August 2015
REVISED

Noise Measurement Survey

Spring 2015

Borough of Haines, Alaska

Prepared for:
Mead and Hunt
1616 East 15th Street
Tulsa, OK 74120

Prepared by:
Cindy Gibbs

BridgeNet INTERNATIONAL

Airports Division
20201 SW Birch Street, Suite 250
Newport Beach, CA 92660
T: 949-250-1222 | F: 949-250-1225

Table of Contents

List of Tables

List of Figures

Executive Summary

The Mead & Hunt team was retained by the Borough of Haines to conduct a noise study to determine the noise levels at and near the Mile 26 base used by Southeast Alaska Backcountry Adventures (SEABA). The onsite noise measurements were conducted March 9 – 15, 2015 at four locations selected by the Borough of Haines. Each noise monitoring location had a dedicated noise monitor collecting noise 24 hours per day; the monitors recorded all noise during the measurement period. These measurements were used to then determine the noise environment with and without helicopter activity. The post-measurement period analysis included calculating the single event noise levels of individual helicopter operations, the duration of helicopter noise, the average background noise level when helicopters are not operating, and the cumulative noise level associated with the overall helicopter activity.

During the measurement period, there were 24 helicopter operations based upon GPS data provided by SEABA that included multiple landings and takeoffs at different locations throughout the day. Of those 24 flights, nine helicopter flights flew a path into/out of the Mile 26 base that resulted in recorded simultaneous noise events at all four sites. This included departures from the helipad, arrivals from the helipad and quick turns where the helicopter lands and quickly departures again without shutting down the engine. The rest of the helicopter flights operated at the airport or Mile 33 base.

Four noise metrics were used in this report. The first is the Maximum Noise Level (Lmax), which is the highest noise level reached during a noise event and this is the metric to which people generally respond when a helicopter flyover occurs. The second metric is the Sound Exposure Level (SEL). SEL metric takes into account the maximum noise level of the event and the duration of the noise event. The third metric is the Day Night Noise Level (DNL). Where Lmax references a single event, the DNL is a summation of all the noise experienced during an entire (24-hour) day, and is therefore generally used for land use compatibility comparisons. DNL calculations account for the noise energy of the aircraft, duration of noise, the number of aircraft operations and a penalty for nighttime operations. Time Above Ambient (TAA) is the fourth metric; it measures time per day, measured in seconds or minutes, which the noise level was above the ambient or background noise.

The noise measurement results show that the average DNL noise exposure level at each site ranged from 30-51 DNL (with the exception of the helipad site itself which was 69 DNL) on the days that helicopter flights occurred.

When conducting a noise analysis, the findings are typically related to adopted standards or guidelines. The analysis is usually will be compared to local, state, and federal guidelines where they exist. The State of Alaska does not have specified noise limits, nor does it have the ability to regulate where and when aircraft fly. Additionally, for this study, the local municipality of Haines does not have land use regulations for acceptable land uses and associated noise levels. DNL, as defined in this report, is specified by the FAA in 14 Code of Federal Regulations (CFR) Part 150 to be used for community and aircraft noise assessment, and is used by all Federal agencies to determine aircraft/land use compatibility for federally funded or approved projects In the absence of a federal interest, the determination of compatibility is a decision by the local community based on local standards and conditions, which is many times based on the federal standard when no local standards exist.

Since there are no local or state noise standards in effect, the federal standard for noise and land use compatibility developed by the Federal Aviation Administration for helicopter and aircraft activity will be the basis of this report. This standard is based on the DNL, which identifies the compatibility of various types of land use with aircraft noise exposure. Under this standard:

- Residential uses are compatible with noise up to 65 DNL and up to 70 DNL with sound insulation;
- Schools are compatible with noise up to 65 DNL and up to 70 DNL with sound insulation; and
- Commercial development is compatible with noise up to 75 DNL.

It is important to note that the measurements detailed in this report are measurements, and not fully modeled annual DNL noise contours, so this report cannot make a full comparison to the annualized 65 DNL. However, except at the helipad site itself, the short-term measured levels are generally below what measurements would be expected at the significant 65 DNL or higher level.

To supplement this, the report also compared a range of expected DNL measurements for different types of locations to give the reader an understanding of typically measured DNL for various land uses and how that compared to the measured noise. For example, noise measured at "wooded residential" land uses is generally around 51 DNL. The noise measurement data for the sites outside the helipad itself ranges from 30-51 DNL, which closely matches what would be expected in wooded residential or quieter land use types (see Table 2-4). Therefore, the noise at the sites were measured at or below the average measurements of typical wooded residential. It is important to note that these examples of typical noise levels for land uses do not correlate to a state or federal standard of noise; rather show *anecdotally* what a typical person would experience in those types of locations compared to the measurements made during the study. The following report focuses on the noise measurements conducted and the resulting analysis.

Subsequent to the publication and review of this report, several comments were received by citizens that live in the Borough. These comments are included in Appendix D. The comments can be generally categorized questioning the validity of the DNL metric, the use of A-weighted metric, not providing the raw data to the Borough, and in making conclusions and recommendations. It must be remembered that the noise modeling was conducted at sites chosen by the Borough, with operational levels and flight tracks not controlled by the consultant, rather controlled by weather conditions. In other words, measurements were taken to reflect only those conditions as they occurred during the measurement sequence.

Based upon the measurement results, the conclusion section projects what the DNL noise levels and TAA would be based different higher levels of daily helicopter operations. Sections of the report have had language added to overall help address the comments without specifically addressing each individual comment. It is the responsibility of the Borough of Haines to determine the acceptability, in terms of land use compatibility, of the helicopter operations. Additionally, due to the sheer volume of raw data, the raw data has been provided to the Borough of Haines on a hard drive.

1.0 Introduction

This document presents the noise measurement results from the spring 2015 noise survey completed for the Borough of Haines. The purpose of this survey is to quantify the aircraft noise exposure in the Borough of Haines from helicopter operations by Southeast Alaska Backcountry Adventures (SEABA) at its base at Mile 26. This report also presents background information on the characteristics of noise as it relates to aircraft operations and determines if the noise at this location is "undue noise."

The noise monitoring program utilized a network of four noise monitors that were located in and around the SEABA base environs to continuously measure and record the A-weighted noise data, which best represents how the human ear hears noise. Noise event information from both aircraft and non-aircraft noise sources are documented through field observations and logs of helicopter operations from SEABA. The term aircraft and helicopter are used interchangeably in this report.

2.0 Background Information on Noise

2.1 Introduction to Background Information on Noise

This section presents background information on the characteristics of sound and the noise metrics that were determined in this study. This section is divided into the following sub-sections:

- Characteristics of Sound - Presents properties of sound that are important for technically describing noise in the airport setting.
- Sound Rating Scales - Presents various sound rating scales and how these scales are applied to assessing noise from aircraft operations.

2.2 Characteristics of Sound

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

Sound pressure is a direct measure of magnitude of a sound without consideration for other factors. The range of sound pressures that occur in the environment is so large that it is convenient to express them on a logarithmic scale. The logarithmic scale accounts for the ratio of differences between measurements since they are not linear. The standard unit of measurement of sound pressure is the Decibel (dB). One decibel is actually an exponent to the reference point of 20 micro Pascals or about .000000003 pounds per square inch. Thus, 65 decibels is that amount to the 65^{th} power. A logarithmic scale is used because of the difficulty in expressing such large numbers.

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

The frequency of a sound is expressed as Hertz (Hz) or cycles per second. The normal audible frequency range for young adults is 20 Hz to 20,000 Hz. The prominent frequency range for community noise, including aircraft and motor vehicles, is between 50 Hz and 5,000 Hz. The human ear is not equally sensitive to all frequencies, with some frequencies judged to be louder for a given signal than others. As a result, research studies have analyzed how individuals make relative judgments as to the "loudness" or "annoyance" to a sound. Noise metrics that are used to measure and present aircraft noise assessments are based upon these frequency-weighting scales.

Frequency-Weighted Contours (dBA, dBB, and dBC). In order to simplify the measurement and computation of sound loudness levels, frequency-weighted networks have obtained wide acceptance. The equal loudness level contours for 40 dB, 70 dB, and 100 dB have been selected to represent human frequency response to low, medium, and loud sound levels. By inverting these equal loudness level contours, the A-weighted, B-weighted and C-weighted frequency weightings were developed. These frequency-weighted contours demonstrate different aspects of noise, and are presented in **Figure 2-1.**

The most common weighting is the A-weighted noise curve. The A-weighted decibel scale (dBA) describes frequencies in a manner approximating the sensitivity of the human ear. In the A-weighted decibel, everyday sounds normally range from 30 dBA (very quiet) to 100 dBA (very loud). Most community noise analyses are based upon the A-weighted decibel scale. Examples of various sound environments, expressed in dBA, are presented in **Figure 2-2.**

Figure 2-1
FREQUENCY WEIGHTING CURVES
Borough of Haines Spring 2015 Helicopter Noise Survey

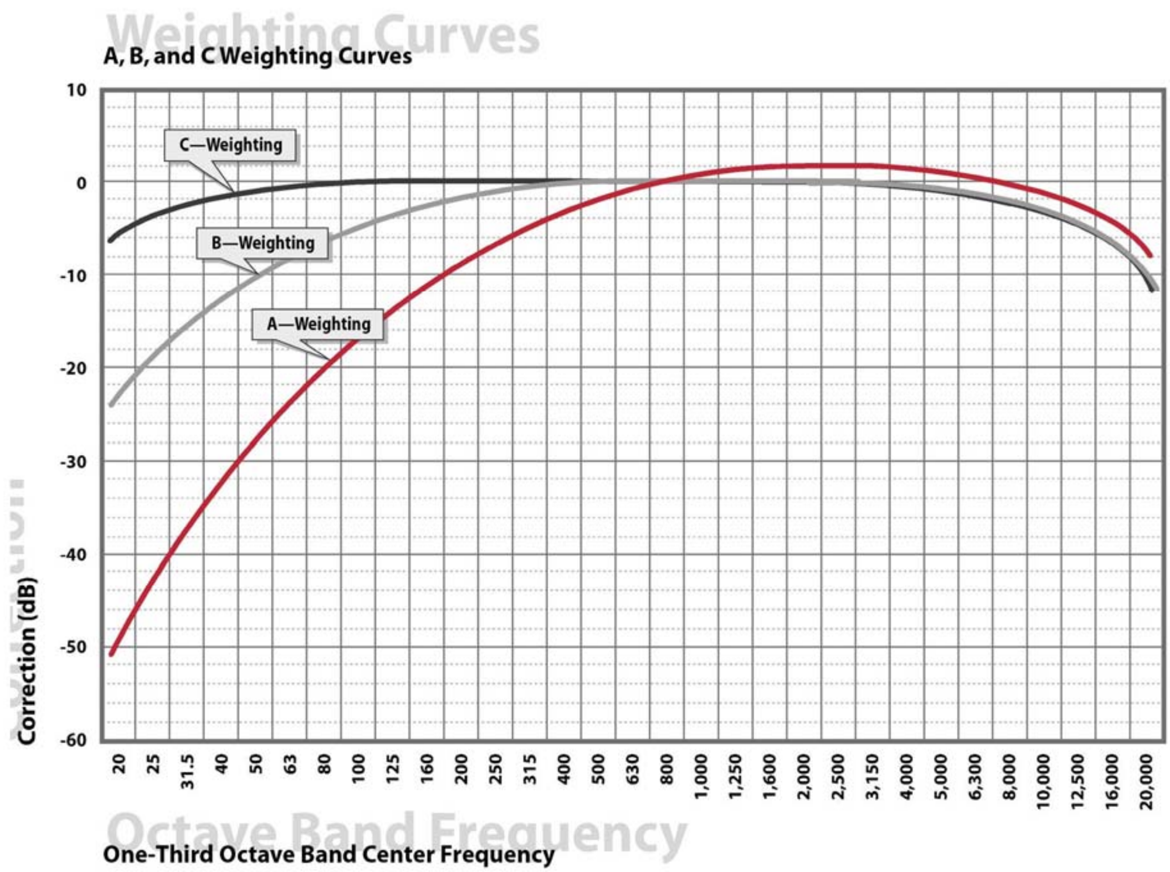


Figure 2-2
EXAMPLE OF VARIOUS SOUND ENVIRONMENTS
Borough of Haines Spring 2015 Helicopter Noise Survey

EXAMPLES OF VARIOUS A-WEIGHTED DECIBEL SOUND ENVIRONMENTS

dB(A)	OVER-ALL LEVEL Sound Pressure Level Approx. 0.0002 Microbar	COMMUNITY (Outdoor)	HOME or INDUSTRY	LOUDNESS Human Judgement of Different Sound Levels
130		Military Jet Aircraft Takeoff with Afterburner from Aircraft Carrier @ 50 ft. (130)	Oxygen Torch (121)	120 dB(A) 32 Times as Loud
120 110	UNCOMFORTABLY LOUD	Concorde Takeoff (113)	Riveting Machine (110) Rock and Roll Band (108-114)	110 dB(A) 16 Times as Loud
100		Boeing 747-200 Takeoff (101)		100 dB(A) 8 Times as Loud
90	VERY LOUD	Power Mower (96) DC-10-30 Takeoff (96)	Newspaper Press (97)	90 dB(A) 4 Times as Loud
80		Car Wash @ 20 ft. (89) Boeing 727 Hushkit Takeoff (89)	Food Blender (88) Milling Machine (85) Garbage Disposal (80)	80 dB(A) 2 Times as Loud
70	MODERATELY LOUD	High Urban Ambient Sound (80) Passenger Car, 65 mph @ 25 ft. (77) Boeing 757 Takeoff (76)	Living Room Music (76) TV-Audio, Vacumn Cleaner	70 dB(A)
60		Propeller Airplane Takeoff (67) Air Conditioning Unit @ 100 ft. (60)	Cash Register @ 10 ft. (65-70) Electric Typewriter @ 10 ft. (64) Conversation (60)	60 dB(A) 1/2 Times as Loud
50	QUIET	Large Transformers @ 100 ft. (50)		50 dB(A) 1/4 Times as Loud
40		Bird Calls (44) Low Urban Ambient Sound (40)		40 dB(A) 1/8 Times as Loud

"Aircraft takeoff noise measured 6,500 meters from beginning of takeoff roll
(Source: Advisory Circular AC-36-3G)"

2.3 Sound Rating Scales

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

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

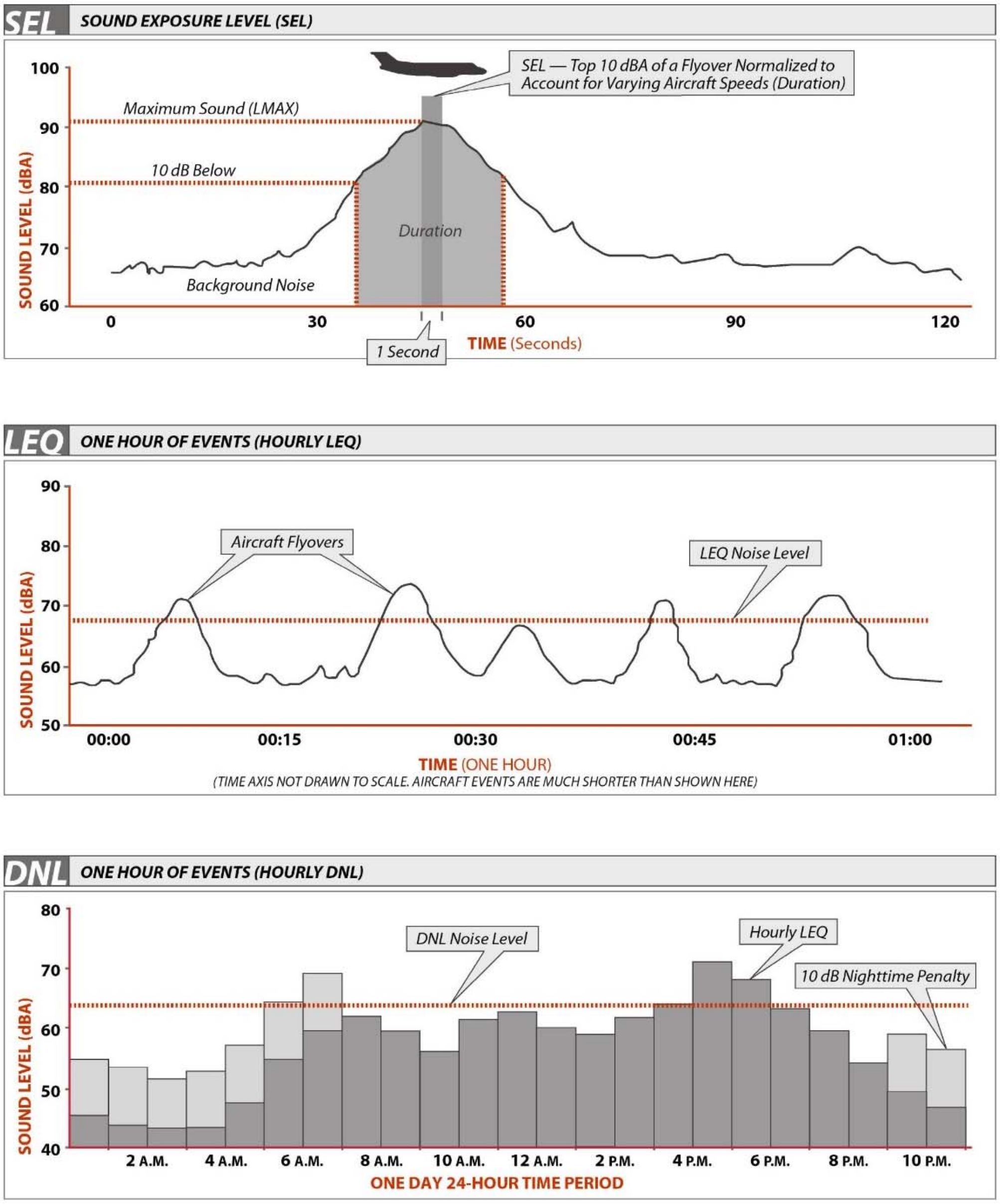
Single Event Metrics

- *Frequency Weighted Metrics (dBA*). In order to simplify the measurement and computation of sound loudness levels, frequency weighted networks have obtained wide acceptance. The A-weighting (dBA) scale has become the most prominent of these scales and is widely used in community noise analysis. This metric has shown good correlation with community response and may be easily measured. The metrics used in this study are all based upon the A-weighted dBA scale.

- *Maximum Noise Level.* The highest noise level reached during a noise event is called the "Maximum Noise Level," or Lmax. For example, as an aircraft approaches, the sound of the aircraft begins to rise above ambient noise levels. The closer the aircraft gets, the louder it is until the aircraft is at its closest point directly overhead. As the aircraft passes, the noise level decreases until the sound level settles to ambient levels. This is plotted at the top of Figure 2-3. It is this metric to which people generally respond when an aircraft flyover occurs.

- *Sound Exposure Level (SEL*). The duration of a noise event, or an aircraft flyover, is an important factor in assessing annoyance and is measured most typically as SEL. The effective duration of a sound starts when a sound rises above the background sound level and ends when it drops back below the background level. An SEL is calculated by summing the dB level at each second during a noise event (referring again to the shaded area at the top of Figure 2-3) and compressing that noise into one second. It is the level the noise would be if it all occurred in one second. The SEL value is the integration of all the acoustic energy contained within the event. This metric takes into account the maximum noise level of the event and the duration of the event. For aircraft flyovers, the SEL value is numerically about 10 dBA higher than the maximum noise level. Single event metrics are a convenient method for describing noise from individual aircraft events. Airport noise models contain aircraft noise curve data based upon the SEL metric. In addition, cumulative noise metrics such as Equivalent Noise Level (LEQ) and Day Night Noise Level (DNL) can be computed from SEL data. These metrics are described in the next paragraphs.

Figure 2-3
EXAMPLES OF Lmax, SEL, LEQ, and DNL NOISE LEVELS
Borough of Haines Spring 2015 Helicopter Noise Survey



Cumulative Metrics

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

- *Equivalent Noise Level (LEQ).* LEQ is the sound level corresponding to a steady-state A-weighted sound level containing the same total energy as a time-varying signal (noise that constantly changes over time) over a given sample period. LEQ is the "energy" average taken from the sum of all the sound that occurs during a certain time period; however, it is based on the observation that the potential for a noise to impact people is dependent on the total acoustical energy content. This is graphically illustrated in the middle graph of Figure 2-3. LEQ can be measured for any time period, but is typically measured for 15 minutes, 1 hour or 24-hours. LEQ for one hour is used to develop the Day Night Noise Level (DNL) values for aircraft operations.

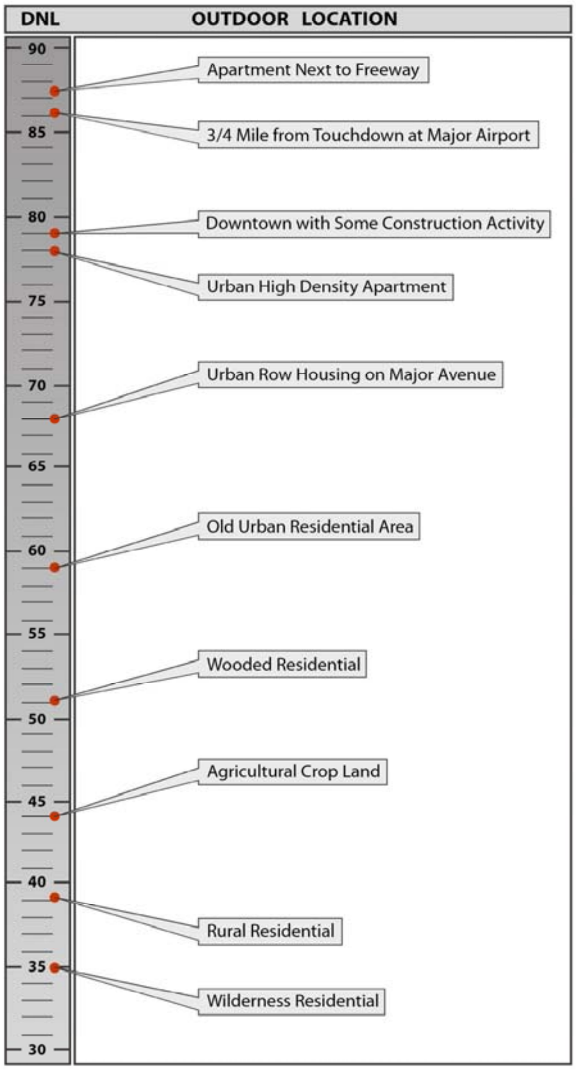
- *Day Night Noise Level (DNL).* The DNL index measures the overall noise experienced during an entire (24-hour) day. DNL calculations account for the SEL of aircraft, the number of aircraft operations and a penalty for nighttime operations. In the DNL scale, noise occurring between the hours of 10 p.m. to 7 a.m. is penalized by 10 dB. This penalty was selected to account for the higher sensitivity to noise in the nighttime and the expected further decrease in background noise levels that typically occur at night. DNL is specified by the FAA in Federal Aviation Regulation Part 150 to be used for community and airport noise assessment. In addition, it is used by other federal agencies including the Environmental Protection Agency (EPA), the Department of Defense (DOD) and the Department of Housing and Urban Development (HUD). DNL is graphically illustrated in the bottom of **Figure 2-3.** As presented by the EPA, examples of various noise environments in terms of DNL are presented in **Figure 2-4.** These examples show typical average noise experienced in the outdoor locations noted on Figure 2-4. The examples do not correlate to a state or federal standard of noise; rather show anecdotally what a typical person would experience in that location.

- *Time Above Ambient (TAA).* The Time Above Ambient metric as a supplemental metric for assessing impacts of aircraft noise. The Time Above Ambient metric refers to the total time in seconds or minutes that aircraft noise exceeds certain dBA noise levels in a 24-hour period. There are no noise/land use standards related to the Time Above Ambient index. The Time Above Ambient levels can be used to illustrate the time that noise may disrupt various activities. One such threshold is the Time Above 65 dBA, which generally represents the time when noise is above 65 dBA, and is the level for where outdoor speech interference starts to occur. Time Above Ambient gives an indication of how long aircraft noise can be heard.

FAA and other federal agencies have established land use compatibility guidelines based on the DNL that identify the acceptability of various types of land use with aircraft noise exposure.

- Residential uses are compatible with noise up to 65 DNL and up to 70 DNL with sound insulation;
- Schools are compatible with noise up to 65 DNL and up to 70 DNL with sound insulation; and
- Commercial development is compatible with noise up to 75 DNL.

Figure 2-4
TYPICAL OUTDOOR NOISE LEVELS IN TERMS OF DNL
Borough of Haines Spring 2015 Helicopter Noise Survey



Source: Environmental Protection Agency
"Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA/ONAC 550/9-74-004, March, 1974.

3.0 Noise Measurement Methodology

3.1 Introduction to Noise Assessment Methodology

The existing noise environment was determined through an on-site sound level measurement program. The on-site measurements also help establish the ambient non-aircraft noise environment and identify noise levels at specific areas of interest. The following sections provide the details on this process. This section is divided into the following sub-sections:

- Noise Measurement Survey – Describes the noise monitoring sites and the methodology used in the noise measurement survey.
- Measurement and Analysis Procedures – Describes the measurement and analysis procedures used to develop the various noise metrics of use in this study.

3.2 Noise Measurement Survey

Purpose of Measurement Survey

The purpose of the noise measurement program was to document the existing noise conditions within the Haines area around the SEABA base. The study recorded noise events from the SEABA base at Mile 26; there is another helicopter landing pad at Mile 33 used by SEABA, these operations were not part of this noise survey but are included in the graphics to show all of the operations by SEABA during the measurement period. The noise environment in terms of the aircraft and non-aircraft noise sources were determined. Once the baseline noise level conditions have been determined, it will then be possible to identify any changes to the noise that may occur in the future.

Types of Noise Measurements

Measurements were conducted at four (4) sites from March 9, 2015 to March 15, 2015. The noise monitors continuously recorded the one-second noise data and were later analyzed to compute two noise metrics of interest, Maximum Noise Level (Lmax) and Sound Exposure Level (SEL). These measurements consisted of A-weighted measurements, as defined in Section 2.2.

The sound level meters collected 1-second average noise levels (dBA Leq) and 1-second one-third octave noise values (dB). The 1-second data was used to calculate the following metrics for incorporation into the report: average (dBA Leq), maximum (dBA Lmax), Sound Exposure Level (SEL), Day-Night Average Sound Level (DNL) and Time Above Ambient (TAA).

Since the A-weighted scale was developed as a set of filters in sound level meters to simulate the frequency sensitivity of the human ear and because the human reaction is normally the reason for an environmental noise study, A-weighted decibels have been used as the industry standard for the assessment of community noise from aircraft and other transportation noise sources.

EPNL is the effective perceived noise level (EPNdB) defined as a rating of the annoyance of a single event and can be used for any high level noise sources. It is primarily used by the aircraft industry and by the FAA to acoustically certify aircraft. This metric is not used in the United States in aviation related community environmental noise studies. A-weighted based metrics such as Lmax and DNL are the metrics used by the FAA and EPA for assessing community noise associated with aircraft operations.

Simultaneous measurements were conducted at all of the sites, therefore a single helicopter operation generated a noise event at each of the noise monitors. An acoustic engineer was onsite for periods of the measurements and used a log of operations from SEABA to correlate helicopter noise events to operations. The primary method used to correlate the SEABA operations with the noise events was using the GPS tracking data provided by SEABA.

Site Selection Criteria

The four measurement locations used in this study were sites chosen by the Borough of Haines to represent locations of interest. The onsite engineer verified the sites conformed to standard site selection criterion are listed below:

General Criteria:

- Exposure to helicopter activity sources
- Representation of the noise environment in the local area
- Locations that are not in close proximity to localized noise sources
- Locations that are not in close proximity to active camp sites
- Locations that are not exposed to excessive high wind speeds
- Locations that are not severely shielded from the aircraft activity
- Security and ease of access to the noise monitoring equipment

Noise Measurement Locations

A vicinity map showing the SEABA base and the surrounding environs is presented in **Figure 3-1**. The noise monitoring locations are presented on a more detailed aerial photo on **Figure 3-2**, with the number of each site noted next to the site. **Table 3-1** includes the name of the site, the general location of the area, and the specific latitude and longitude of the noise monitor location.

Measurement Procedures

Noise monitors were set up to simultaneously collect continuous 1-second noise levels during the entire time the noise monitor was at a given location. The equipment was checked and calibrated on a regular basis throughout the measurement survey. Each of the four sites were measured for the same duration; March 9 and March 15 were partial measurement days, measured for 13 and 11 hours, respectively. All other measurement days were measured for a full 24-hour period.

Table 3-1
NOISE MEASUREMENT SITES
Borough of Haines Spring 2015 Helicopter Noise Survey

Site	Name	Longitude	Latitude
1	Helipad	-136.0130484	59.4029614
2	Home By Helipad	-136.0119003	59.4022874
3	Roadway	-136.006578	59.403724
4	Neighboring Estate	-136.0120859	59.4060923

Acoustic Data

The noise measurement survey utilized specialized monitoring instrumentation that allowed for the calculation of aircraft single event data and ambient noise levels from the measured one-second noise data. The data measured and calculated at each noise measurement site are as follows:

- Continuous one-second noise levels,
- Single event data (Lmax, SEL, and Duration) for individual aircraft,
- Correlation of noise data with aircraft identification,
- Calculation of daily noise metrics such as DNL, LEQ and Time Above Ambient, and
- Non-aircraft ambient sound level.

The survey utilized software that provides continuous measurement and storage of the 1-second noise level. From this data the above noise descriptors could be calculated. In addition, this data can be used to plot the time histories for noise events of interest.

Figure 3-1

Vicinity Map

Borough of Haines – Noise Measurement Survey, Spring 2015

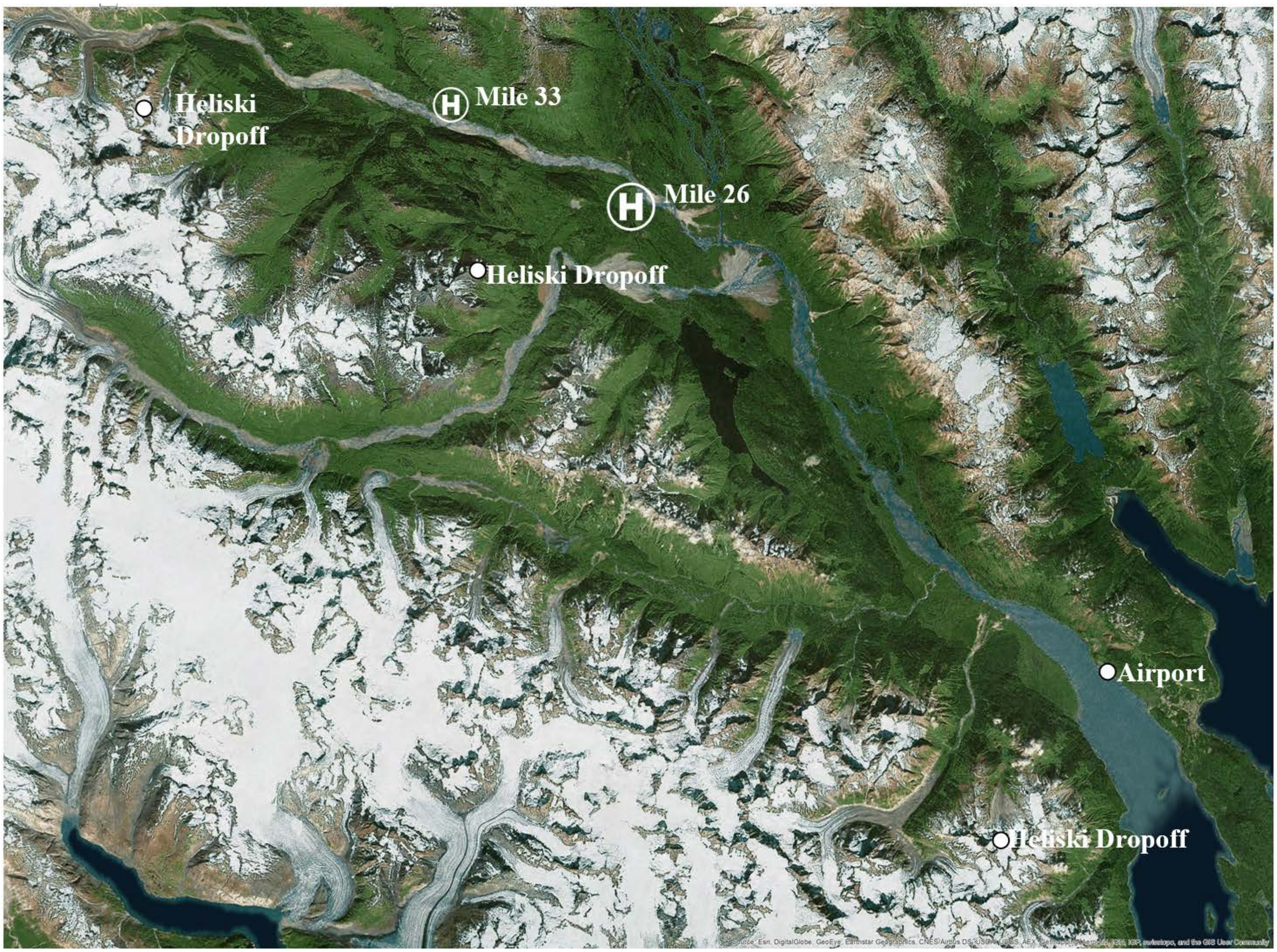


Figure 3-2

Noise Measurement Location Map

Noise measurement location sites: O

Borough of Haines – Noise Measurement Survey, Spring 2015

Instrumentation

The monitoring program was consistent with state-of-the-art noise measurement procedures and equipment. The measurements consisted of monitoring A-weighted decibels in accordance with procedures and equipment that comply with specific International Standards (IEC), and measurement standards established by the American National Standards Institute (ANSI) for Type 1 instrumentation. **Figure 3-3** shows each of the four measurement sites.

These sites utilized 01dB Solo Sound Level Meters. The meters automatically calculate the various single event data. The 01dB system includes software that provides data storage for later retrieval and analysis.

Microphone location – The microphones were located at a height of 5 feet directed vertically.

Windscreen – The 01dB standard foam windscreen (UA0207 for ½" microphones) were placed over the microphone for each site.

Calibration – During the survey the noise monitoring instrumentation was calibrated at the start and end of each measurement cycle. This calibration was based on standards set by the National Institute of Standards and Technology, formerly the National Bureau of Standards. An accurate record of the meteorological conditions during measurement times was also maintained.

Figure 3-3
Noise Monitors In the Field

Borough of Haines – Noise Measurement Survey, Spring 2015

Site 1

Site 2

Site 3

Site 4

3.3 Measurement and Analysis Procedures

The following section outlines the methodology used to measure and quantify noise levels from aircraft operations and ambient noise level conditions. Measurement methodology and analysis techniques used in the study are also included.

Continuous Measurement of the Noise

The methodology employed in this study used a program that was designed to continuously measure noise at each measurement location. An example of the time history of the continuous noise measured by each monitor is presented in **Figure 3-4**. This graph shows the continuous noise at all of the sites for a 15-minute period. It is possible to see the time period of noise events and the time period of ambient noise in between the events. The process of calculating noise events from this data uses a floating threshold methodology. This allows for the measurement and identification of lower noise level events. The parameters are adjustable and can be modified so that it is possible to recalculate noise events from raw data any time in the future. Additional measurement data can be found in Appendix A.

Network of Multiple Noise Monitors

A network of the four noise monitors was set up to simultaneously and continuously measure noise at multiple monitoring sites. The network of noise monitors is useful to compare noise levels simultaneously at different locations, for the same helicopter. For example, networks of noise monitors are established to illustrate the sideline noise levels at varying distances from the flight path centerline. An example of data from the four sites used during the monitoring is presented in **Figure 3-5**, illustrating a departure of an A-star AS350 B2 helicopter operation, which is the type of helicopter flown by SEABA. This figure shows the continuous noise levels at all of the sites. It is possible to see the aircraft noise levels and time sequence of the noise as the aircraft passes over each site. The network of noise monitors is also used to help separate aircraft noise from other noise sources. Knowing the time sequence of noise events provides a pattern that is one of the components of the noise and flight data correlation process.

Figure 3-4
EXAMPLE OF CONTINUOUS MEASUREMENT OF NOISE
Borough of Haines Spring 2015 Helicopter Noise Survey
Time Period: March 12, 2015

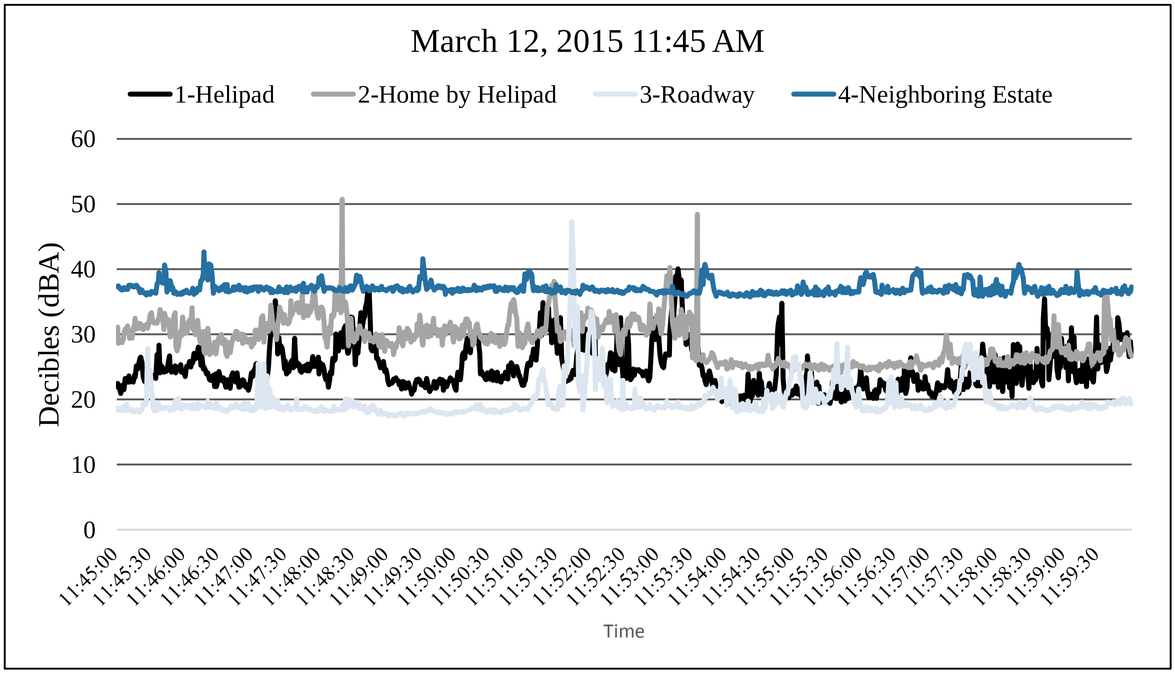
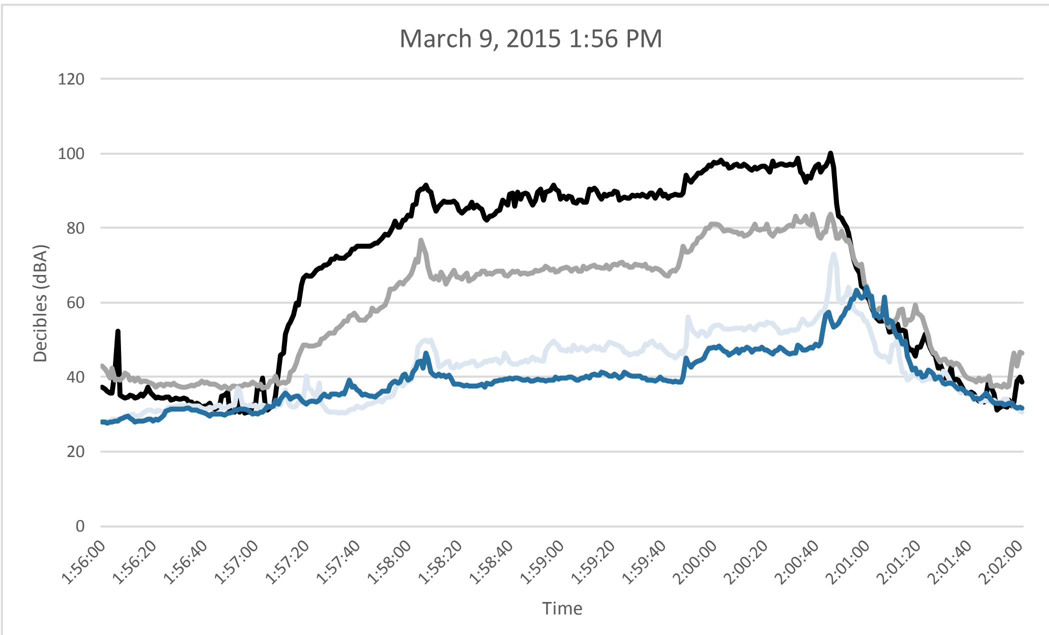


Figure 3-5
EXAMPLE OF CONTINUOUS MEASUREMENT OF NOISE AT MULTIPLE SITES
Borough of Haines Spring 2015 Helicopter Noise Survey
Event 1: March 9, 2015 1:56 PM

Description	$Time_{Max}$	Duration (sec)	Start to Peak	L_{MAX}	SEL
1-Helipad	3/9/2015 2:00:46 PM	222	208	100.1	115.2
2-Home by Helipad	3/9/2015 2:00:39 PM	189	166	83.8	98.6
3-Roadway	3/9/2015 2:00:47 PM	73	57	72.9	78.2
4-Neighboring Estate	3/9/2015 2:01:00 PM	281	221	64.1	74.5



Operational Data and Field Observations

Various data sources are utilized to document, identify and correlate the aircraft operations during the noise measurement period. Each of these sources of flight information is described below.

An acoustic engineer managed the noise measurement equipment during the survey, responsible for setting up and maintaining the equipment as well as documenting the aircraft activity during certain times of the measurement study. SEABA provided the consultant with GPS coordinates (2 minute update rate) for the flights conducted during the noise measurement period. The types of data that were collected in the field include:

- Start and end time of noise events (audible time);
- Helicopter information (type, flight track, airport/SEABA base); and
- Non-aircraft event information (type, activity).

Correlation of Noise and Flight Data

Custom noise monitoring software was used to help correlate aircraft flight activity to the noise data. This software utilizes such methods as aircraft position information, noise event sequencing, and noise event profiling to correlate noise data to the aircraft activity. The GPS unit in the helicopter recorded the location of the helicopter every two minutes. The noise event profiling is used to identify characteristics of both the aircraft and non-aircraft noise events.

From the latitude and longitude of the GPS data provided by SEABA, it is possible to reconstruct the flight path for each operation. An example of a flight path from the Mile 26 base to the heliski dropoff is presented in **Figure 3-6**. This figure illustrates the flight path of an arriving helicopter at one point in time. The noise levels from each of the noise monitors is also shown at that same point in time, with the number of each monitor in parenthesis. Computer software was used to correlate the measured noise events with the specific aircraft operating in the sky near the noise monitor at that same point in time. **Figure 3-7** shows all flight tracks recorded by SEABA operations during the measurement period. The helicopters typically have five routes; to/from the Haines Airport to Mile 26 or Mile 33 base, from Mile 26 base to the mountain, from Mile 33 to the mountain, and between the SEABA bases at Mile 26 and Mile 33. Based upon the GPS data, there were a total of 9 flight events that operated at Mile 26 base. This includes departures, arrivals, and quick turn arrival departures (counted for the purposes of the noise study as one event in that the noise generally stayed high throughout the arrival/departure sequence).

Calculation of Aircraft Noise Metrics

Once the collection and correlation of the noise and flight data is complete, the various noise metrics can be calculated. A custom computer program is used to calculate the single event and ambient noise metrics of interest from the data collected at each of the noise monitoring sites.

Figure 3-6

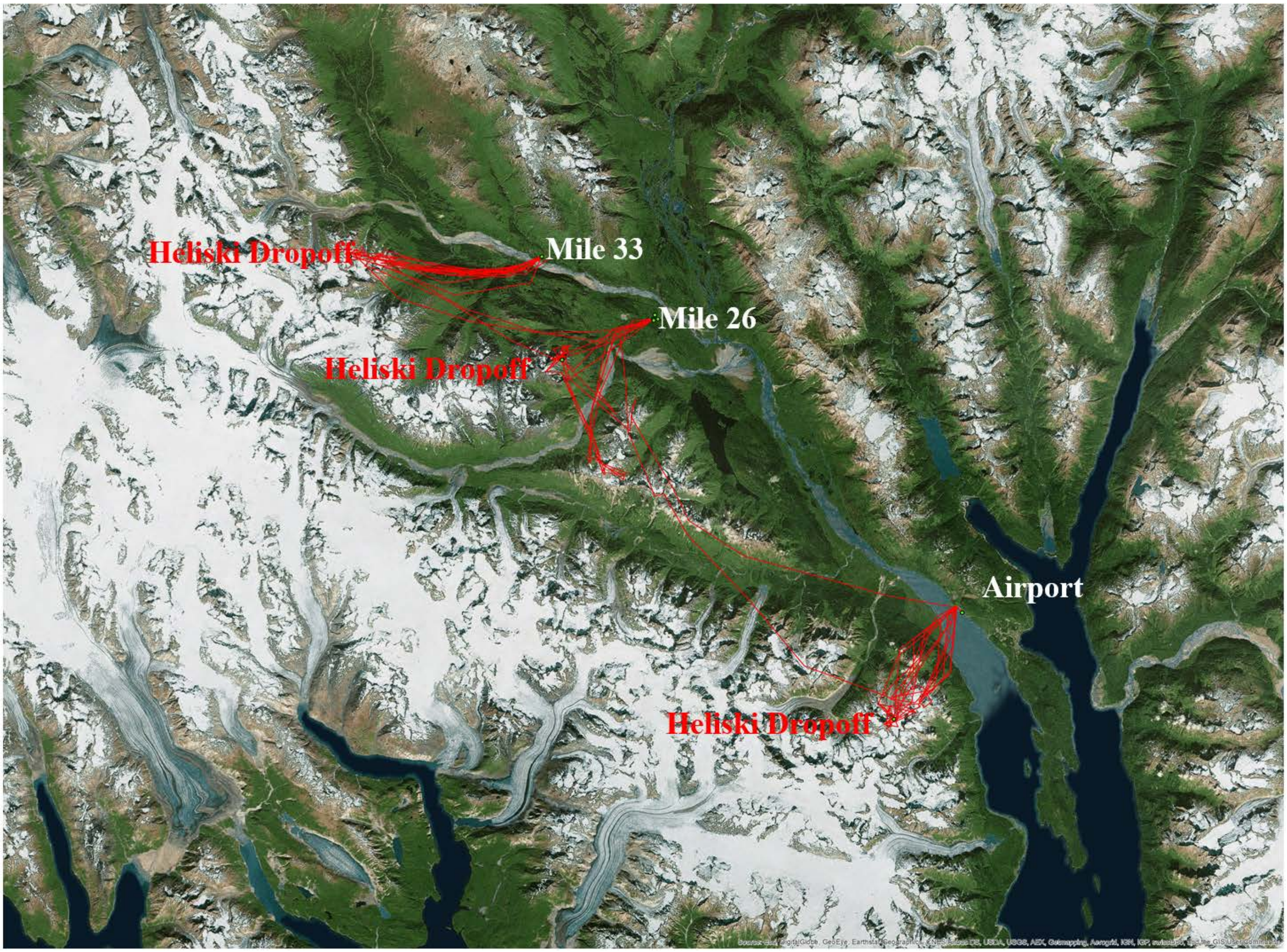
Example of Playback of Noise

Event 6 – Arrival : March 14, 2015 11:15 am

Borough of Haines – Noise Measurement Survey, Spring 2015

Figure 3-7
Flight Track Map

Borough of Haines – Noise Measurement Survey, Spring 2015



4.0 Noise Measurement Results

The existing noise environment for the area near the SEABA base was determined through a noise measurement survey. The results of the measurement survey are summarized in the following paragraphs. This section presents the overall findings from the noise measurement survey. This includes an explanation of the results and are divided into the following sub-sections:

- Noise Measurement Results
  - Ambient noise measurement results
  - Single event noise measurement results (Lmax)
  - Sound Exposure Level (SEL)
  - Hourly Noise Level (LEQ)
  - Day Night Noise Level (DNL)
  - Time Above Ambient (TAA)

4.1 INTRODUCTION

Noise measurements were conducted between March 9, 2015 and March 15, 2015 at four (4) locations. Continuous measurements were taken at each site for approximately seven (7) days. The measurements consisted of the continuous recording of 1-second noise levels, and the results consist of: (1) single event noise levels from individual helicopter 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 sound at the respective sites. The methodology used in the noise measurement program and a description of measurement locations is presented in Section 2 (Background Information) and Section 3 (Methodology).

4.2 AMBIENT NOISE MEASUREMENT RESULTS

Background, or ambient noise, levels (those without aircraft noise) were measured at each of the monitoring locations, and these results are presented using Percent Noise Levels (Ln). Described in greater detail in the background section (Section 2), Percent Noise Level characterizes intermittent or fluctuating noise by showing the noise level that is exceeded during a significant percent of time during the noise measurement period. Ln is most often used to characterize background noise where, for example, L90 is the noise level exceeded 90 percent of the time, L50 is the level exceeded 50 percent of the time, and L10 is the level exceeded 10 percent of the time. Other noise sources that are part of the background noise environment include roadway, wind in the trees, and people activities. This data aids in assessing how intrusive aircraft noise is on the ambient environment. Typically, L90 represents the residual noise level; L50 represents the median or ambient noise level and L10 the most intrusive noise levels.

Results of the ambient noise measurement survey at each measurement site are displayed in the following figures and tables. **Table 4-1** presents the statistical summary of the ambient measurements for the entire measurement period at each site using the Ln noise levels for the Lmin (Minimum Noise Level), L90, L50, L10 and Lmax (Maximum Noise Level). The Lmax is presented for the loudest 1-second dBA value that was measured while the Lmin is the lowest 1-second dBA value that was measured. This table illustrates the range in noise levels that exist at each site. Note that aircraft noise events are included in this data and are typically the source of the peak or maximum noise levels. A graphic depiction of the same information is presented in **Figure 4-1**.

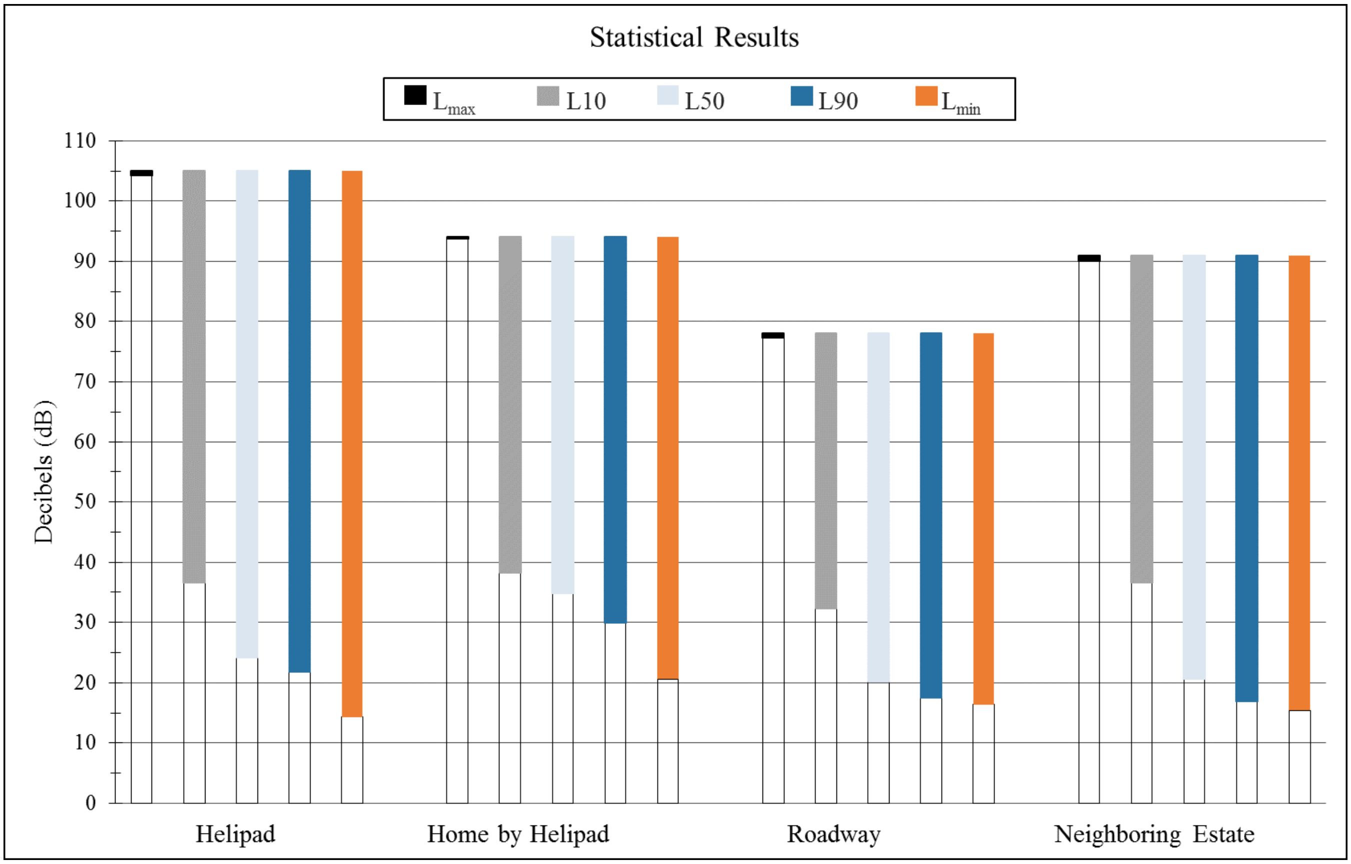
Table 4-1
AMBIENT NOISE MEASUREMENT RESULTS
Borough of Haines Spring 2015 Helicopter Noise Survey

Site #	Name	Description	Statistical Noise Levels (dBA) LMax	L10	**L50**	L90	LMin
1	HA1	Helipad	104	37	**24**	22	14
2	HA2	Home By Helipad	94	38	**35**	30	21
3	HA3	Roadway	77	32	**20**	18	16
4	HA4	Neighboring Estate	90	37	**21**	17	15

Industry practices indicate that L90 is a good representation of the residual noise level and L50 the ambient noise level. These represent the levels that are exceeded 90 percent of the time and 50 percent of the time, respectively. The L90 is referred to as the residual noise, when other sources of noise are not present, and is the level above which noise events occur, such as an aircraft overflight or a vehicle pass-by. Aircraft noise would have very little if any contribution to this noise level because of the relatively short duration of these noise events. The L50 noise level is referred to as the median or ambient noise level. Half the time the noise is below this level, and half the time it is above this level. Even during peak hours of aircraft activity, the L50 noise level would not be influenced by the aircraft noise. On a 24-hour basis, this level is generally reflective of ambient noise levels.

The measurements show that residual L90 noise levels ranged from the high 10s dBA to (a high of the high) 20s dBA. Most sites had an average L90 noise level right around 21 dBA. The ambient L50 noise levels ranged from the low 20s dBA to the mid 30s dBA. Ambient noise levels vary by day and time of day. Day-to-day ambient noise levels are generally similar with higher levels occurring during high wind conditions. Ambient noise levels vary by time of day with quieter levels typically occurring during night and early morning hours, and with higher levels occurring during daytime hours. Typical quiet ambient noise levels range from 5 to 10 dBA lower than average hours.

Figure 4-1
AMBIENT NOISE MEASUREMENT RESULTS FOR ALL SITES
Borough of Haines Spring 2015 Helicopter Noise Survey



4.3 AIRCRAFT SINGLE EVENT NOISE MEASUREMENT RESULTS

Aircraft single event noise levels were identified at each measurement site. The acoustic data included the Maximum Noise Level (Lmax), the Sound Exposure Level (SEL), and the time duration of aircraft events (Time Above Ambient). The single events measured during the survey were correlated when possible with flight operations information. With this correlated single event noise data, it was possible to separately identify the single event noise levels from the different sources of noise. The single event results are summarized in the following paragraphs.

The single event data were analyzed to determine the Lmax noise level for the helicopter events. An example of the range in noise data is presented for all the measurement sites in **Table 4-2**. This table presents the results of the Lmax levels for the identified 9 measured helicopter operations at Mile 26. The Helipad site is representative of a location close to the SEABA base while the Neighboring Estate is representative of the site most distant from the SEABA base. These results show the range in Lmax noise level generated by aircraft events that occur at each site. Note that the noise from a departure, arrival or quick turn generated similar Lmax noise levels.

Single event noise levels are what people hear when a helicopter flies overhead and are more easily related to by the community than an averaging of noise over a period of time. These are the noise levels that helicopters make as they approach, depart and overfly a specific location. The level of annoyance can be influenced by how much of a decibel difference there is between the maximum single event noise level associated with a flyover and the ambient noise level without the flyover. The ambient noise levels during these helicopter events typically ranged from the high teens to low 30s.

Table 4-2
MEASURED LMAX NOISE LEVELS OF IDENTIFED HELICOPTER EVENTS
Borough of Haines Spring 2015 Helicopter Noise Survey
Period: March 9, 2015 to March 15, 2015

Event	Time	Operation	Maximum Noise Level (LMAX) dBA			
			HA1	HA2	HA3	HA4
1	3/9/2015 2:00 pm	Departure	100	84	73	64
2	3/9/2015 2:21 pm	Quick Turn	102	85	72	64
3	3/9/2015 4:45 pm	Quick Turn	100	87	63	65
4	3/9/2015 5:01 pm	Arrival	100	84	63	61
5	3/11/2015 8:12 am	Departure	101	86	69	68
6	3/14/2015 11:15 am	Arrival	100	85	65	63
7	3/14/2015 3:28 pm	Departure	100	82	62	66
8	3/14/2015 4:18 pm	Arrival	103	83	64	66
9	3/15/2015 8:21 am	Departure	104	85	68	71
Average			**101**	**85**	**66**	**65**

The duration that the aircraft were above the ambient, (Time Above Ambient), was also determined. This is generally a good indication of when the aircraft noise is above the background noise, it will be audible. For these events, the TAA typically includes all phases of the operation, including not only when the aircraft is in flight but also when the aircraft is hovering or on the ground with the engine operating. These TAA levels were roughly the same at all locations. Although as shown in the Lmax data presented above, the magnitude is less at sites further from the helipad location.

The results of the TAA measurements for the 9 identified flight events are presented in **Table 4-3.** For arrival operations the TAA levels were generally 2 to 4 minutes in duration; for departure they were generally 5 to 10 minutes in duration. And for the arrival/departure quick turn, these events ranged in duration from 6 to 12 minutes, depending upon how long the aircraft was located at the helipad before departing again.

Table 4-3
MEASURED TIME ABOVE AMBIENT NOISE MEASUREMENT RESULTS
Borough of Haines Spring 2015 Helicopter Noise Survey

Event	Time	Operation	Time Above Ambient (TAA) - Minutes			
			HA1	HA2	HA3	HA4
1	3/9/2015 2:00 pm	Departure	5	5	8	8
2	3/9/2015 2:21 pm	Quick Turn	11	10	12	12
3	3/9/2015 4:45 pm	Quick Turn	6	6	6	8
4	3/9/2015 5:01 pm	Arrival	3	3	3	2
5	3/11/2015 8:12 am	Departure	6	7	5	5
6	3/14/2015 11:15 am	Arrival	3	4	4	2
7	3/14/2015 3:28 pm	Departure	5	5	5	5
8	3/14/2015 4:18 pm	Arrival	3	3	4	3
9	3/15/2015 8:21 am	Departure	7	7	10	9
Average	**(Minutes)**		**5**	**6**	**6**	**6**

4.4 DNL Noise Measurement Results

Aircraft-related DNL levels were calculated for each of the four noise monitoring locations. **Table 4-4** presents these results. This table lists the average aircraft related measured DNL for the period monitored at each site (March 9, 2015 to March 15, 2015).

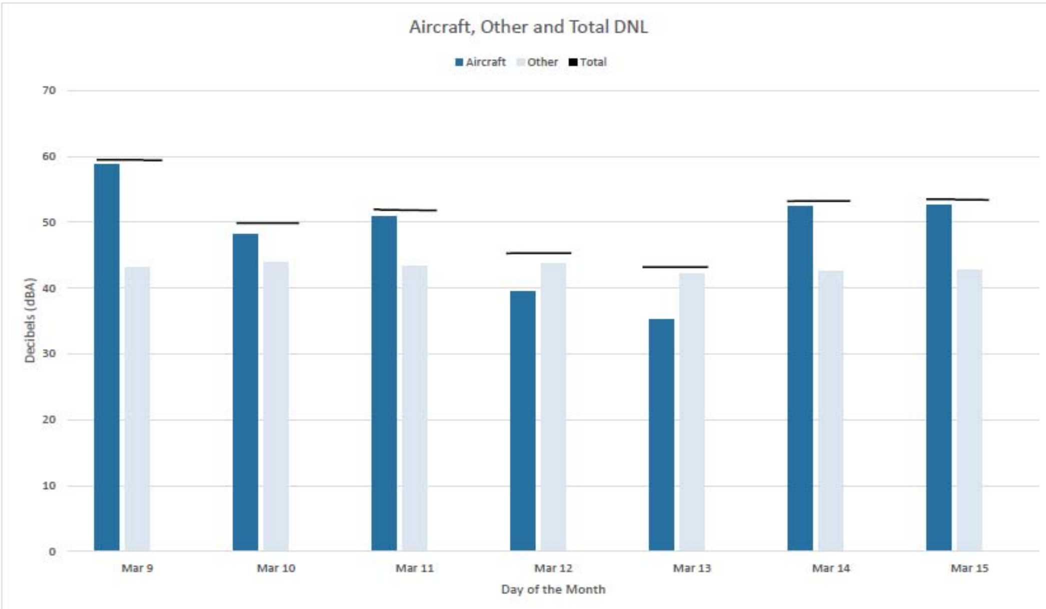
Figure 4-2 shows the same results of the DNL noise measurements at the noise-monitoring locations in a graphical format. The top portion of the graph shows the average DNL noise level measured at each noise monitoring location. The bottom portion of the figure shows the numbers of events and each Lmax noise level. Note that other sources of noise that generated higher noise events were typically vehicles, snowmobile or snow removal equipment. The results show the average noise exposure level at each site stays fairly consistent, with the range of DNL values at any given site is less than 10 dB. The day to day variation in DNL was primarily related to the number of operations. The higher DNL noise level days occurred on days with higher activity. Since the DNL is a cumulative noise metric, people do not hear the DNL level. It is a predictor of human response to aircraft noise used by the FAA and EPA. Additional measurement data can be found in Appendix B.

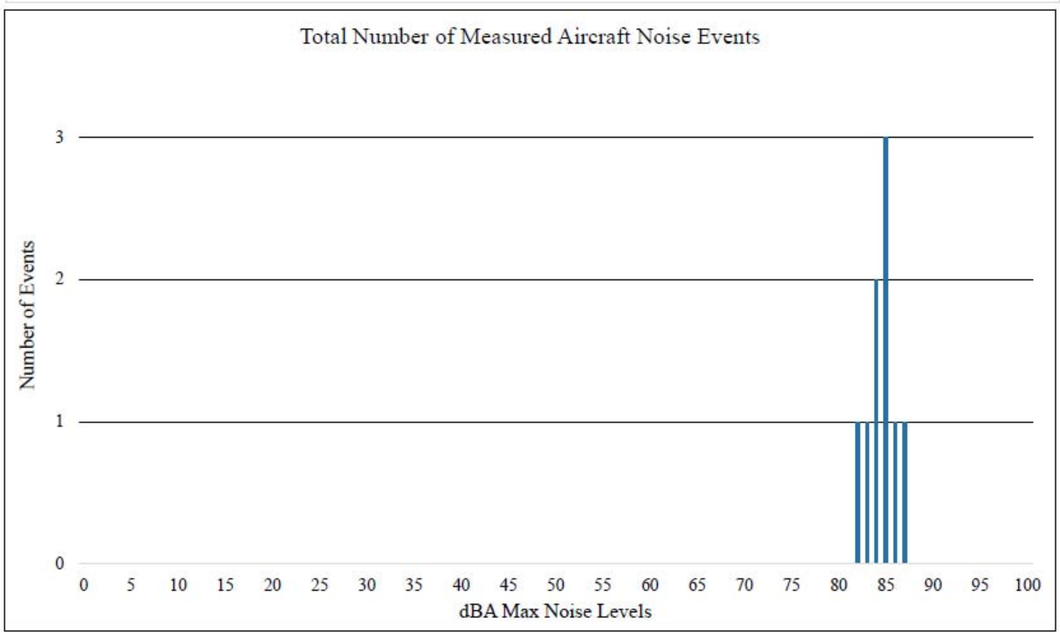
Table 4-4
AIRCRAFT DNL NOISE MEASUREMENT RESULTS
Borough of Haines Spring 2015 Helicopter Noise Survey

Site #	Name	Description	Aircraft DNL
1	HA1	Helipad	69
2	HA2	Home by Helipad	51
3	HA3	Roadway	30
4	HA4	Neighboring Estate	43*

**Site 4 includes some noise events that were not confirmed as helicopter but were included for worst case purposes. Without these events included the Aircraft DNL would be in the low 30s.*

Figure 4-2
DNL CONTRIBUTION & NUMBER OF EVENTS
Borough of Haines Spring 2015 Helicopter Noise Survey
Period: March 9, 2015 to March 15, 2015
Site: 2





4.5 Hourly LEQ Noise Measurement Results

Hourly average noise level values were calculated for each of the measurement locations. Hourly values include the aircraft LEQ, non-aircraft LEQ, and total LEQ.

An example of the hourly aircraft LEQ and total LEQ noise data for the Roadway Site (Site 3) is presented in **Table 4-5.** The total LEQ noise level includes all sources of noise, including residual noise, aircraft, other man made, and natural sources. This table shows that the hourly LEQ noise level varies throughout the day. Tables listing the calculated hourly LEQ noise levels for the remaining sites during each hour of measurement are presented in Appendix C.

Table 4-5
HOURLY NOISE LEVEL SITE REPORT
Borough of Haines Spring 2015 Helicopter Noise Survey
Period: March 9, 2015 to March 15, 2015
Site: 3 - Roadway

Metric: Aircraft LEQ

DATE	Hour Of The Day																								DNL
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Mar 9	--	--	--	--	--	--	--	--	--	--	--	0	0	27	46	31	37	34	0	0	0	0	0	0	36
Mar 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar 11	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Mar 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar 14	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	46	40	0	0	0	0	0	28	0	35
Mar 15	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--	32
Energy Average	0	0	0	0	0	0	0	0	38	0	0	33	0	19	38	38	34	26	0	0	0	0	20	0	30

Metric: Total LEQ

DATE	Hour Of The Day																								DNL
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Mar 9	--	--	--	--	--	--	--	--	--	--	--	53	36	38	47	43	41	38	35	30	34	23	26	24	44
Mar 10	20	31	44	30	23	23	24	31	33	47	49	30	28	38	44	44	33	27	39	33	35	25	27	24	43
Mar 11	19	24	21	21	19	19	36	35	42	44	30	31	35	37	36	42	23	31	36	35	32	17	20	24	37
Mar 12	25	22	24	19	18	18	19	22	24	45	50	25	28	32	42	24	28	24	29	33	19	18	18	22	39
Mar 13	17	20	22	22	26	28	28	45	44	48	39	43	46	37	41	41	35	31	30	27	36	31	19	19	40
Mar 14	19	19	19	19	19	19	30	34	35	47	38	43	33	31	36	48	41	36	19	29	29	27	30	18	39
Mar 15	19	19	26	27	20	20	26	29	45	34	37	41	36	35	43	--	--	--	--	--	--	--	--	--	38
Energy Average	21	25	37	25	22	23	30	38	41	46	46	46	39	36	43	43	37	33	34	32	33	26	26	22	41

4.6 Time Above Ambient Noise Measurement Results

Aircraft-related Time Above Ambient (TAA) levels were calculated for each of the four noise monitoring locations. **Table 4-6** presents these results; this table lists the time that helicopter noise related events were above the ambient noise level for the noise monitoring period. Instead of programming each noise monitor with a fixed noise level as the threshold, the threshold fluctuates to account for varying ambient noise levels. Thus, sites with a lower ambient background may have a longer TAA duration than sites with a higher background noise.

Table 4-6
AVERAGE DAILY AIRCRAFT TAA NOISE MEASUREMENT RESULTS
Borough of Haines Spring 2015 Helicopter Noise Survey

Site #	Name	Description	Aircraft TAA, minutes
1	HA1	Helipad	12
2	HA2	Home by Helipad	13
3	HA3	Roadway	14
4	HA4	Neighboring Estate	13

Section 5 Conclusions

The noise study defined and quantified operations by SEABA helicopters at its Mile 26 base flying to the heliski dropff and the Haines Airport. The results indicate there were nine helicopter flight events during the measurement period at the Mile 26 base. The noise measurements conducted used the standard noise measurement weighting that mimics how the human ear hears noise (dBA). These measurements were analyzed to find the ambient background noise level, the peak Lmax level of the helicopter noise event (and SEL), Time Above Ambient and the daily DNL noise levels. For the four sites that were measured, the loudest events occurred at Site 1, the helipad site, and the quietest events occurred at Site 4, the furthest site from the helipad. The area with the quietest ambient noise level was Site 3, the roadway site, followed by the Site 4, the neighboring estate. Aircraft events were loudest at the helipad site, followed by Site 2, the home by the helipad.

During the measurement period, there were nine recorded noise events from helicopter activity that also correlated with the GPS tracks from the helicopter operations; these flight events were recorded at each of the four noise monitoring sites. While noise was reported through several different noise metrics (including Lmax, SEL, TAA, DNL), the DNL results, since they represent the average noise level, are best for comparative purposes with other similar land uses. The results show that the average noise exposure level (DNL) at each of the three sites outside the helipad itself stays fairly consistent for the level of activity during the measurements. This average noise ranges from 30-51 DNL at the sites, and 69 DNL at the helipad location.

While the Lmax is more closely related to what an individual actually hears, and thus experiences, there are no land use compatibility standards associated with Lmax, or even SEL, noise levels. At the helicopter site itself, the Lmax noise levels were 100 dBA. At the three off-site locations the Lmax Levels were typically in the mid-60s to mid-80s dBA. With the background noise levels in the area, these Lmax levels were often 40 to 60 dBA higher than the ambient background. During a helicopter event, the noise level is above the ambient an average of 6 minutes per event.

To draw some conclusions from the measurement data, it is important to look at noise standards that could be guiding the noise environment. As stated in the report, there are no local noise standards in effect. In comparison, the FAA uses a DNL metric, which is an annual average and must be modeled using a specific program (the Integrated Noise Model). For this standard, residential uses are compatible with noise up to 65 DNL (annual average). For this Study, the measured DNL from the sites above cannot be directly compared to the 65 DNL significance threshold because the annual average was not modeled using Integrated Noise Model. However, the measured average levels at the three sites during the study period (outside of the helipad itself) are generally below what measurements would be expected at the significant 65 DNL or higher level.

In addition, to help put the measured DNL into perspective, the report examined the range of typical land uses and their typical DNL noise measurements, and then compared them to the results from the noise monitoring at the three sites. As stated above, the three sites outside the helipad ranged from 30-51 DNL. Typical noise measurements at an average "wooded residential" land use is generally around 51 DNL. This means that the measured average noise level at the three sites fairly closely matches, or is quieter than what would be expected in wooded residential or quieter land use types. However, it is important to note that these comparisons do not link to any specific noise standard or regulation, but rather give a generalized comparison between what is typical in similar land uses and the results measured during this Study.

The measurement survey measured 9 flight events at the Helipad during the 7 day period with a range of 0 to 4 flight events per day and an average of 1.3 flight events per day (for days with helicopter operations the average was 2.3 flights events per day). The number of helicopter flights can vary significantly based upon many factors including weather, ski conditions and number of customers. Using the single event noise data collected during the measurements, it is possible to project what the daily noise metrics, such as daily DNL and daily TAA would be on more active days than what actually occurred during the measurement survey. **Table 5-1** below presents the potential DNL and TAA levels for higher levels of activity than occurred during the noise measurement period to show how the noise might change if more events occurred per day.

Table 5-1
POTENTIAL DNL AND TAA LEVELS WITH VARIOUS LEVELS OF THEORETICAL ACTIVITY
Borough of Haines Spring 2015 Helicopter Noise Survey

Flights Events Per Day	Day Night Noise Level (DNL)				Daily Time Above Ambient (TAA), minutes			
	HA1	HA2	HA3	HA4	HA1	HA2	HA3	HA4
2	70	52	31	31	11	11	12	12
5	74	56	35	35	27	28	31	29
10	77	59	38	38	53	55	62	59
15	79	61	40	40	80	83	93	88
20	80	62	41	41	106	111	124	117