Ambient Noise Study
BC Oil and Gas Research and Innovation Society
Farmington Development Area
Highway 97 Report-Final

Prepared for:
BC Oil and Gas Research and Innovation Society

Prepared by:
Patching Associates Acoustical Engineering Ltd.
Consultants in Acoustics, Noise Control and Vibration

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Professional Authentication

Project Role: Engineer of Record
Date: 2020-05-30
Patching Associates Acoustical Engineering Ltd. Permit to Practice: P05273
Title: Principal
Name: Justin Caskey, P.Eng.

Prepared by:

Analyst and Report Author: Sheying Sun, PhD.
Principal In Charge & Engineer of Record: Justin Caskey, P.Eng.
Project Manager: Sharna Batey, BA (Hons.), CAPM

Executive Summary

BC Oil and Gas Research and Innovation Society (BC OGRIS, the client) retained Patching Associates Acoustical Engineering Ltd. (PAAE) to conduct an ambient noise study for Highway 97 in the Farmington Development Area (FDA), located NW of Dawson Creek, British Columbia.

The purpose of the sound survey is to quantify the current (2019/2020) ambient sound levels near Highway 97, which will provide data for consideration in a review of current noise regulations and associated permissible sound levels in B.C., and provide more targeted and specific information to optimize noise mitigation planning. This preliminary report outlines the results from Phases 1 and 2 and outlines the results from monitoring and initial modeling results for Highway 97 through the Farmington Development Area. To achieve this purpose a section of highway was selected and studied in detail through noise monitoring and detailed noise modeling in order to establish a reliable method for modeling. The noise modeling was also extended to include the entire length of Highway 97 through the Farmington Development Area. Several sound monitoring locations were selected in detail and results are presented below.

Table A: Predicted sound level Results (Summertime)

Receiver	BC OGC Current Assumed BSL (ASL) (dBA)		Weather Condition	Measured Daytime SPL (dBA)	Measured Nighttime SPL (dBA)	Predicted Daytime SPL (dBA)	Predicted Nighttime SPL (dBA)	Difference Daytime Predicted - Measured (dB)	Difference Nighttime Predicted - Measured (dB)
	Daytime	Nighttime							
Sound Monitor C (Category 3)	60.0 (55.0)	50.0 (45.0)	ISO Standard	65.5	61.3	65.5	61.3	0	0
			Downwind	66.5	62.7	65.2	61.0	1.3	1.7
			Crosswind	66.6	61.8	64.6	60.3	2.0	1.5
			Upwind	64.9	60.9	63.5	59.3	1.4	1.6
			Long Term Prevailing Wind Conditions	*65.5	*61.3	64.3	60.1	1.2	1.2
Sound Monitor A (Category 1/2)	55.0 (50.0)	45.0 (40.0)	ISO Standard	48.0	43.7	43.2	40.4	4.8	3.3
			Downwind	49.5	45.3	42.7	40.0	6.8	5.3
			Crosswind	45.2	37.8	41.4	38.6	3.8	-0.8
			Upwind	38.5	33.4	38.5	35.3	0.0	-1.9
			Long Term Prevailing Wind Conditions	*48.0	*43.7	41.6	38.9	6.4	4.8
Sound Monitor D (Category 1)	50.0 (45.0)	40.0 (35.0)	ISO Standard	**49.8	**46.9	39.2	35.4	10.6	11.5
			Downwind	**50.6	**47.4	38.8	35.0	11.8	12.4
			Crosswind	**48.3	**45.6	37.4	33.6	10.9	12.0
			Upwind	**46.6	**45.2	34.2	30.4	12.4	14.8
			Long Term Prevailing Wind Conditions	*49.8	*46.9	37.7	33.8	12.1	13.1

* Measured sound levels for the long term prevailing wind conditions listed are based on the data available during the monitoring period as an analogue and do not match long term prevailing wind conditions;
** Measured sound levels inconclusive due to strong winds and intermittent contamination caused by equipment malfunction.

Table B: Predicted sound level Results (Wintertime)

Receiver	BC OGC Current Assumed BSL (ASL) (dBA)		Weather Condition	Measured Daytime SPL (dBA)	Measured Nighttime SPL (dBA)	Predicted Daytime SPL (dBA)	Predicted Nighttime SPL (dBA)	Difference Daytime Predicted - Measured (dB)	Difference Nighttime Predicted - Measured (dB)
	Daytime	Nighttime							
Sound Monitor C (Category 3)	60.0 (55.0)	50.0 (45.0)	ISO Standard	67.4	62.6	67.4	62.6	0	0
			Downwind	67.7	61.8	67.1	62.2	0.6	-0.4
			Crosswind	67.3	62.3	66.4	61.6	0.9	0.7
			Upwind	67.3	63.4	65.4	60.5	1.9	2.9
			Long Term Prevailing Wind Conditions	*67.4	*62.6	66.2	61.4	1.2	1.2
Sound Monitor A (Category 1/2)	55.0 (50.0)	45.0 (40.0)	ISO Standard	42.3	38.0	42.1	38.9	0.2	-0.9
			Downwind	44.8	40.5	41.7	38.5	3.1	2.0
			Crosswind	40.4	37.2	40.3	37.2	0.1	0.0
			Upwind	42.8	37.5	37.0	33.4	5.8	4.1
			Long Term Prevailing Wind Conditions	*42.3	*38.0	40.6	37.4	1.7	0.6
Sound Monitor D (Category 1)	50.0 (45.0)	40.0 (35.0)	ISO Standard	39.4	35.5	36.4	32.0	3.0	3.5
			Downwind	41.3	37.6	36.0	31.6	5.3	6.0
			Crosswind	38.2	35.2	34.7	30.2	3.5	5.0
			Upwind	39.7	35.0	31.1	26.6	8.6	8.4
			Long Term Prevailing Wind Conditions	*41.3	*35.5	34.9	30.4	4.5	5.1
Sound Monitor F (Category 1/2)	55.0 (50.0)	45.0 (40.0)	ISO Standard	45.4	40.2	45.2	41.3	0.2	-1.1
			Downwind	45.9	39.9	44.8	41.0	1.1	-1.1
			Crosswind	45.2	39.1	43.5	39.6	1.7	-0.5
			Upwind	45.4	41.4	39.9	35.6	5.5	5.8
			Long Term Prevailing Wind Conditions	*45.4	*40.2	43.0	38.9	2.4	1.3

* Measured sound levels for the long term prevailing wind conditions listed are based on the data available during the monitoring period as an analogue and do not match long term prevailing wind conditions.

The key findings and recommendations of the ambient noise study results are the following:

- The results of the noise monitoring survey show that the acoustic environment was **dominated by wind and transportation noise** during monitoring period.
- **Category 3 Receivers (<30m):** T
- **Category 2 Receivers (<500m):** Sound Levels from Highway 97 dominate the ambient sound levels within 500 meters of Highway 97 (Category 2) and this extends past 500m under downwind conditions. Recommend applying A2 adjustment based on modeling results herein when designing noise mitigation, this recommendation extends to receivers in Category 1.
- **Category 1 Receivers (>500m):** Results at receiver locations approximately 1000 metres from Highway 97 is inconclusive due to high wind speeds and intermittent sound data contamination during summertime period. Results during wintertime period indicate ambient sound levels at locations 1000 metres from Highway 97 were 2-3 dBA higher than those currently considered in the BC OGC Guidelines under downwind conditions. Suggesting that current guidelines could be adjusted upwards at these locations under downwind conditions.
- All Categories the **local topography** near the highway affects sound levels from traffic noise. This means that ambient sound levels can not be generalized. Patching Associates recommends using specific noise model results (sound contours) for A2 adjustments, as opposed to generic categories. Recommend providing open access to these noise modeling results in electronic format for efficient use in planning by multiple operators.
- **Wind direction** affects ambient sound level propagation from Highway 97 at receivers in Category 1 and 2. Prevailing winds should be considered when establishing A2 ambient adjustment. Recommend using long term prevailing wind noise contour calculations to establish A2 ambient adjustment. Operators may apply other wind condition scenarios to specific operations to assess risk or set A2 adjustments.
- **Background non-highway** sound levels are not included in the noise model contours and are expected to dominate the sound environment under some wind conditions for residences in Category 1 and 2. Recommend including background non-highway ambient sound levels (35 dBA unless otherwise established) when traffic noise model predicts levels between 30 and 40 dBA at receivers.
- The noise model prediction for the overall Farming Development Area should be used for noise mitigation planning when receivers are within 1000m of Highway 97.

Table of Contents

Acronyms

Acronym	Description
AADT	Average Annual Daily Traffic
AB	Alberta
AER	Alberta Energy Regulator
ASL	Ambient Sound Level
BSL	Basic Sound Level
dB	Decibel
dBA	A-Weighted Decibel
dBC	C-Weighted Decibel
dBZ	Z-Weighted Decibel or Linear Decibel
CSL	Comprehensive Sound Level
DIL	Dynamic Insertion Loss
ISO	International Organization for Standardization
L_{eq}	Energy Equivalent Sound Level
LFN	Low Frequency Noise
LSD	Legal Subdivision
NIA	Noise Impact Assessment
NC	Noise Control
NR	Noise Reduction
PSL	Permissible Sound Level
PWL	Sound Power Level
SPL	Sound Pressure Level
TL	Transmission Loss
UTM	Universal Transverse Mercator

Introduction

BC Oil and Gas Research and Innovation Society (BC OGRIS, the client) retained Patching Associates Acoustical Engineering Ltd. (PAAE) to conduct an ambient noise study for Highway 97 in the Farmington Development Area (FDA), located NW of Dawson Creek, British Columbia.

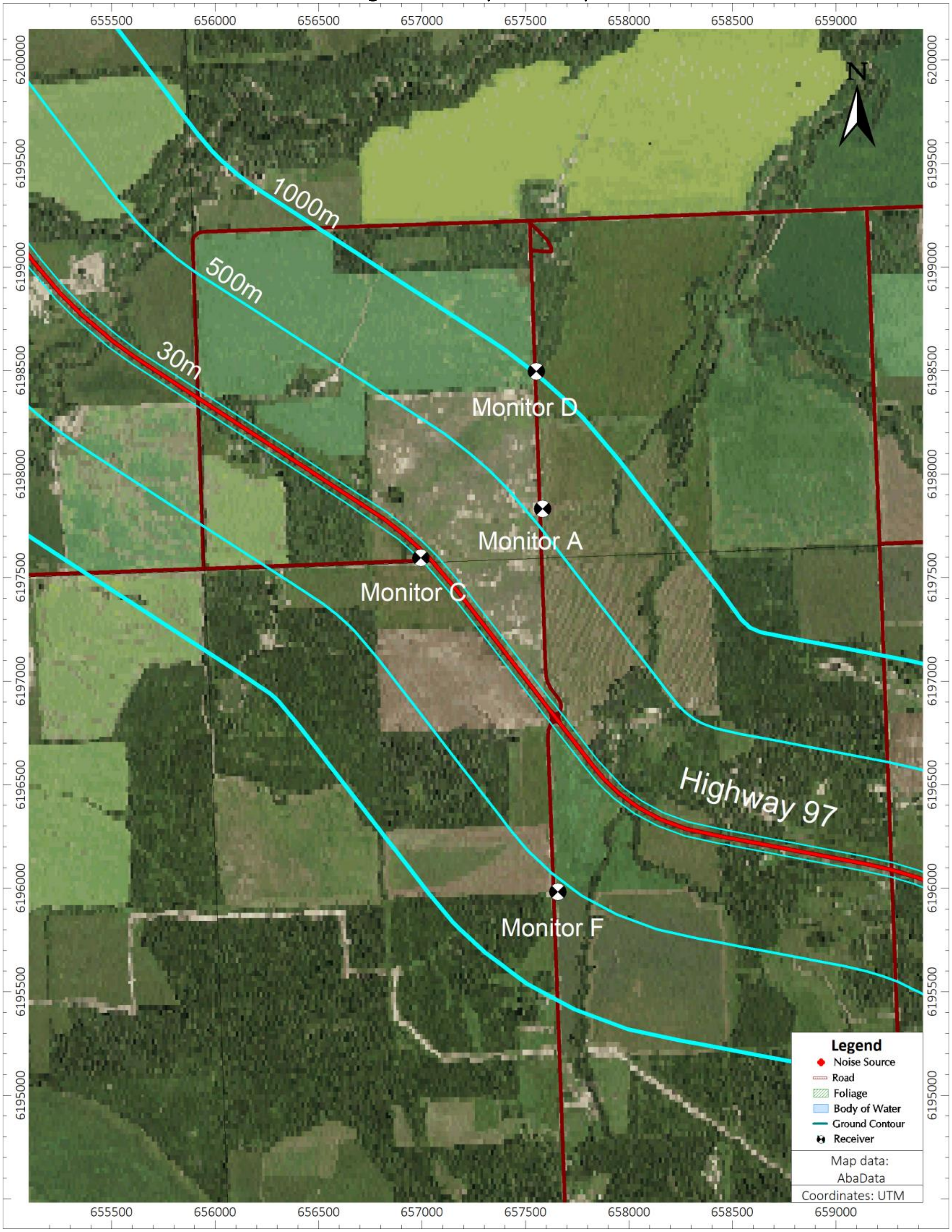
The purpose of the sound survey is to quantify the current (2019/2020) ambient sound levels near Highway 97, which will provide data for consideration in a review of current noise regulations and associated permissible sound levels in B.C., and provide more targeted and specific information to optimize noise mitigation planning. This preliminary report outlines the results from Phases 1 and 2 and outlines the results from monitoring and initial modeling results for Highway 97 through the Farmington Development Area. To achieve this purpose a section of highway was selected and studied in detail through noise monitoring and detailed noise modeling in order to establish a reliable method for modeling. The noise modeling was also extended to include the entire length of Highway 97 through the Farmington Development Area. Four sound monitoring locations were selected in detail and results are presented below.

Study Area

The Farmington Development Area is located NW of Dawson Creek, British Columbia, setup by the BC OGC. The terrain cover is mainly rolling farmland with patches of tree. The four monitoring locations were selected to validate the noise emission from Highway 97, which are located approximately 23 km NW of Dawson Creek.

Highway 97 goes through this area from SE to NW. Based on site observations by PAAE staff, there is one residence located south side of the Highway 97, selected to setup sound monitor C and weather station. The other three selected sound monitoring locations denoted as Sound Monitor A, D and F, shown in Figure 1.

Figure 1: Study Area Map



Noise Criteria

Noise for energy related facilities is regulated through the BC OGC Noise Control Guideline (the Guideline). The Guideline sets the Permissible Sound Level (PSL), which is the limit that the Sound Pressure Level (SPL) emanating from the facilities in the study area plus the Ambient Sound Level (ASL) may not exceed over a specified period, as measured at specific locations of interest (the receivers). These allowable limits are dependent on the population density, proximity to heavily traveled transportation routes (motor vehicles, rail and aircraft) and other specified adjustments. The SPL is the sound level received at a specific location. The ASL is the average background sound level not attributable to energy industry facilities. The ASL is assumed to be 5 dBA below the PSL, as prescribed by the Guideline. The receivers are located at the residences existing within 1500 m of the subject facility, or else at the study area boundary.

The ambient sound level (ASL) is the average sound environment in a given area without contribution from any energy-related industry. This project aims to collect data for consideration in a review of noise regulations and associated permissible sound levels in B.C. Current regulations are based on research conducted in Alberta several decades ago that relied on approximate and simplified categories to establish permissible sound levels and compliance criteria for oil and gas activities.

The three survey locations C, A (F) and D, have been selected to cover the nearby areas along the Highway 97 to get representative conditions in this area, and classified as each of the Categories for the Basic and Ambient Noise Levels definition, See Appendix B for the BSL and PSL calculations based on the Guideline.

Environmental noise level is typically not steady and continuous, but constantly varies over time. To account for the time-varying nature of environmental noise, a single number descriptor known as the energy equivalent sound level (L_{eq}) is used. The L_{eq} value, expressed in dBA, is the A-weighted equivalent-continuous sound level for the complete period of interest that has the same acoustic energy as the actual varying sound levels over the same time period. The use of this index permits the description of a varying sound level environment as a single number. As the L_{eq} is an "average" level, the measured sound level may exceed the criterion level for a short period, provided that the duration is limited. The L_{eq} value considers both the sound level and the length of time that the sound level occurs.

Methodology

The sound monitoring survey at each of the three locations was conducted with NTI XL2 Sound Level Meters. The microphones were mounted with windscreens to reduce the potential for wind-induced noise at the microphone. The sound level meters were calibrated at the beginning and confirmed after the survey with a Brüel & Kjær Model 4231 Sound Level Calibrator. Sound recording equipment recorded the sound for the whole period. These sound recordings were used to help identify the source of different noises. During the sound survey, continuous weather monitoring equipment recorded the wind speed, wind direction, temperature and humidity in the local study area.

Table 1 provides a summary of the major equipment used for this survey and the calibration dates for this equipment. Table 2 describes each monitoring location.

Table 1: Instrumentation Summary

Equipment	Manufacturer	**NetBox SN**	**XL2 SN**	**M2230 Transducer SN**	Calibration Date	Calibration Valid
Sound Level Meter NTI Kit C	NTI	XHN9M-RNT3R	A2A-16136-E0	8473	07/17/2019	Yes
Sound Level Meter NTI Kit A	NTI	JKJNZ-3F7SV	A2A-16189-E0	8414	07/17/2019	Yes
*Sound Level Meter NTI Kit D	NTI	ADP5U-SR59Q	A2A-15338-E0	7948	07/17/2019	Yes
Nomad Weather Station #2	Industrial Scientific	-	14010US-024	-	23/06/2017	Yes
Meter Calibrator 4231 #4	Bruel & Kjaer	4231	2052131	-	27/04/2018	Yes

*Intermittent contamination rendered some data unreliable.

Table 2: Monitoring Locations

Equipment	Location	Description
Sound Level Meter	Sound Monitor A	• NTI kit A • 12 m east from Sweetwater road • 560m northeast from Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C3 in Appendix C
Sound Level Meter	Sound Monitor C	• NTI kit C • 20m southwest from the Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C1 and C2 in Appendix C
Sound Level Meter	Sound Monitor D	• NTI kit D • 12 m east from Sweetwater road • ~1000m northeast from Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C4 in Appendix C
Sound Level Meter	Sound Monitor F	• NTI kit D • 10 m east from Mason road • ~515m southwest from Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C5 in Appendix C

Environmental Conditions

Environmental conditions of the area were recorded with a weather station installed by PAAE staff at the location, which is also beside the sound monitor C. Tables 3A and 3B summarize the weather measurement results for the daytime and nighttime periods during the two survey periods. The detailed records are presented in Appendix D.

Table 3A: Environmental Conditions (Summertime)

Date (2019)	Average Speed (kph)	General Direction	General Description	Minutes of Audible Precipitation	Minutes of Valid Condition
Sep 17	3	NW	Light wind	0	270
Sep 17 - Sep 18	2	SSW	Light wind	0	540
Sep 18	9	SSW	Moderate wind	0	545
Sep 18 - Sep 19	17	SSW	Strong wind	0	0
Sep 19	21	SSW	Strong wind	0	0
Sep 19 - Sep 20	8	SW	Moderate wind	5	410
Sep 20	14	SSW	Moderate wind	0	155
Sep 20 - Sep 21	21	SSW	Strong wind	0	0
Sep 21	23	SSW	Strong wind	0	90
Sep 21 - Sep 22	14	SSW	Moderate wind	0	190
Sep 22	18	SSW	Strong wind	5	10
Sep 22 - Sep 23	16	SSW	Strong wind	0	40
Sep 23	18	SSW	Strong wind	0	115
Sep 23 - Sep 24	18	SSW	Strong wind	0	0
Sep 24	23	SSW	Strong wind	0	5
Sep 24 - Sep 25	11	SSW	Moderate wind	0	255
Sep 25	15	SSW	Strong wind	0	170
Sep 25 - Sep 26	13	SSW	Moderate wind	5	115
Sep 26	6	NW	Moderate wind	20	570
Sep 26 - Sep 27	7	N	Moderate wind	10	150
Sep 27	8	N	Moderate wind	0	295
Sep 27 - Sep 28	2	NNW	Light wind	0	535
Sep 28	5	NNE	Moderate wind	0	545
Sep 28 - Sep 29	2	SSE	Calm wind	0	540
Sep 29	9	SSE	Moderate wind	0	485
Sep 29 - Sep 30	6	SSE	Moderate wind	0	540
Sep 30	6	S	Moderate wind	0	805
Sep 30 - Oct 01	13	SSW	Moderate wind	0	200
Oct 01	13	SSW	Moderate wind	0	120

Table 3B: Environmental Conditions (Wintertime)

Date (2020)	Average Speed (kph)	General Direction	General Description	Minutes of Audible Precipitation	Minutes of Valid Condition
Jan 06	3	SE	Light wind	0	400
Jan 06 - Jan 07	3	SW	Light wind	0	540
Jan 07	5	NE	Moderate wind	0	900
Jan 07 - Jan 08	4	NW	Light wind	0	540
Jan 08	3	NW	Light wind	0	900
Jan 08 - Jan 09	6	NE	Moderate wind	0	540
Jan 09	5	N	Moderate wind	0	900
Jan 09 - Jan 10	5	NNE	Moderate wind	0	540
Jan 10	5	NW	Light wind	0	900
Jan 10 - Jan 11	3	NW	Light wind	0	540
Jan 11	4	NW	Light wind	0	235
Jan 11 - Jan 12	*-	*-	*-	N/A	N/A
Jan 12	-	-	-	N/A	N/A
Jan 12 - Jan 13	-	-	-	N/A	N/A
Jan 13	-	-	-	N/A	N/A
Jan 13 - Jan 14	-	-	-	N/A	N/A
Jan 14	5	WNW	Light wind	0	670
Jan 14 - Jan 15	3	W	Light wind	0	540
Jan 15	5	WSW	Moderate wind	0	900
Jan 15 - Jan 16	4	NE	Light wind	0	540
Jan 16	5	NNW	Moderate wind	0	900
Jan 16 - Jan 17	5	WNW	Moderate wind	0	540
Jan 17	3	W	Light wind	0	900
Jan 17 - Jan 18	2	SSE	Light wind	0	540
Jan 18	4	ENE	Light wind	0	900
Jan 18 - Jan 19	8	SE	Moderate wind	0	465
Jan 19	4	ESE	Light wind	0	865
Jan 19 - Jan 20	3	ENE	Light wind	0	540
Jan 20	4	NNE	Light wind	0	590

Note: * Data not available due to equipment malfunction.

The survey results indicate that the daytime and nighttime periods from September 17 to October 1, 2019 have moderate to strong wind conditions for this survey, only a few days have light wind conditions. Wind data collected during the monitoring period has been used to create a wind rose experienced at the sound monitor C location, which is shown in Figure 2A.

The survey results indicate that the daytime and nighttime periods from January 06 to 20, 2020 have light wind to moderate wind conditions for this survey. Wind data collected during the monitoring period has been used to create a wind rose experienced at the sound monitor C location, which is shown in Figure 2B.

Figure 2A: Wind Rose (September 17 to October 1, 2019)

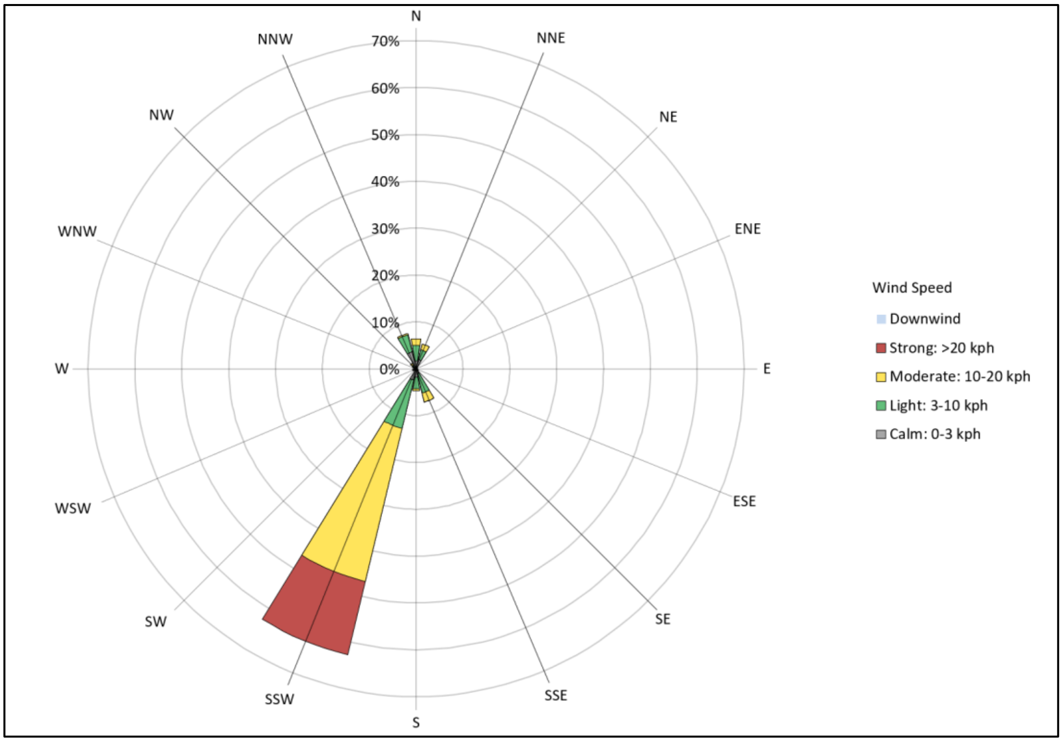
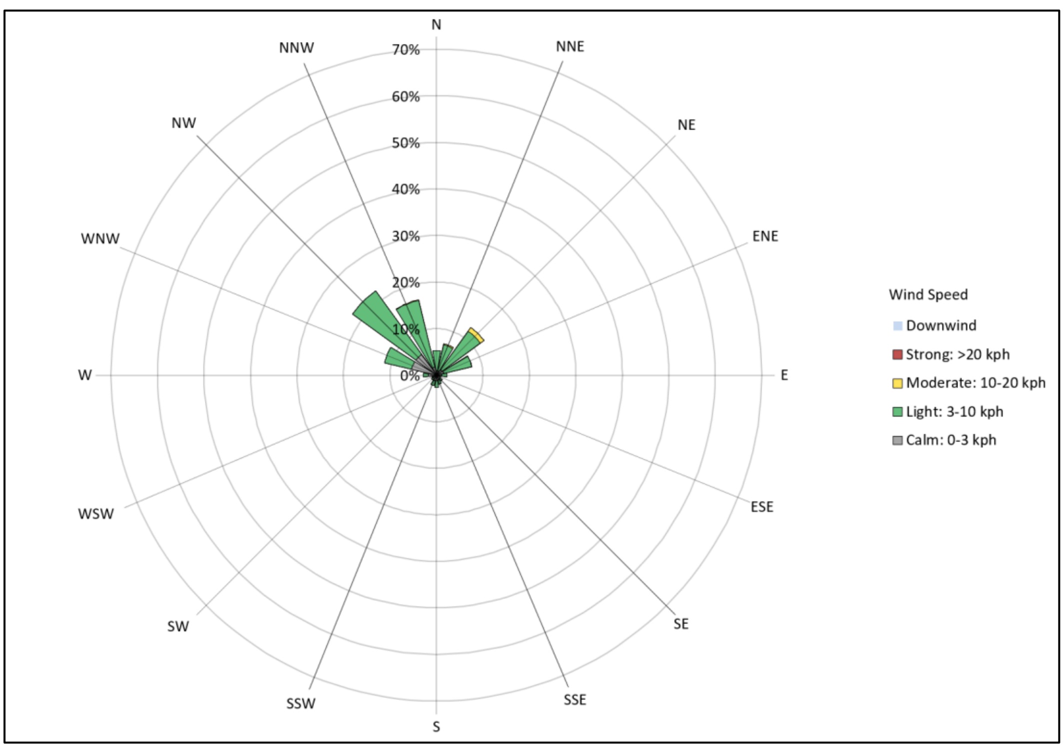


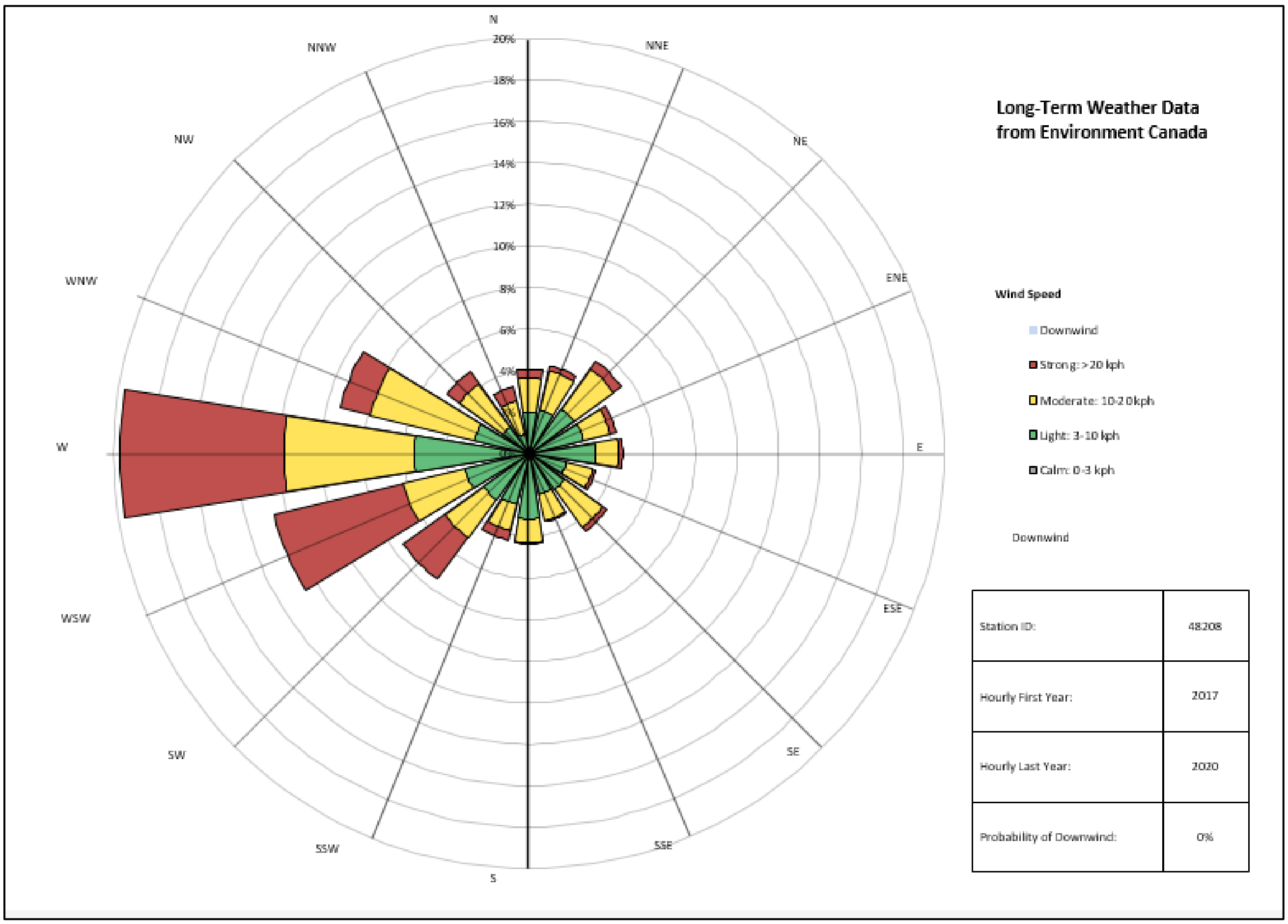
Figure 2B: Wind Rose (January 06 to 20, 2020)



In order to investigate the long term prevailing wind conditions in the study area, 3-years historical hourly weather data (from 2017 – 2020) was collected from Environment Canada database to capture the distribution of wind direction and wind speed. The nearest available weather station was located at Dawson Creek airport.

The data was processed to obtain the percentage of wind in different direction, which results in the following wind rose map.

Figure 2C: Wind Rose (Year 2017 to 2020)



Results and Discussion

Sound Monitor C Measurement Location

Sound Monitor C was located at the south side of the Highway 97, approximately 20m away. This location is also a residence and was selected because it represents the traffic noise emissions from Highway 97.

Based on site observations during the survey and from the audio playback, the sound environment is dominated by sound from wind and transportation.

The detailed results including graphical presentation of the measured and residual levels are presented in Appendix E.

The survey results contained short-term sound events that are due to occasional noise events from local traffic and wind. Where possible, these short-term sounds were isolated from the measured comprehensive sound level data set resulting in the residual comprehensive sound level. These residual levels become the Comprehensive Sound Levels (CSL) for each period.

Tables 4A and 4B summarize the comprehensive sound level measurement results for the summertime and wintertime periods of the survey based on daytime and nighttime periods. Tables 4C and 4D also summarize the sound level measurement results for the summertime and wintertime periods of the survey based on wind conditions, and predicted results based on the wind conditions.

Table 4A: Sound Monitor C Results (Summertime)

Period	Date (2019)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Sep 17	77.3	4.8	65.7	4.7
Night 01	Sep 17 - Sep 18	62.6	9.0	62.6	9.0
Day 02	Sep 18	60.0	15.0	60.0	15.0
Night 02	Sep 18 - Sep 19	0.0	9.0	0.0	9.0
Day 03	Sep 19	64.4	15.0	64.4	15.0
Night 03	Sep 19 - Sep 20	62.3	9.0	62.3	9.0
Day 04	Sep 20	65.2	15.0	65.2	15.0
Night 04	Sep 20 - Sep 21	61.0	9.0	61.0	9.0
Day 05	Sep 21	65.1	15.0	65.1	15.0
Night 05	Sep 21 - Sep 22	59.6	9.0	59.6	9.0
Day 06	Sep 22	64.2	15.0	64.2	15.0
Night 06	Sep 22 - Sep 23	61.0	9.0	61.0	9.0
Day 07	Sep 23	65.3	15.0	65.3	15.0
Night 07	Sep 23 - Sep 24	61.4	9.0	61.4	9.0
Day 08	Sep 24	65.6	15.0	65.6	15.0
Night 08	Sep 24 - Sep 25	62.4	9.0	62.4	9.0
Day 09	Sep 25	65.8	15.0	65.8	15.0
Night 09	Sep 25 - Sep 26	61.5	9.0	61.5	9.0
Day 10	Sep 26	67.0	15.0	67.0	15.0
Night 10	Sep 26 - Sep 27	62.2	9.0	62.2	9.0
Day 11	Sep 27	67.4	15.0	67.4	15.0
Night 11	Sep 27 - Sep 28	61.5	9.0	61.5	9.0
Day 12	Sep 28	65.9	15.0	65.9	15.0
Night 12	Sep 28 - Sep 29	60.1	9.0	60.1	9.0
Day 13	Sep 29	65.5	15.0	65.5	15.0
Night 13	Sep 29 - Sep 30	62.8	9.0	62.8	9.0
Day 14	Sep 30	66.5	15.0	66.5	15.0
Night 14	Sep 30 - Oct 01	61.4	9.0	61.4	9.0
Day 15	Oct 01	63.8	15.0	65.9	8.8
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				60.0 (55.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				50.0 (45.0)	

Table 4B: Sound Monitor C Results (Wintertime)

Period	Date (2019)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Jan 06	77.6	6.4	68.1	6.2
Night 01	Jan 06 - Jan 07	64.7	9.0	64.7	9.0
Day 02	Jan 07	68.8	15.0	68.8	15.0
Night 02	Jan 07 - Jan 08	61.0	9.0	61.0	9.0
Day 03	Jan 08	67.9	15.0	67.9	15.0
Night 03	Jan 08 - Jan 09	62.6	9.0	62.6	9.0
Day 04	Jan 09	67.8	15.0	67.8	15.0
Night 04	Jan 09 - Jan 10	62.1	9.0	62.1	9.0
Day 05	Jan 10	66.6	15.0	66.6	15.0
Night 05	Jan 10 - Jan 11	60.3	9.0	60.3	9.0
Day 06	Jan 11	65.9	15.0	65.9	15.0
Night 06	Jan 11 - Jan 12	61.6	9.0	61.6	9.0
Day 07	Jan 12	67.6	15.0	67.6	15.0
Night 07	Jan 12 - Jan 13	63.2	9.0	63.2	9.0
Day 08	Jan 13	66.9	15.0	66.9	15.0
Night 08	Jan 13 - Jan 14	62.7	9.0	62.7	9.0
Day 09	Jan 14	67.2	15.0	67.2	15.0
Night 09	Jan 14 - Jan 15	63.3	9.0	63.3	9.0
Day 10	Jan 15	68.7	15.0	68.7	15.0
Night 10	Jan 15 - Jan 16	63.7	9.0	63.7	9.0
Day 11	Jan 16	67.0	15.0	67.0	15.0
Night 11	Jan 16 - Jan 17	62.5	9.0	62.5	9.0
Day 12	Jan 17	67.3	15.0	67.3	15.0
Night 12	Jan 17 - Jan 18	63.9	9.0	63.9	9.0
Day 13	Jan 18	67.0	15.0	67.0	15.0
Night 13	Jan 18 - Jan 19	61.5	9.0	61.5	9.0
Day 14	Jan 19	66.1	15.0	66.1	15.0
Night 14	Jan 19 - Jan 20	59.8	9.0	60.2	8.2
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				60.0 (55.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				50.0 (45.0)	

Table 4C: Sound Monitor C Results (Summertime)

Summer Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	65.5	208.4	13.2	65.5	0.0
Total Survey Period - Nighttime	61.3	126.0	10.6	61.3	0.0
Total Survey Period – Daytime (Downwind)	66.5	23.6	6.7	65.2	1.3
Total Survey Period – Nighttime (Downwind)	62.7	10.2	5.6	61.0	1.7
Total Survey Period – Daytime (Crosswind)	66.6	45.6	6.8	64.6	2.0
Total Survey Period – Nighttime (Crosswind)	61.8	29.7	3.5	60.3	1.5
Total Survey Period – Daytime (Upwind)	64.9	139.1	16.3	63.5	1.4
Total Survey Period – Nighttime (Upwind)	60.9	86.2	13.7	59.3	1.6
Long Term Prevailing Wind - Daytime	65.5	208.4	13.2	64.3	1.2
Long Term Prevailing Wind - Nighttime	61.3	126.0	10.6	60.1	1.2
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	60.0 (55.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	50.0 (45.0)				

Table 4D: Sound Monitor C Results (Wintertime)

Wintertime Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	67.4	201.2	3.5	67.4	0.0
Total Survey Period - Nighttime	62.6	125.2	3.3	62.6	0.0
Total Survey Period – Daytime (Downwind)	67.7	42.7	4.9	67.1	0.6
Total Survey Period – Nighttime (Downwind)	61.8	26.7	4.8	62.2	-0.4
Total Survey Period – Daytime (Crosswind)	67.3	87.4	4.1	66.4	0.9
Total Survey Period – Nighttime (Crosswind)	62.3	57.4	4.0	61.6	0.7
Total Survey Period – Daytime (Upwind)	67.3	71.2	1.9	65.4	1.9
Total Survey Period – Nighttime (Upwind)	63.4	41.1	1.5	60.5	2.9
Long Term Prevailing Wind - Daytime	67.4	201.2	3.5	66.2	1.2
Long Term Prevailing Wind - Nighttime	62.6	125.2	3.3	61.4	1.2
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	60.0 (55.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	50.0 (45.0)				

The results of the survey show that the acoustic environment was dominated by wind and transportation noise during monitoring period. Based on site observations and audio recordings, the sources of sounds in the study area includes sounds from transportation (Highway 97), local activities (i.e., human and other local industrial related activities), fauna and weather and sounds of nature.

The results indicate that the ambient sound pressure levels ranged from 60.9 to 66.6 dBA during summertime period and ranged from 61.8 to 67.7 dBA during wintertime period, and both daytime and Nighttime CSL are higher than BC OGC current assumed BSL (ASL) at this location. The acoustic environment was dominated by the highway traffic and consistent, with some fluctuation by the highway traffic, strong wind and direction during the monitoring period. There would be some contamination due to the strong winds in most of the time.

Sound Monitor A Measurement Location

Sound Monitor A was located approximately 12 m east from Sweetwater road and 560m northeast from Highway 97.

Based on site observations during the survey and from the audio playback, the sound environment is dominated by sound from local traffic from Sweetwater road, wind and traffic from Highway 97.

The detailed results including graphical presentation of the measured and residual levels are presented in Appendix F.

The survey results contained short-term sound events that are due to occasional noise events from local traffic and wind. Where possible, these short-term sounds and local traffic from Sweetwater road were isolated from the measured comprehensive sound level data set resulting in the residual comprehensive sound level. These residual levels become the Comprehensive Sound Levels (CSL) for each period, which represents the noise emission from Highway 97.

Tables 5A and 5B summarize the comprehensive sound level measurement results for the summertime and wintertime periods of the survey based on daytime and nighttime periods. Tables 5C and 5D also summarize the sound level measurement results for the summertime and wintertime periods of the survey based on wind conditions, and predicted results based on the wind conditions

Table 5A: Sound Monitor A Results (Summertime)

Period	Date (2019)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Sep 19	76.1	8.8	49.9	4.7
Night 01	Sep 19 - Sep 20	56.4	9.0	46.7	7.5
Day 02	Sep 20	60.5	15.0	49.3	7.9
Night 02	Sep 20 - Sep 21	58.8	9.0	45.6	7.3
Day 03	Sep 21	62.2	15.0	50.8	8.3
Night 03	Sep 21 - Sep 22	53.6	9.0	43.3	8.1
Day 04	Sep 22	59.8	15.0	47.5	9.1
Night 04	Sep 22 - Sep 23	54.9	9.0	45.5	8.0
Day 05	Sep 23	59.6	15.0	48.9	9.4
Night 05	Sep 23 - Sep 24	54.7	9.0	45.8	7.9
Day 06	Sep 24	60.3	15.0	50.9	9.3
Night 06	Sep 24 - Sep 25	55.4	9.0	45.1	7.8
Day 07	Sep 25	62.1	15.0	50.4	7.0
Night 07	Sep 25 - Sep 26	57.3	9.0	44.3	7.5
Day 08	Sep 26	62.0	15.0	48.5	8.2
Night 08	Sep 26 - Sep 27	55.5	9.0	31.1	7.5
Day 09	Sep 27	60.6	15.0	39.0	9.2
Night 09	Sep 27 - Sep 28	49.8	9.0	26.6	8.6
Day 10	Sep 28	0.0	15.0	0.0	15.0
Night 10	Sep 28 - Sep 29	0.0	9.0	0.0	9.0
Day 11	Sep 29	58.6	15.0	43.8	10.0
Night 11	Sep 29 - Sep 30	56.0	9.0	41.0	6.9
Day 12	Sep 30	62.1	15.0	47.0	6.9
Night 12	Sep 30 - Oct 01	56.4	9.0	45.7	7.0
Day 13	Oct 01	61.2	15.0	49.4	5.0
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				55.0 (50.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				45.0 (40.0)	

Table 5B: Sound Monitor A Results (Wintertime)

Period	Date (2019)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Jan 06	75.5	7.7	40.0	5.5
Night 01	Jan 06 - Jan 07	52.0	9.0	41.7	8.0
Day 02	Jan 07	58.4	15.0	43.8	9.0
Night 02	Jan 07 - Jan 08	50.1	9.0	34.7	8.0
Day 03	Jan 08	57.8	15.0	40.4	9.2
Night 03	Jan 08 - Jan 09	49.7	9.0	29.5	8.1
Day 04	Jan 09	53.6	15.0	31.9	11.7
Night 04	Jan 09 - Jan 10	49.7	9.0	28.7	8.3
Day 05	Jan 10	54.6	15.0	36.0	11.0
Night 05	Jan 10 - Jan 11	48.9	9.0	32.2	8.2
Day 06	Jan 11	54.3	15.0	40.8	11.8
Night 06	Jan 11 - Jan 12	55.0	9.0	37.9	7.7
Day 07	Jan 12	58.8	15.0	43.9	10.0
Night 07	Jan 12 - Jan 13	57.7	9.0	39.1	7.1
Day 08	Jan 13	61.0	15.0	45.7	8.3
Night 08	Jan 13 - Jan 14	57.3	9.0	36.6	7.0
Day 09	Jan 14	61.0	15.0	44.5	8.3
Night 09	Jan 14 - Jan 15	54.4	9.0	39.9	7.5
Day 10	Jan 15	61.3	15.0	45.4	8.2
Night 10	Jan 15 - Jan 16	54.6	9.0	41.2	6.7
Day 11	Jan 16	58.5	15.0	37.2	8.7
Night 11	Jan 16 - Jan 17	57.3	9.0	33.0	6.6
Day 12	Jan 17	59.2	15.0	41.7	9.3
Night 12	Jan 17 - Jan 18	56.9	9.0	42.2	6.8
Day 13	Jan 18	58.2	15.0	41.6	8.6
Night 13	Jan 18 - Jan 19	54.5	9.0	32.7	7.0
Day 14	Jan 19	55.7	15.0	39.3	11.1
Night 14	Jan 19 - Jan 20	52.2	9.0	38.3	7.7
Day 15	Jan 20	74.0	15.0	47.1	4.5
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				55.0 (50.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				45.0 (40.0)	

Table 5C: Sound Monitor A Results (Summertime)

Summer Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	48.0	110.0	12.7	43.2	4.8
Total Survey Period - Nighttime	43.7	93.1	10.7	40.4	3.3
Total Survey Period – Daytime (Downwind)	49.5	64.2	16.9	42.7	6.8
Total Survey Period – Nighttime (Downwind)	45.3	59.9	14.4	40.0	5.3
Total Survey Period – Daytime (Crosswind)	45.2	31.7	6.7	41.4	3.8
Total Survey Period – Nighttime (Crosswind)	37.8	28.1	3.9	38.6	-0.8
Total Survey Period – Daytime (Upwind)	38.5	13.0	6.6	38.5	0.0
Total Survey Period – Nighttime (Upwind)	33.4	5.1	3.7	35.3	-1.9
Long Term Prevailing Wind - Daytime	48.0	110.0	12.7	41.6	6.4
Long Term Prevailing Wind - Nighttime	43.7	93.1	10.7	38.9	4.8
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	55.0 (50.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	45.0 (40.0)				

Table 5D: Sound Monitor A Results (Wintertime)

Winter Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	42.3	135.1	3.5	42.1	0.2
Total Survey Period - Nighttime	38.0	104.9	3.4	38.9	-0.9
Total Survey Period – Daytime (Downwind)	44.8	18.1	5.0	41.7	3.1
Total Survey Period – Nighttime (Downwind)	40.5	15.0	3.9	38.5	2.0
Total Survey Period – Daytime (Crosswind)	40.4	59.1	4.2	40.3	0.1
Total Survey Period – Nighttime (Crosswind)	37.2	43.2	4.0	37.2	0.0
Total Survey Period – Daytime (Upwind)	42.8	57.4	2.3	37.0	5.8
Total Survey Period – Nighttime (Upwind)	37.5	46.6	2.6	33.4	4.1
Long Term Prevailing Wind - Daytime	42.3	135.1	3.5	40.6	1.7
Long Term Prevailing Wind - Nighttime	38.0	104.9	3.4	37.4	0.6
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	55.0 (50.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	45.0 (40.0)				

The results of the survey show the acoustic environment was dominated by wind and transportation noise during monitoring period. Based on site observations and audio recordings, the sources of sounds in the study area includes sounds from transportation (highway 97 and adjacent road), local activities (i.e., human and other local industrial related activities), fauna and weather and sounds of nature.

The results indicate that the ambient sound pressure levels ranged from 33.4 to 49.5 dBA during summer time period and ranged from 37.2 to 44.8 dBA during winter time, and the Nighttime ASLs are higher than BC OGC current assumed ASL at this location in downwind conditions. The acoustic environment was dominated by the highway traffic, after removing the local traffic from the Sweetwater road. There are some fluctuations due to the strong wind and direction during the monitoring period. Contamination from wind noise was also present at this monitoring location.

Sound Monitor D Measurement Location

Sound Monitor D was located approximately 12 m east from Sweetwater road and 1000m northeast from Highway 97.

Based on site observations during the survey and from the audio playback, the sound environment is dominated by sound from wind, transportation and fauna and local activities. Contamination from the acoustic instrument internal noise was also present intermittently.

The detailed results including graphical presentation of the measured and residual levels are presented in Appendix G.

The survey results contained short-term sound events that are due to occasional noise events from local traffic and wind. Where possible, these short-term sounds were isolated from the measured comprehensive sound level data set resulting in the residual comprehensive sound level. These residual levels become the Comprehensive Sound Levels (CSL) for each period.

Tables 6A and 6B summarize the comprehensive sound level measurement results for the summertime and wintertime periods of the survey based on daytime and nighttime periods. Tables 6C and 6D also summarize the sound level measurement results for the summertime and wintertime periods of the survey based on wind conditions, and predicted results based on the wind conditions

Table 6A: Sound Monitor D Results (Summertime)

Period	Date (2019)	*Measured Leq (dBA)	Measured Hours	*Residual Leq (dBA)	Residual Hours
Day 01	Sep 19	61.5	9.7	49.4	5.2
Night 01	Sep 19 - Sep 20	56.9	9.0	43.1	7.6
Day 02	Sep 20	61.1	15.0	46.6	7.6
Night 02	Sep 20 - Sep 21	59.7	9.0	47.8	7.3
Day 03	Sep 21	62.8	15.0	52.3	8.1
Night 03	Sep 21 - Sep 22	54.5	9.0	47.0	8.0
Day 04	Sep 22	70.1	15.0	49.3	8.3
Night 04	Sep 22 - Sep 23	55.4	9.0	43.7	8.0
Day 05	Sep 23	68.4	15.0	49.5	8.4
Night 05	Sep 23 - Sep 24	54.7	9.0	46.6	7.8
Day 06	Sep 24	61.6	15.0	54.7	8.4
Night 06	Sep 24 - Sep 25	56.4	9.0	50.4	7.6
Day 07	Sep 25	63.1	15.0	50.5	6.8
Night 07	Sep 25 - Sep 26	57.5	9.0	48.9	7.4
Day 08	Sep 26	62.0	15.0	49.9	8.1
Night 08	Sep 26 - Sep 27	56.5	9.0	45.8	7.4
Day 09	Sep 27	61.3	15.0	45.5	9.0
Night 09	Sep 27 - Sep 28	54.9	9.0	46.5	7.8
Day 10	Sep 28	59.5	15.0	45.8	9.3
Night 10	Sep 28 - Sep 29	53.5	9.0	43.8	8.0
Day 11	Sep 29	59.5	15.0	46.4	9.0
Night 11	Sep 29 - Sep 30	56.1	9.0	43.9	7.1
Day 12	Sep 30	62.3	15.0	47.7	6.3
Night 12	Sep 30 - Oct 01	57.5	9.0	48.3	7.3
Day 13	Oct 01	62.5	15.0	48.5	4.9
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				50.0 (45.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				40.0 (35.0)	

*Measured sound levels inconclusive due to strong winds and intermittent contamination caused by equipment malfunction.

Table 6B: Sound Monitor D Results (Wintertime)

Period	Date (2019)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Jan 06	73.8	8.5	37.4	6.3
Night 01	Jan 06 - Jan 07	52.5	9.0	37.8	8.2
Day 02	Jan 07	59.0	15.0	41.7	9.0
Night 02	Jan 07 - Jan 08	51.2	9.0	32.8	8.0
Day 03	Jan 08	58.0	15.0	34.9	9.1
Night 03	Jan 08 - Jan 09	51.1	9.0	27.4	8.1
Day 04	Jan 09	54.6	15.0	29.1	11.5
Night 04	Jan 09 - Jan 10	49.8	9.0	27.2	8.3
Day 05	Jan 10	55.5	15.0	31.8	10.9
Night 05	Jan 10 - Jan 11	50.1	9.0	29.1	8.1
Day 06	Jan 11	54.7	15.0	38.2	11.9
Night 06	Jan 11 - Jan 12	56.6	9.0	32.5	7.8
Day 07	Jan 12	58.9	15.0	38.7	10.2
Night 07	Jan 12 - Jan 13	58.4	9.0	34.8	7.4
Day 08	Jan 13	61.3	15.0	40.3	9.6
Night 08	Jan 13 - Jan 14	57.3	9.0	31.9	7.2
Day 09	Jan 14	61.2	15.0	38.8	8.5
Night 09	Jan 14 - Jan 15	54.2	9.0	34.0	7.6
Day 10	Jan 15	60.6	15.0	41.6	8.7
Night 10	Jan 15 - Jan 16	54.5	9.0	39.9	7.3
Day 11	Jan 16	58.7	15.0	35.0	9.0
Night 11	Jan 16 - Jan 17	58.3	9.0	31.8	6.8
Day 12	Jan 17	59.0	15.0	38.9	9.2
Night 12	Jan 17 - Jan 18	56.3	9.0	39.8	7.1
Day 13	Jan 18	58.3	15.0	42.7	9.0
Night 13	Jan 18 - Jan 19	54.8	9.0	30.7	7.0
Day 14	Jan 19	55.5	15.0	39.7	11.0
Night 14	Jan 19 - Jan 20	52.2	9.0	39.7	7.8
Day 15	Jan 20	71.4	15.0	45.5	4.3
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				50.0 (45.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				40.0 (35.0)	

Table 6C: Sound Monitor D Results (Summertime)

Summer Measured Period	*Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	49.8	99.1	13.0	39.2	10.6
Total Survey Period - Nighttime	46.9	91.0	10.8	35.4	11.5
Total Survey Period – Daytime (Downwind)	50.6	60.8	16.8	38.8	11.8
Total Survey Period – Nighttime (Downwind)	47.4	60.2	14.2	35.0	12.4
Total Survey Period – Daytime (Crosswind)	48.3	25.6	6.8	37.4	10.9
Total Survey Period – Nighttime (Crosswind)	45.6	23.9	3.6	33.6	12.0
Total Survey Period – Daytime (Upwind)	46.6	11.5	6.7	34.2	12.4
Total Survey Period – Nighttime (Upwind)	45.2	7.0	5.4	30.4	14.8
Long Term Prevailing Wind - Daytime	49.8	99.1	13.0	37.7	12.1
Long Term Prevailing Wind - Nighttime	46.9	91.0	10.8	33.8	13.1
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	50.0 (45.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	40.0 (35.0)				

*Measured sound levels inconclusive due to strong winds and intermittent contamination caused by equipment malfunction.

Table 6D: Sound Monitor D Results (Wintertime)

Winter Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	39.4	138.0	3.5	36.4	3.0
Total Survey Period - Nighttime	35.5	106.7	3.3	32.0	3.5
Total Survey Period – Daytime (Downwind)	41.3	17.6	5.2	36.0	5.3
Total Survey Period – Nighttime (Downwind)	37.6	12.4	4.2	31.6	6.0
Total Survey Period – Daytime (Crosswind)	38.2	59.1	4.1	34.7	3.5
Total Survey Period – Nighttime (Crosswind)	35.2	47.6	3.9	30.2	5.0
Total Survey Period – Daytime (Upwind)	39.7	60.0	2.4	31.1	8.6
Total Survey Period – Nighttime (Upwind)	35.0	46.7	2.5	26.6	8.4
Long Term Prevailing Wind - Daytime	39.4	138.0	3.5	34.9	4.5
Long Term Prevailing Wind - Nighttime	35.5	106.7	3.3	30.4	5.1
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	50.0 (45.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	40.0 (35.0)				

The results of the survey show that the acoustic environment was dominated by wind and transportation noise during monitoring period. Based on site observations and audio recordings, the sources of sounds in the study area includes sounds from transportation (Highway 97 and adjacent road), local activities (i.e., human and other local industrial related activities), fauna and weather and sounds of nature.

The results indicate that the ambient sound pressure levels ranged from 45.2 to 50.6 dBA during summertime period, ranged from 35.0 to 46.0 dBA during wintertime period. The sound level results during the summertime period included intermittent contamination from the instrument which rendered some data unreliable. The results during the summertime period indicate that Nighttime CSL are higher than BC OGC current assumed BSL (ASL) at this location at all wind conditions.

Sound Monitor F Measurement Location

Sound Monitor F was located approximately 10 m east from Mason road and 515m southwest from Highway 97.

Based on site observations during the survey and from the audio playback, the sound environment is dominated by sound from wind, transportation and local activities.

The detailed results including graphical presentation of the measured and residual levels are presented in Appendix H.

The survey results contained short-term sound events that are due to occasional noise events from local traffic and wind. Where possible, these short-term sounds were isolated from the measured comprehensive sound level data set resulting in the residual comprehensive sound level. These residual levels become the Comprehensive Sound Levels (CSL) for each period.

Table 7A summarizes the comprehensive sound level measurement results for the wintertime period of the survey based on daytime and nighttime periods. Table 7B also summarizes the sound level measurement results for the wintertime period of the survey based on wind conditions, and predicted results based on the wind conditions

Table 7A: Sound Monitor F Results (Wintertime)

Period	Date (2019)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Jan 06	73.8	8.5	37.4	6.3
Night 01	Jan 06 - Jan 07	52.5	9.0	37.8	8.2
Day 02	Jan 07	59.0	15.0	41.7	9.0
Night 02	Jan 07 - Jan 08	51.2	9.0	32.8	8.0
Day 03	Jan 08	58.0	15.0	34.9	9.1
Night 03	Jan 08 - Jan 09	51.1	9.0	27.4	8.1
Day 04	Jan 09	54.6	15.0	29.1	11.5
Night 04	Jan 09 - Jan 10	49.8	9.0	27.2	8.3
Day 05	Jan 10	55.5	15.0	31.8	10.9
Night 05	Jan 10 - Jan 11	50.1	9.0	29.1	8.1
Day 06	Jan 11	54.7	15.0	38.2	11.9
Night 06	Jan 11 - Jan 12	56.6	9.0	32.5	7.8
Day 07	Jan 12	58.9	15.0	38.7	10.2
Night 07	Jan 12 - Jan 13	58.4	9.0	34.8	7.4
Day 08	Jan 13	61.3	15.0	40.3	9.6
Night 08	Jan 13 - Jan 14	57.3	9.0	31.9	7.2
Day 09	Jan 14	61.2	15.0	38.8	8.5
Night 09	Jan 14 - Jan 15	54.2	9.0	34.0	7.6
Day 10	Jan 15	60.6	15.0	41.6	8.7
Night 10	Jan 15 - Jan 16	54.5	9.0	39.9	7.3
Day 11	Jan 16	58.7	15.0	35.0	9.0
Night 11	Jan 16 - Jan 17	58.3	9.0	31.8	6.8
Day 12	Jan 17	59.0	15.0	38.9	9.2
Night 12	Jan 17 - Jan 18	56.3	9.0	39.8	7.1
Day 13	Jan 18	58.3	15.0	42.7	9.0
Night 13	Jan 18 - Jan 19	54.8	9.0	30.7	7.0
Day 14	Jan 19	55.5	15.0	39.7	11.0
Night 14	Jan 19 - Jan 20	52.2	9.0	39.7	7.8
Day 15	Jan 20	71.4	15.0	51.8	4.6
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime				50.0 (45.0)	
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime				40.0 (35.0)	

Table 7B: Sound Monitor F Results (Wintertime)

Winter Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted SPL (dBA)	Difference Measured SPL Predicted - CSS (dB)
Total Survey Period - Daytime	45.4	82.1	3.3	45.2	0.2
Total Survey Period - Nighttime	40.2	80.2	3.0	41.3	-1.1
Total Survey Period – Daytime (Downwind)	45.9	13.7	5.3	44.8	1.1
Total Survey Period – Nighttime (Downwind)	39.9	17.6	5.5	41.0	-1.1
Total Survey Period – Daytime (Crosswind)	45.2	37.6	4.2	43.5	1.7
Total Survey Period – Nighttime (Crosswind)	39.1	34.0	3.6	39.6	-0.5
Total Survey Period – Daytime (Upwind)	45.4	30.8	1.3	39.9	5.5
Total Survey Period – Nighttime (Upwind)	41.4	28.6	0.9	35.6	5.8
Long Term Prevailing Wind - Daytime	45.4	82.1	3.3	43.0	2.4
Long Term Prevailing Wind - Nighttime	40.2	80.2	3.0	38.9	1.3
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	55.0 (50.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	40.0 (40.0)				

The results of the survey show that the acoustic environment was dominated by wind and transportation noise during monitoring period. Based on site observations and audio recordings, the sources of sounds in the study area includes sounds from transportation (Highway 97 and adjacent road), local activities (i.e., human and other local industrial related activities), fauna and weather and sounds of nature.

The results indicate that the ambient sound pressure levels ranged from 39.1 to 45.9 dBA during wintertime survey period, and the Nighttime ASLs are marginally higher than BC OGC current assumed ASL at this location in downwind conditions and upwind conditions. The acoustic environment was dominated by the highway traffic, after removing the local traffic from the Mason road.

Noise Predictions

In the Farmington Development Area, the Highway 97 is a major noise source, which has a significant impact in the area adjacent to the roadway. In order to assess the potential impact from the traffic noise from Highway 97 to the ambient noise, noise prediction model was built in this area.

The physical layout near the Highway 97 were obtained from the field visit, aerial photos and topographical maps. Sound power levels of the Highway 97 were determined as per the daytime and nighttime hourly traffic volume in the area during the monitoring period at the nearby traffic counting location. Sound propagation calculations were then undertaken to predict the sound pressure level that will exist at the receiver locations considered. All calculations were undertaken in octave bands.

The noise modeling was conducted using the noise modeling software package CadnaA by Datakustik incorporated the FHWA TNM 2.5 module based on the traffic volumes, grades of roads, speeds and land topography. CadnaA is an advanced noise propagation model that considers geometric spreading, atmospheric sound absorption, ground impedance effects, site topography and geometry, vegetation and environmental conditions. The calculations performed in CadnaA were conducted in accordance with ISO 9613. The ground cover was modeled as mixed ground with the consideration of ground covered by grass, trees or other vegetation.

The CadnaA implementation of TNM v2.5 has two modes, the default mode is the compatibility mode where the algorithm of TNM v2.5 is implemented in its original form, and the other is an updated TNM v2.5 mode where modifications have been applied to improve the accuracy of the original algorithm. The latter mode was used in this analysis.

Traffic data (See Appendix I) provided by the BC Ministry of Transportation and Infrastructure gave the classifications of truck percentages for Highway 97 at the current traffic volume. In this area approximately 1/3 of the trucks are to be medium trucks (e.g. buses and single unit trucks) and 2/3 are heavy trucks, where modeled on Highway 97.

The modeled speeds were based on posted and monitored median speeds of the roads in this study area, which is 100 kph.

Table 7 lists the major parameters used in the noise model. These parameters follow accepted acoustical engineering methodologies. The modeled conditions produce results representative of meteorological conditions favouring sound propagation (e.g., downwind or mild temperature inversion conditions), as prescribed by the Guideline. This environmental condition modeled represents “close-to-worst-case” sound propagation conditions as per ISO 9613-2. The other conditions such as enhanced downwind condition, crosswind, upwind and long term prevailing wind conditions during summertime and wintertime period were also considered in this noise study.

Table 7: Modeling Parameters

Parameter	Value	Description
Modeling software	CadnaA by Datakustik Version 2020	An advanced noise propagation model that considers geometric spreading, atmospheric sound absorption, ground impedance effects, site topography and geometry, vegetation and environmental conditions. The CadnaA model calculates the contribution level of each noise source at the receiver location in octave bands as well as calculating the overall facility sound level.
Standard followed	ISO 9613	As recommended in the Guideline. Specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The published accuracy for this standard is ±3 dBA between 100 m to 1000 m. Accuracy levels beyond 1000 m are not published.
Wind Condition	ISO 9613 Standard Condition: 1 – 5 m/s Downwind	ISO 9613 uses a slight downwind condition from each noise source to each receiver. Wind speed is measured at a height of 3 m to 11 m above ground and covers the acceptable range specified in the Guideline.
	Downwind Condition	Modeled as SSW wind with a speed of 2 m/s (7.2 kph) as per weather station collected data in this area during the monitoring period.
	Upwind Condition	Modeled as NNW wind with a speed of 3 m/s (10.8 kph) as per weather station collected data in this area during the monitoring period.
Ground Factor	0.0 for water bodies and roads 0.6 everywhere else	The ground factor G is a property of the ground material, with value ranging from 0 to 1. The typical values below were determined from several standards and guidelines, including ISO 9613, Commission Directive EU 2015/996, and Nord 2000. G = 0.0 is suitable for asphalt, concrete, pavement, water G = 0.3 is suitable for compacted dense ground, gravel road, hard soil G = 0.6 is suitable for sand, compacted field and gravel, roadside dirt G = 0.8 is suitable for cultivated land, such as farm land G = 1.0 is suitable for uncultivated land, such as forest floor and loose ground For residential properties, the ground factor was determined from the proportion of the above typical values, based on satellite images.
Order of Reflection	3	The model calculates reflection effects from the reflective surfaces included in the model.
Foliage	Included	Modeled as ground absorption 0.8, based on conservative considerations due to the presence of human dwelling residences in the study area.
Temperature	10ºC (Summertime) -20ºC (Wintertime)	Represents typical nighttime temperature.
Relative Humidity	80%(Summertime) 50%((Wintertime)	Represents typical nighttime relative humidity.
Topography	Included	Topographical data obtained from Natural Resources Canada. Resolution of 1 m.

Tables 8A and 8B shows the predicted sound level results for the four selected monitoring locations, which impacted by the Highway 97.

Table 8A: Predicted sound level Results (Summertime)

Receiver	BC OGC Current Assumed BSL (ASL) (dBA)		Weather Condition	Residual CSS Daytime SPL (dBA)	Residual CSS Nighttime SPL (dBA)	Predicted Daytime SPL (dBA)	Predicted Nighttime SPL (dBA)	Difference Daytime SPL Predicted - CSS (dB)	Difference Nighttime SPL Predicted - CSS (dB)
	Daytime	Nighttime							
Sound Monitor C (Category 3)	60.0 (55.0)	50.0 (45.0)	ISO Standard	65.5	61.3	65.5	61.3	0	0
			Downwind	66.5	62.7	65.2	61.0	1.3	1.7
			Crosswind	66.6	61.8	64.6	60.3	2.0	1.5
			Upwind	64.9	60.9	63.5	59.3	1.4	1.6
			Long Term Prevailing Wind Conditions	*65.5	*61.3	64.3	60.1	1.2	1.2
Sound Monitor A (Category 1/2)	55.0 (50.0)	45.0 (40.0)	ISO Standard	48.0	43.7	43.2	40.4	4.8	3.3
			Downwind	49.5	45.3	42.7	40.0	6.8	5.3
			Crosswind	45.2	37.8	41.4	38.6	3.8	-0.8
			Upwind	38.5	33.4	38.5	35.3	0.0	-1.9
			Long Term Prevailing Wind Conditions	*48.0	*43.7	41.6	38.9	6.4	4.8
Sound Monitor D (Category 1)	50.0 (45.0)	40.0 (35.0)	ISO Standard	**49.8	**46.9	39.2	35.4	10.6	11.5
			Downwind	**50.6	**47.4	38.8	35.0	11.8	12.4
			Crosswind	**48.3	**45.6	37.4	33.6	10.9	12.0
			Upwind	**46.6	**45.2	34.2	30.4	12.4	14.8
			Long Term Prevailing Wind Conditions	*49.8	*46.9	37.7	33.8	12.1	13.1

* Measured sound levels for the long term prevailing wind conditions listed are based on the data available during the monitoring period as an analogue and do not match long term prevailing wind conditions;
* Measured sound levels inconclusive due to strong winds and intermittent contamination caused by equipment malfunction.

Table 8B: Predicted sound level Results (Wintertime)

Receiver	BC OGC Current Assumed BSL (ASL) (dBA)		Weather Condition	Residual CSS Daytime SPL (dBA)	Residual CSS Nighttime SPL (dBA)	Predicted Daytime SPL (dBA)	Predicted Nighttime SPL (dBA)	Difference Daytime SPL Predicted - CSS (dB)	Difference Nighttime SPL Predicted - CSS (dB)
	Daytime	Nighttime							
Sound Monitor C (Category 3)	60.0 (55.0)	50.0 (45.0)	ISO Standard	67.4	62.6	67.4	62.6	0	0
			Downwind	67.7	61.8	67.1	62.2	0.6	-0.4
			Crosswind	67.3	62.3	66.4	61.6	0.9	0.7
			Upwind	67.3	63.4	65.4	60.5	1.9	2.9
			Long Term Prevailing Wind Conditions	*67.4	*62.6	66.2	61.4	1.2	1.2
Sound Monitor A (Category 1/2)	55.0 (50.0)	45.0 (40.0)	ISO Standard	42.3	38.0	42.1	38.9	0.2	-0.9
			Downwind	44.8	40.5	41.7	38.5	3.1	2.0
			Crosswind	40.4	37.2	40.3	37.2	0.1	0.0
			Upwind	42.8	37.5	37.0	33.4	5.8	4.1
			Long Term Prevailing Wind Conditions	*42.3	*38.0	40.6	37.4	1.7	0.6
Sound Monitor D (Category 1)	50.0 (45.0)	40.0 (35.0)	ISO Standard	39.4	35.5	36.4	32.0	3.0	3.5
			Downwind	41.3	37.6	36.0	31.6	5.3	6.0
			Crosswind	38.2	35.2	34.7	30.2	3.5	5.0
			Upwind	39.7	35.0	31.1	26.6	8.6	8.4
			Long Term Prevailing Wind Conditions	*41.3	*35.5	34.9	30.4	4.5	5.1
Sound Monitor F (Category 1/2)	55.0 (50.0)	45.0 (40.0)	ISO Standard	45.4	40.2	45.2	41.3	0.2	-1.1
			Downwind	45.9	39.9	44.8	41.0	1.1	-1.1
			Crosswind	45.2	39.1	43.5	39.6	1.7	-0.5
			Upwind	45.4	41.4	39.9	35.6	5.5	5.8
			Long Term Prevailing Wind Conditions	*45.4	*40.2	43.0	38.9	2.4	1.3

* Measured sound levels for the long term prevailing wind conditions listed are based on the data available during the monitoring period as an analogue and do not match long term prevailing wind conditions;

- The predicted sound level results were validated with sound monitor C location during the measurement period. The results indicate that they are lower than the BC OGC BSL at the monitoring locations A, D and F except location C, and most of the predicted results are lower than the CSS residual level at the monitoring locations, which could be affected by the following factors:

- The noise emission model was built as per the average traffic volume and traffic classifications at the traffic count location. Traffic volume was obtained from the average daytime and nighttime hourly data between September 16 and 30th, 2019, which may not represent the actual fluctuation of the traffic noise.
- The truck percentage and classifications were assumed the same pattern during daytime and nighttime period, in the actual situation there will be more trucks and different traffic pattern during the nighttime, which may under-predict the noise emission from highway during nighttime period.
- There will be noise contamination from the strong wind condition.
- The residual CSL levels includes some background level coming from fauna and other nature sound, but the predicted noise level only considers the noise emission from the highway traffic.

The results of the CadnaA noise modeling were also converted into a noise map of the area. The following figures depict the daytime and nighttime predicted sound level from the Highway 97 traffic for the monitoring area during the monitoring period (summertime and wintertime) excluding the ambient sound levels (ASL) with different wind conditions.

- Figures 3a to 3d were based on ISO standard wind condition, which is mild downwind conditions for the area.

- Figures 4a to 4d were based on southwest wind condition, in which situation monitoring location D and A are located downwind and monitoring C and F are upwind.

- Figures 5a to 5d were based on northeast wind condition, in which situation monitoring location D and A are located upwind and monitoring C and F are downwind;

- Figures 6a to 6d were based on northwest and southeast wind condition, in which situation all the monitoring location are located crosswind;

- Figures 7a to 7d were based on long term prevailing wind condition.

Figure 3a: Noise Emission map from Highway 97

(ISO Condition, Daytime, Summertime)

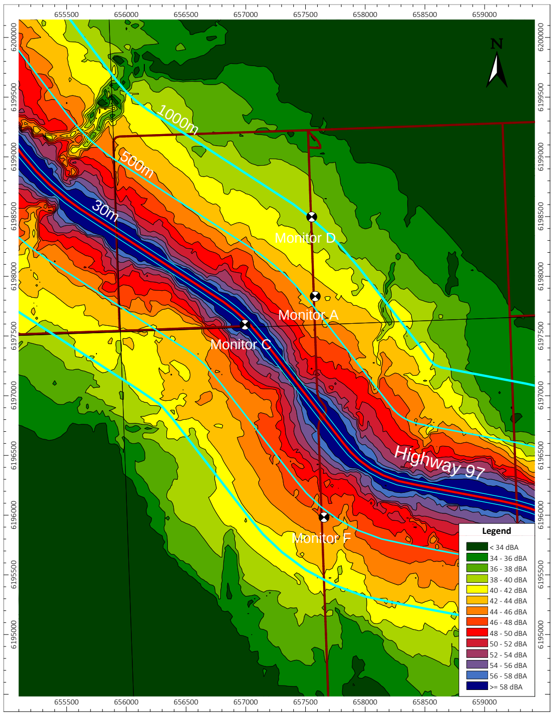


Figure 3b: Noise Emission map from Highway 97

(ISO Condition, Nighttime, Summertime)

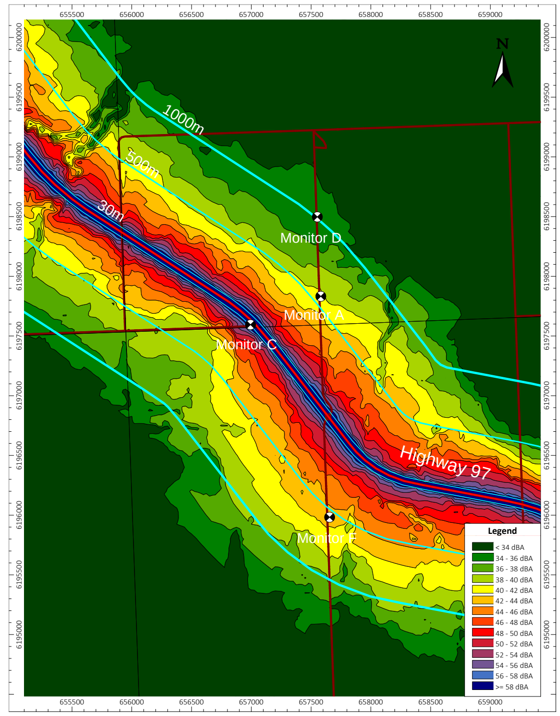


Figure 3c: Noise Emission map from Highway 97

(ISO Condition, Daytime, Wintertime)

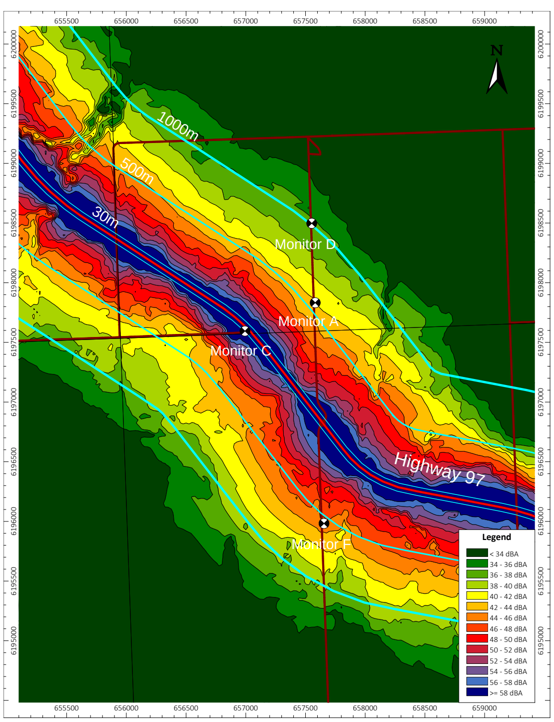


Figure 3d: Noise Emission map from Highway 97

(ISO Condition, Nighttime, Wintertime)

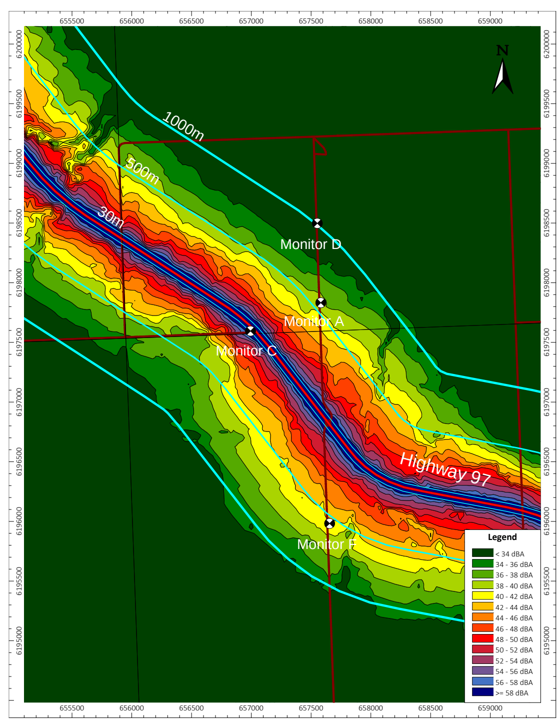


Figure 4a: Noise Emission map from Highway 97

(SW Wind Conditions, Daytime, Summertime)

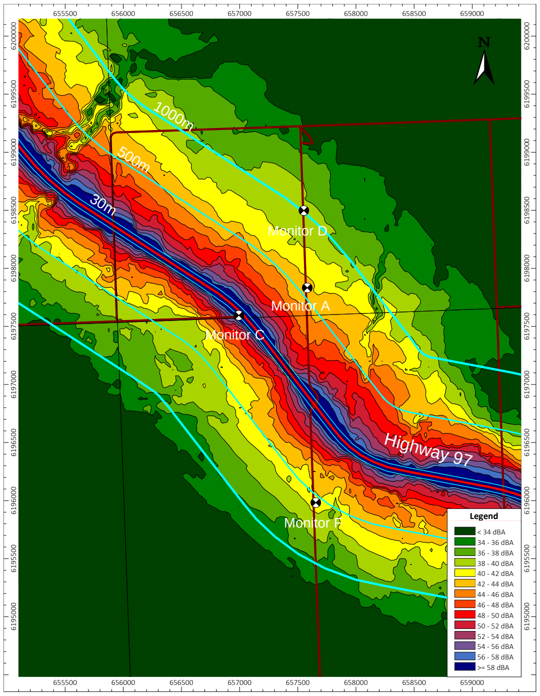


Figure 4b: Noise Emission map from Highway 97

(SW Wind Conditions, Nighttime, Summertime)

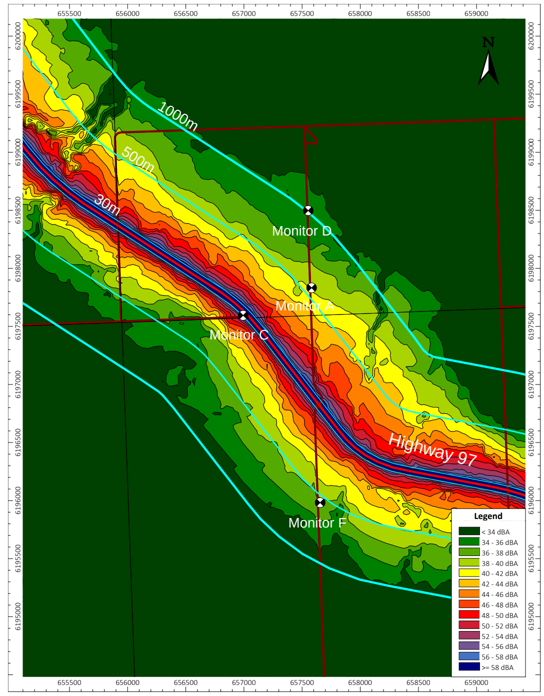


Figure 4c: Noise Emission map from Highway 97

(SW Wind Conditions, Daytime, Wintertime)

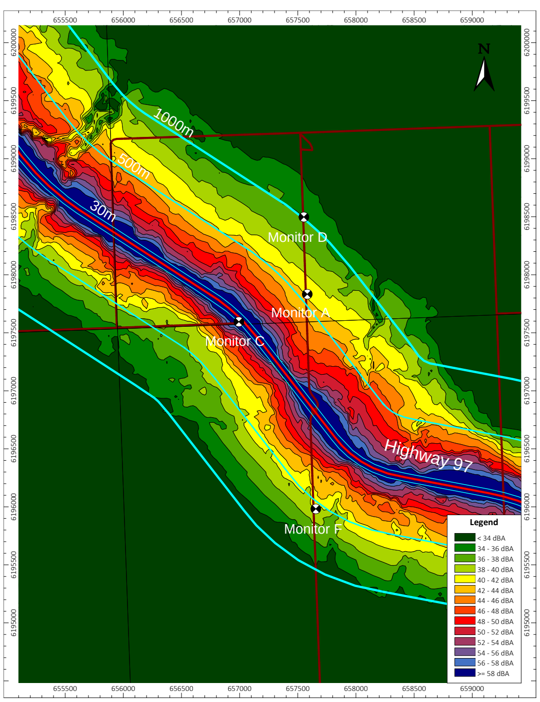


Figure 4d: Noise Emission map from Highway 97

(SW Wind Conditions, Nighttime, Wintertime)

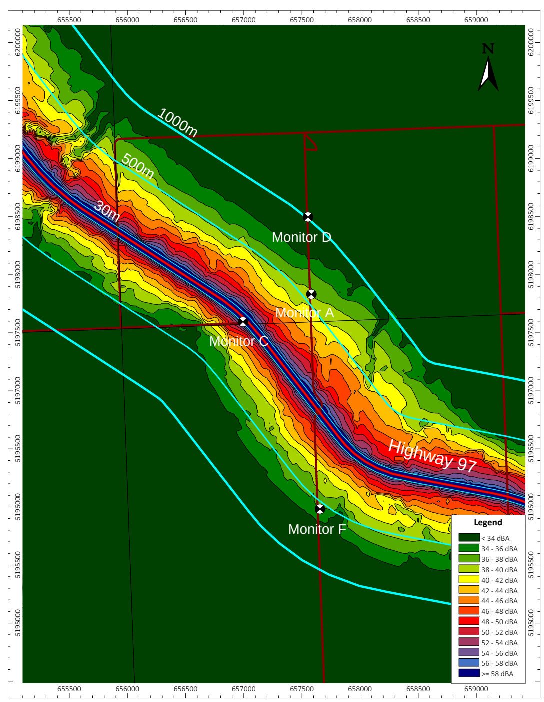


Figure 5a: Noise Emission map from Highway 97

(NE Wind Conditions, Daytime, Summertime)

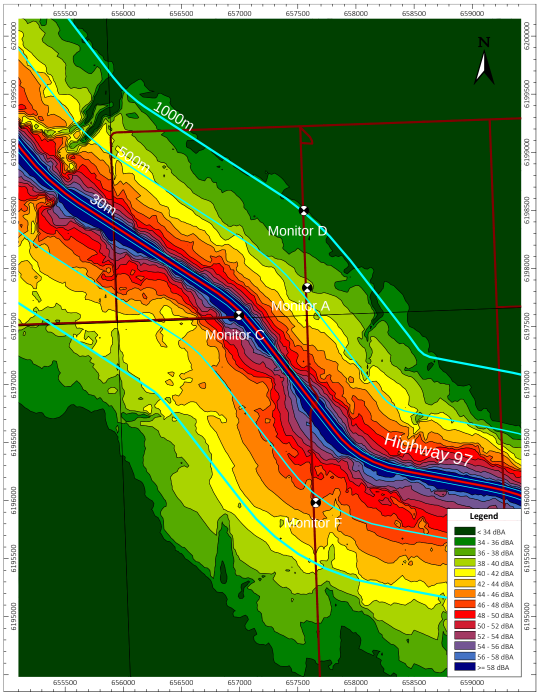


Figure 5b: Noise Emission map from Highway 97

(NE Wind Conditions, Nighttime, Summertime)

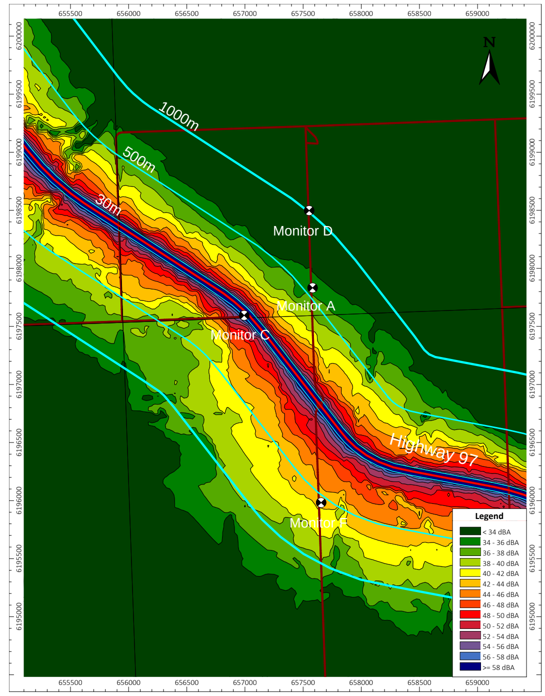


Figure 5c: Noise Emission map from Highway 97

(NE Wind Conditions, Daytime, Wintertime)

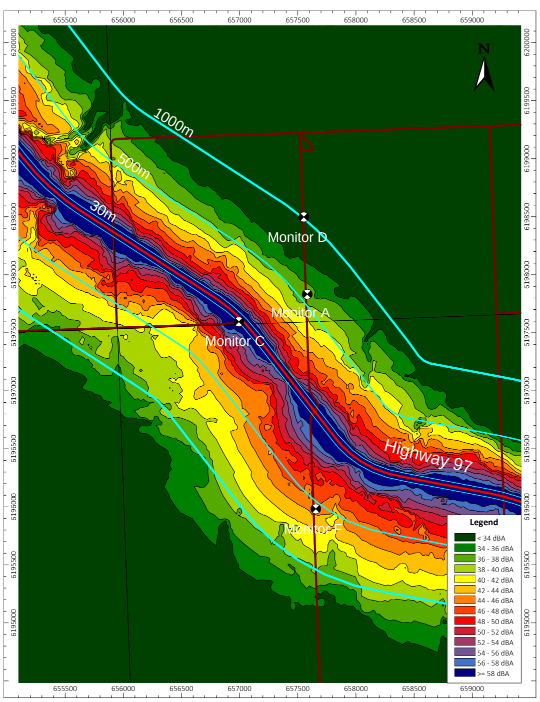


Figure 5d: Noise Emission map from Highway 97

(NE Wind Conditions, Nighttime, Wintertime)

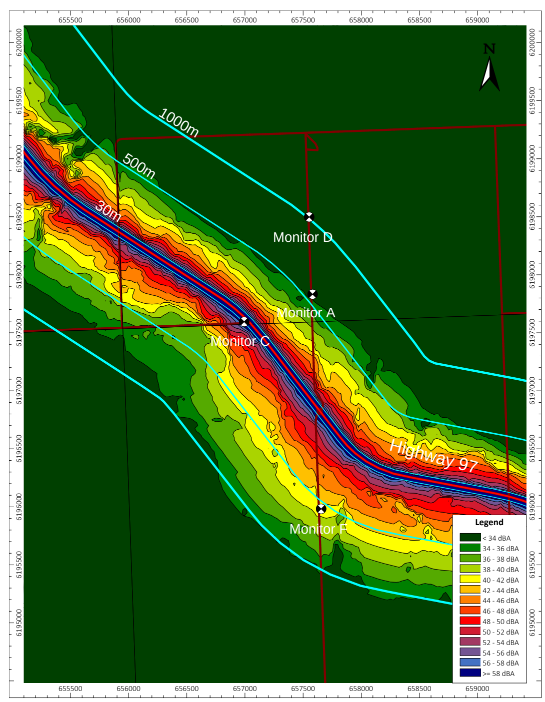


Figure 6a: Noise Emission map from Highway 97

(Crosswind Conditions, Daytime, Summertime)

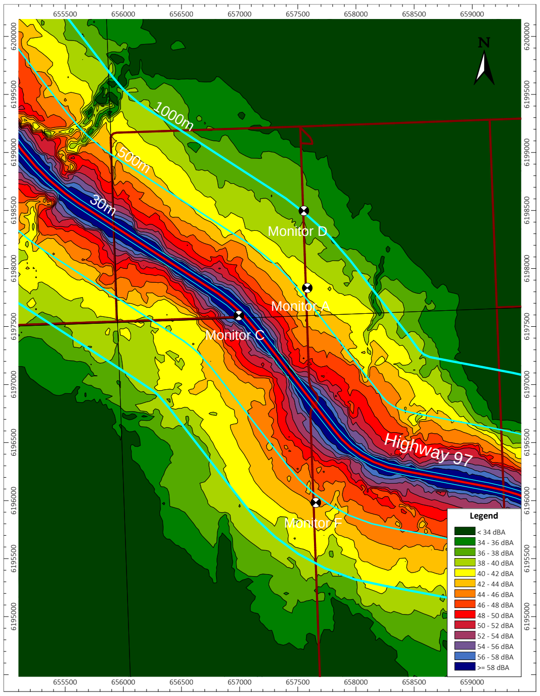


Figure 6b: Noise Emission map from Highway 97

(Crosswind Wind Conditions, Nighttime, Summertime)

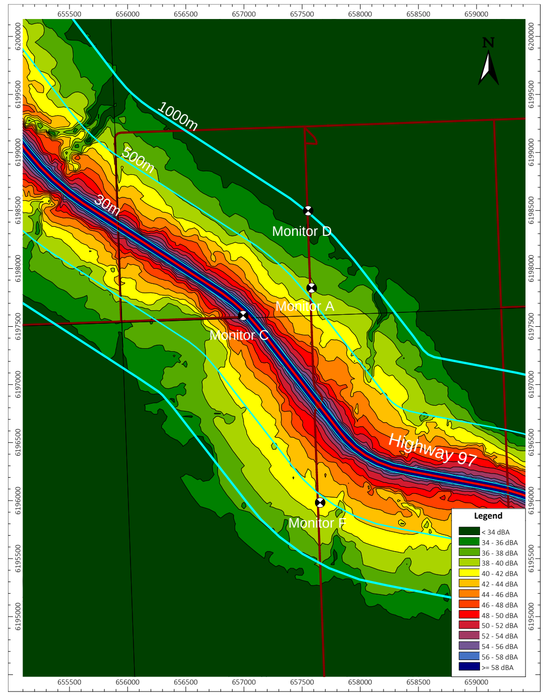


Figure 6c: Noise Emission map from Highway 97

(Crosswind Conditions, Daytime, Wintertime)

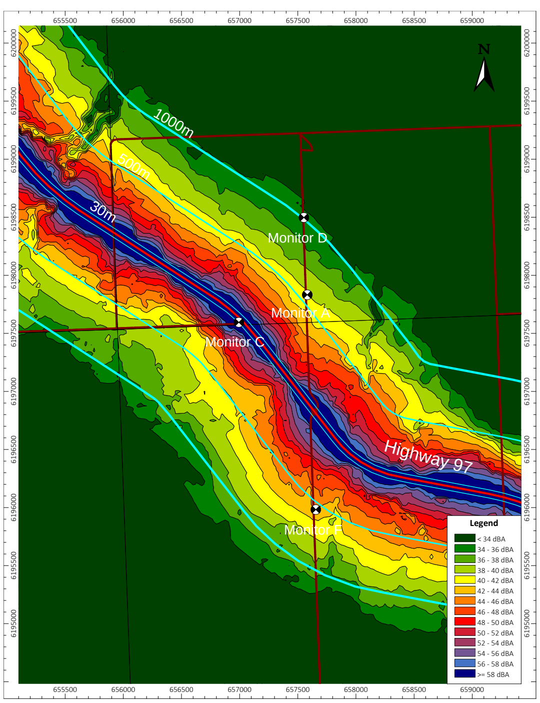


Figure 6d: Noise Emission map from Highway 97

(Crosswind Wind Conditions, Nighttime, Wintertime)

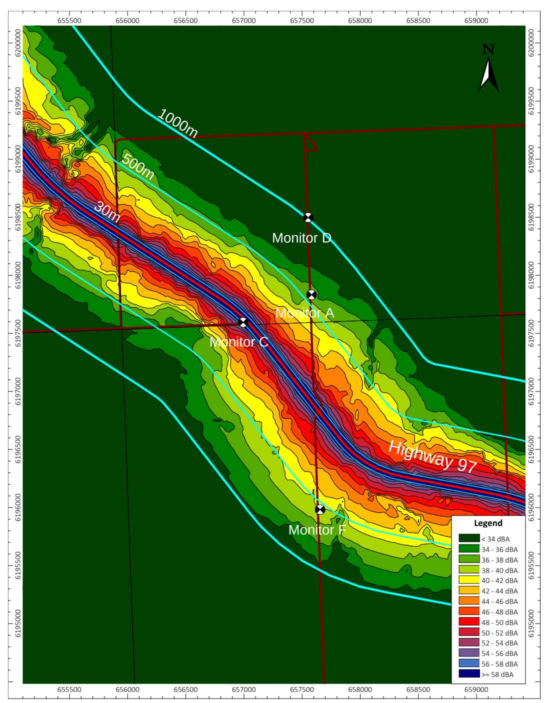


Figure 7a: Noise Emission map from Highway 97

(Long Term Prevailing Wind Conditions, Daytime, Summertime)

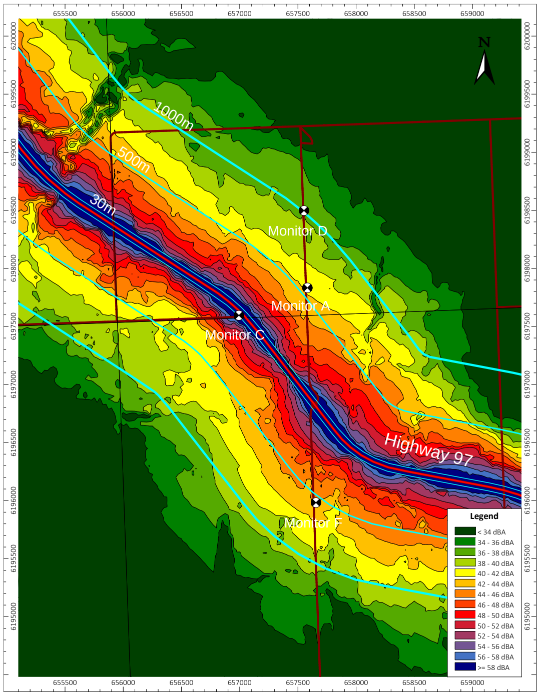


Figure 7b: Noise Emission map from Highway 97

(Long Term Prevailing Wind Conditions, Nighttime, Summertime)

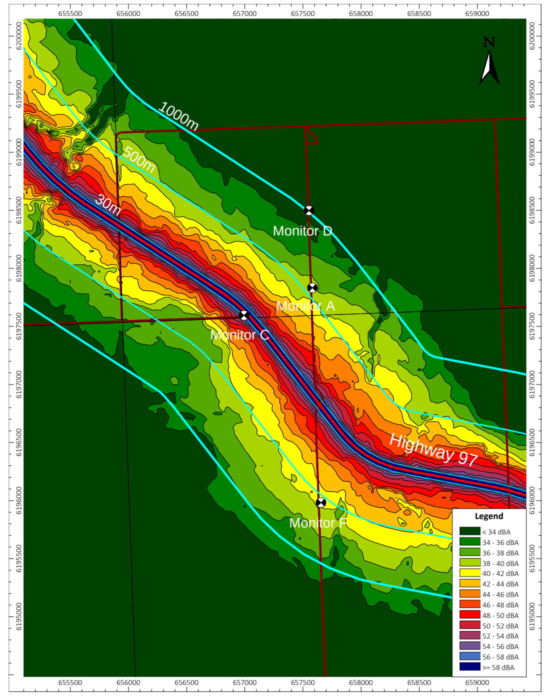


Figure 7c: Noise Emission map from Highway 97

(Long Term Prevailing Wind Conditions, Daytime, Wintertime)

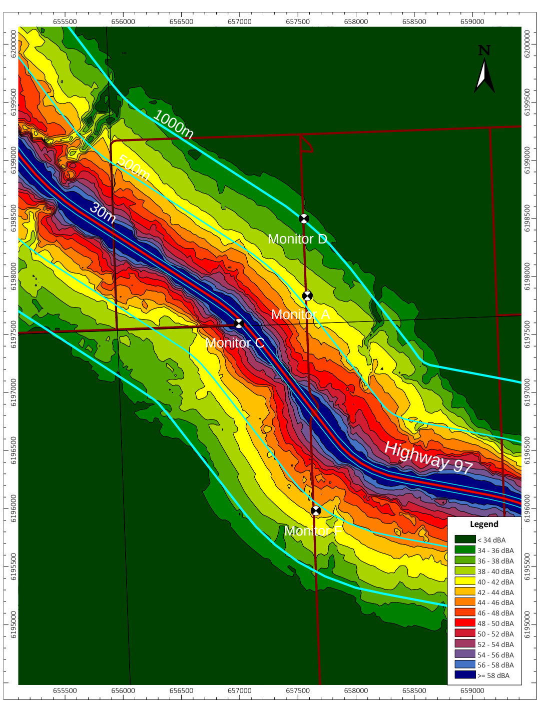
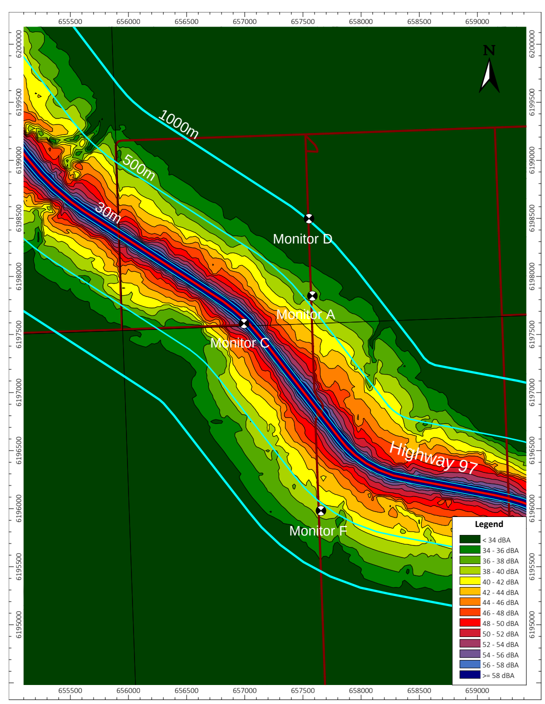


Figure 7d: Noise Emission map from Highway 97

(Long Term Prevailing Wind Conditions, Nighttime, Wintertime)



The noise prediction results indicate that there will be significant noise impacts on the nearby area along the Highway 97, the overall Farmington Development Area is shown in Figure 8. Figure 9 depicts the summer nighttime predicted sound level from the Highway 97 traffic for the overall area excluding the ambient sound levels (ASL) under the long term prevailing wind condition. The detailed map info as per different segment of Highway 97 is shown Appendix J.

Figure 7: Study Area Map - Overall Farmington Development Area

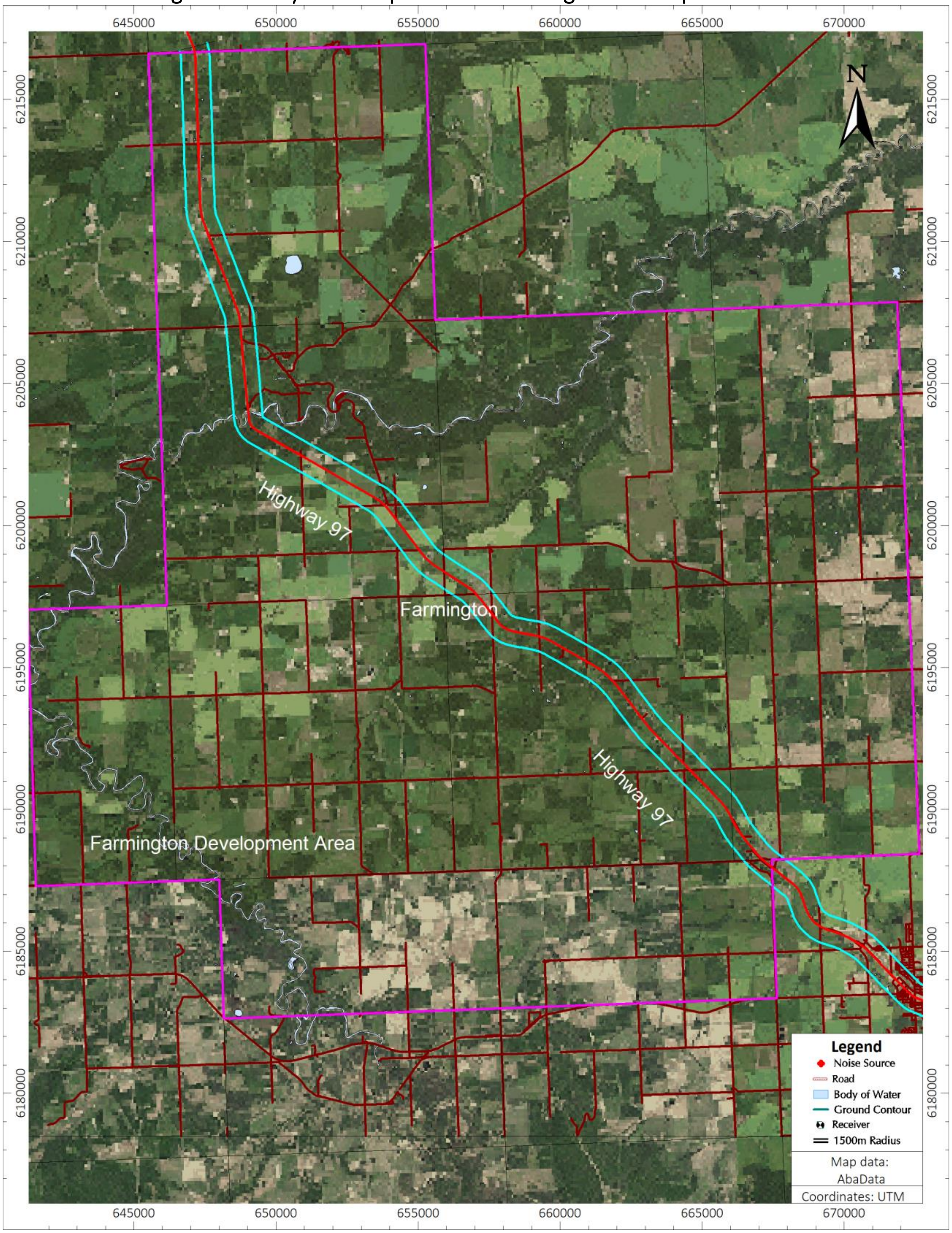
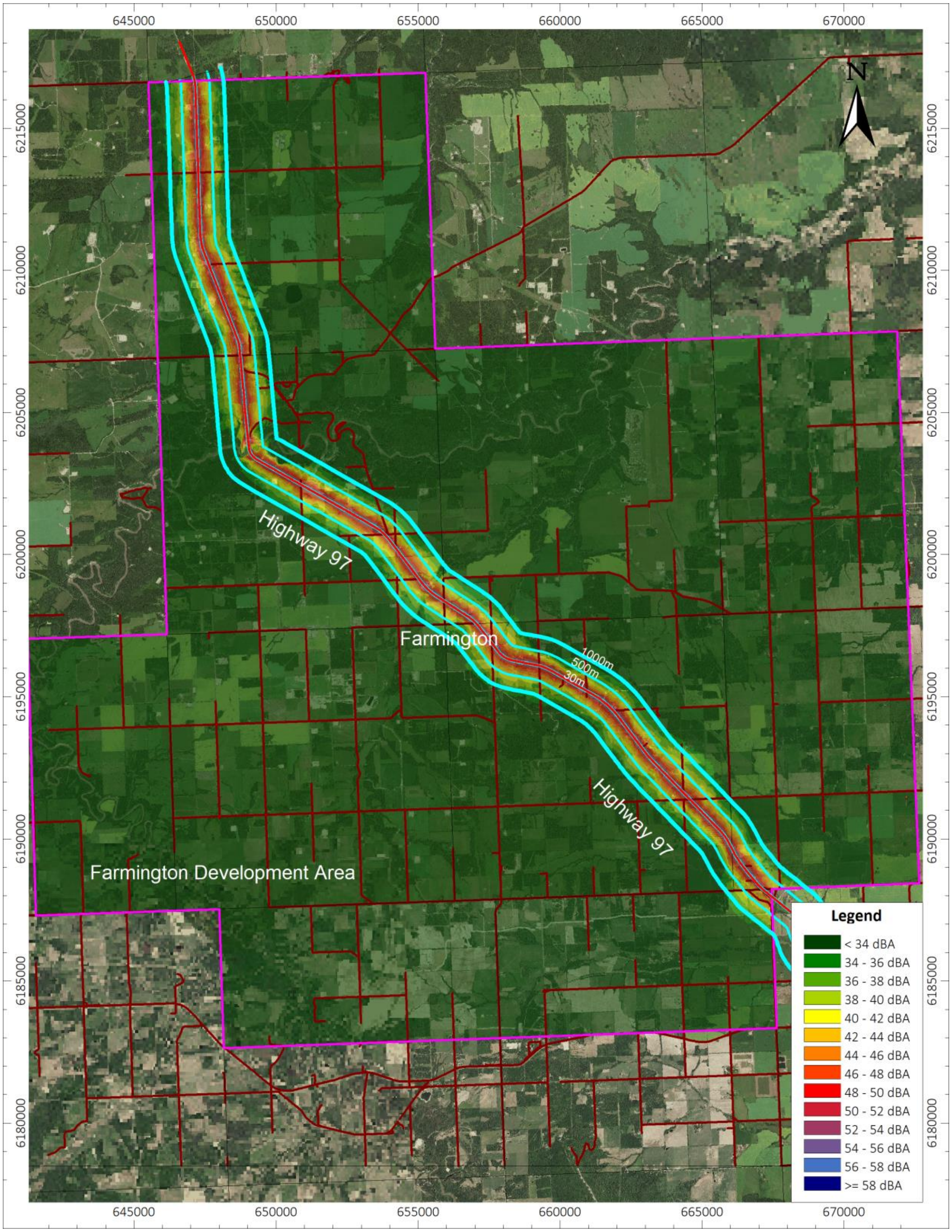


Figure 8: Noise Emission map from Highway 97
- Overall Farmington Development Area
(Long Term Prevailing Wind Condition, Nighttime)



Conclusion

BC Oil and Gas Research and Innovation Society retained Patching Associates Acoustical Engineering Ltd. to conduct an ambient noise study for Highway 97 in the Farmington Development Area, located NW of Dawson Creek, British Columbia.

The purpose of the sound survey is to quantify the current (2019/2020) ambient sound levels near Highway 97, which will provide data for consideration in a review of current noise regulations and associated permissible sound levels in B.C., and provide more targeted and specific information to optimize noise mitigation planning. This preliminary report outlines the results from Phases 1 and 2 and outlines the results from monitoring and initial modeling results for Highway 97 through the Farmington Development Area. To achieve this purpose a section of highway was selected and studied in detail through noise monitoring and detailed noise modeling in order to establish a reliable method for modeling. The noise modeling was also extended to include the entire length of Highway 97 through the Farmington Development Area. Four sound monitoring locations were selected in detail and results are presented below.

The key findings of the ambient noise study results are the following:
The key findings and recommendations of the ambient noise study results are the following:

- The results of the noise monitoring survey show that the acoustic environment was **dominated by wind and transportation noise** during monitoring period.
- **Category 3 Receivers (<30m):** Sound Levels from Highway 97 dominate the ambient sound levels; measured ambient sound levels for receivers near Highway 97 (Category 3) were 10-15 dBA higher than those currently considered in the BC OGC Guidelines. Recommend applying A2 adjustment based on modeling results herein when designing noise mitigation, this recommendation extends to receivers in Category 2.
- **Category 2 Receivers (<500m):** Sound Levels from Highway 97 dominate the ambient sound levels within 500 meters of Highway 97 (Category 2) and this extends past 500m under downwind conditions. Recommend applying A2 adjustment based on modeling results herein when designing noise mitigation, this recommendation extends to receivers in Category 1.
- **Category 1 Receivers (>500m):** Results at receiver locations approximately 1000 metres from Highway 97 is inconclusive due to high wind speeds and intermittent sound data contamination during summertime period. Results during wintertime period indicate ambient sound levels at locations 1000 metres from Highway 97 were 2-3 dBA higher than those currently considered in the BC OGC Guidelines under downwind conditions. Suggesting that current guidelines could be adjusted upwards at these locations under downwind conditions.
- All Categories the **local topography** near the highway affects sound levels from traffic noise. This means that ambient sound levels can not be generalized. Patching Associates recommends using specific noise model results (sound contours) for A2 adjustments, as opposed to generic categories. Recommend providing open access to these noise modeling results in electronic format for efficient use in planning by multiple operators.

- **Wind direction** affects ambient sound level propagation from Highway 97 at receivers in Category 1 and 2. Prevailing winds should be considered when establishing A2 ambient adjustment. Recommend using long term prevailing wind noise contour calculations to establish A2 ambient adjustment. Operators may apply other wind condition scenarios to specific operations to assess risk or set A2 adjustments.
- **Background non-highway** sound levels are not included in the noise model contours and are expected to dominate the sound environment under some wind conditions for residences in Category 1 and 2. Recommend including background non-highway ambient sound levels (35 dBA unless otherwise established) when traffic noise model predicts levels between 30 and 40 dBA at receivers.
- The noise model prediction for the overall Farming Development Area should be used for noise mitigation planning when receivers are within 1000m of Highway 97.

References

Alberta Utilities Commission (AUC) Rule 012: Noise Control (AUC 2013).

British Columbia Oil and Gas Commission (BC OGC) *British Columbia Noise Control Best Practices Guideline*. 2009. British Columbia, Canada.

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International Organization for Standardization (ISO) 1996. *Standard 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation*, Geneva Switzerland.

Natural Resources Canada: www.nrcan.gc.ca

Google Earth Pro, licensed to Patching Associates Acoustical Engineering Ltd.

AbaData 2.0, licensed to Patching Associates Acoustical Engineering Ltd.

APPENDIX A

Technical Details Regarding
Sound Measurement and Analysis

Technical Details

Sound is the phenomena of vibrations transmitted through air, or other medium such as water or a building structure. The range of pressure amplitudes, intensities, and frequencies of the sound energy is very wide, and many specialized fields have developed using different ranges of these variables, such as room acoustics and medical ultrasound.

Due to the wide range of intensities, which are perceived as sound, standard engineering units become inconvenient. Sound levels are commonly measured on a logarithmic scale, with the level (in decibels, or dB) being proportional to ten times the common logarithm of the sound energy or intensity. Normal human hearing covers a range of about twelve to fourteen orders of magnitude in energy, from the threshold of hearing to the threshold of pain. On the decibel scale, the threshold of hearing is set as zero, written as 0 dB, while the threshold of pain varies between 120 to 140 dB. The most usual measure of sound is the sound pressure level (SPL), with 0 dB SPL set at 2.0 X 10^{-5} N/m^2 (also written 20 μPa), which corresponds to a sound intensity of 10^{-12} Watts/m^2 (or 1 picoWatt/m^2, written 1 pW/m^2).

Normal human hearing spans a frequency range from about 20 Hertz (Hz, or cycles per second) to about 20,000 Hz (written 20 kHz). However, the sensitivity of human hearing is not the same at all frequencies. To accommodate the variation in sensitivity, various frequency-weighting scales have been developed. The most common is the A-weighting scale, which is based on the sensitivity of human hearing at moderate levels; this scale reflects the low sensitivity to sounds of very high or very low frequencies. Sound levels measured on the A-weighted scale are written in A-weighted decibels, commonly shown as dBA or dB(A).

Human hearing becomes more sensitive to lower frequency sounds as the level of the sound increases. For this purpose, the C-weighing scale was developed to assess reaction to higher levels sounds. Although the C-weighting scale, or the sound level in dBC, is seldom used on its own, the levels in dBC and dBA are often used together to assess the significance of the low-frequency components of sound. In some cases, a limit is placed on the dBC level at a location in order to limit the amount of low-frequency noise.

When sound is measured using the A-weighting scale, the reading is often called the “Noise level”, to confirm that human sensitivity and reactions are being addressed. A table of some common noise sources and their associated noise levels are shown in the table below.

When the A-weighting scale is not used, the measurement is said to have a “linear” weighting, or to be unweighted, and may be called a “linear” level. As the linear reading is an accurate measurement of the physical (sound) pressure, the term “Sound Pressure Level”, or SPL, is usually (but not universally) reserved for unweighted measurements.

Noise is usually defined as “unwanted sound”, which indicates that it is not just the physical sound that is important, but also the human reaction to the sound that leads to the perception of sound as noise. It implies a judgment of the quality or quantity of sound experienced. As a human reaction to sound is involved, noise levels are usually given in A-weighted decibels (dBA). However, use of the C-weighting scale, usually in combination with the dBA level, is becoming more common as well. An alternate definition of noise is “sound made by somebody else”, which emphasizes that the ability to control the level of the sound alters the perception of noise.

Table A1: Noise Levels of Familiar Sources

Source Or Environment	Noise Level (dBA)
High Pressure Steam Venting To Atmosphere (3 m)	121
Steam Boiler (2 m)	90-95
Drilling Rig (10 m)	80-90
Pneumatic Drill (15 m)	85
Pump Jack (10 m)	68-72
Truck (15 m)	65-70
Business Office	65
Conversational Speech (1 m)	60
Light Auto Traffic (30 m)	50
Living Room	40
Library	35
Soft Whisper (5 m)	20-35

The single number A-weighted level is often inadequate for engineering purposes, although it does supply a good estimate of people's reaction to a noise environment. As noise sources, control measures, and materials differ in the frequency dependence of their noise responses or production, sound is measured with a narrower frequency bandwidth; the specific methodology varies with the application. For most work, the acoustic frequency range is divided into frequency bands where the center frequency of each band is twice the frequency of the next lower band; these are called "Octave" bands, as their frequency relation is called an "Octave" in music, where the field of acoustics has its roots. For more detailed work, the octave bands, and certain standard octave and 1/3 octave bands have been specified by international agreements.

Where the noise at the receiver is steady, it is easy to assess the noise level. However, both the production of noise at the source and the transmission of noise can vary with time; most noise levels are not constant, either because of the motion of the noise source (as in traffic noise), because the noise source itself varies, or because the transmission of sound to the receiver location is not steady as over long distances. This is almost always the case for environmental noise studies. Several single number descriptors have been developed and are used to assess noise in these conditions.

The most common is the measurement of the "equivalent continuous" sound level, or L_{eq}, which is the level of a hypothetical source of a constant level which would give the same total sound energy as is measured during the sampling period. This is the "energy" average noise level. Typical sampling periods are one hour, nighttime (9 hours) or one day (24 hours); the sampling period used must be reported when using this unit.

The greatest value of the L_{eq} is that the contributions of different sources to the total noise level can be assessed, or in a case where a new noise source is to be added to an existing environment, the total noise level from new and old sources can be easily calculated. It is also sensitive to short term high noise levels.

Statistical noise levels are sometimes used to assess an unsteady noise environment. They indicate the levels that are exceeded a fixed percentage of the measurement time period measured. For example, the 10th percentile level, written L_{10}, is the levels exceeded 10% of the time; this level is a good measure of frequent noisy occurrences such as steady road traffic. The 90% level, L_{90}, is the level exceeded 90% of the time, and is the background level, or noise floor. A steady noise source will modify the background level, while an intermittent noise source such as road or rail traffic will affect the short-term levels only.

One disadvantage with the L_{eq} measure, when used alone, is that nearby loud sources (e.g. dogs barking, or birds singing) can confuse the assessment of the situation when it is the noise from a distant plant that is the concern. For this reason, the equivalent level and the statistical levels can be used together to better understand the noise environment. One such indication is the difference between the L_{eq} and the L_{90} levels. A large difference between the L_{eq} and L_{90}, greater than 10 dB, indicates the intrusion of short-term noise events on the general background level. A small difference, less than 5 dB, indicates a very steady noise environment. If the L_{eq} value exceeds the L_{10} value this indicates the presence of significant short-term loud events.

For most noise measurement, instruments are adjusted so that the time response of the instrument is similar to the response of the human ear; this is the “Fast” setting. Measurement with the “Fast” setting therefore assesses the sound environment according to the way humans would hear it and react to it. Where the noise level varies substantially and an average level is wanted without the complexity of and L_{eq} or statistical measurement, the “Slow” setting is used on the sound level meter. The “Slow” setting is also typically used in industrial settings where hearing damage is a concern. Where the noise level changes very rapidly, for example due to impacts or detonations, the “Fast” and “Slow” settings do not respond quickly enough to assess the maximum levels, and the “Impulse” meter setting us used.

The Sound Power Level (abbreviated L_w, SWL or PWL) is the decibel equivalent of the total energy emitted from a source in the form of noise. The reference level for the sound power is 10^{-12} Watts, or 1 picoWatt (abbreviated pW). The sound power level is given by:

$$L_w, SWL, PWL = 10 \times \log_{10} (\text{Emitted Power} / 1\ \text{pW})\ \text{dB}$$

Therefore, a source emitting 1 Watt of power in the form of sound would have a sound power level of 120 dB. Sound power levels can be expressed in terms of frequency bands, an overall linear-weighted level or A-weighted, as is the case for sound pressure levels. However, sound power levels are inherent to the source of noise, whereas the sound pressure level is dependant on the source, but also on the distance from the source and other environmental factors.

Note that according to the acoustical literature (E.g. Noise Control Engineering from Bies and Hanson), the subjective effect of changes in SPL is as follows:

- A 3 dB change is “just perceptible”.
- A 5 dB change is “clearly noticeable”.
- A 10 dB change is “twice as loud or half as loud”.
- A 20 dB change is “much louder or much quieter”.

Table A2: Glossary

Term	Description
Average Annual Daily Traffic (AADT)	The total volume of vehicle traffic of a highway or road for a year divided by 365 days.
Alberta Energy Regulator (AER)	The Alberta Energy Regulator ensures the safe, efficient, orderly, and environmentally responsible development of hydrocarbon resources over their entire life cycle. This includes allocating and conserving water resources, managing public lands, and protecting the environment while providing economic benefits for all Albertans.
Ambient sound level (ASL)	The sound pressure level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ASL does not include any energy-related industrial component and must be measured without it. The ASL is assumed to be 5 dBA below the determined PSL as per Rule 012.
A-weighted sound level (dBA)	The sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear at levels typical of rural backgrounds in mid frequencies.
Bands (full octave or 1/3 octave)	A series of electronic filters separate sound into discrete frequency bands, making it possible to know how sound energy is distributed as a function of frequency. Each octave band has a centre frequency that is double the centre frequency of the octave band preceding it. The 1/3 octave band analysis provides a finer breakdown of sound distribution as a function of frequency.
Cumulative SPL	The cumulative sound pressure level from the facilities and the ambient sound level.
Comprehensive Sound Level (CSL)	The sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The CSL does include industrial components and must be measured with them, but it should exclude abnormal noise events. The CSL is used to determine whether a facility is in compliance with the Directive.
Cumulative noise level	The sound level that is the total contribution of all industrial noise sources (existing and proposed) from EUB-regulated facilities at the receptor.
C-weighted sound level (dBC)	The C-weighting approximates the sensitivity of human hearing at industrial noise levels (above about 85 dBA). The C-weighted sound level (i.e., measured with the C-weighting) is more sensitive to sounds at low frequencies than the A-weighted sound level and is sometimes used to assess the low-frequency content of complex sound environments.
Daytime	Defined as the hours from 07:00 to 22:00.
Deferred facility	Facilities constructed and in operation prior to October 1988. These facilities do not have to demonstrate compliance in the absence of a complaint. This does not exempt them from the requirements but does recognize that they were potentially designed without the same considerations for noise as facilities approved after the date when the first comprehensive noise control directive (ID 88-1) was published and put into effect.
Directive 038: Noise Control	Directive 038: Noise Control states the requirements for noise control as they apply to all operations and facilities under the jurisdiction of the Alberta Energy and Utilities Board (EUB). The directive also provides background information and describes an approach to deal with noise problems. This directive is the fifth edition, superseding Interim Directive (ID) 99-8.
Energy equivalent sound level (Leq)	The average weighted sound level over a specified period of time. It is a single-number representation of the cumulative acoustical energy measured over a time interval. The time interval used should be specified in brackets following the Leq—e.g., Leq (9) is a 9-hour Leq. If a sound level is constant over the measurement period, the Leq will equal the constant sound level.
Emergency	An unplanned event requiring immediate action to prevent loss of life or property. Events occurring more than four times a year are not considered unplanned.
Facility SPL	The overall sound pressure level from all the facilities in the study area

Table A2: Glossary

Term	Description
Heavily Travelled Road	Generally includes highways and any other road where the average traffic count is at least 10 vehicles/hour over the nighttime period. It is acknowledged that highways are sometimes lightly travelled during the nighttime period, which is usually the period of greatest concern. The AER will use the 10 vehicles/hour criterion to determine whether highways qualify as heavily travelled during the nighttime period.
Low Frequency Noise (LFN)	Where a clear tone is present below and including 250Hz and the difference between the overall C-weighted sound level and the overall A-weighted sound level exceeds 20 dB.
Nighttime	Defined as the hours from 22:00 to 07:00.
Noise	Generally associated with the unwanted portion of sound.
Noise Impact Assessment (NIA)	An NIA identifies the expected sound level emanating from a facility as measured 15 m from the nearest or most impacted permanently or seasonally occupied dwelling. It also identifies what the permissible sound level is and how it was calculated.
Permanent facility	A facility that is in operation for more than two months.
Permissible Sound Level (SPL)	The maximum SPL that a facility must not exceed at receivers located within 1500 m from the subject facility fence line. The PSL for each receiver is determined as per section 2.1 of the Directive.
Receiver	The location of the residences existing in the NIA study area for which the SPL is determined. In the event that there are no residences existing in the study area, then hypothetical receivers are included at 1500 m from the subject facility fence line.
Representative conditions	Those conditions typical for an area and/or the nature of a complaint. For ASLs, these are conditions that portray the typical activities for the area, not the quietest time. For CSLs, these do not constitute absolute worst-case conditions or the exact conditions the complainant has highlighted if those conditions are not easily duplicated. Sound levels must be taken only when representative conditions exist; this may necessitate a survey of extensive duration (two or more consecutive nights).
Sound Power Level (PWL)	The sound level emitted. The decibel equivalent of the rate of energy (or power) emitted in the form of noise. The sound power level is given by: $PWL = 10 \times LOG_{10}\left(\frac{Sound\ as\ Power}{W_0}\right)$ Where $W_0 = 10^{-12}$ watts (or 1 pW)
Sound Pressure Level (SPL)	The sound level received. The decibel equivalent of the pressure of sound waves at a specific location, which is measured with a microphone. The sound pressure level is given by: $SPL = 10 \times LOG_{10}\left(\frac{Sound\ as\ Pressure}{P_0}\right)$ Where $P_0 = 2 \times 10^{-5}$ Pa (or 20 μPa)
Subject facility	The energy industry facility which is the object of the NIA.
Temporary facility	Any facility that will be in operation less than 60 days.
Tonal component	A pronounced peak clearly obvious within the sound level spectrum.

Appendix B: Permissible Sound Level Determination

BC OGC Noise Control Guideline: Permissible Sound Level Determination
Sound Monitor C

Basic Nighttime Sound Level

Proximity to Transportation	Dwelling Unit Density per ¼ Section of Land			Nighttime	Daytime
	1 - 8 Dwellings	9 - 160 Dwellings	>160 Dwellings		
Category 1	40	43	46		
Category 2	45	48	51		
Category 3	50	53	56	50	50
Daytime Adjustment				N/A	10
Basic Sound Levels				40	60

Class A Adjustments

Class	Reason for Adjustment	Value (dBA L_{eq})	Nighttime	Daytime
A1	Seasonal Adjustment (Wintertime Operation)	+5	N/A	N/A
A2	Ambient Monitoring Adjustment	-10 to +10	N/A	N/A
	Class Adjustment = Sum of A1 and A2 (as applicable), but not to exceed a maximum of 10 dBA L_{eq}			
	Total Class A Adjustments		0	0

Class B Adjustments

Class	Duration of Activity	Value (dBA L_{eq})	Nighttime	Daytime
B1	1 day	+15		
B2	7 days	+10		
B3	< or = to 60 days	+5		
B4	> 60 days	0	0	0
	Class B Adjustment = one only of B1, B2, B3 or B4			
	Class B Adjustment		0	0

	Nighttime	Daytime
PERMISSIBLE SOUND LEVEL (dBA)	**50**	**60**

Category 1: Dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
Category 2: Dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
Category 3: Dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.

BC OGC Noise Control Guideline: Permissible Sound Level Determination
Sound Monitor A and F

Basic Nighttime Sound Level

Proximity to Transportation	Dwelling Unit Density per ¼ Section of Land: 1 - 8 Dwellings	9 - 160 Dwellings	>160 Dwellings	Nighttime	Daytime
Category 1	40	43	46		
Category 2	45	48	51	45	45
Category 3	50	53	56		
Daytime Adjustment				N/A	10
Basic Sound Levels				45	55

Class A Adjustments

Class	Reason for Adjustment	Value (dBA L_{eq})	Nighttime	Daytime
A1	Seasonal Adjustment (Wintertime Operation)	+5	N/A	N/A
A2	Ambient Monitoring Adjustment	-10 to +10	N/A	N/A
	Class Adjustment = Sum of A1 and A2 (as applicable), but not to exceed a maximum of 10 dBA L_{eq}			
Total Class A Adjustments			0	0

Class B Adjustments

Class	Duration of Activity	Value (dBA L_{eq})	Nighttime	Daytime
B1	1 day	+15		
B2	7 days	+10		
B3	< or = to 60 days	+5		
B4	> 60 days	0	0	0
Class B Adjustment = one only of B1, B2, B3 or B4				
Class B Adjustment			0	0

	Nighttime	Daytime
PERMISSIBLE SOUND LEVEL (dBA)	45	55

Category 1: Dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
Category 2: Dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
Category 3: Dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.

BC OGC Noise Control Guideline: Permissible Sound Level Determination
Sound Monitor D

Basic Nighttime Sound Level

Proximity to Transportation	Dwelling Unit Density per ¼ Section of Land 1 - 8 Dwellings	9 - 160 Dwellings	>160 Dwellings
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

	Nighttime	Daytime
Basic Nighttime Sound Level	40	40
Daytime Adjustment	N/A	10
Basic Sound Levels	40	50

Class A Adjustments

Class	Reason for Adjustment	Value (dBA L_{eq})	Nighttime	Daytime
A1	Seasonal Adjustment (Wintertime Operation)	+5	N/A	N/A
A2	Ambient Monitoring Adjustment	-10 to +10	N/A	N/A
	Class Adjustment = Sum of A1 and A2 (as applicable), but not to exceed a maximum of 10 dBA L_{eq}			
Total Class A Adjustments			0	0

Class B Adjustments

Class	Duration of Activity	Value (dBA L_{eq})	Nighttime	Daytime
B1	1 day	+15		
B2	7 days	+10		
B3	< or = to 60 days	+5		
B4	> 60 days	0	0	0
	Class B Adjustment = one only of B1, B2, B3 or B4			
Class B Adjustment			0	0

	Nighttime	Daytime
PERMISSIBLE SOUND LEVEL (dBA)	**40**	**50**

Category 1: Dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
Category 2: Dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
Category 3: Dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.

APPENDIX C

Photographs of Monitoring Locations and Equipment

Picture C1: Sound Monitor C and Weather Monitor Setup
(Southwest 20m from the Highway 97)

Picture C2: Sound Monitor C and Weather Monitor Setup
(Southwest 20m from the Highway 97)

Picture C3: Sound Monitor A Setup
(560m North from Highway 97)

Picture C4: Sound Monitor D Setup
(East from Sweetwater road,1000m north from Highway 97)

Picture C5: Sound Monitor F Setup
(East from Mason road,500m south from Highway 97)

APPENDIX D

Weather Measurement Data

APPENDIX E

Sound Level Measurements
Sound Monitor C
South Adjacent to the Highway 97

APPENDIX F

Sound Level Measurements
Sound Monitor A
560m North from Highway 97

APPENDIX G

Sound Level Measurements
Sound Monitor D
East from Sweetwater road,1000m north from Highway 97)

APPENDIX H

Sound Level Measurements
Sound Monitor F
East from Mason road,515m south from Highway 97)

APPENDIX I

Hourly Traffic data and monthly Classification Info

Traffic Data For: Farmington - P-43-3NS - N

Route 97, 0.2 north of Road 237, Dawson Creek

APPENDIX J

Detailed Noise Maps for the Farmington Development Area

(Nighttime predicted sound levels, Under the Long Term Wind Condition)

Figure J1: Noise Map -FDA 1

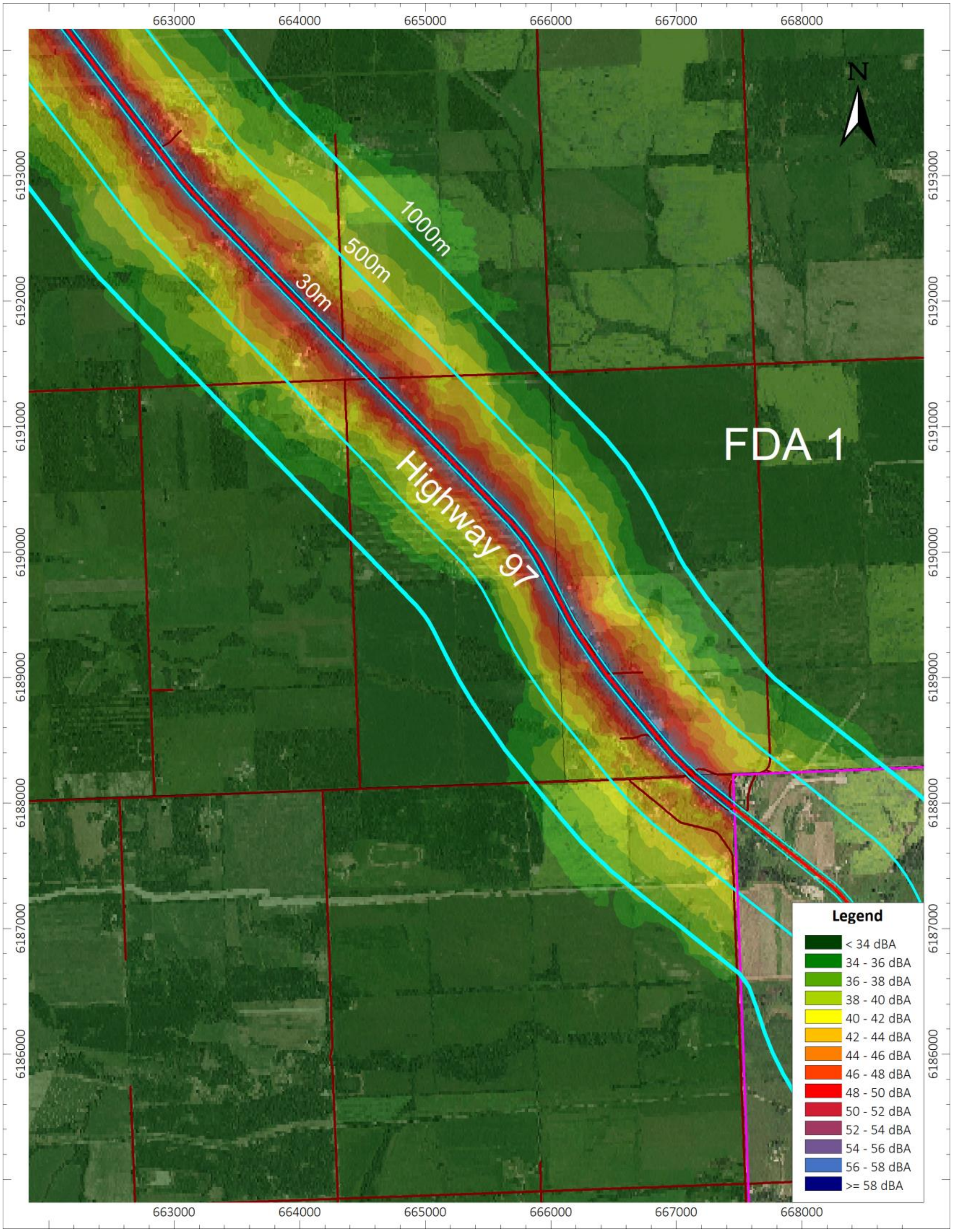

Figure J2: Noise Map -FDA 2

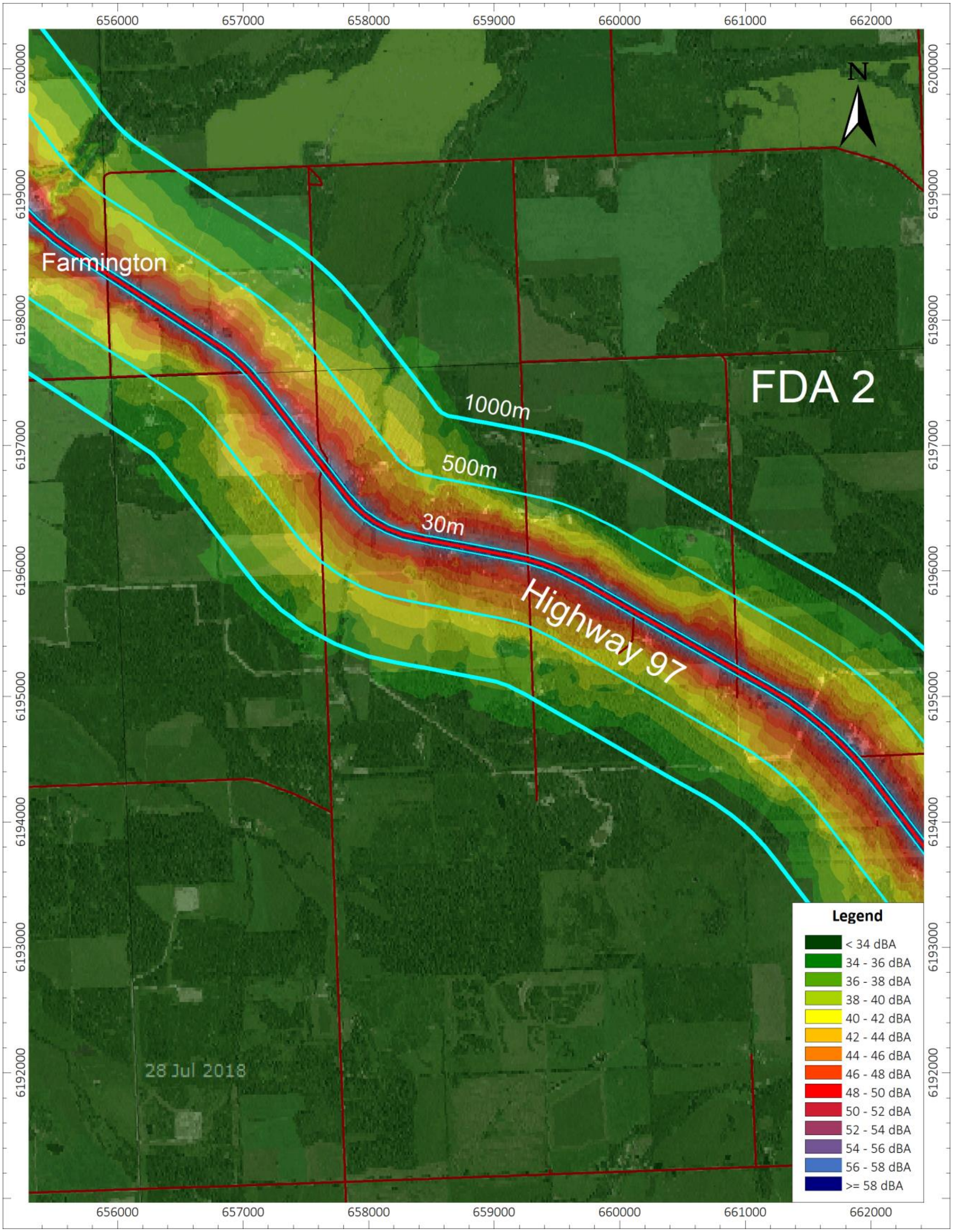

Figure J3: Noise Map -FDA 3

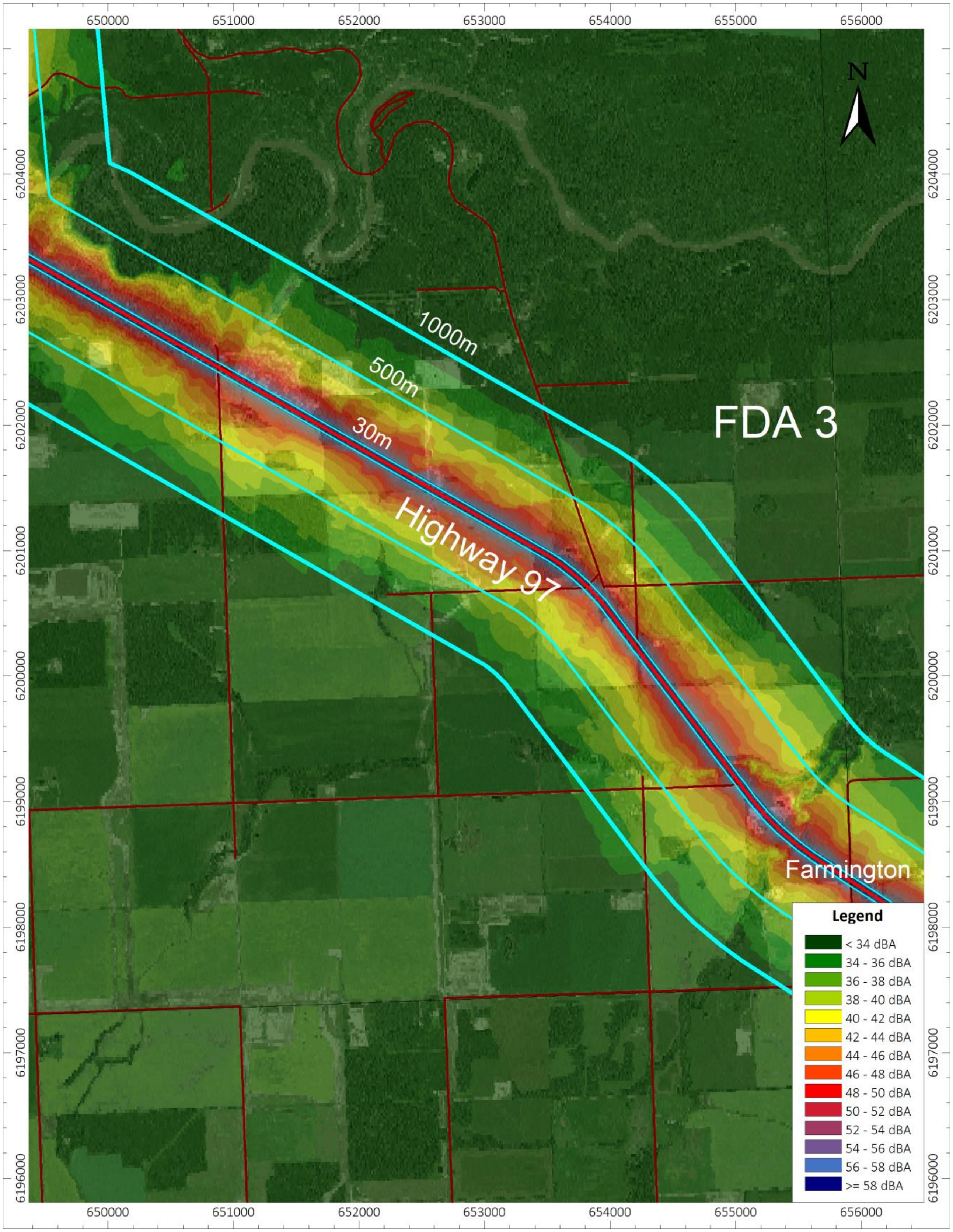

Figure J4: Noise Map -FDA 4

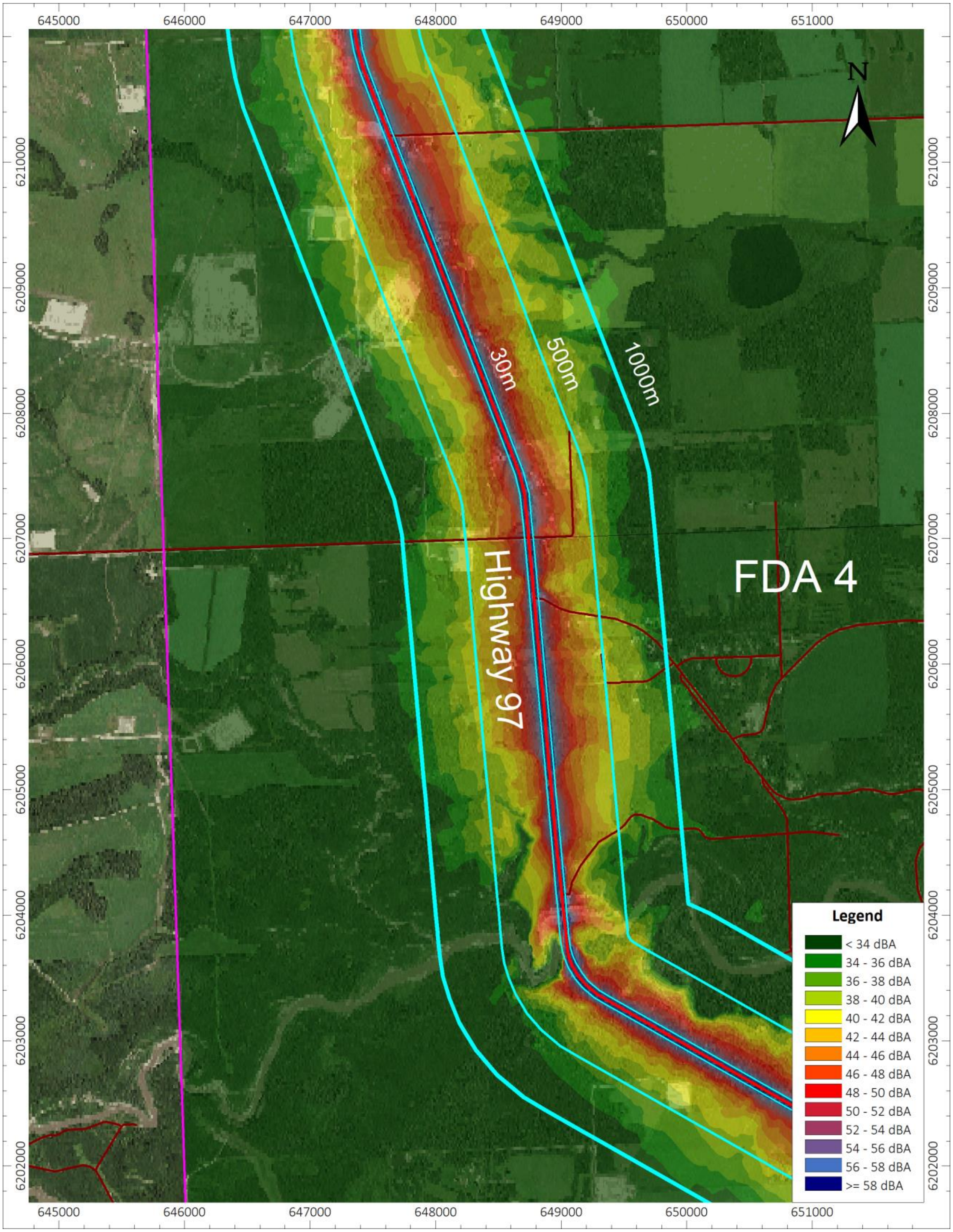

Figure J5: Noise Map -FDA 5