90 noise levels in the low 50s dBA.

The ambient noise level varies by day and time of day. To illustrate this range in noise, ambient noise data from one of the sites is summarized in **Figure 4-8**. These results for the other sites are presented in the Appendix. The top portion of this figure presents the day-to-day measurement results. The bottom portion of the figure shows each hour of measurement for one typical day. The results show that day-to-day ambient noise levels approximately the same for each day, except occasional days that are higher. These higher ambient days are generally during bad weather conditions. The ambient noise levels do vary by time of day. The data shows that the ambient noise levels are quieter at night and in late evening and early morning hours. These levels increase during daytime hours. Typical daytime ambient noise levels are about 5 dBA higher than during the nighttime hours.

In general, except for locations downtown or near major roadways, the background ambient noise levels were relatively similar throughout Juneau and are typical of a quiet suburban area. Because of the type of vegetation, weather and proximity to water, these levels are not as low as would occur in a desert type remote setting. They are, however, lower than is typical for more urban areas.

Figure 4-8
Graphic of Ambient Measurement Results for Example Site
Flightseeing Noise Assessment -- City and Borough of Juneau
Site: PS4 - 3220 Foster, West Juneau



4.5 Aircraft Single Event Noise Measurement Results

Aircraft single event noise levels were determined at each measurement site. The acoustic data included the maximum noise level (Lmax), Sound Exposure Level (SEL), and the time duration of aircraft events. The single events measured during the survey were correlated with flight operations information. With this correlated single event noise data, it is possible to separately determine the single event noise levels from the different sources of aircraft noise. The single event results are summarized in the following paragraphs. Additional single event noise data is presented in the Appendix.

The typical daily number of aircraft noise events measured at a site is presented graphically in **Figure 4-9**. This table presents one day of events for one measurement site. The table presents the Lmax noise value plotted as a histogram. The vertical axis presents the number of events in each hour. The horizontal axis reports the hour of the day. The Lmax values are plotted vertically for each event in each hour. The data shows that the noise events generally occur during peak times of the day. This peak period varies from day to day and does not always occur during the same hours.

The correlated events at each of the monitoring sites were sorted to determine which operations produced the loudest events. **Table 4-2** lists the date, time, aircraft type, and measured noise levels for the loudest event measured at each site. The results show the loudest event measured from flightseeing aircraft was 87 dBA. The typical highest level was in the mid to high 70s dBA. The tables listing the loudest ten events and associated aircraft for all noise monitoring sites are presented in the appendix.

The average Lmax noise event for each type of aircraft operation was also determined. These results are presented in **Table 4-3**, which presents the average maximum or peak noise level (Lmax) measured for each type of operation. This data illustrates typical peak noise levels. The results show that average Lmax noise levels were measured in the high 60s dBA value. This was the same for both floatplanes and helicopter operations.

Figure 4-9
Daily Noise Events Histogram Report
Flightseeing Noise Assessment -- City and Borough of Juneau
Period: July 31, 2000
Site: PS4 - 3220 Foster, West Juneau

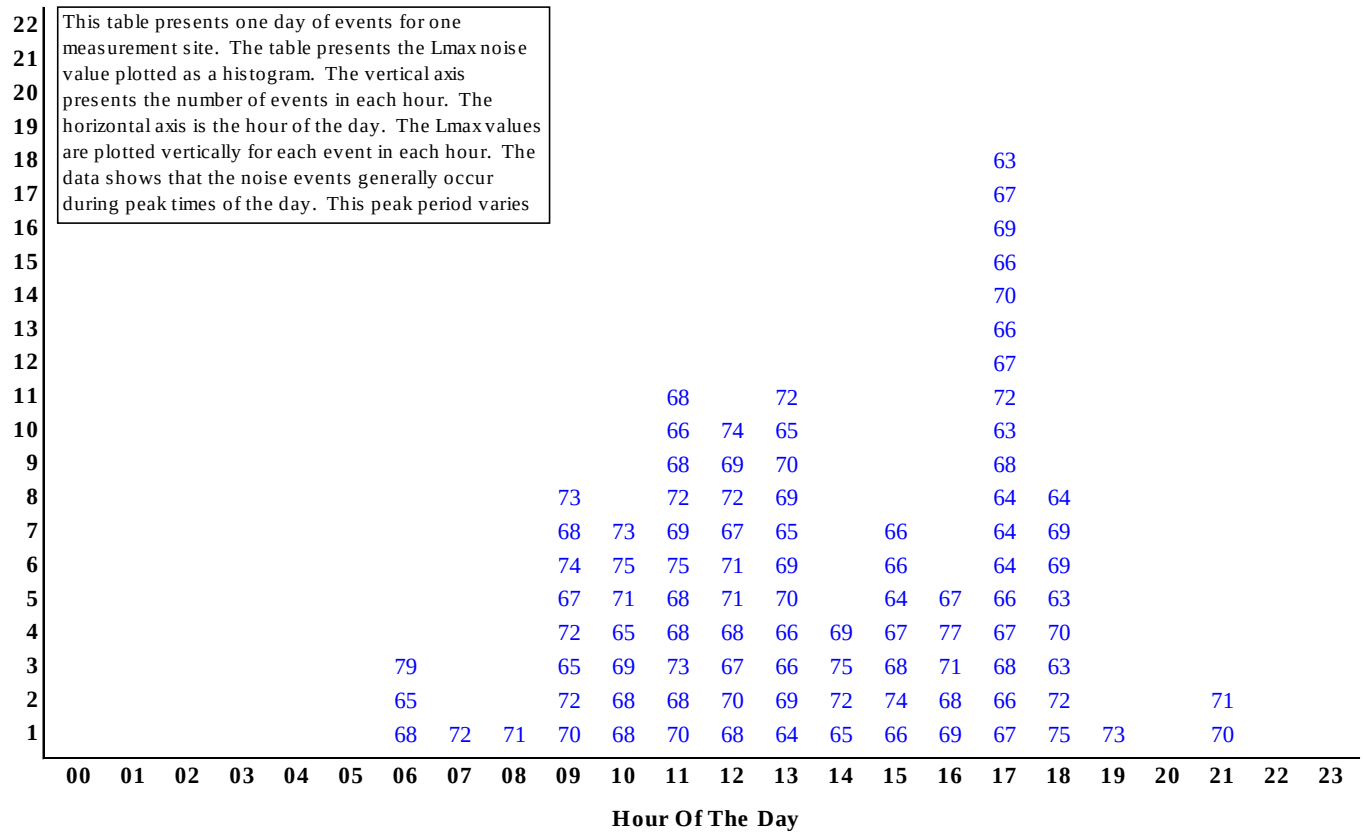


Table 4-2
Highest Measured Noise Event (Lmax)
Flightseeing Noise Assessment -- City and Borough of Juneau

Site Information			Date Time	Aircraft	Lmax (dBA)
RMS ID	Community	Address			
Semi-Permanent Sites					
PS1	Downtown Juneau	1544 Pine St.	8/13/00 9:39	Heli	80
PS2	Bonnie Brae	6736 Margurite	8/13/00 17:33	Float	87
PS3	Douglas 2nd	1208 2nd St.	8/5/00 8:18	Float	81
PS4	West Juneau	3220 Foster	7/30/00 13:05	Heli	81
PS5	Twin Lakes	4111 Blackerby	8/7/00 16:45	Jet	80
PS6	Douglas 5th	400 5th St.	8/6/00 18:02	Float	79
PS7	Thane	4990 Thane Rd	7/30/00 21:33	Jet	77
PS8	Thane Sheep	4545 Thane Rd.	8/2/00 18:38	Heli	78
PN1	Lower Mendenhall	2395 Aurora Ct.	8/18/00 20:43	Jet	81
PN2	Brotherhood Park	3110 WildMeadow	8/16/00 16:49	Jet	82
PN3	Fritz Cove Rd.	2180 Fritz Cove Rd.	8/19/00 5:55	Jet	85
PN4	Mendenhaven	4396 Taku Blvd.	8/11/00 19:31	Heli	74
PN5	North Douglas	10624 Starlight Court	8/14/00 10:00	Jet	87
PN6	Lemon Creek	5140 Glacier Highway	8/14/00 8:20	Heli	78
PN7	Upper Mendenhall	8298 Garnet	8/13/00 12:53	Heli	73
PN8	West Mendenhall	9688 Moraine Way	8/18/00 16:52	Heli	70
Temporary Sites					
T01	Douglas	Savikko Recreation Area	7/30/00 12:14	Float	77
T02	West Juneau	Upper Pioneer	7/30/00 14:04	Float	77
T03	Downtown Juneau	Wickersham House 7th St./	7/31/00 12:52	Float	71
T04	Downtown Juneau	Marine Park	7/31/00 17:08	Float	82
T05	Douglas	Orca Point Apartments	8/1/00 10:19	Heli	80
T06	Downtown Juneau	10th & Bst	8/1/00 17:49	Float	72
T07	Juneau	Bartlett Memorial Hospital	8/2/00 10:01	Heli	76
T08	Downtown Juneau	Juneau Douglas High School	8/2/00 18:43	Float	77
T09	Douglas	2616 Edgewater Place	8/3/00 11:43	Float	79
T10	Douglas	Alaska Belle Ct.	8/3/00 13:44	Float	74
T11	Douglas	2374 Lawson Creek Rd.	8/8/00 13:19	Float	79
T12	Upper East Valley	8437 Canyon Drive	8/10/00 16:56	Heli	59
T13	Lower East Valley	3001 Tongass Blvd.	8/11/00 11:54	Heli	67
T14	West Valley	9992 Silver Street	8/11/00 15:32	Heli	60
T15	Lower West Valley	9347 Betty Court	8/12/00 11:34	Heli	72
T16	Tee Harbor	Milepost 19	8/12/00 15:14	Jet	78
T17	Middle Valley	8573 Duran Court	8/13/00 10:33	Heli	73
T18	Indian Point	14185 Otter Way	8/13/00 16:18	Heli	71
T19	Lemon Creek	6044 Pine St.	8/14/00 16:46	Jet	86
T20	Lemon Creek	Lemon Creek Manor Mobile Home	8/15/00 16:06	Heli	74
T21	Airport	Juneau Ranger District	8/16/00 16:28	Heli	80

Table 4-3
Average Measured Maximum Noise Events (Lmax)
Flightseeing Noise Assessment -- City and Borough of Juneau

Site Information			Average dBA Value Per Aircraft Type			
RMS ID	Community	Address	Helicopter	Float	GA	JET
Semi-Permanent Sites						
PS1	Downtown Juneau	1544 Pine St.	67	67	68	67
PS2	Bonnie Brae	6736 Margurite	65	65	68	73
PS3	Douglas 2nd	1208 2nd St.	67	67	68	69
PS4	West Juneau	3220 Foster	68	69	69	71
PS5	Twin Lakes	4111 Blackerby	69	69	70	74
PS6	Douglas 5th	400 5th St.	67	66	67	69
PS7	Thane	4990 Thane Rd	66	66	66	66
PS8	Thane Sheep	4545 Thane Rd.	64	63	64	66
PN1	Lower Mendenhall	2395 Aurora Ct.	68	62	65	71
PN2	Brotherhood Park	3110 WildMeadow	68	64	65	73
PN3	Fritz Cove Rd.	2180 Fritz Cove Rd.	68	65	66	75
PN4	Mendenhaven	4396 Taku Blvd.	67	61	56	53
PN5	North Douglas	10624 Starlight Court	69	67	66	75
PN6	Lemon Creek	5140 Glacier Highway	67	65	63	61
PN7	Upper Mendenhall	8298 Garnet	60	57	57	59
PN8	West Mendenhall	9688 Moraine Way	58	59	54	53
Temporary Sites						
T01	Douglas	Savikko Recreation Area	71	65	65	---
T02	West Juneau	Upper Pioneer	69	71	70	67
T03	Downtown Juneau	Wickersham House 7th St. &	67	68	69	70
T04	Downtown Juneau	Marine Park	---	82	---	68
T05	Douglas	Orca Point Apartments	69	69	70	76
T06	Downtown Juneau	10th & Bst	---	71	---	70
T07	Juneau	Bartlett Memorial Hospital	73	72	---	71
T08	Downtown Juneau	Juneau Douglas High School	72	72	---	72
T09	Douglas	2616 Edgewater Place	71	72	---	---
T10	Douglas	Alaska Belle Ct.	61	63	63	70
T11	Douglas	2374 Lawson Creek Rd.	---	77	---	---
T12	Upper East Valley	8437 Canyon Drive	53	---	---	---
T13	Lower East Valley	3001 Tongass Blvd.	62	---	61	63
T14	West Valley	9992 Silver Street	59	---	58	---
T15	Lower West Valley	9347 Betty Court	61	68	---	---
T16	Tee Harbor	Milepost 19	---	68	73	78
T17	Middle Valley	8573 Duran Court	56	73	---	---
T18	Indian Point	14185 Otter Way	63	63	66	62
T19	Lemon Creek	6044 Pine St.	67	67	---	76
T20	Lemon Creek	Lemon Creek Manor Mobile Home	73	68	---	70
T21	Airport	Juneau Ranger District	73	---	73	79

4.6 DNL Noise Measurement Results

The aircraft DNL noise levels were determined at each of the semi-permanent noise monitoring locations. **Table 4-4** presents the results of the DNL noise measurements at the 16 semi-permanent noise-monitoring locations. This table lists the average DNL due to aircraft events for the period the noise level was monitored at each site. The measurement results show that nearly all of these locations are exposed to some degree of aircraft noise with the levels ranging from 58 to below 45 DNL.

The table also presents the minimum and maximum range in the measured DNL noise level. The data shows that the DNL noise levels show a large day-to-day range in the DNL noise levels; with some days the aircraft noise levels are very low. This is reflective of an environment where there is variability in the level of aircraft operations. The primary variability is the changes in weather that affect the number of operations and were the aircraft actually fly.

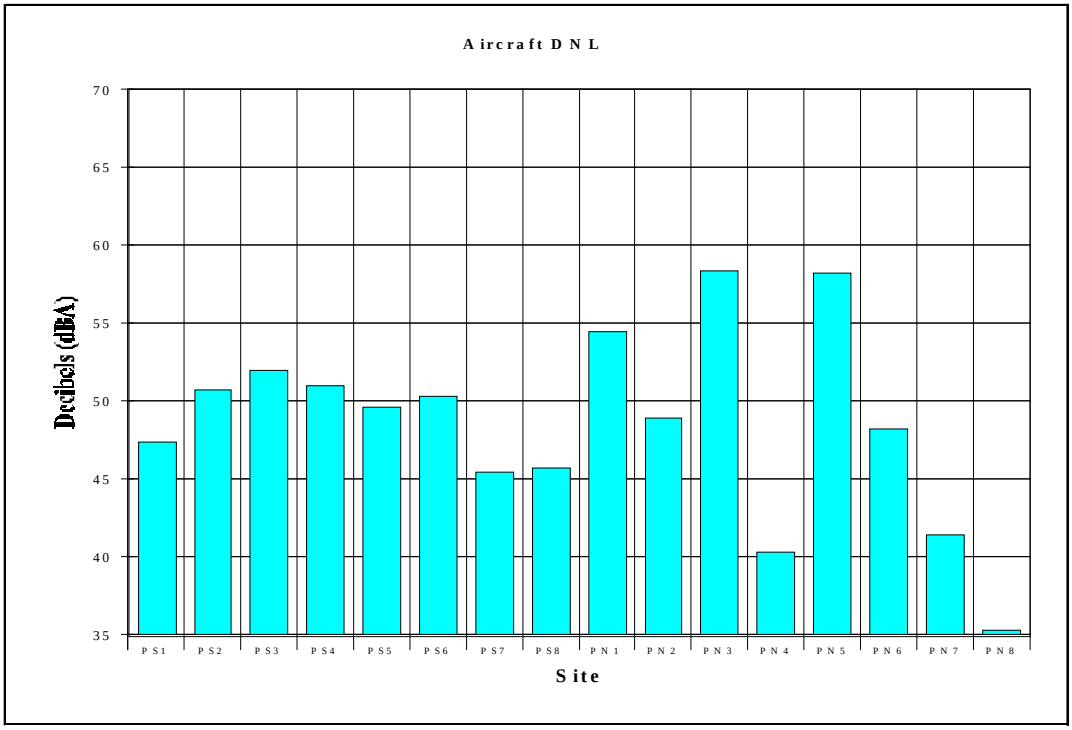
Table 4-4
MEASURED AIRCRAFT DNL NOISE LEVELS
City & Borough of Juneau – Flight Seeing Noise Study

Site	Name	Neighborhood	Average DNL	Maximum DNL	Minimum DNL
1	PS1	Downtown Juneau	48	50	<35
2	PS2	Bonnie Brae	51	55	<35
3	PS3	Douglas 2nd	52	56	<35
4	PS4	West Juneau	51	54	<35
5	PS5	Twin Lakes	50	53	<35
6	PS6	Douglas 5th	50	54	<35
7	PS7	Thane	46	48	<35
8	PS8	Thane Sheep Creek	46	50	32
9	PN1	Lower Mendenhall	55	60	42
10	PN2	Brotherhood Park	49	56	<35
11	PN3	Fritz Cove Road	58	65	54
12	PN4	Mendenhaven	40	44	35
13	PN5	North Douglas	58	62	55
14	PN6	Lemon Creek	48	52	39
15	PN7	Upper Mendenhall	41	45	35
16	PN8	West Mendenhall	35	37	<35

Figure 4-10 shows the same results of the DNL noise measurements at the 16 semi-permanent noise-monitoring locations in a graphical format. The top portion of the graph shows the average DNL noise level measured at each noise monitoring location. The bottom portion of the table shows the range of daily DNL values along with the overall DNL for the entire measurement period. The results show the wide range in noise level that is experienced at each location. For example, the average difference between the minimum and maximum DNL is 9 dBA. This is primarily due to weather. The number of operations and the pattern of the operations vary with the weather. Peak DNL days were an average of 3 to 4 dBA higher than the average day.

Figure 4-11 graphically presents the DNL noise level due to the aircraft events for each day the noise level was monitored at Site PS6 at Douglas. This figure also includes a histogram of the noise events levels of all of the aircraft events measured at the site. This helps illustrate the range in the single event noise levels measured at the site and the relative number of events. Additional figures presenting this information for the other sites are presented in the Appendix.

Figure 4-10
Measured Aircraft DNL Noise Levels
Flightseeing Noise Assessment -- City and Borough of Juneau



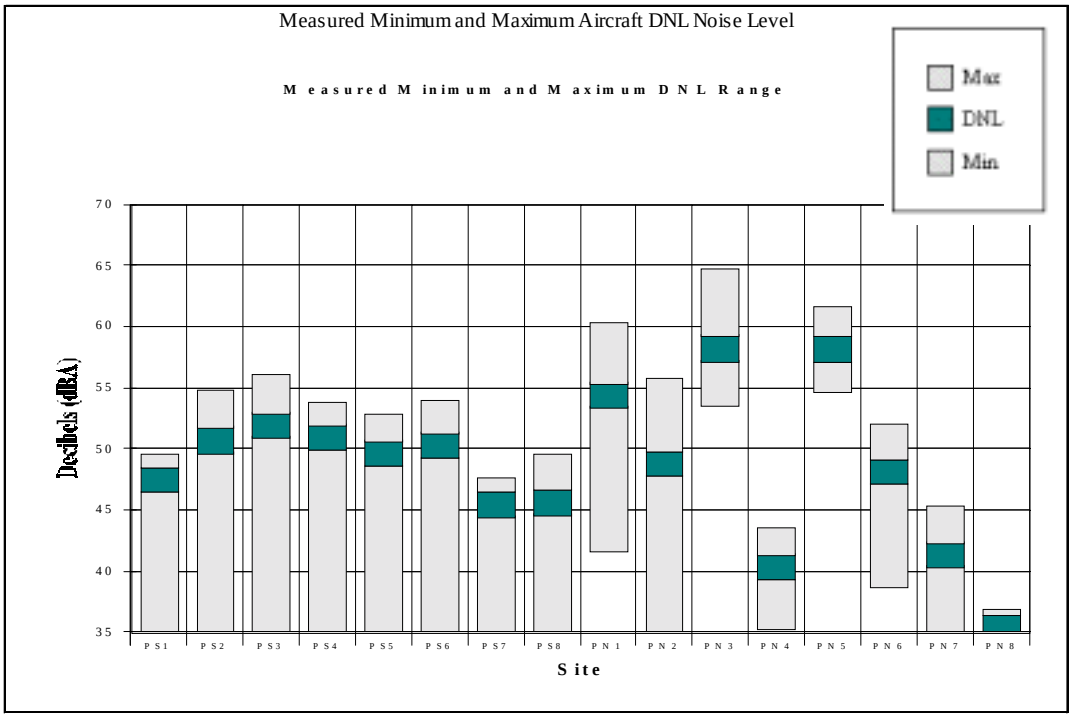
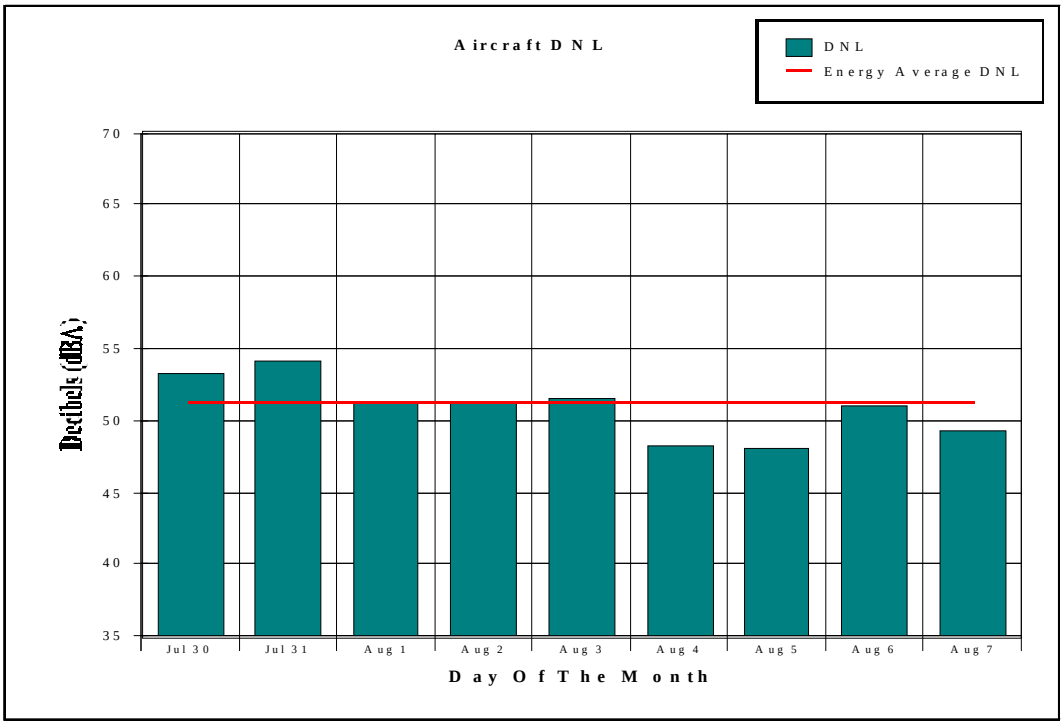
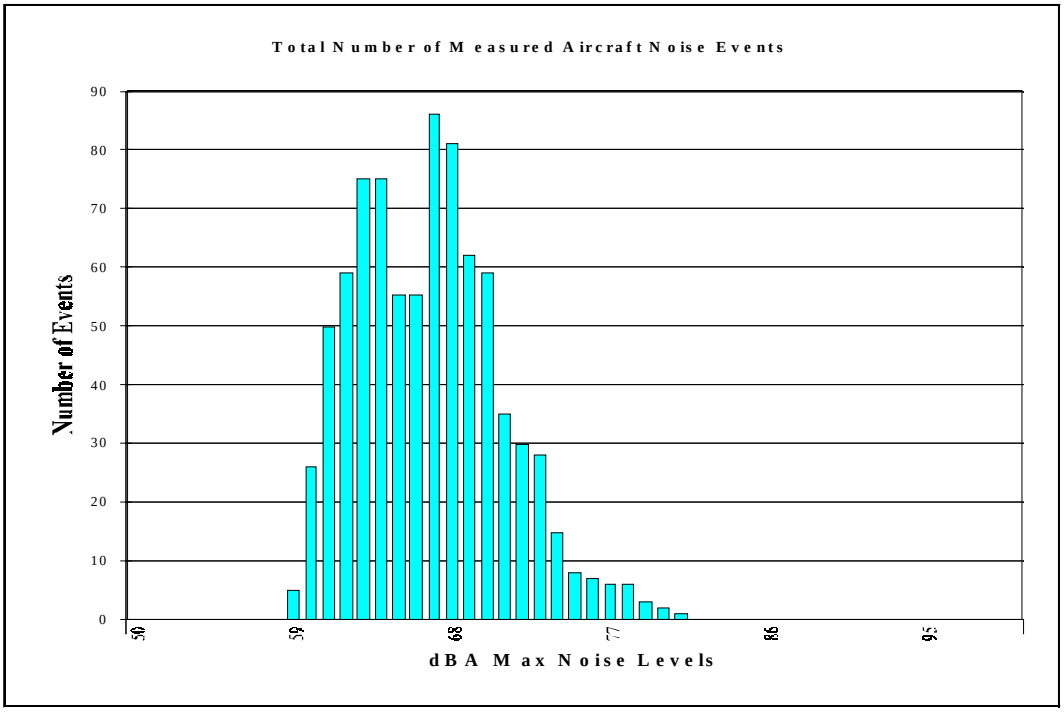


Figure 4-11
Flightseeing Noise Assessment -- City and Borough of Juneau
Period: July 30, 2000 to August 7, 2000
Site: PS6 - 400 5th St., Douglas





4.7 Flightseeing Hours LEQ Noise Level (Modified DNL)

The DNL noise metric is a 24-hour energy average noise value. Because most people find noise more objectionable during the night, nighttime noise is weighted by a factor of 10 in the standard DNL. Since flightseeing noise occurs only during the daytime hours, there has been concern that the DNL metric unfairly averages the noise over time periods when flightseeing noise does not occur. As a result, a modified DNL is presented that reflects the noise during the flightseeing hours only. This modified DNL is actually a LEQ for the flightseeing hours. The Flightseeing Hours LEQ (Modified DNL) is the energy average LEQ noise level for the hours of 8 am to 8 pm). Both of these metrics were described in Section 2 of the report.

The results of the noise measurements in terms of the Flightseeing Hours LEQ are presented in **Table 4.5**. This table presents the hourly aircraft LEQ noise level for each hour of the day between 8 am and 8 pm, as well as the modified DNL that is represented by that period. This data is presented for the 16 long term noise-monitoring locations for the average of each of the days of measurement.

The Modified DNL (Flightseeing hours LEQ) shows a similar trend in noise as the standard DNL. On days or sites where the DNL is higher, the Modified DNL is also higher. On days or sites where the DNL is lower, the Modified DNL is roughly 2 dBA higher numerically than the DNL for flightseeing operations only. Note that there are some sites that are exposed to other aircraft sources near the airport. For these sources, the DNL is actually higher than the Flightseeing Hours LEQ. That is because these sites are exposed to nighttime aircraft operations. The dominant source of nighttime aircraft noise near the airport are the two nighttime cargo jet operations.

The data in Table 4.5 also shows the measured hourly aircraft LEQ noise level for each hour of normal flightseeing operations. The results show that the LEQ noise levels for the peak hour is 2 to 3 dBA higher than the average value. There is no set pattern as to which hour is the highest. The data shows that it varies per day and hour of the day. This is probably caused by variations in the weather and tour ship arrival times.

Table 4-5
Hourly Noise and Modifed DNL Noise Level
City and Borough of Juneau
Metric: Aircraft Hourly Noise and Modified DNL

Site Information			Hour Of The Day													Modifed
RMS ID	Name	Community	08	09	10	11	12	13	14	15	16	17	18	19	20	21	DNL
1	PS1	Downtown	45	50	51	51	49	52	51	52	51	52	52	43	34	43	50
2	PS2	Bonnie Brae	52	54	55	51	52	53	55	53	55	54	53	49	41	44	53
3	PS3	Douglas 2nd	52	55	56	56	52	56	56	56	55	55	54	48	45	43	54
4	PS4	West Juneau	51	53	54	53	51	56	55	56	53	54	55	48	42	44	53
5	PS5	Twin Lakes	50	53	54	52	52	52	52	52	54	52	54	49	40	47	52
6	PS6	Douglas 5th	51	55	53	55	52	56	54	55	54	55	53	47	42	42	53
7	PS7	Thane	46	49	50	50	49	48	50	50	51	50	46	44	0	47	49
8	PS8	Thane Sheep	44	47	50	49	48	51	50	51	48	46	50	41	0	0	48
9	PN1	Lower	52	48	52	45	44	46	48	46	50	53	49	60	59	45	53
10	PN2	Brotherhood	54	49	56	50	49	52	48	51	52	50	47	54	50	47	52
11	PN3	Fritz Cove Rd.	54	55	59	55	53	55	54	55	56	55	53	52	53	46	55
12	PN4	Mendenhaven	41	41	39	40	40	40	43	41	39	42	38	41	27	22	40
13	PN5	North Douglas	59	56	58	58	57	58	58	57	55	57	57	52	49	44	57
14	PN6	Lemon Creek	50	54	51	49	49	48	49	56	47	49	48	44	33	33	50
15	PN7	Upper	42	44	41	40	51	48	40	44	39	41	45	43	30	30	44
16	PN8	West Mendenhall	37	35	39	36	38	38	36	39	38	35	40	39	26	31	37

4.8 Time Above Noise Measurement Results

Time Above was determined in terms of the time in minutes per day that the noise levels were greater then specific noise levels. These levels were designed to reflect different degrees of magnitude of the noise. The Time Above levels that were determined from the noise measurement survey are: 55 dBA which is designed to reflect when aircraft are clearly audible; 65 dBA which is designed to reflect when aircraft would start to cause speech interference, and 75 dBA which is designed to reflect when aircraft are sufficiently loud so that speech is clearly interfered with.

The Time Above 55 dBA is not to imply that noise levels below 55 dBA would not be audible or be annoying to all individuals, but it is reflective of when an aircraft would be clearly audible in the typical daytime environments around Juneau. Quantifying the Time Above noise levels below 55 dBA is more difficult because many noise sources are often at or near 55 dBA. Therefore it is not always possible to separate aircraft noise from other noise sources when the background and aircraft noise levels are similar.

The results of the Time Above measurements are summarized in Table 4-6. These results show the time in percent of time that the noise levels were greater than the specified noise levels. The time period used was from 8 am to 8 pm, which are the primary hours of flightseeing operations.

The results show that the Time Above 75 dBA noise levels occur less than 1% of the time. Time Above 75 dBA represents the high interruption level. There results show that the high noise levels do not occur often and when they do occur the level is of short duration. Generally the noise is only above 75 dBA when an aircraft is directly overhead or in close proximity. The duration of events that have a maximum noise level greater than 75 dBA is typically less than 5 seconds.

In terms of the Time Above 65 dBA level, the results show that at sites exposed to flightseeing noise, the Time Above 65 dBA noise levels occur about 2% to 5% of the time. Time Above 65 dBA roughly represents when some degree of activity interference may occur such as speech communication. For those aircraft events that generate noise levels greater than 65 dBA the noise from the aircraft overflight is generally above 65 dBA for a period of 10 to 20 seconds. The data shows that noise levels above 65 dBA occur more often than the higher level, but that the majority of the noises from flightseeing operations are below 65 dBA.

Table 4-6
TIME ABOVE NOISE LEVELS MEASUREMENT RESULTS
Percentage of Time Noise Level is Above Time Above Threshold

Site	Name	Neighborhood	TA 75	TA 65	TA 55
1	PS1	Downtown Juneau	<1%	2%	10%
2	PS2	Bonnie Brae	<1%	2%	13%
3	PS3	Douglas 2nd	<1%	5%	18%
4	PS4	West Juneau	<1%	3%	11%
5	PS5	Twin Lakes	<1%	2%	18%
6	PS6	Douglas 5th	<1%	3%	13%
7	PS7	Thane	<1%	3%	14%
8	PS8	Thane Sheep Creek	<1%	2%	12%
9	PN1	Lower Mendenhall	<1%	1%	10%
10	PN2	Brotherhood Park	<1%	1%	7%
11	PN3	Fritz Cove Road	<1%	2%	10%
12	PN4	Mendenhaven	<1%	0%	1%
13	PN5	North Douglas	<1%	3%	19%
14	PN6	Lemon Creek	<1%	1%	3%
15	PN7	Upper Mendenhall	<1%	1%	1%
16	PN8	West Mendenhall	<1%	1%	6%

Hours: 8 am to 8 pm

The results in terms of Time Above 55 dBA show that at sites exposed to flightseeing noise, the time above noise levels are above 55 dBA 10% to 20% of the time. During certain hours of the day, the aircraft noise will be above this 55 dBA level up to 80% of the hour.

The majority of measurable noise events from flightseeing operations generated noise levels greater than 55 dBA. The noise events from aircraft noise are on average above 55 dBA for 50 seconds. Many events can last much longer, such as with the helicopter operations flying in groups. Very long events occured at sites such as Bonnie Brae, where helicopter operations are in close proximity to the ERA base.

The Time Above 55 dBA results present a good characterization of the flightseeing noise environment. The data shows that the magnitude of the noise events is not high, but the noise from flightseeing operations is above 55 dBA for long periods of the daylight hours. There are some periods of the day that flightseeing noise is nearly constant.

4.9 Spectral Measurement Results

In addition to continuous one-second noise measurement data that was collected at all of the sites, noise measurements were also made at several sites throughout the study area which recorded the frequency content of the helicopters and float planes. This data was used to obtain a more detailed look at the frequency characteristics of the primary sources of noise within the study area.

The continuous one-second noise levels are based on the "A-weighted" decibel. "A-weighting" is a frequency correction that correlates overall sounds pressure levels with the frequency response of the human ear. This weighting is applied to the broad band of frequencies normally heard by the human ear, which is generally the range of frequencies from 20 Hz (20 cycles per second) up to 20 KHz (20,000 cycles per second). The A-weighting is applied to this broad band of frequencies and a single noise level is recorded which reflects the total amount of acoustic energy measured.

A-weighted measurement does not convey the different pitches, or timbres, that are associated with differing noise sources. There is no way to determine how much of the noise consisted of a low frequency rumble, such as an engine would make, and how much of the noise was high in pitch, such as an aircraft turbine. In order to account for these different frequency characteristics of the different noise sources, the frequency components of the noise sources must be analyzed.

In order to analyze the spectral content of the various noise sources within the project area, measurements were made of the frequency content of these sources with an audio spectrum analyzer. This analyzer breaks the noise levels down from one broad band of noise into thirty-one (31) narrow bands, with each band being one-third of an octave wide. This allows for a much more refined analysis of the individual spectra produced by each of the unique noise sources.

The purpose of narrow band spectral noise measurements is to determine the specific frequency characteristics generated by the noise source. Therefore, these types of measurements are made without any frequency weighting networks and are known as un-weighted noise measurements. The results of these measurements are generally shown as bar graphs or line graphs with each line or point representing the noise level within each of the one-third octave bands.

Figure 4-12 shows one hour of continuous one-second noise levels measured at Site PS1 on August 13, 2000. The loudest noise event measured during this period is recorded at approximately 9:39 a.m. with a maximum level of about 80 dBA. **Figure 4-13** shows the frequency content of this event, which consisted of two AS350 helicopter flying by the site at an elevation of about 1,000 feet about ground level. The spectra are averaged over the duration of the event that lasted 74 seconds. This figure shows that the noise generated by the helicopters consists primarily of mid-range and low frequency noise. As a comparison, the figure also includes the average A-weighted noise level of the event.

It can be seen in **Figure 4-13** that the highest spectral noise level was measured in the 125 Hz band, and the acoustic energy is fairly consistent down to the lowest frequencies. The main reason all of this low frequency information is not perceived is because the human ear is not nearly as sensitive as precision noise measurement equipment, particularly in the low frequency range. For example, in the 50 Hz range, the human ear would perceive this level to be about 30 dB quiet than it was measured.

As a comparison, one-third spectral noise measurements were also made of the float planes which operate in and out of the channel. **Figure 4-14** shows the one-second noise levels of an aircraft event measured at Site PS2 on August 13, 2000. The event was a float plane flying down the middle of the channel at an altitude of approximately 1,200 feet. The maximum noise level of this event measured about 87 dBA. **Figure 4-15** shows the average frequency content of this event, which lasted about one minute.

Figure 4-12
One-Second Noise Measurement Data at Site PS1

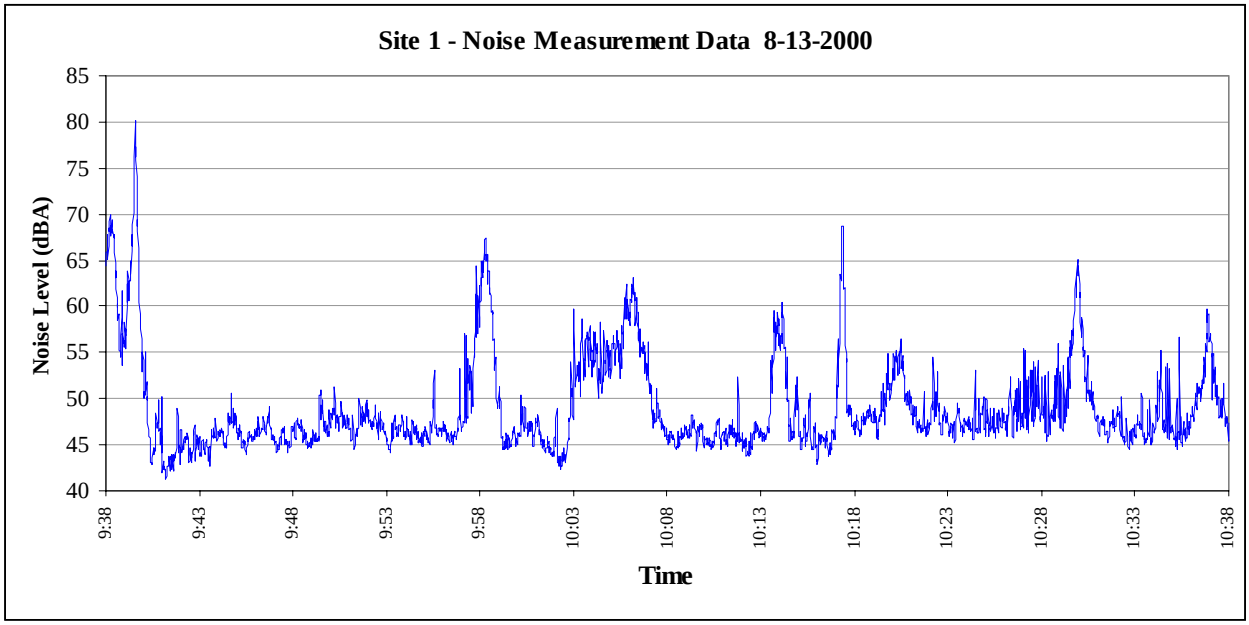


Figure 4-13
One-Third Octave Spectra of Noise Event

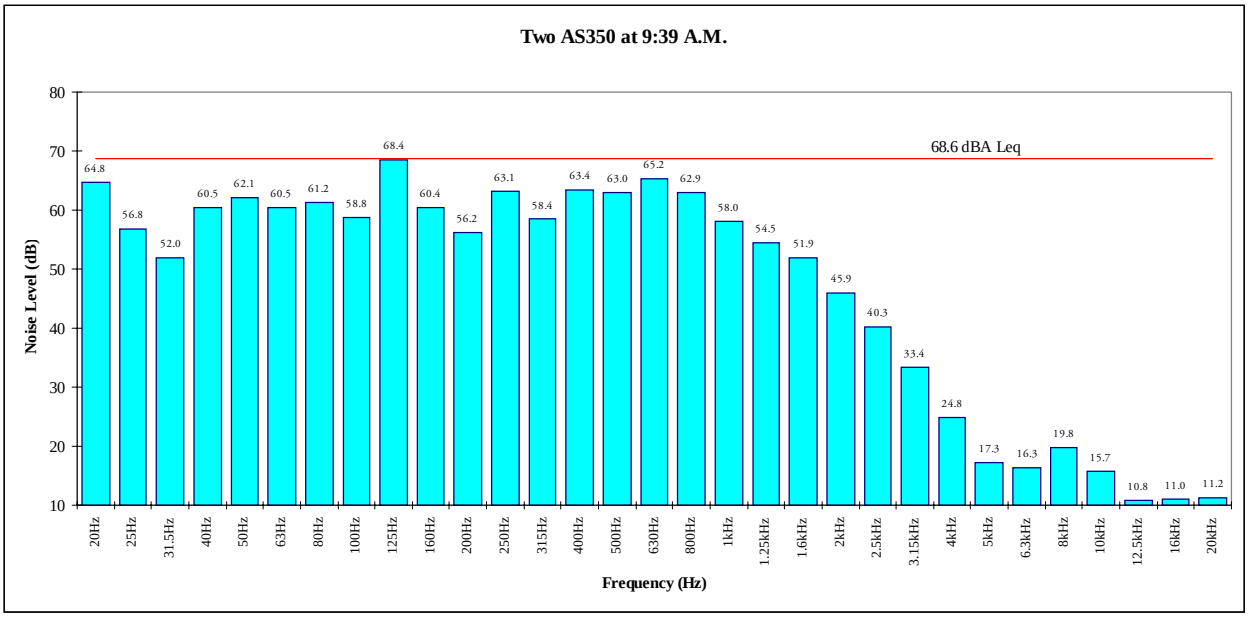


Figure 4-14
One-Second Noise Measurement Data at Site PS2

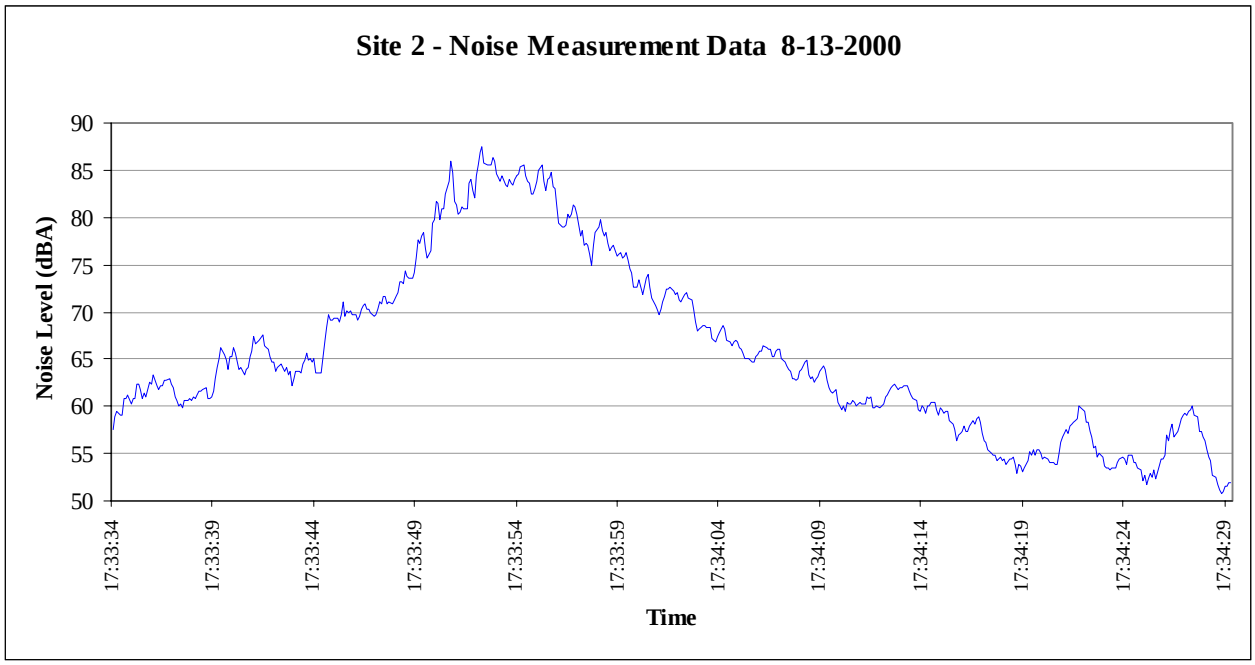
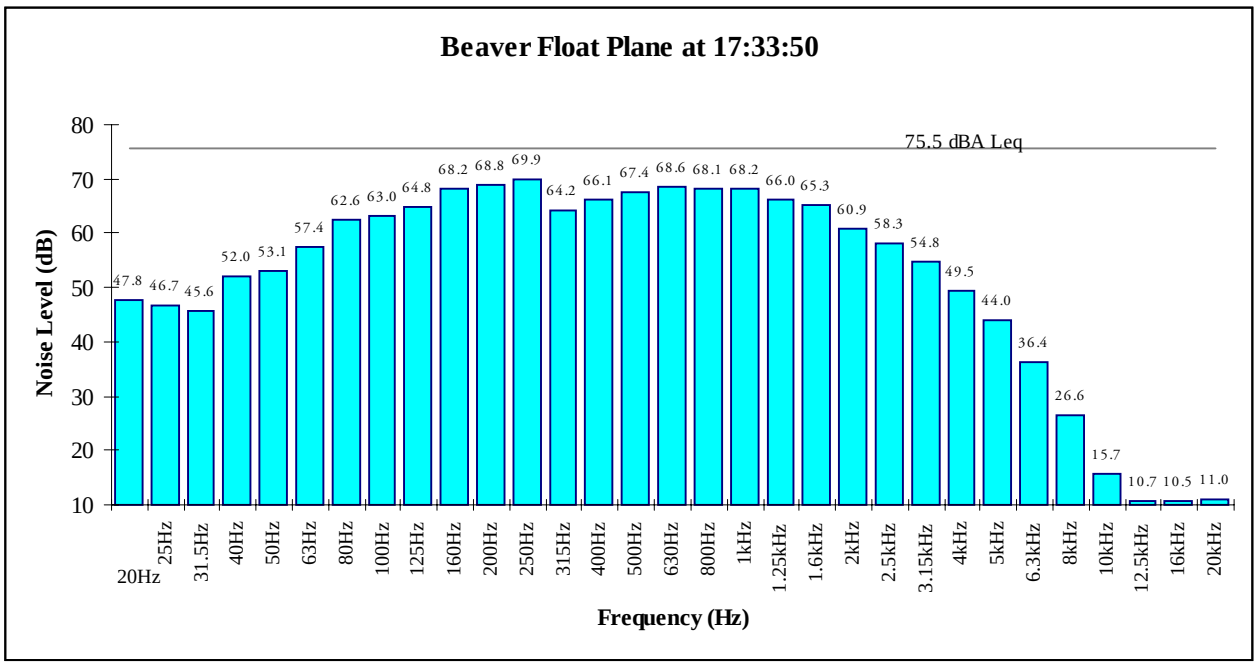


Figure 4-15
One-Third Octave Spectra of Noise Event



4.10 Indoor/Outdoor Measurement Results

Most of the exterior noise measurements were taken in the rear yards of the residences so the unmitigated noise level generated by the aircraft could be determined. The measurement survey also included noise measurements taken within four of the residences impacted by the helicopter and float plane noise. These measurements were used to determine the amount of noise that is transmitted inside the homes during aircraft events. The interior noise measurements were conducted simultaneously with the exterior noise measurements at the same site. The difference between the two noise levels determines the amount of noise reduced by the structure.

Simultaneous outdoor and indoor noise measurements were conducted at Site PS1 on August 11, 2000 for about four hours. The continuous one-second noise data from the exterior and interior noise monitoring systems was correlated by time and the results for one hour are shown in **Figure 4-16**. The top line in the graph shows the noise level measured in the middle of the rear yard and the bottom line of the graph shows the noise level measured in the middle of the living room. All of the windows and doors of the house were kept closed during the measurement period. The correlation between the exterior noise event and the interior noise event is quite stable.

The results from the noise measurement data were calculated and are listed in **Table 4-7**. The table lists the maximum noise level, the average noise level, and the minimum noise level measured outside and inside the home for the same one-hour period. The results show that the noise level measured within the home was on average 22 dB lower than the noise level measured outside the home. This level of reduction is typical for flightseeing aircraft and the type of residential construction found in the four study homes.

Figure 4-16
Site 1 Outdoor & Indoor Noise Measurement Data – August 11, 2000

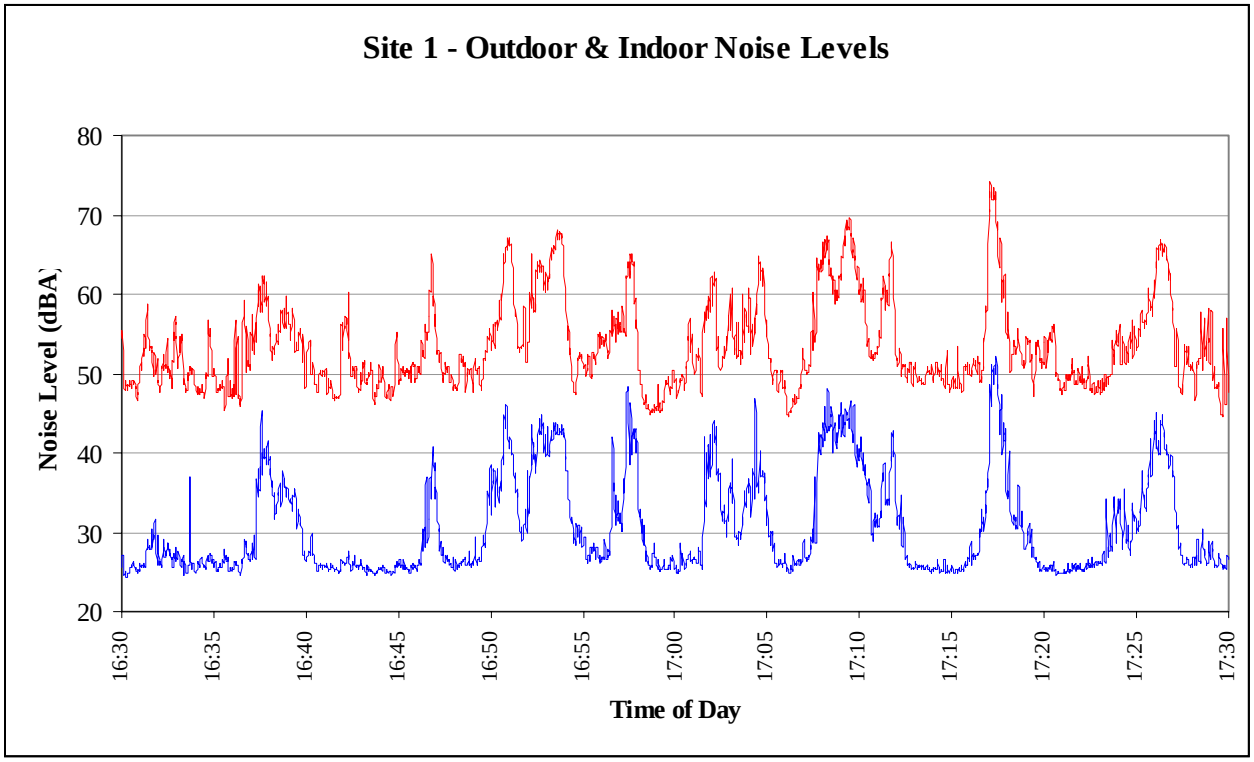


Table 4-7
Outdoor-Indoor Measurement Results
Location PS1

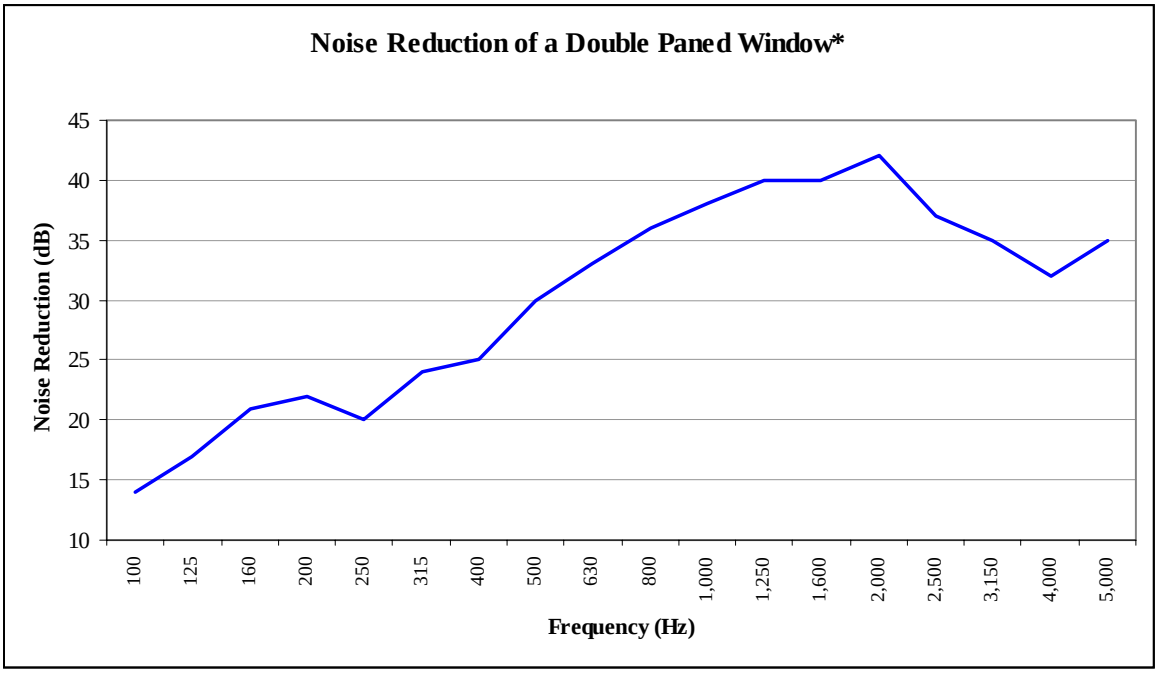
	Lmax	Average	Lmin
Outdoor	74	58	44
Indoor	52	36	24
Difference	22	22	20

The residence at Site PS1 included three large picture windows with one looking out in each direction. All of the windows were double paned in order to provide sufficient thermal insulation for the home. This was also typical of most of the homes within which noise measurements were taken. The noise reduction for all four homes where interior noise measurements were taken averaged about 20 dB. Windows are acoustically the weakest part of the structure that is they provide the least amount of reduction from exterior noise.

Windows provide much more reduction of middle and high frequency noise than they do of low frequency noise. This is generally true of most of the building elements of the home, be the walls, roof or windows. Low frequency sounds contain more energy due to the long wavelengths and mass of air required to be moved. A large amount of mass is usually required to absorb the low frequency energy and reduce it's transmission into a residential structure. The structural elements within most homes do not reduce low frequency noises as well as middle and high frequency noises do to the low mass of these elements. The building noise reduction of these homes is less than what would be expected for homes as well insulated as this home. This is due to the low frequency content of the flightseeing aircraft. These aircraft have a greater low frequency component that is not mitigated by the building structure.

In order to show the noise reduction characteristics of large double paned windows, noise reduction test data from a window manufacturer was plotted and the results are shown in **Figure 4-17**. This data shows that for a high quality dual paned window, the assembly reduces high frequency noise much more effectively than it does low frequency noise. This particular window will reduce the noise in the 100 Hz band by about 14 dB, while reducing noise in the 2 KHz band by over 40 dB. This type of noise reduction curve, where more noise is transmitted in the low frequency bands, is typical of most windows used in residential construction.

Figure 4-17
Noise Reduction Characteristics of a Typical Double Paned Window



*Western Electro Acoustical Laboratories test #WEAL TL90-105