Ambient Noise Study
BC Oil and Gas Research and Innovation Society
Farmington Development Area
Phase 2 Regional Roads Report-Final
Sweetwater Road and Tower Lake Road

Prepared for:
BC Oil and Gas Research and Innovation Society

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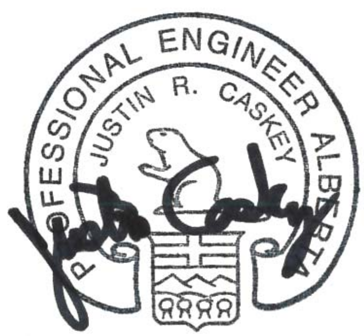
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Executive Summary

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 two typical regional roads in the Farmington Development Area (FDA), located NW of Dawson Creek, British Columbia. The roads studied were the Tower Lake Road and the Sweetwater Road.

The purpose of the sound survey is to quantify the current (2020) ambient sound levels near some typical regional roads, 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 report outlines the results from the typical regional roads and outlines the results from monitoring and initial modeling results for these roads through the Farmington Development Area. To achieve this purpose two areas were selected and studied in detail through noise monitoring and noise modeling. Three sound monitoring locations were selected in detail and results are presented below.

Table A: Sound Monitor Tower Lake 1 (69m off Roadway) Results

Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted Noise Contribution from Tower Lake Road (dBA)	Difference Measured SPL - Predicted Tower Lake Road Contribution (dB)
Total Survey Period - Daytime	44.2	97.5	7.2	31.4	12.8
Total Survey Period - Nighttime	37.6	61.1	4.7	22.2	15.4
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 B: Sound Monitor Tower Lake 2 (300m off Roadway) Results

Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted Noise Contribution from Tower Lake Road (dBA)	Difference Measured SPL -Predicted Tower Lake Road Contribution (dB)
Total Survey Period - Daytime	47.0	84.8	7.9	26.4	20.6
Total Survey Period - Nighttime	39.3	59.2	4.8	20.2	19.1
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	50.0 (45.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	40.0 (35.0)				

Table C: Sound Monitor Sweetwater Road (50m off Roadway) Results

Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted Noise Contribution from Sweet water Road (dBA)	Difference Measured SPL - Predicted Sweet water Road Contribution (dB)
Total Survey Period - Daytime	51.9	78.4	20.2	36.6	15.3
Total Survey Period - Nighttime	48.2	57.8	13.3	29.0	19.2
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 key findings of the ambient noise study results are the following:

- The acoustic environment at the three receivers studied was affected by transportation, fauna and weather. The measured ambient sound levels at all the monitoring locations were generally higher than the assumed BC OGC current assumed ASL the major contributors were wind noise and traffic noise.
- Tower Lake Road: Measured ambient sound levels for receivers near Tower Lake Road were slightly higher than those currently considered in the BC OGC Guidelines. Ambient sound levels were dominated by wind and other environmental sounds; traffic noise did not contribute significantly at the measurement locations. Traffic volumes along Tower Lake Road are low and do not warrant adjustments to the PSL.
- Sweetwater Road: Measured ambient sound levels for receivers near the Sweetwater Road were higher than those currently considered in the BC OGC Guidelines. Ambient sound levels were dominated by wind and other environmental sounds; traffic noise did not dominate the sound environment during the measurement period. Limited data was available to accurately predict traffic noise affects there is some evidence to suggest traffic volumes for residences within 50 metres of Sweetwater Road would qualify for ambient adjustments under some circumstances. This may apply to fewer than 20 residences and PAAE recommends assessing these on a case by case basis. Additional monitoring is required, with lower levels of wind contamination, to quantify ambient sound levels from traffic.
- Local Wind Conditions: Wind contamination was significant at both locations during the monitoring period. Wind induced sound corelated to ambient sound levels above 45 dBA when wind speeds were above 15 k/hr. This suggests that wind induced sound may provide masking for industrial or traffic noise and thus qualify for A2 adjustments. Additional research is recommended to determine changes to wind induced sound from foliage (leaves) and ground cover (snow/grass) as well as receiver experienced (wind induced microphone noise) prior to developing general guidelines. In addition, the study highlights that local wind conditions vary greatly from regional wind conditions; local site specific weather data should be used for all sound monitoring, as opposed to relying on weather data from regional weather stations several kilometres from the monitoring site.

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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 two typical regional roads in the Farmington Development Area (FDA), located NW of Dawson Creek, British Columbia. The roads studied were the Tower Lake Road and the Sweetwater Road.

The purpose of the sound survey is to quantify the current (2020) ambient sound levels near some typical regional roads, 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 report outlines the results from the typical regional roads and outlines the results from monitoring and initial modeling results for these roads through the Farmington Development Area. To achieve this purpose two areas were selected and studied in detail through noise monitoring and detailed noise modeling in order to establish a reliable method for modeling. Three 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.

Highway 97 runs through this area from SE to NW. Tower Lake Road and Sweet Water Road, were selected for this assessment. Three monitoring locations were used to assess noise emission from the these roads. The monitoring locations selected were far from Highway 97 so as to avoid potential contamination. The overall Farmington area and the two areas including the three selected sound monitoring locations denoted as Sound Monitor TL 1, TL 2 and SW, shown in Figures 1A, 1B and 1C.

Figure 1A: Study Area Map - Overall Farmington Development Area

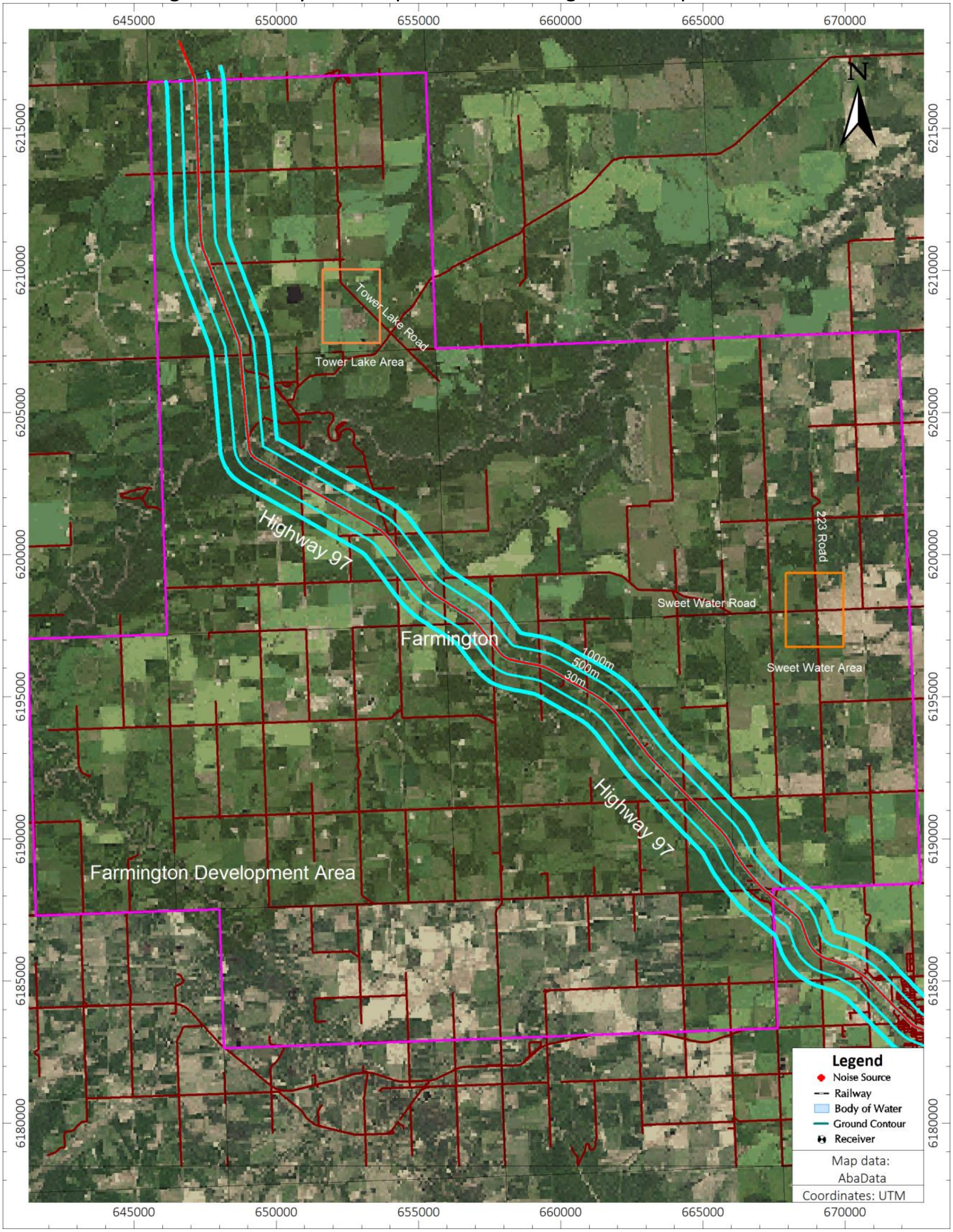


Figure 1B: Tower Lake Local Area Map

Figure 1C: Sweet Water Local 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 study 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 TL1, TL 2 and SW, have been selected to cover the nearby areas of Tower Lake and Sweetwater, which far away from the Highway 97 to get representative conditions in this area, and classified as the Category 1 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	**SN**	**SN**	**Transducer SN**	Calibration/ Certification 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 B	NTI	ADP5U-SR59Q	A2A-16096-E0	5419	06/19/2019	Yes
Nomad Weather Station #3	Vaisala	-	R3530325	-	03/09/2019	Yes
Meter Calibrator 4231 #4	Bruel & Kjaer	-	2730772	-	23/05/2019	Yes

Table 2: Monitoring Locations

Equipment	Location	Description
Sound Level Meter	Sound Monitor TL 1	• NTI kit A • Approximately 69 m south from Tower Lake Road • Approximately 4400m east from Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C1 in Appendix C
Sound Level Meter and Weather Station	Sound Monitor TL 2	• NTI kit B • Approximately 300 m south from Tower Lake Road • Approximately 4200m east from Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C2 in Appendix C
Sound Level Meter	Sound Monitor SW	• NTI kit C • Approximately 50m north form Sweet Water Road • Approximately 7800m northeast from the Highway 97 • Mic is 1.5 m above ground • For site photo, see Picture C3 in Appendix C

Environmental Conditions

Environmental conditions of the Tower Lake area were recorded with a weather station installed by PAAE staff at the location, which is also beside the sound monitor TL2.

Environmental conditions of the Sweet Water area were obtained from the Environment Canada weather station located at Dawson Creek Airport, which was the nearest permanent weather station in this area.

The weather summaries for the Tower Lake local areas during the monitoring period are presented in Appendix D.

Table 3A summarizes the weather measurement results for the daytime and nighttime periods during the survey period. Table 3B summarizes the weather results for the daytime and nighttime periods during the survey period as per hourly data from Environment Canada at Dawson Creek.

Table 3A: Environmental Conditions (Tower Lake Area)

Date (2020)	Average Speed (kph)	General Direction	General Description	Minutes of Audible Precipitation	Minutes of Valid Condition
Feb 20	12	SW	Moderate wind	0	280
Feb 20 - Feb 21	7	SW	Moderate wind	0	425
Feb 21	10	SW	Moderate wind	0	495
Feb 21 - Feb 22	6	SW	Moderate wind	0	495
Feb 22	14	WSW	Moderate wind	0	340
Feb 22 - Feb 23	4	SSW	Light wind	5	520
Feb 23	2	W	Light wind	0	900
Feb 23 - Feb 24	2	SW	Light wind	0	540
Feb 24	3	SSW	Light wind	0	900
Feb 24 - Feb 25	3	SSW	Light wind	0	540
Feb 25	4	SSW	Light wind	5	900
Feb 25 - Feb 26	5	SSW	Light wind	0	540
Feb 26	9	SW	Moderate wind	0	595
Feb 26 - Feb 27	6	SSW	Moderate wind	0	515
Feb 27	6	SW	Moderate wind	0	55

Table 3B: Environmental Conditions (Dawson Creek / Sweetwater Area)

Date (2020)	Average Speed (kph)	General Direction	General Description	Minutes of Valid Condition
Feb 20	25	NNE	Strong Wind	60
Feb 20 - Feb 21	18	NNE	Moderate Wind	60
Feb 21	30	NNE	Strong Wind	0
Feb 21 - Feb 22	22	NNE	Strong Wind	0
Feb 22	32	NNE	Strong Wind	0
Feb 22 - Feb 23	11	NNE	Moderate Wind	240
Feb 23	4	NNE	Light Wind	571
Feb 23 - Feb 24	4	NNE	Light Wind	449
Feb 24	3	N	Calm wind	511
Feb 24 - Feb 25	6	NNE	Light Wind	480
Feb 25	9	NNE	Light Wind	509
Feb 25 - Feb 26	7	NNE	Light Wind	240
Feb 26	28	NNE	Strong Wind	0
Feb 26 - Feb 27	24	NNE	Strong Wind	0
Feb 27	26	NNE	Strong Wind	0

The survey results in Table 3A indicate that the daytime and nighttime periods from Feb. 20 to 27, 2020 have light to moderate wind conditions for this survey, most of the time the wind came from southwest. 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 results in Table 2B indicate that the daytime and nighttime periods from Feb. 20 to 27, 2020 have calm wind to strong wind conditions for the survey period, most of the time the wind came from north northeast. Wind data collected during the monitoring period has been used to create a wind rose experienced for the sound monitor SW location, which is shown in Figure 2B.

Significant variability existed for both wind speed and direction for the two weather monitoring sites. The wind direction for the Tower Lake monitoring location and the Dawson Creek were opposite for much of the monitoring period, despite being approximately 40 km apart. This study highlights that local wind conditions vary greatly from regional wind conditions; local site specific weather data should be used for all sound monitoring, as opposed to relying on weather data from regional weather stations several kilometres from the monitoring site.

Figure 2A: Wind Rose (Tower Lake Area, Feb. 20-27, 2020)

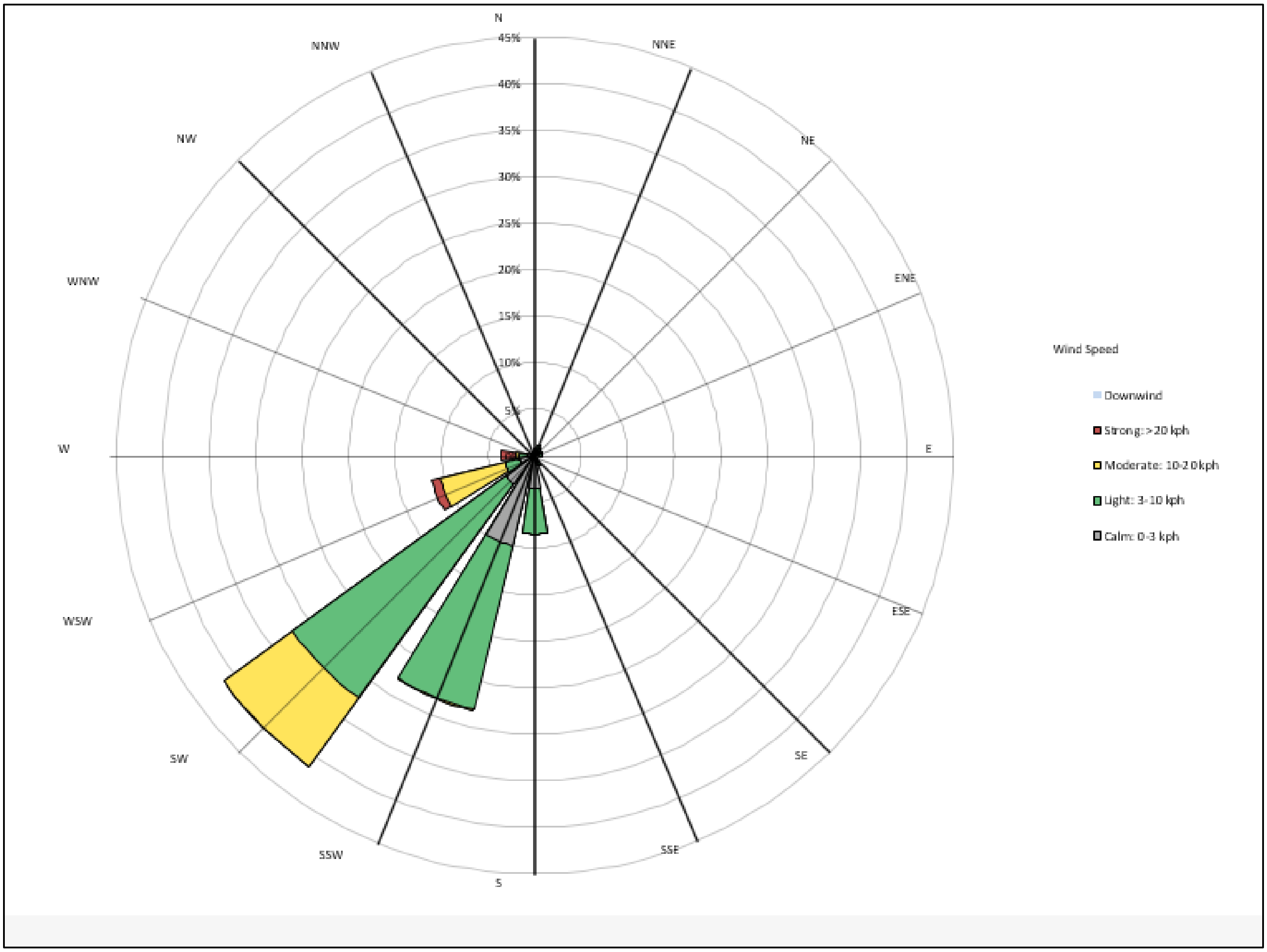
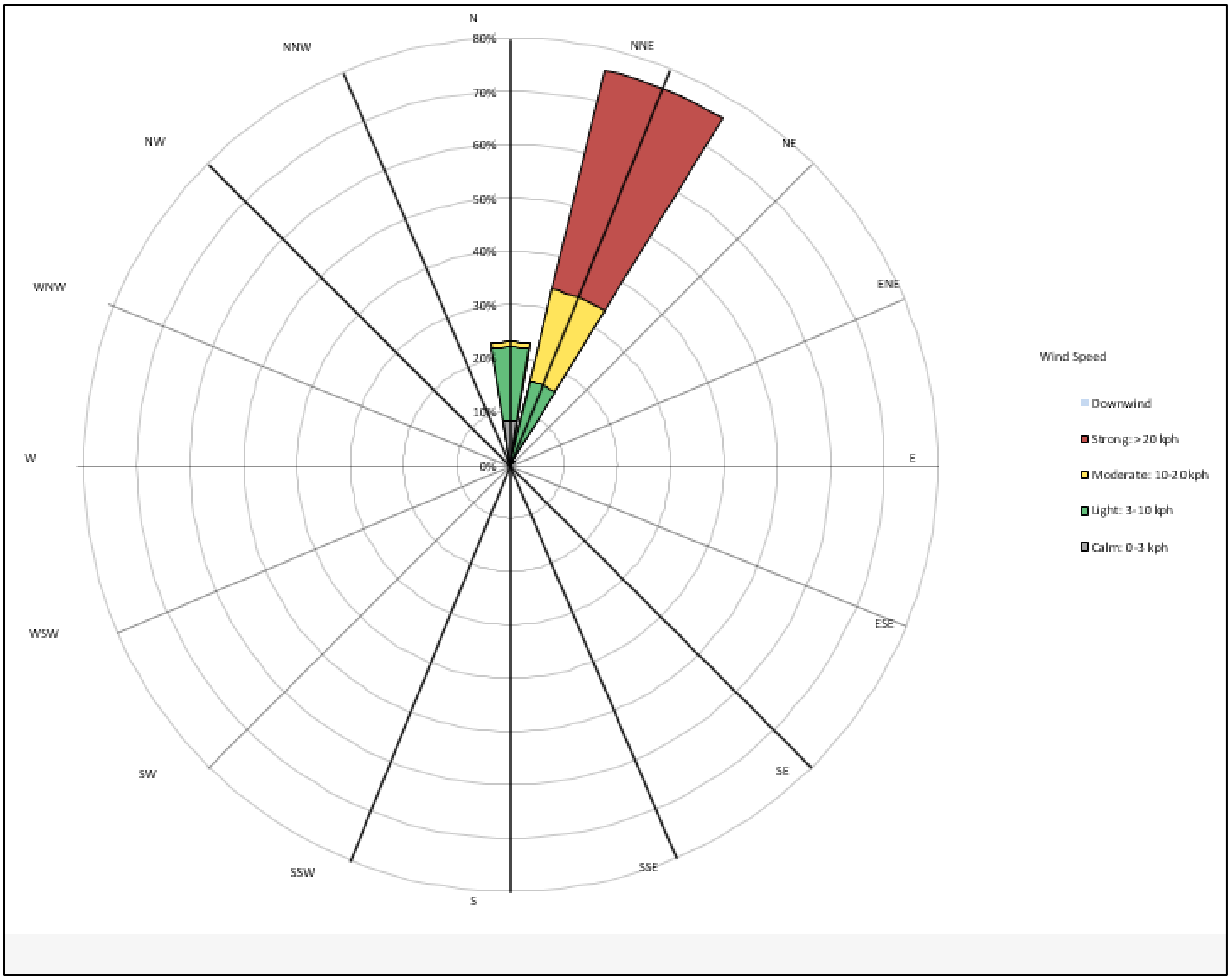


Figure 2B: Wind Rose (Sweetwater Area, Feb. 20-27, 2020)

(Data from Environment Canada Dawson Creek)



Results and Discussion

Sound Monitor Tower Lake (TL) 1&2 Measurement Locations

Sound Monitors TL 1&2 was located at approximately 69m and 300m south from Tower Lake road, 4400m east from Highway 97. These locations were selected because they represent the potential traffic noise emissions from local road, Tower Lake Road.

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.

The detailed results including graphical presentation of the measured and residual levels are presented in Appendix E and 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 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 summarizes the comprehensive sound level measurement results for the period of the survey based on daytime and nighttime periods. Tables 5A and 5B also summarizes the sound level measurement results for the period of the survey based on wind conditions.

Table 4A: Sound Monitor TL 1 Results

Period	Date (2020)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Feb 20	71.6	10.8	47.5	9.0
Night 01	Feb 20 - Feb 21	45.7	9.0	44.1	8.8
Day 02	Feb 21	50.5	15.0	50.2	14.6
Night 02	Feb 21 - Feb 22	41.0	9.0	35.3	8.5
Day 03	Feb 22	47.1	15.0	45.6	13.3
Night 03	Feb 22 - Feb 23	37.4	9.0	33.6	8.7
Day 04	Feb 23	41.1	15.0	26.2	12.9
Night 04	Feb 23 - Feb 24	-	-	-	-
Day 05	Feb 24	-	-	-	-
Night 05	Feb 24 - Feb 25	-	-	-	-
Day 06	Feb 25	-	-	-	-
Night 06	Feb 25 - Feb 26	-	-	-	-
Day 07	Feb 26	34.2	15.0	31.2	14.5
Night 07	Feb 26 - Feb 27	42.6	9.0	39.8	8.2
Day 08	Feb 27	72.2	15.0	41.6	3.3
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 4B: Sound Monitor TL 2 Results

Period	Date (2020)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Feb 20	73.5	11.6	48.3	10.6
Night 01	Feb 20 - Feb 21	46.1	9.0	44.5	8.8
Day 02	Feb 21	51.6	15.0	51.6	14.5
Night 02	Feb 21 - Feb 22	39.9	9.0	36.9	8.9
Day 03	Feb 22	47.2	15.0	46.9	14.0
Night 03	Feb 22 - Feb 23	35.2	9.0	34.8	8.7
Day 04	Feb 23	35.6	15.0	30.1	12.3
Night 04	Feb 23 - Feb 24	39.4	9.0	30.0	8.5
Day 05	Feb 24	48.7	15.0	37.4	10.3
Night 05	Feb 24 - Feb 25	38.1	9.0	34.2	8.8
Day 06	Feb 25	44.5	15.0	38.4	11.0
Night 06	Feb 25 - Feb 26	41.6	9.0	36.9	6.9
Day 07	Feb 26	48.0	15.0	47.7	9.3
Night 07	Feb 26 - Feb 27	42.3	9.0	41.3	8.7
Day 08	Feb 27	75.3	15.0	44.4	2.8
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 5A: Sound Monitor TL 1 Results

Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted Noise Contribution from Tower Lake Road (dBA)	Difference Measured SPL Predicted Tower Lake Road Contribution (dB)
Total Survey Period - Daytime	44.2	97.5	7.2	31.4	12.8
Total Survey Period - Nighttime	37.6	61.1	4.7	22.2	15.4
Total Survey Period – Daytime (Downwind)	-	-	-	-	-
Total Survey Period – Nighttime (Downwind)	-	-	-	-	-
Total Survey Period – Daytime (Crosswind)	41.2	9.7	6.9	-	-
Total Survey Period – Nighttime (Crosswind)	27.4	1.4	2.4	-	-
Total Survey Period – Daytime (Upwind)	44.8	82.1	7.5	-	-
Total Survey Period – Nighttime (Upwind)	37.7	59.7	4.8	-	-
Long Term Prevailing Wind - Daytime	44.2	97.5	7.2	-	-
Long Term Prevailing Wind - Nighttime	37.6	61.1	4.7	-	-
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 5B: Sound Monitor TL 2 Results

Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted Noise Contribution from Tower Lake Road (dBA)	Difference Measured SPL Predicted Tower Lake Road Contribution (dB)
Total Survey Period - Daytime	47.0	84.8	7.9	26.4	20.6
Total Survey Period - Nighttime	39.3	59.2	4.8	20.2	19.1
Total Survey Period – Daytime (Downwind)	29.3	4.6	3.0	-	-
Total Survey Period – Nighttime (Downwind)	-	-	-	-	-
Total Survey Period – Daytime (Crosswind)	44.7	8.2	7.7	-	-
Total Survey Period – Nighttime (Crosswind)	31.6	1.4	2.3	-	-
Total Survey Period – Daytime (Upwind)	47.5	72.0	8.2	-	-
Total Survey Period – Nighttime (Upwind)	39.4	57.9	4.8	-	-
Long Term Prevailing Wind - Daytime	47.0	84.8	7.9	-	-
Long Term Prevailing Wind - Nighttime	39.3	59.2	4.8	-	-
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 at times during monitoring period. Based on site observations and audio recordings, the sources of sounds in the study area includes sounds from transportation (Tower Lake 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 27.4 to 44.2 dBA at 69m and ranged from 31.6 to 47.0 dBA at 300m south from Tower lake Road during the measurement period, and both daytime and Nighttime CSL are lower than BC OGC current assumed BSL but higher than the ASL at both locations. The monitor TL 2 location is farther away from the Tower lake Road, but the measured SPL were even higher than the monitor TL 1 location, which means Tower lake Road does no dominate sound levels at this area. The traffic counting information collected as per on-site camera and noise recording during the survey also indicated there is much lower traffic along Tower Lake road. Traffic count in one typical day is shown Table 6, compared with the BC OGOC heavy travelled road criteria, 10 vehicles per hour during the nighttime period.

Table 6 Traffic Information Collected along Tower Lake Road
(Count days Feb 20-21, 2020)

	Daytime (7:00-22:00)	Nighttime (22:00-7:00)	Vehicle Observed
Total vehicles	80	6	Most of the vehicles for the nearby facility site, which include pick up trucks, Kubotas, tankers, and passenger cars.

The noise contribution from Tower Lake Road were also modeled as per ISO mild downwind conditions, listed in table 5A and 5B for each monitoring location. The results indicated that the road traffic contribution is minor in this area. Therefore, the measured noise results were dominated by the wind, fauna and weather and sounds of nature. During the survey, most of the time were upwind conditions from Tower Lake Road, there is not enough data for the downwind and crosswind conditions. Based on this survey the ASL may be adjusted upward during wind conditions above 15 km/hr, it is recommended that longer term monitoring study is required to quantify the typical ambient noise level in this area.

Sound Monitor Sweetwater (SW) Measurement Location

Sound Monitor SW was located approximately 50 m south from Sweetwater Road, 7800m northeast from Highway 97. This location was selected because it represents the traffic noise emissions from the Sweetwater Road.

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 due to extreme wind.

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.

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

Table 7A: Sound Monitor SW Results

Period	Date (2020)	Measured Leq (dBA)	Measured Hours	*Residual Leq (dBA)	Residual Hours
Day 01	Feb 20	73.5	7.2	53.3	6.5
Night 01	Feb 20 - Feb 21	53.9	9.0	52.4	8.6
Day 02	Feb 21	56.6	15.0	55.9	12.6
Night 02	Feb 21 - Feb 22	49.8	9.0	49.0	8.7
Day 03	Feb 22	54.0	15.0	53.9	13.8
Night 03	Feb 22 - Feb 23	46.1	9.0	41.9	7.8
Day 04	Feb 23	48.3	15.0	33.1	10.4
Night 04	Feb 23 - Feb 24	44.4	9.0	27.1	8.1
Day 05	Feb 24	56.1	15.0	37.7	9.4
Night 05	Feb 24 - Feb 25	48.5	9.0	37.3	7.7
Day 06	Feb 25	56.0	15.0	36.9	9.7
Night 06	Feb 25 - Feb 26	48.9	9.0	48.0	8.5
Day 07	Feb 26	57.4	15.0	51.6	11.4
Night 07	Feb 26 - Feb 27	51.0	9.0	50.4	8.5
Day 08	Feb 27	69.7	15.0	51.8	4.4
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 SW Results

Measured Period	Measured Residual Leq (dBA)	Measured Hours	Wind Speed (kph)	Predicted Noise Contribution from Sweet water Road (dBA)	Difference Measured SPL -Predicted Sweet water Road Contribution (dB)
Total Survey Period - Daytime	51.9	78.4	20.2	36.6	15.3
Total Survey Period - Nighttime	48.2	57.8	13.3	29.0	19.2
Total Survey Period – Daytime (Upwind)	51.9	78.4	20.2	-	-
Total Survey Period – Nighttime (Upwind)	48.2	57.8	13.3	-	-
BC OGC Current Assumed BSL (ASL) (dBA) - Daytime	50.0 (45.0)				
BC OGC Current Assumed BSL (ASL) (dBA) - Nighttime	40.0 (35.0)				

The results of the survey show that the acoustic environment was dominated by wind and transportation noise (during periods with lower wind speeds) during monitoring period. Based on site observations and audio recordings, the sources of sounds in the study area includes sounds from transportation (Sweet Water Road and 223 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 27.1 to 55.9 dBA during measurement period, and both daytime and Nighttime CSL are higher than BC OGC current assumed BSL (ASL) at the monitoring location. The sound level results during the survey period included intermittent contamination from strong wind conditions which rendered some data unreliable. The measured sound level results during night 04 period (Feb 23 - Feb 24) indicated that the noise levels could be lower than 30 dBA during calm wind conditions. The traffic counting information collected as per on-site camera and noise recording during the survey indicated that traffic volumes along Sweetwater Road and 223 Road are lower than BC OGOC heavy travelled road criteria, 10 vehicles per hour during the nighttime period. Outlined in Table 8.

Table 8 Traffic Information Collected along the local Roads
(Count days Feb 21-22, 2020)

	Daytime (7:00-22:00)	Nighttime (22:00-7:00)	Vehicle Observed
Total vehicles along Sweet Water Road	161	25	Pick up trucks and passenger cars.
Total vehicles along 223 Road	12	2	

The noise contribution from the Sweet Water Road were also modeled as per ISO mild downwind conditions, listed in table 7B for the monitoring location. The results indicated that the road traffic contribution is minor in this area relative to the wind noise. Therefore, the measured noise results were dominated by the wind, fauna and weather and sounds of nature. During the survey, most of the time were upwind conditions from Sweetwater Road, there is no data captured for the downwind and crosswind conditions. The limited data available suggests that some residences within 50 metres of the Sweetwater Road would qualify for ambient adjustments for traffic noise under certain circumstances. This would be dependant on residence specific factors like yard layout, precise distance to the traffic lanes, and road profiles; given the limited data available it is not possible to assess these factors on a general basis. Review of publicly available data suggests that fewer than 20 residences may be within 50 metres of the Sweetwater road and PAAE recommends assessing these on a site specific basis, as opposed to conducting more research into a method for broad based modeling.

Based on this survey the ASL may be adjusted upward during period of high wind. Wind speeds above 15 km/hr corelate to sound levels above 45 dBA. This suggests that wind induced sound may provide masking for industrial or traffic noise and thus qualify for A2 adjustments during periods of high wind. Additional research is recommended to determine changes to wind induced sound from foliage (leaves) and ground cover (snow/grass) as well as receiver experienced (wind induced microphone noise) prior to developing general guidelines. It is recommended that longer term monitoring study is required to quantify the typical ambient noise level in this area as well as practical implications for noise mitigation design.

At this location, weather data was obtained from the Environment Canada Dawson Creek Airport, which is close to this studied area, but may still not represent this specific local situation. Audio recordings were relied on to determine if wind was contaminating the sound measurements.

Measured ambient sound levels for receivers near the Sweetwater Road were higher than those currently considered in the BC OGC Guidelines. Ambient sound levels were dominated by wind and other environmental sounds; traffic noise did not dominate the sound environment during the measurement period. Limited data was available to accurately predict traffic noise affects there is some evidence to suggest traffic volumes for residences within 50 metres of Sweetwater Road would qualify for ambient adjustments under some circumstances. This may apply to fewer than 20 residences and PAAE recommends assessing these on a case by case basis. Additional monitoring is required, with lower levels of wind contamination, to quantify ambient sound levels from traffic.

Noise Predictions from Roads' Traffic

In the Farmington Development Area, the Regional Roads may have a potential impact in the local area adjacent to the roadway. For the selected two local areas, Tower lake Road and Sweet Water Road were modeled with the traffic counting data assessed during the monitoring period.

The physical layout near Tower Lake road and Sweetwater Road were obtained from the field visit, aerial photos and topographical maps. Sound power levels of the road were determined as per the daytime and nighttime hourly traffic volume in the area during the monitoring period. 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.

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 procedure used to create the noise model follows acoustical engineering methodologies, which are typically used for heavily traveled roads and traffic noise barrier design. It is not known if these methodologies apply to roadways with low traffic volume.

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	Represents typical nighttime temperature.
Relative Humidity	80%	Represents typical nighttime relative humidity.
Topography	Included	Topographical data obtained from Natural Resources Canada. Resolution of 1 m.

The predicted results have been listed in Table 5A, 5B and 7B in previous sections.

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 for both studied local areas excluding the ambient sound levels (ASL).

- Figures 3A to 3B were based on ISO standard wind condition, which is mild downwind conditions for the area for Tower lake area.

- Figures 4A to 4B were based on ISO standard wind condition, which is mild downwind conditions for the area for Sweet Water area

In general the modeled noise contributions from the roads are more than 10 to 20 dB lower than the measured results. Two possible hypotheses follow:

- Traffic noise was subdominant to other ambient sounds during the measurement period, this was confirmed at the Tower Lake site, but not at Sweetwater due to limited data.
- The standard acoustical modeling technique applied to these roadways produces results that are lower than actual, possibly because of low traffic volumes.

Both hypotheses could be tested through additional monitoring and by capturing data that was not contaminated by wind.

Figure 3a: Noise Emission map in Tower Lake Area

(ISO Condition, Daytime)

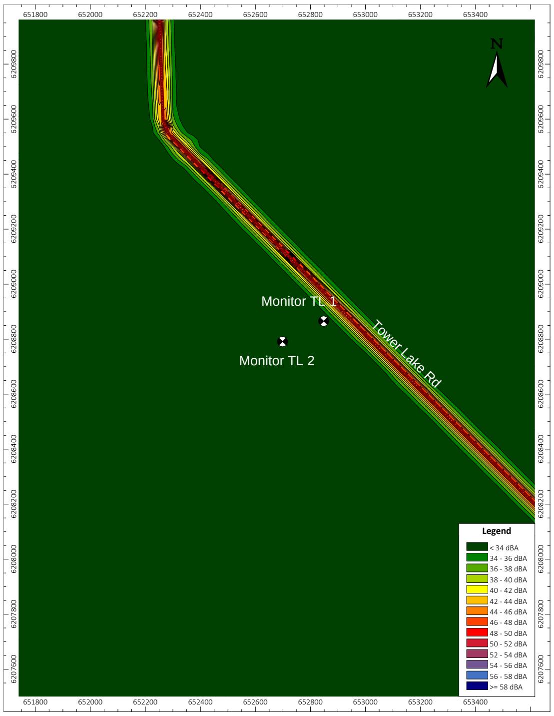


Figure 3b: Noise Emission map in Tower Lake Area

(ISO Condition, Nighttime)

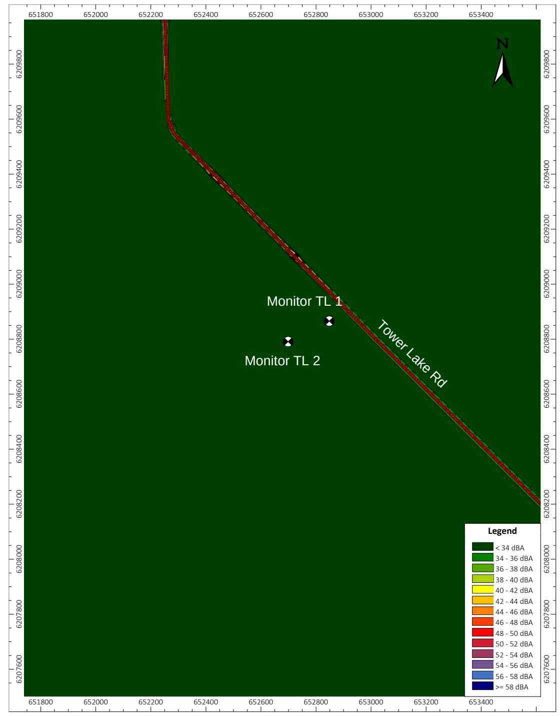


Figure 3c: Noise Emission map in Sweet water Area

(ISO Condition, Daytime)

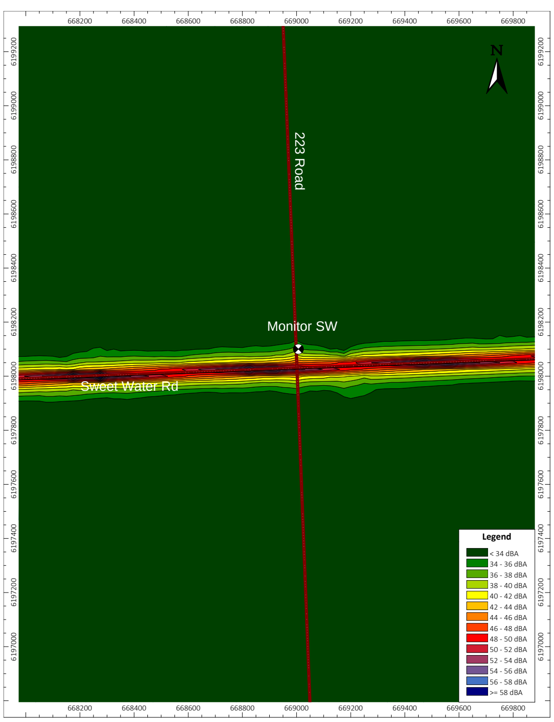
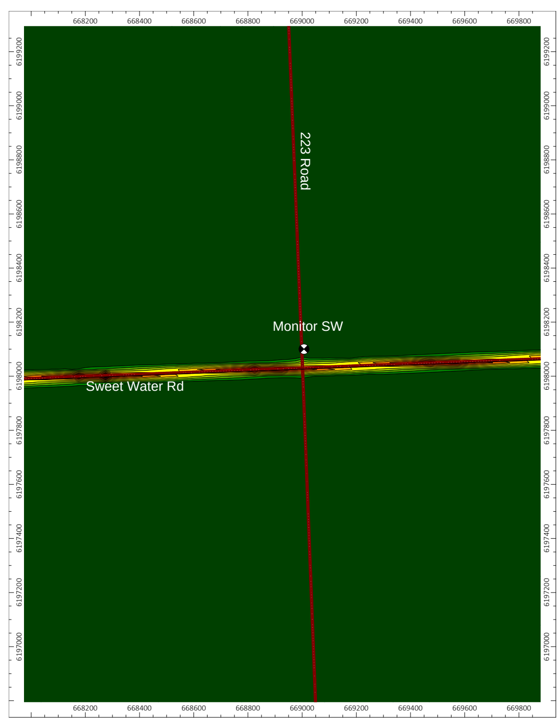


Figure 3d: Noise Emission map in Sweet water Area

(ISO Condition, Nighttime)



Conclusion

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 two typical regional roads in the Farmington Development Area (FDA), located NW of Dawson Creek, British Columbia. The roads studied were the Tower Lake Road and the Sweetwater Road.

The purpose of the sound survey is to quantify the current (2020) ambient sound levels near some typical regional roads, 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 report outlines the results from the typical regional roads and outlines the results from monitoring and initial modeling results for these roads through the Farmington Development Area. To achieve this purpose two areas were selected and studied in detail through noise monitoring and noise modeling. Three 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 acoustic environment at the three receivers studied was affected by transportation, fauna and weather. The measured ambient sound levels at all the monitoring locations were generally higher than the assumed BC OGC current assumed ASL the major contributors were wind noise and traffic noise.
- **Tower Lake Road:** Measured ambient sound levels for receivers near Tower Lake Road were slightly higher than those currently considered in the BC OGC Guidelines. Ambient sound levels were dominated by wind and other environmental sounds; traffic noise did not contribute significantly at the measurement locations. Traffic volumes along Tower Lake Road are low and do not warrant adjustments to the PSL.
- **Sweetwater Road:** Measured ambient sound levels for receivers near the Sweetwater Road were higher than those currently considered in the BC OGC Guidelines. Ambient sound levels were dominated by wind and other environmental sounds; traffic noise did not dominate the sound environment during the measurement period. Limited data was available to accurately predict traffic noise affects there is some evidence to suggest traffic volumes for residences within 50 metres of Sweetwater Road would qualify for ambient adjustments under some circumstances. This may apply to fewer than 20 residences and PAAE recommends assessing these on a case by case basis. Additional monitoring is required, with lower levels of wind contamination, to quantify ambient sound levels from traffic.
- **Local Wind Conditions:** Wind contamination was significant at both locations during the monitoring period. Wind induced sound corelated to ambient sound levels above 45 dBA when wind speeds were above 15 k/hr. This suggests that wind induced sound may provide masking for industrial or traffic noise and thus qualify for A2 adjustments. Additional research is recommended to determine changes to wind induced sound from foliage (leaves) and ground cover (snow/grass) as well as receiver experienced (wind induced microphone noise) prior to developing general guidelines. In addition, the study highlights that local wind conditions vary greatly from regional wind conditions; local site specific weather data should be used for all sound monitoring, as opposed to relying on weather data from regional weather stations several kilometres from the monitoring site.

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.

International Organization for Standardization (ISO). 1993. *Standard 9613-1, Acoustics – Attenuation of Sound during Propagation Outdoors – Part 1: Calculation of Absorption of Sound by the Atmosphere*, Geneva Switzerland.

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 10^{th} 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:

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

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 Monitors TL1, TL 2 and SW

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}			

	Nighttime	Daytime
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				

	Nighttime	Daytime
Class B Adjustment	0	0
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 TL 1 and Weather Monitor Setup
(South 69m from the Tower Lake Road)

Picture C2: Sound Monitor Tl 2 and Weather Monitor Setup
(South 300m from Tower Lake Road)

Picture C3: Sound Monitor SW Setup
(50m North from Sweet Water Road)

APPENDIX D

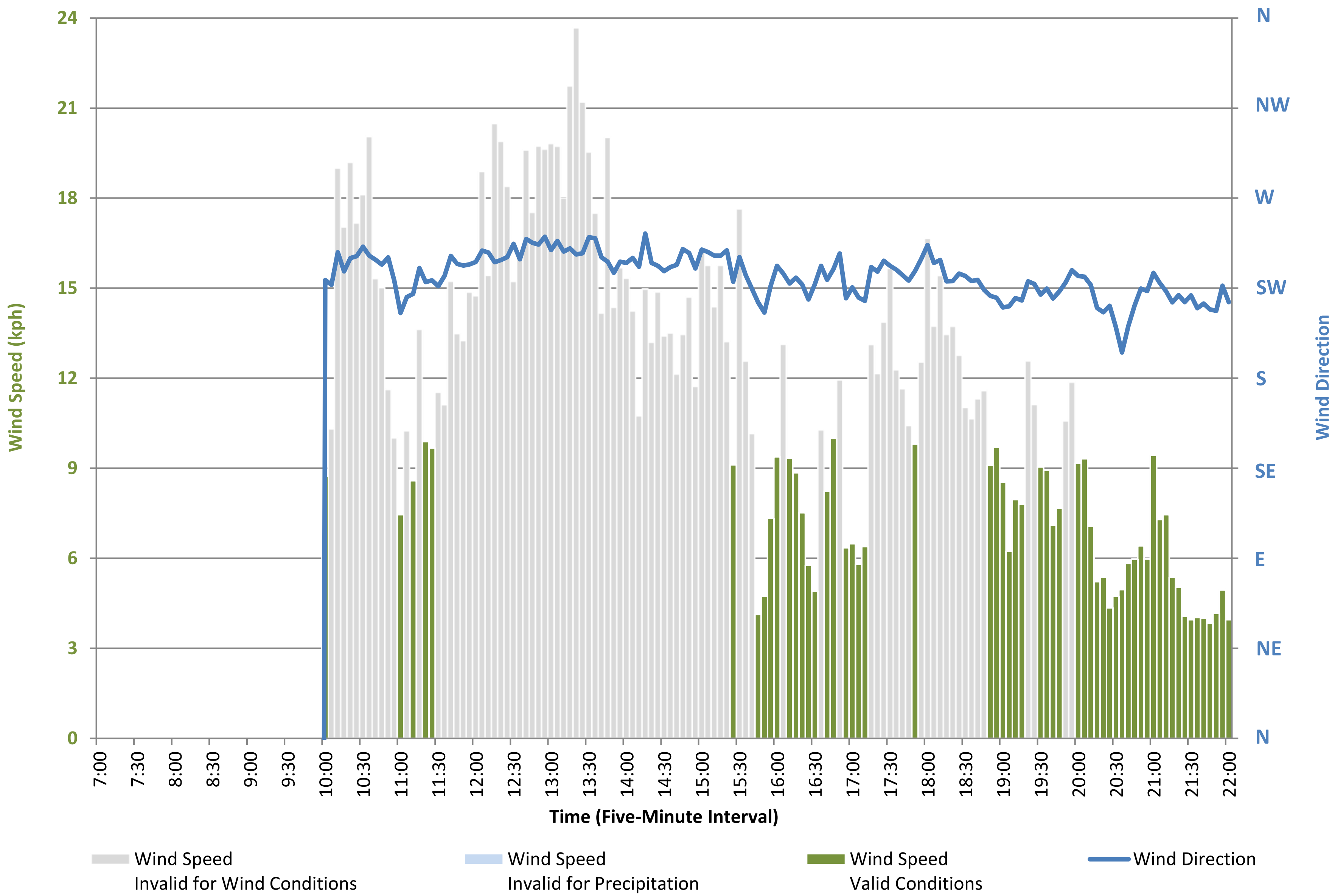
Weather Measurement Data

Table D: Weather Summary

Period	Date (2020)	Average Speed (kph)	Average Direction	Minutes of Audible Precipitation	Minutes of Downwind Conditions	Minutes of Valid Conditions	General Description	Period Valid
Day 01	Feb 20	12	SW	0	0	280	Moderate wind	Yes
Night 01	Feb 20 - Feb 21	7	SW	0	0	425	Moderate wind	Yes
Day 02	Feb 21	10	SW	0	0	495	Moderate wind	Yes
Night 02	Feb 21 - Feb 22	6	SW	0	0	495	Moderate wind	Yes
Day 03	Feb 22	14	WSW	0	0	340	Moderate wind	Yes
Night 03	Feb 22 - Feb 23	4	SSW	0	0	520	Light wind	Yes
Day 04	Feb 23	2	W	0	305	900	Light wind	Yes
Night 04	Feb 23 - Feb 24	2	SW	0	0	540	Light wind	Yes
Day 05	Feb 24	3	SSW	0	45	900	Light wind	Yes
Night 05	Feb 24 - Feb 25	3	SSW	0	0	540	Light wind	Yes
Day 06	Feb 25	4	SSW	0	0	900	Light wind	Yes
Night 06	Feb 25 - Feb 26	5	SSW	0	0	540	Light wind	Yes
Day 07	Feb 26	9	SW	0	0	595	Moderate wind	Yes
Night 07	Feb 26 - Feb 27	6	SSW	0	0	515	Moderate wind	Yes
Day 08	Feb 27	6	SW	0	0	55	Moderate wind	No

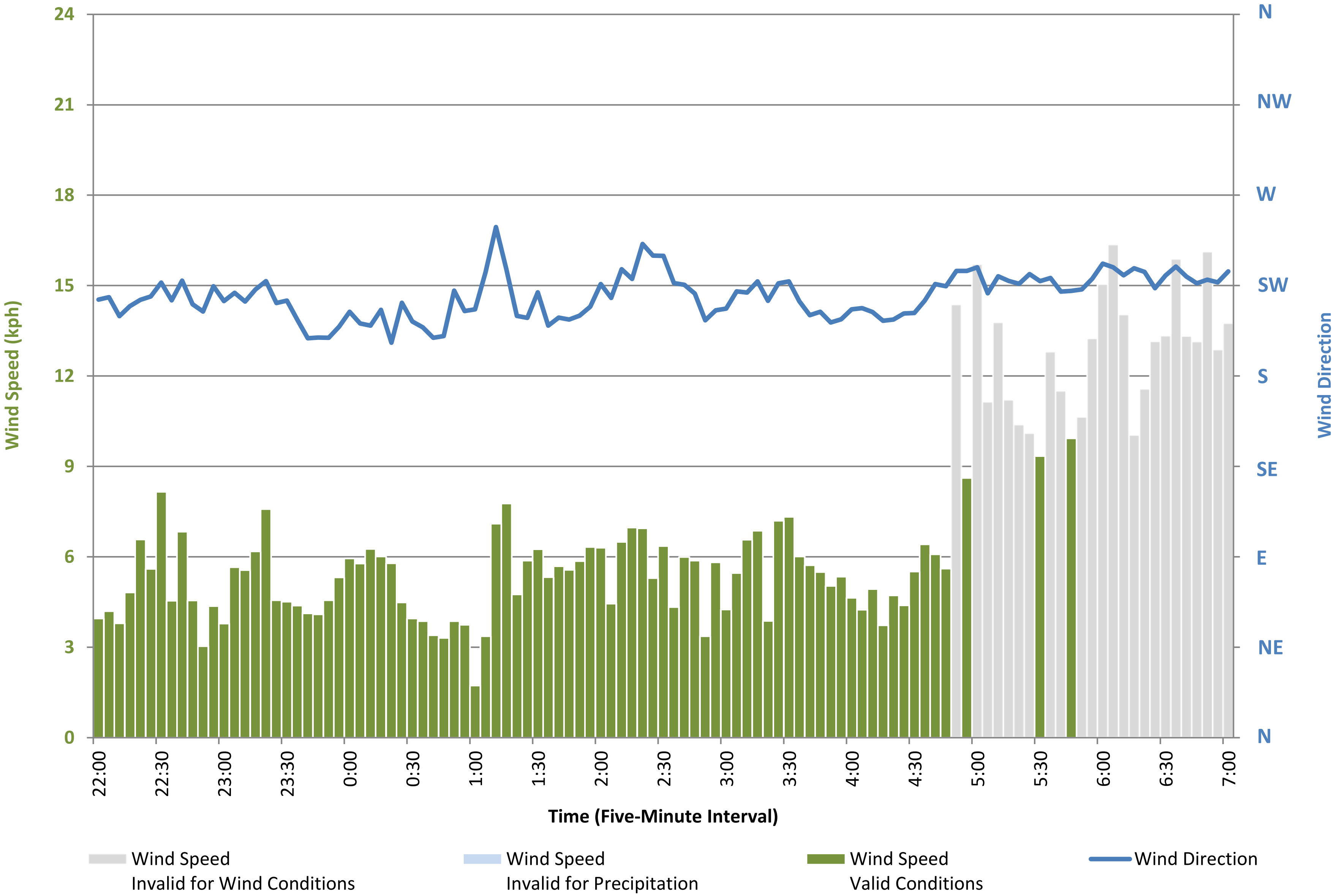
Weather Monitor Data - Tower Lake Rd

Figure D1 Day 1 Feb 20



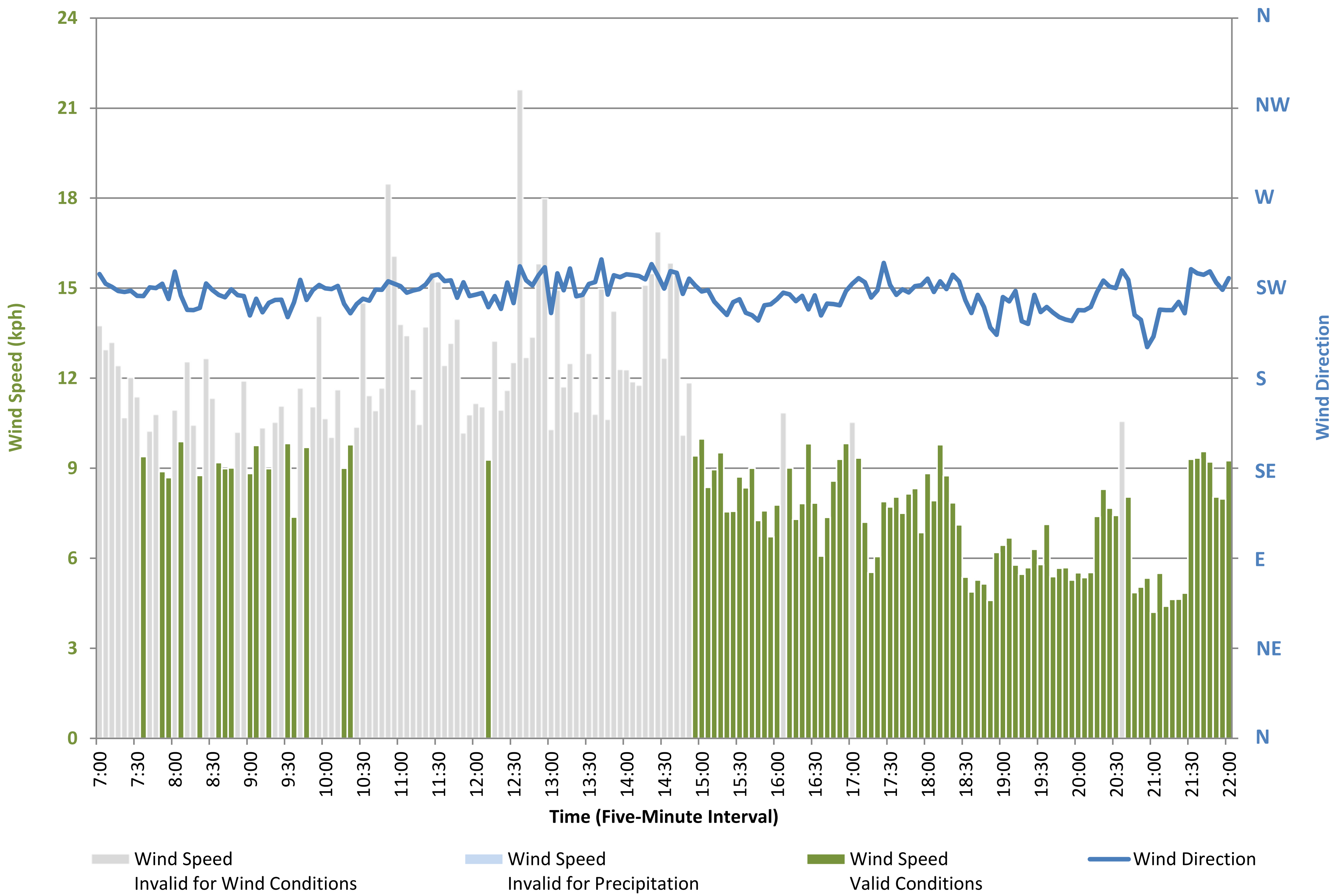
Weather Monitor Data - Tower Lake Rd

Figure D2 Night 1 Feb 20 - Feb 21



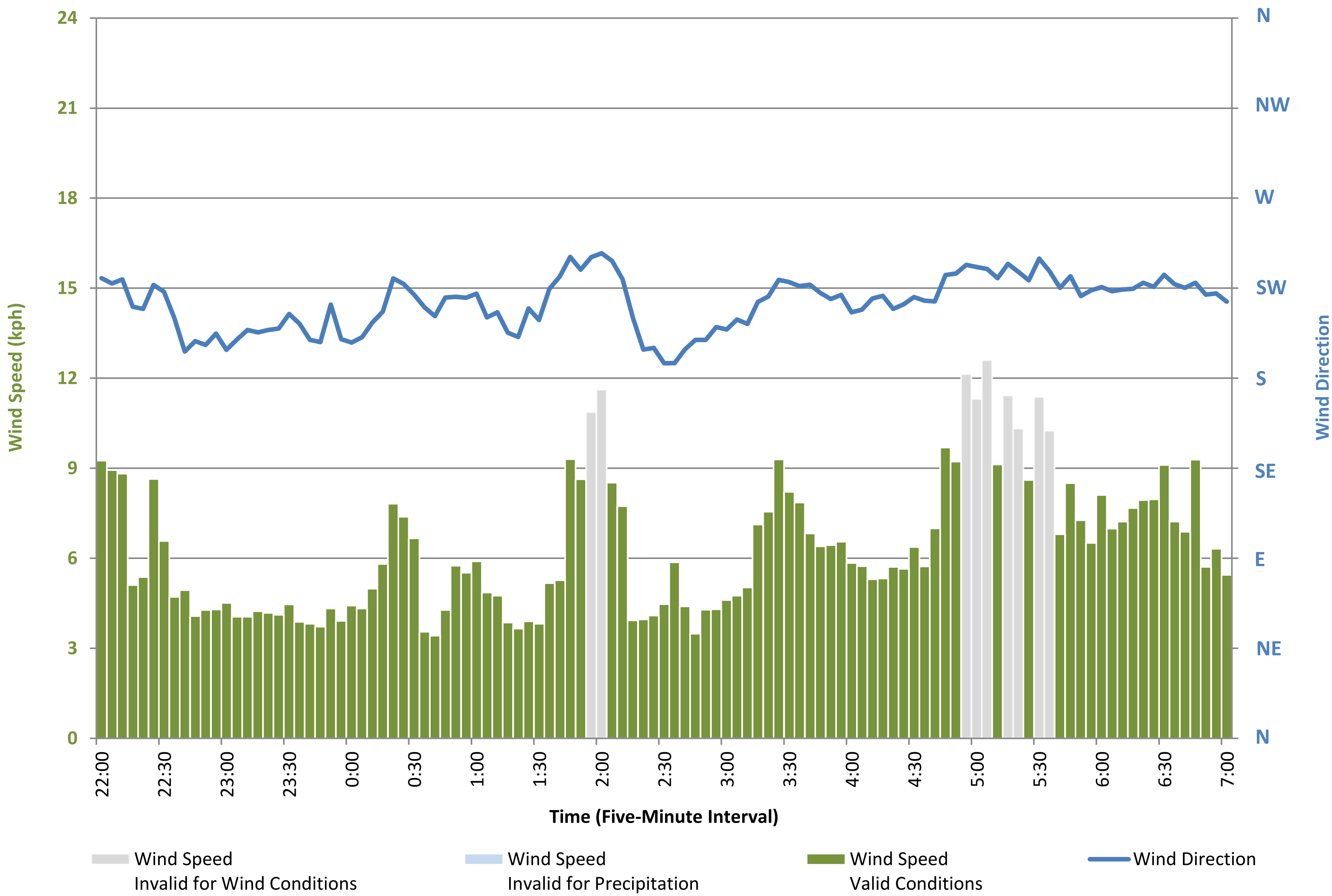
Weather Monitor Data - Tower Lake Rd

Figure D3 Day 2 Feb 21



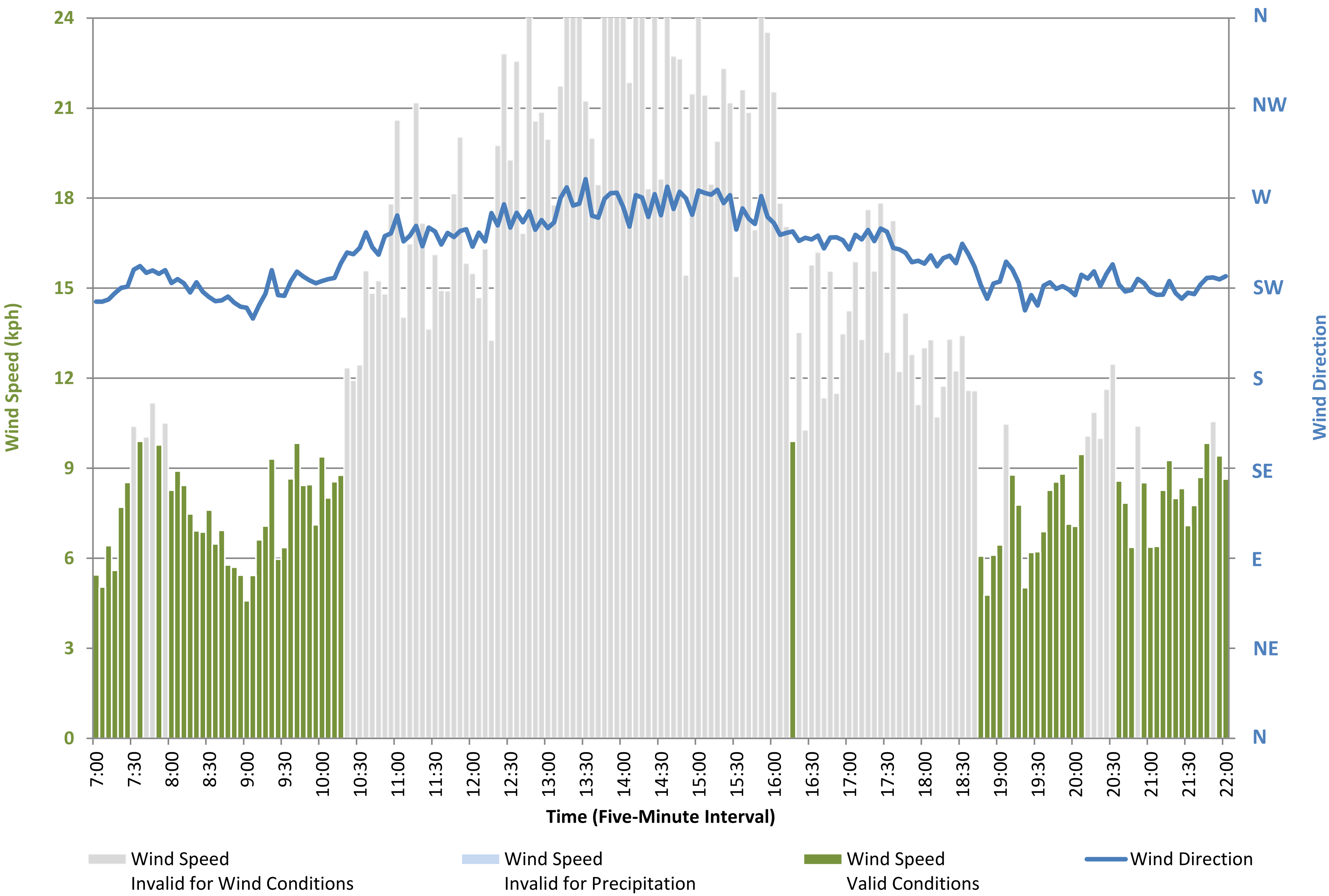
Weather Monitor Data - Tower Lake Rd

Figure D4 Night 2 Feb 21 - Feb 22



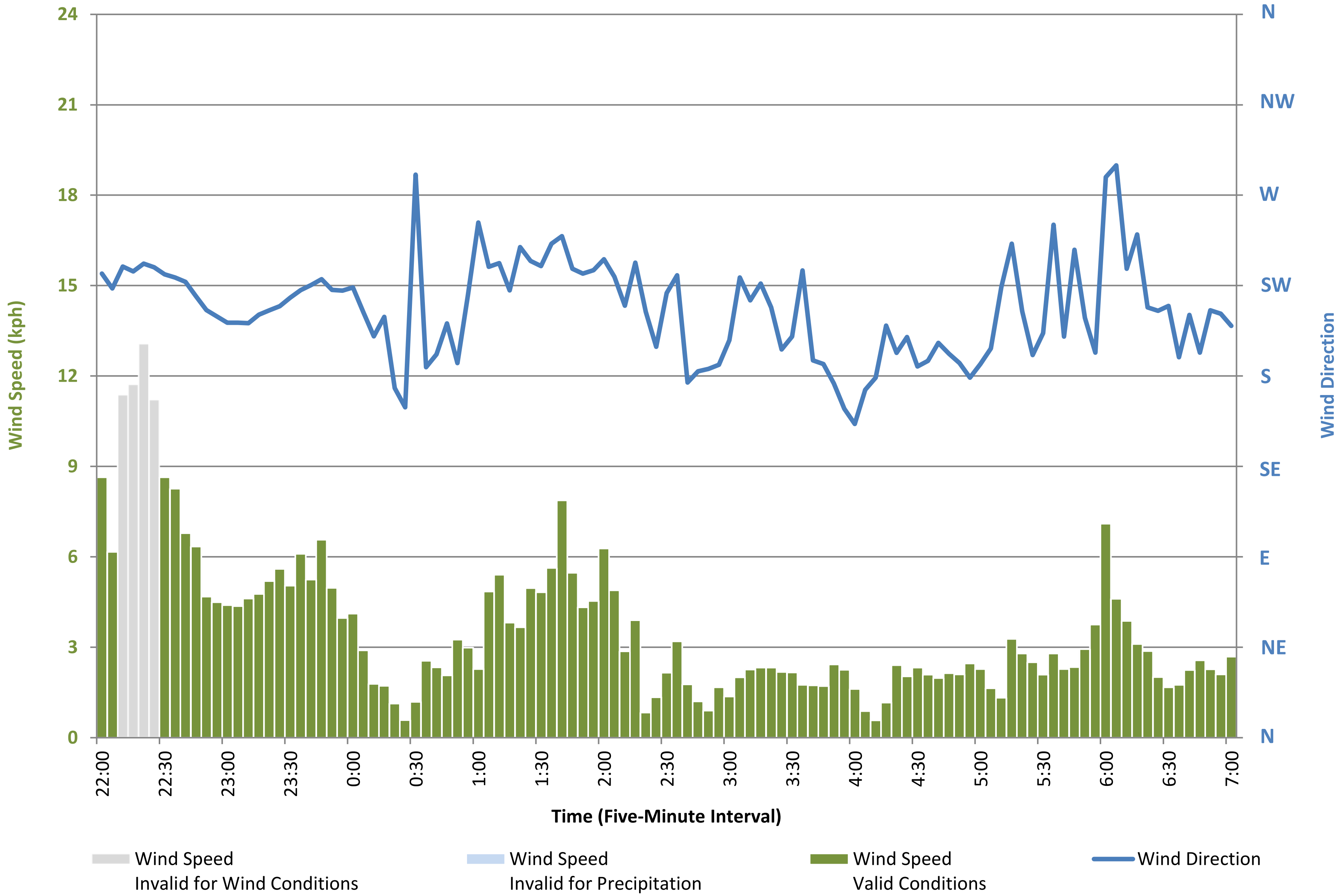
Weather Monitor Data - Tower Lake Rd

Figure D5 Day 3 Feb 22



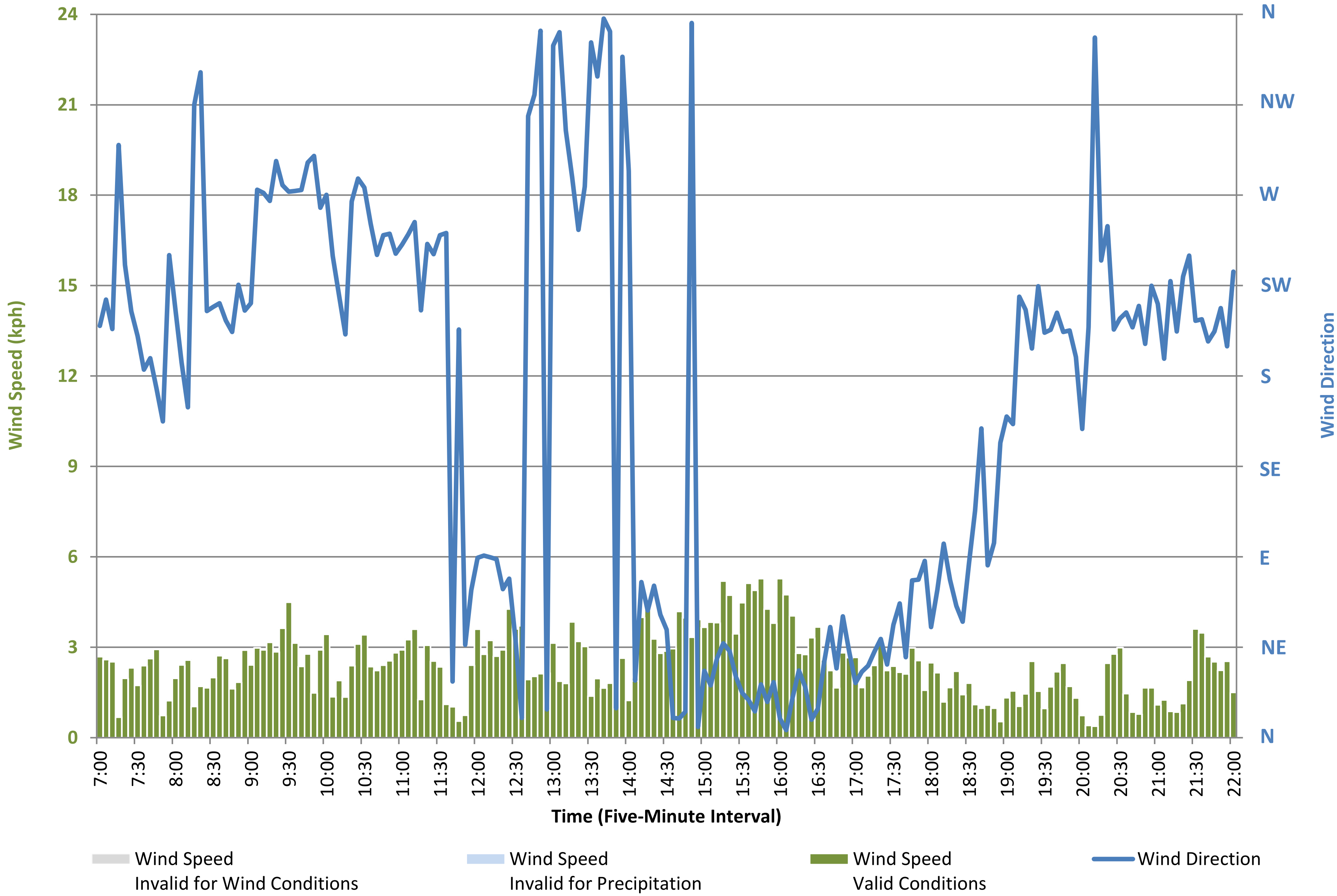
Weather Monitor Data - Tower Lake Rd

Figure D6 Night 3 Feb 22 - Feb 23



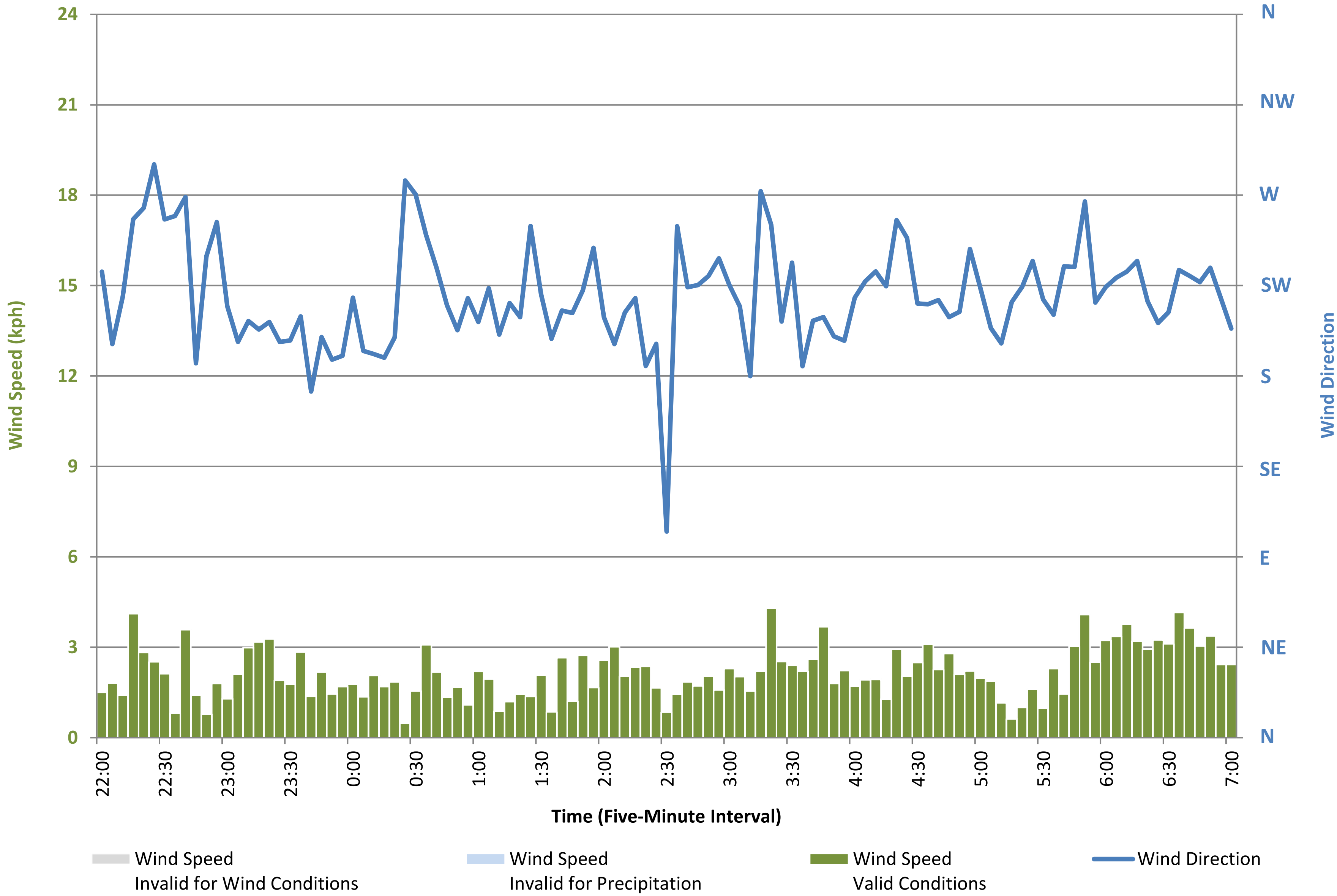
Weather Monitor Data - Tower Lake Rd

Figure D7 Day 4 Feb 23



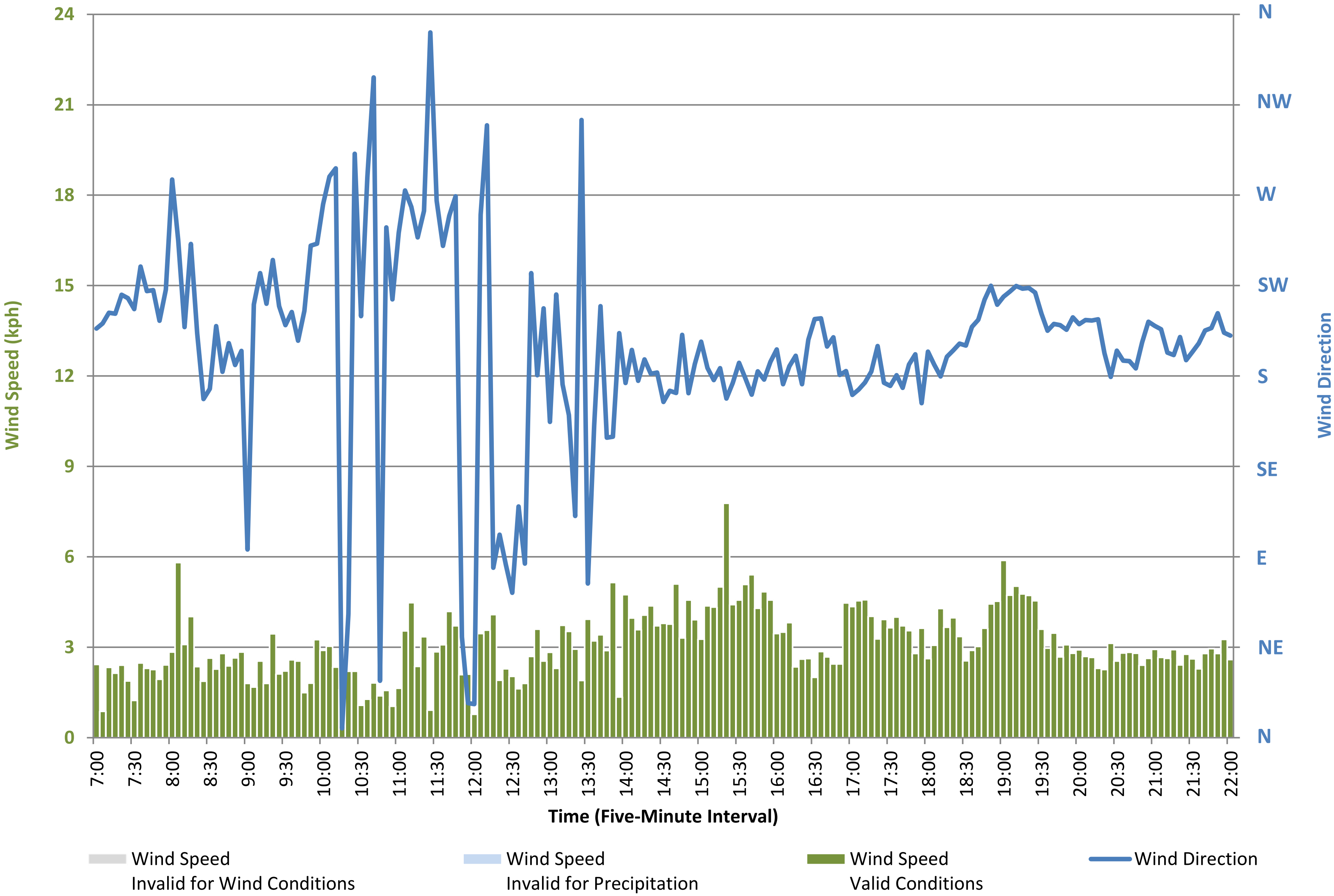
Weather Monitor Data - Tower Lake Rd

Figure D8 Night 4 Feb 23 - Feb 24



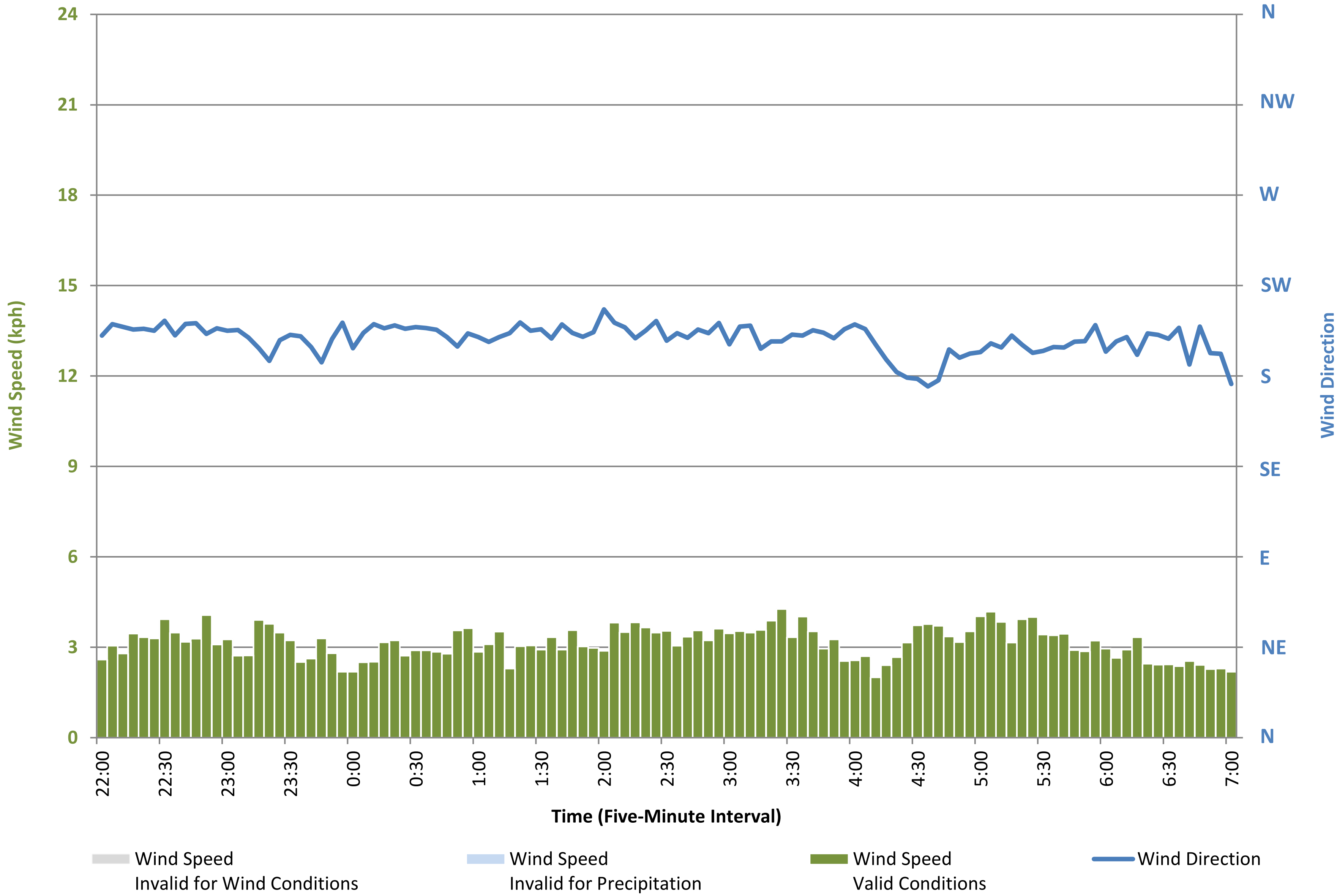
Weather Monitor Data - Tower Lake Rd

Figure D9 Day 5 Feb 24



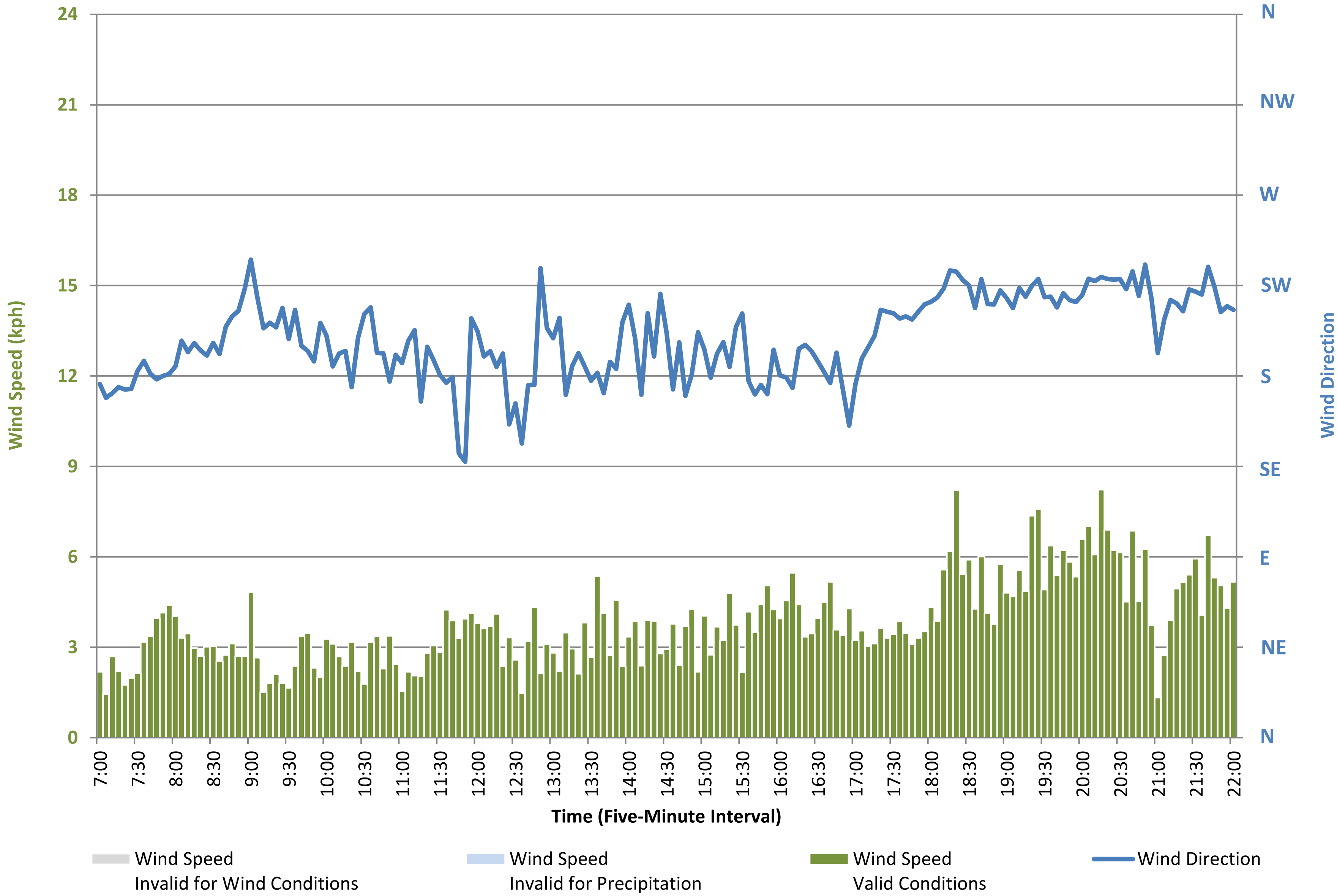
Weather Monitor Data - Tower Lake Rd

Figure D10 Night 5 Feb 24 - Feb 25



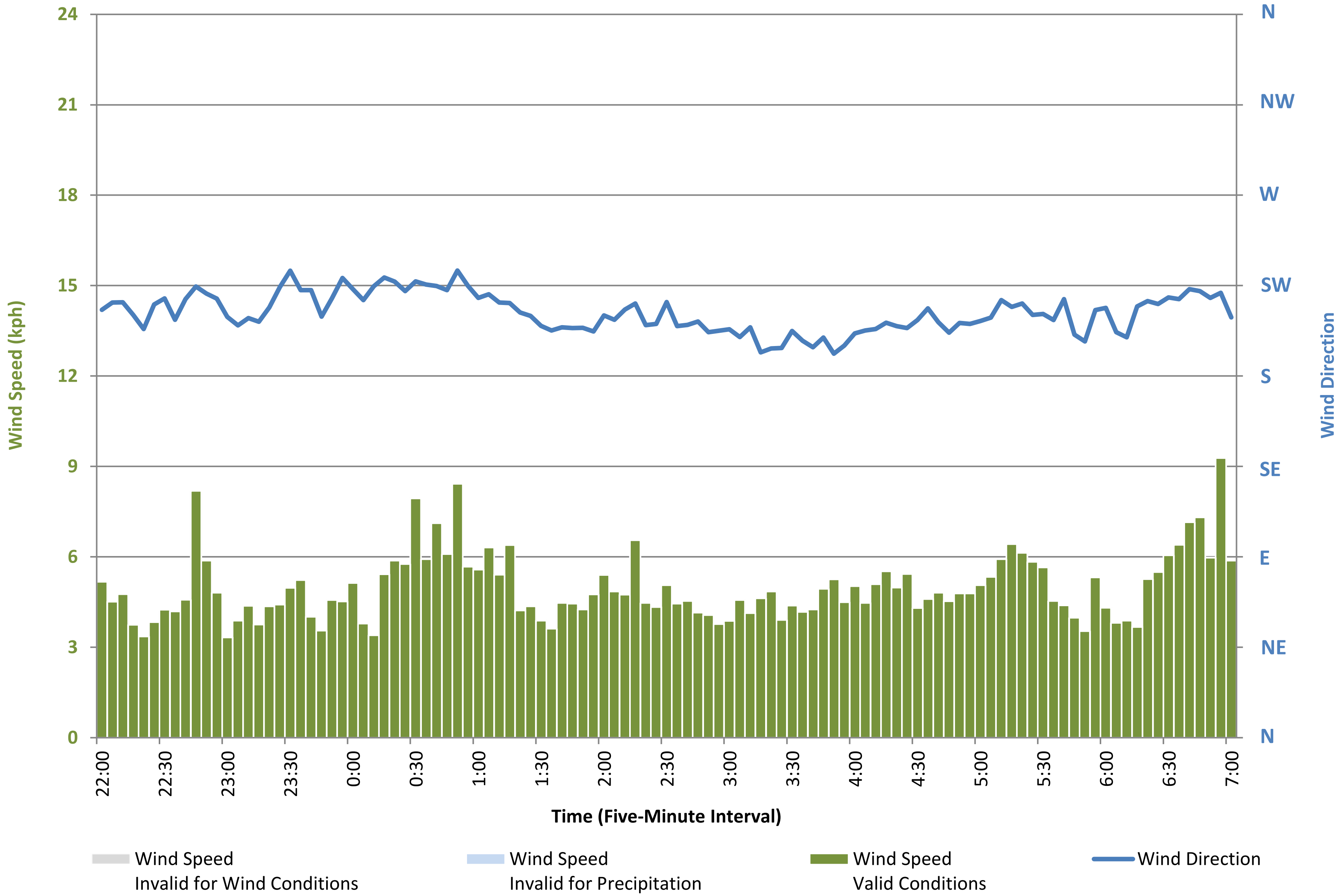
Weather Monitor Data - Tower Lake Rd

Figure D11 Day 6 Feb 25



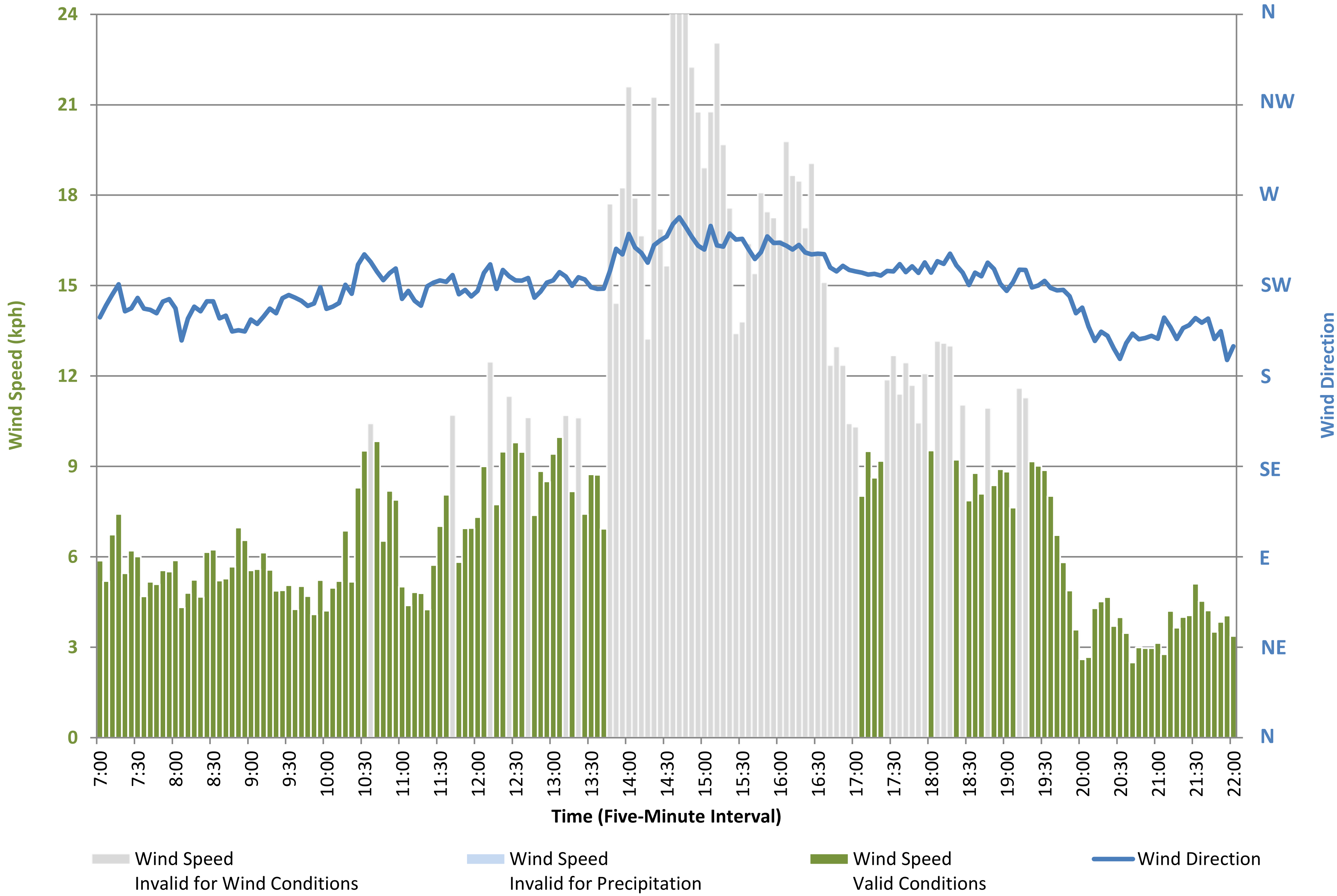
Weather Monitor Data - Tower Lake Rd

Figure D12 Night 6 Feb 25 - Feb 26



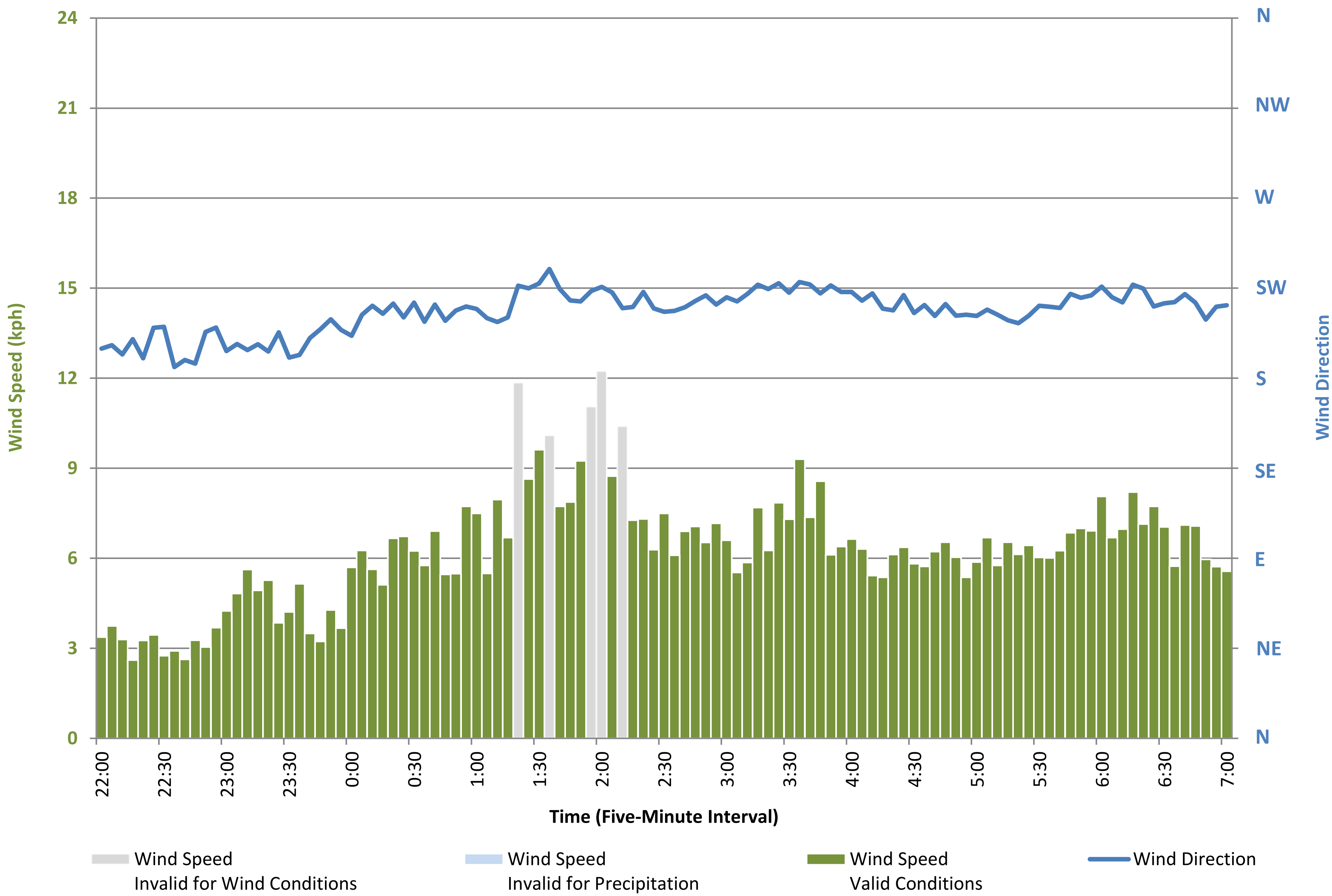
Weather Monitor Data - Tower Lake Rd

Figure D13 Day 7 Feb 26



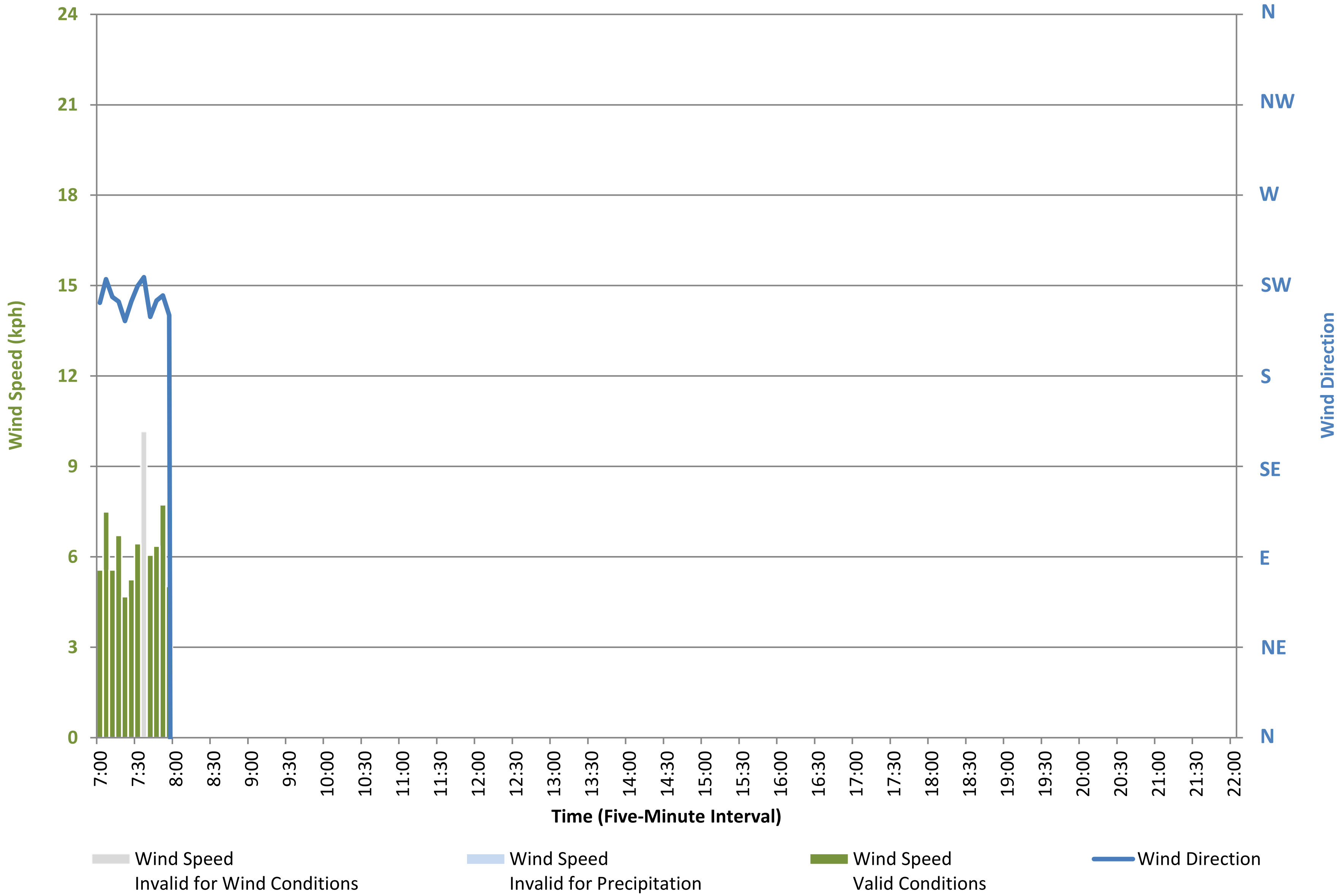
Weather Monitor Data - Tower Lake Rd

Figure D14 Night 7 Feb 26 - Feb 27



Weather Monitor Data - Tower Lake Rd

Figure D15 Day 8 Feb 27

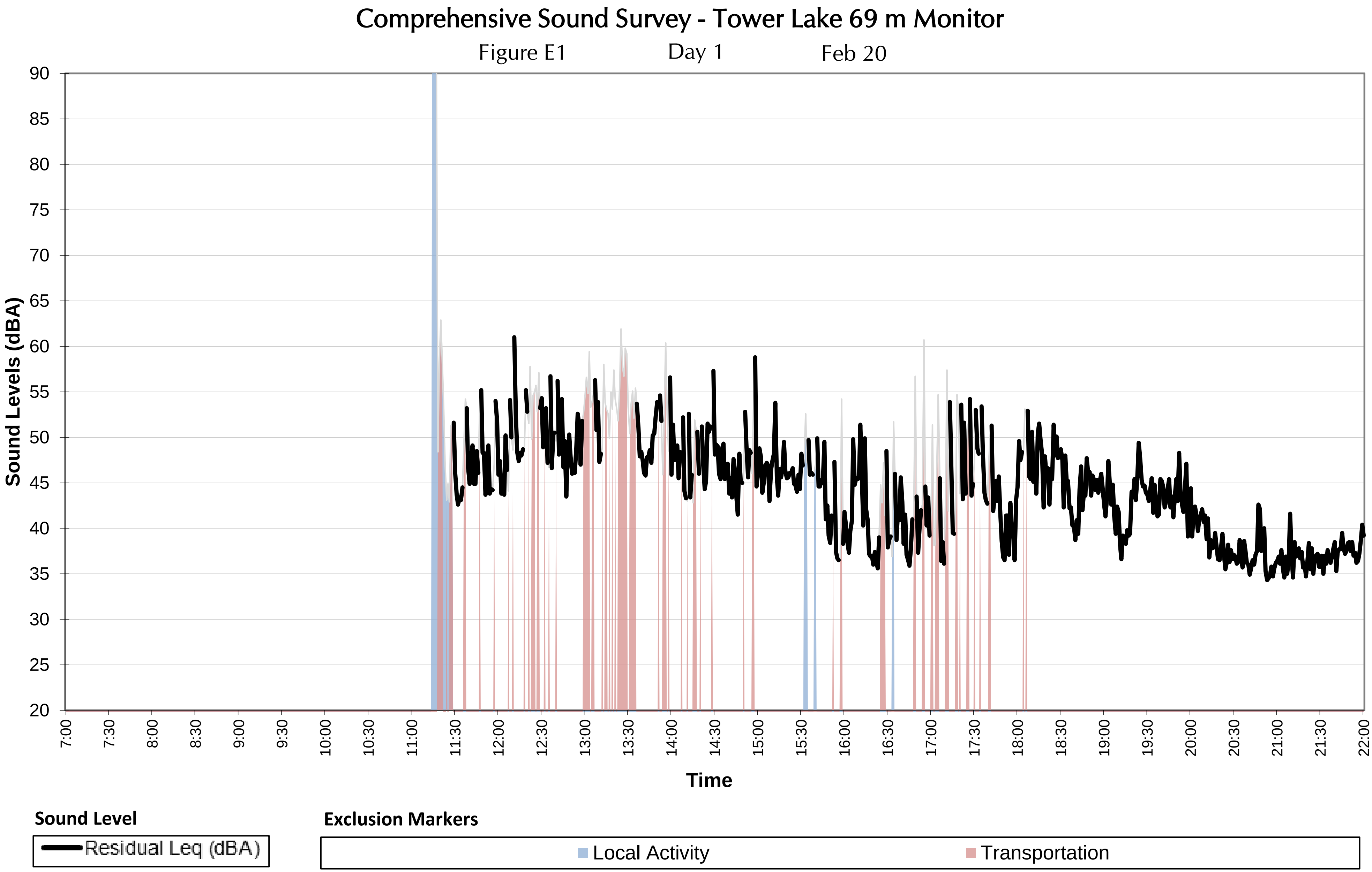


APPENDIX E

Sound Level Measurements
Sound Monitor TL 1
South 69m from Tower Lake Road

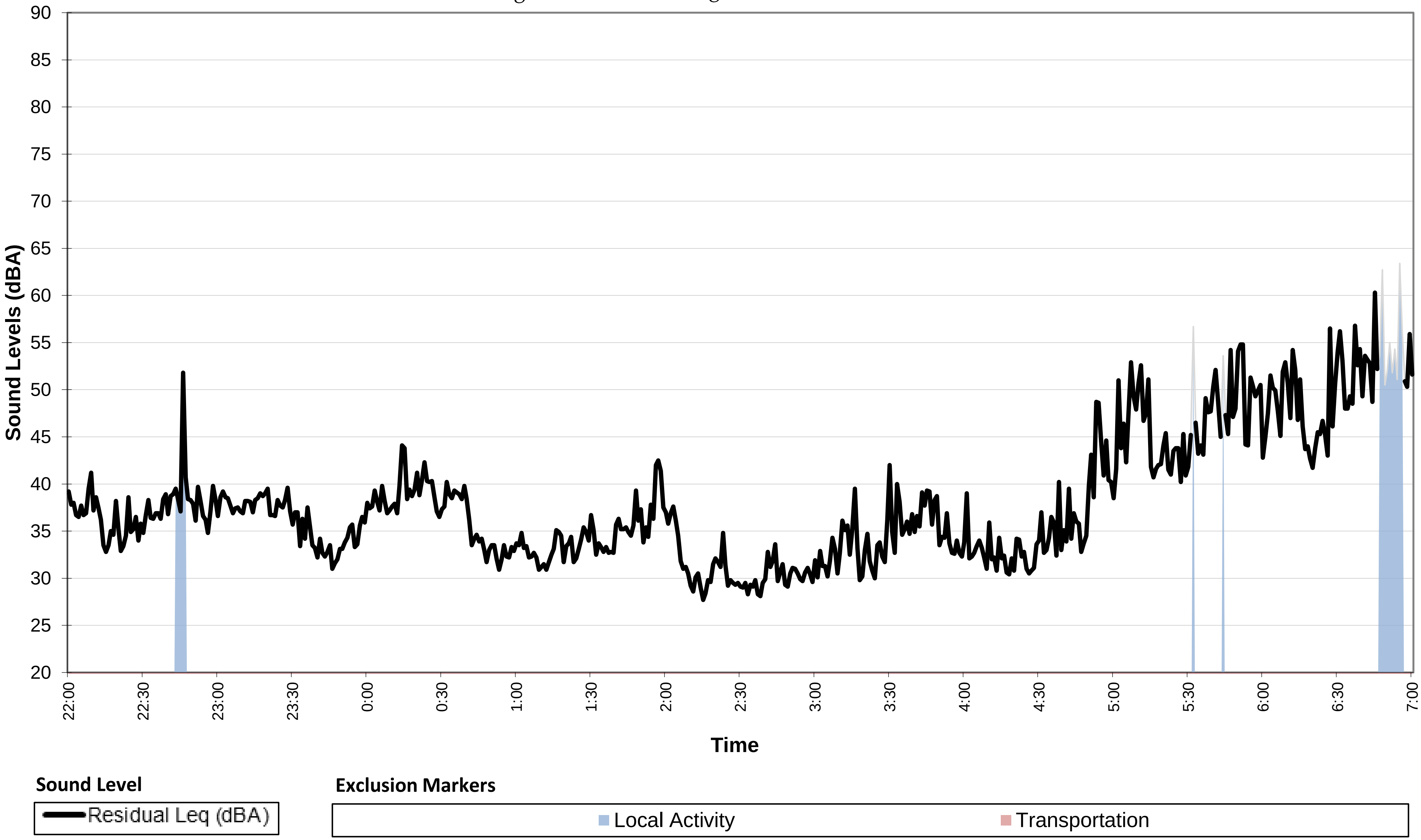
Table E: Comprehensive Sound Survey - Tower Lake 69 m Monitor

Period	Date (2020)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Feb 20	71.6	10.8	47.5	9.0
Night 01	Feb 20 - Feb 21	45.7	9.0	44.1	8.8
Day 02	Feb 21	50.5	15.0	50.2	14.6
Night 02	Feb 21 - Feb 22	41.0	9.0	35.3	8.5
Day 03	Feb 22	47.1	15.0	45.6	13.3
Night 03	Feb 22 - Feb 23	37.4	9.0	33.6	8.7
Day 04	Feb 23	41.1	15.0	26.2	12.9
Night 04	Feb 23 - Feb 24	0.0	9.0	0.0	9.0
Day 05	Feb 24	0.0	15.0	0.0	15.0
Night 05	Feb 24 - Feb 25	0.0	9.0	0.0	9.0
Day 06	Feb 25	0.0	15.0	0.0	15.0
Night 06	Feb 25 - Feb 26	0.0	9.0	0.0	9.0
Day 07	Feb 26	34.2	15.0	31.2	14.5
Night 07	Feb 26 - Feb 27	42.6	9.0	39.8	8.2
Day 08	Feb 27	72.2	15.0	41.6	3.3


Comprehensive Sound Survey - Tower Lake 69 m Monitor
Figure E1
Day 1
Feb 20
Sound Levels (dBA)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
7:00
7:30
8:00
8:30
9:00
9:30
10:00
10:30
11:00
11:30
12:00
12:30
13:00
13:30
14:00
14:30
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
20:30
21:00
21:30
22:00
Time
Sound Level
Residual Leq (dBA)
Exclusion Markers
Local Activity
Transportation

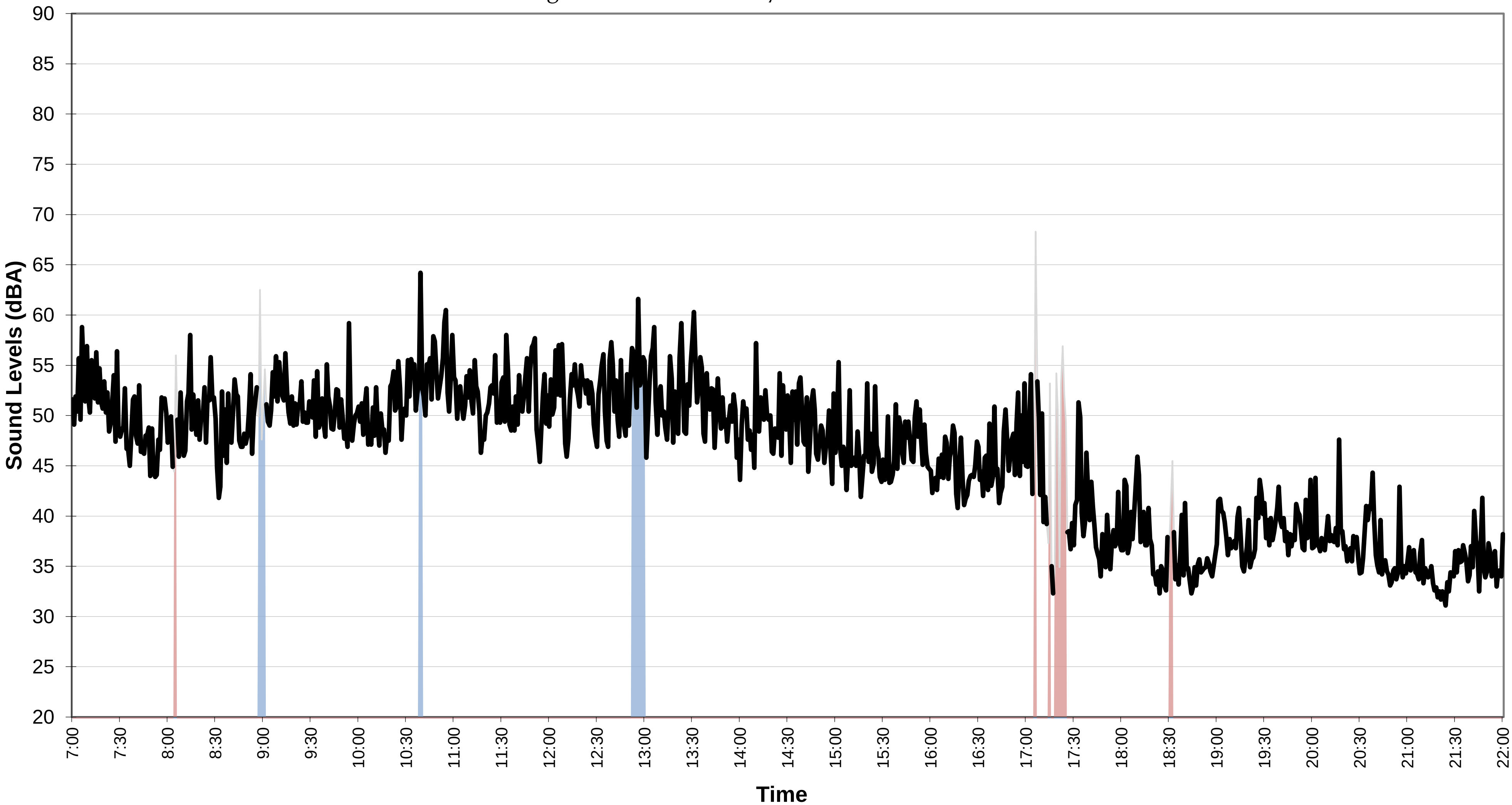
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E2 Night 1 Feb 20 - Feb 21



Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E3 Day 2 Feb 21



Sound Level

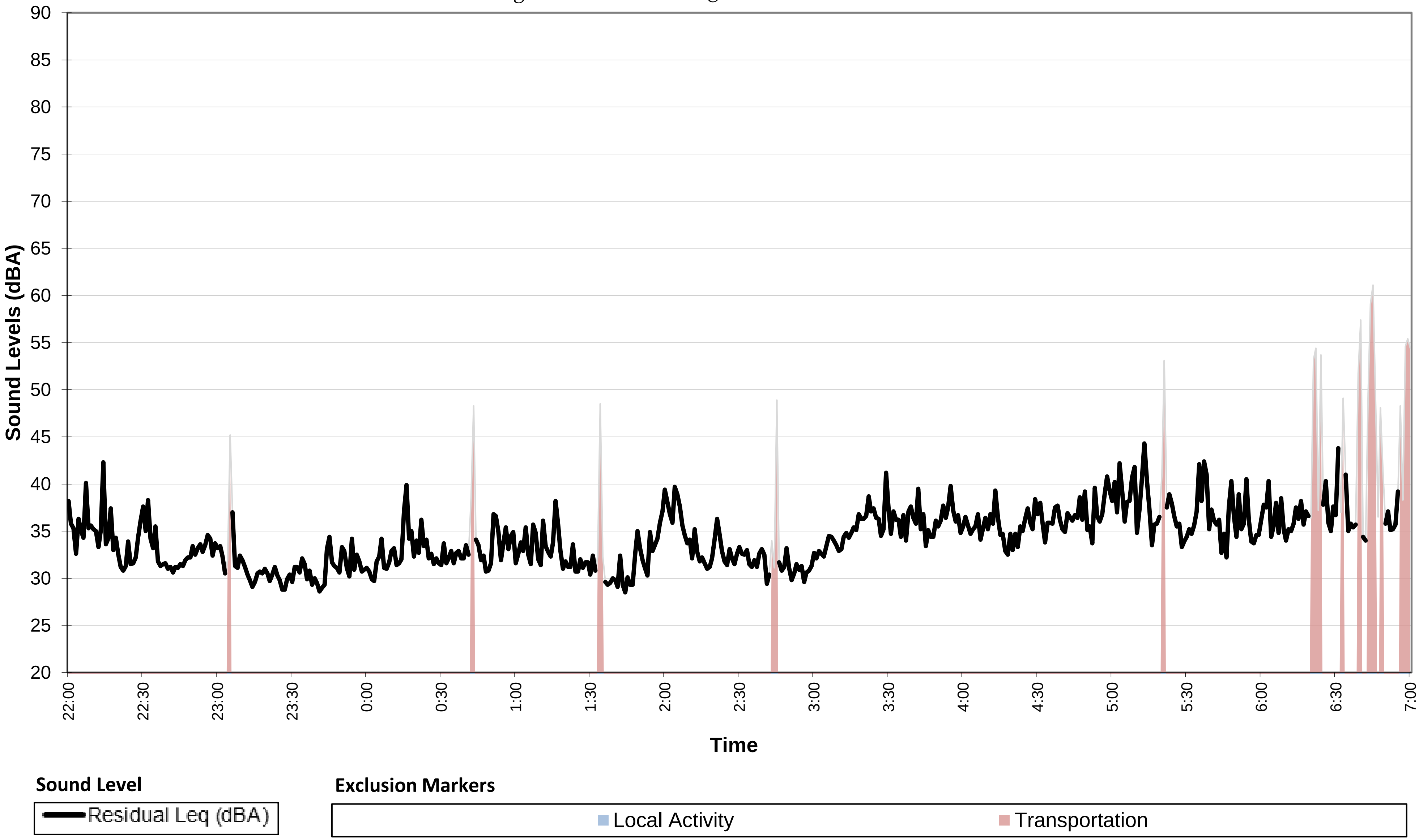
Residual Leq (dBA)

Exclusion Markers

Local Activity Transportation

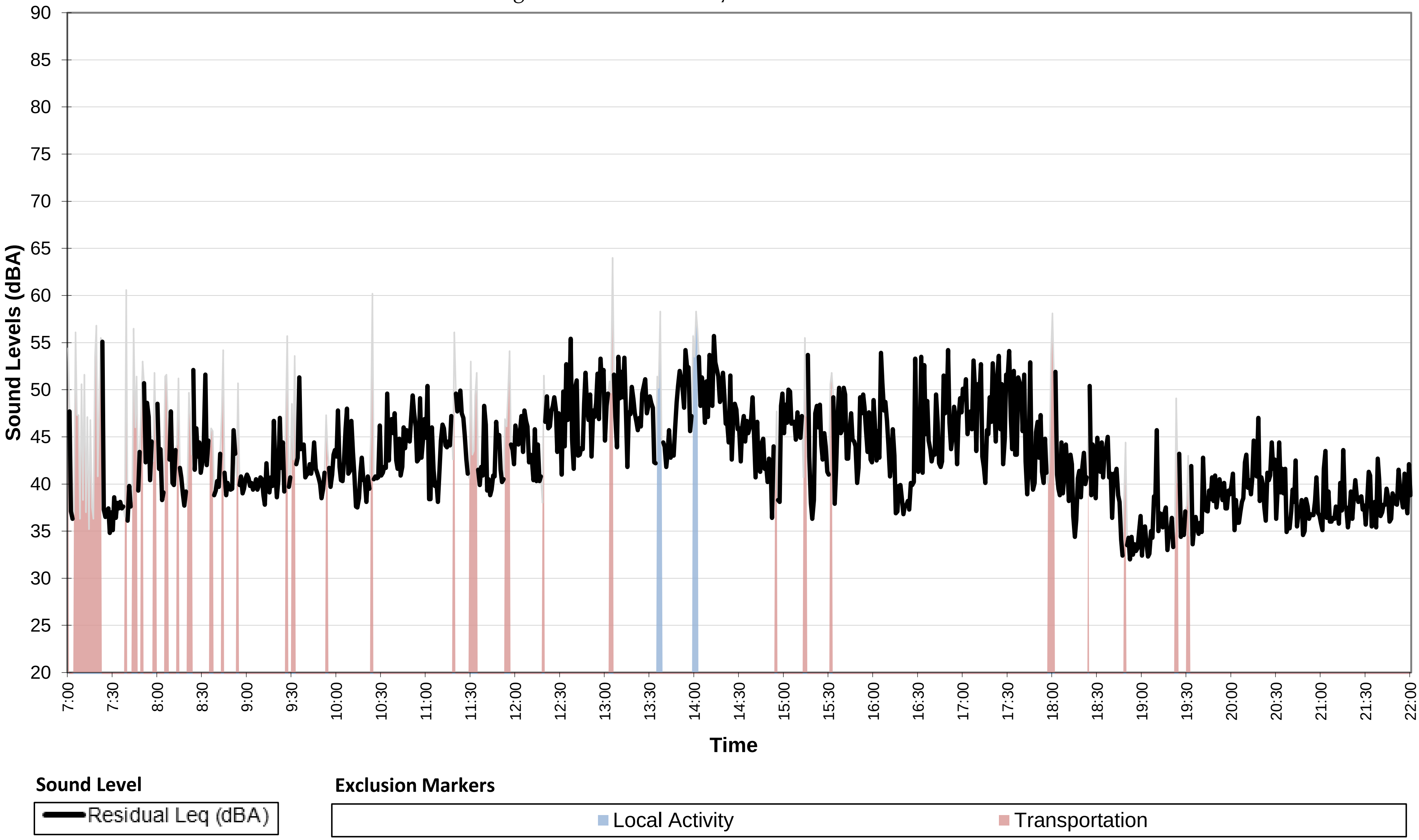
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E4 Night 2 Feb 21 - Feb 22



Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E5 Day 3 Feb 22



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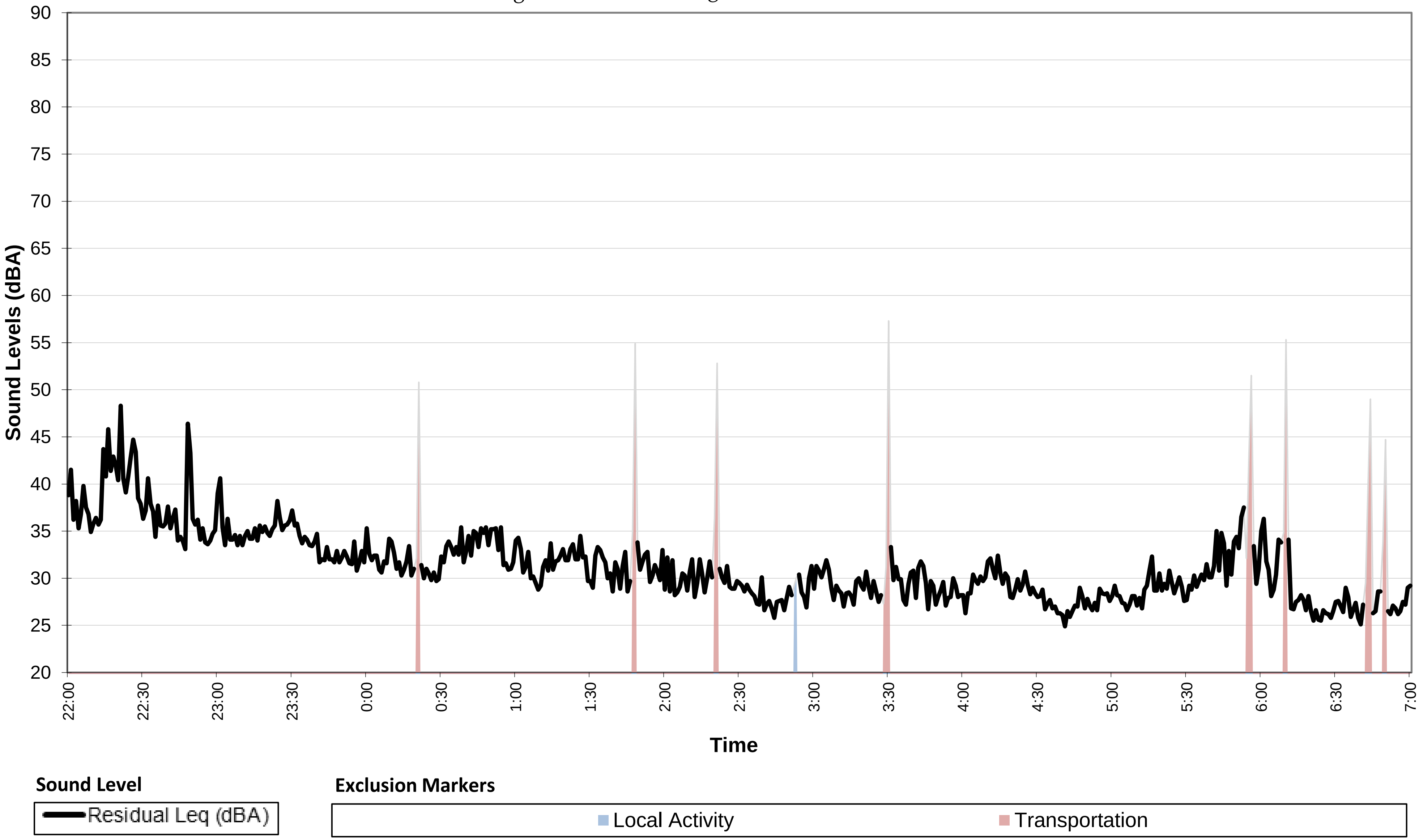
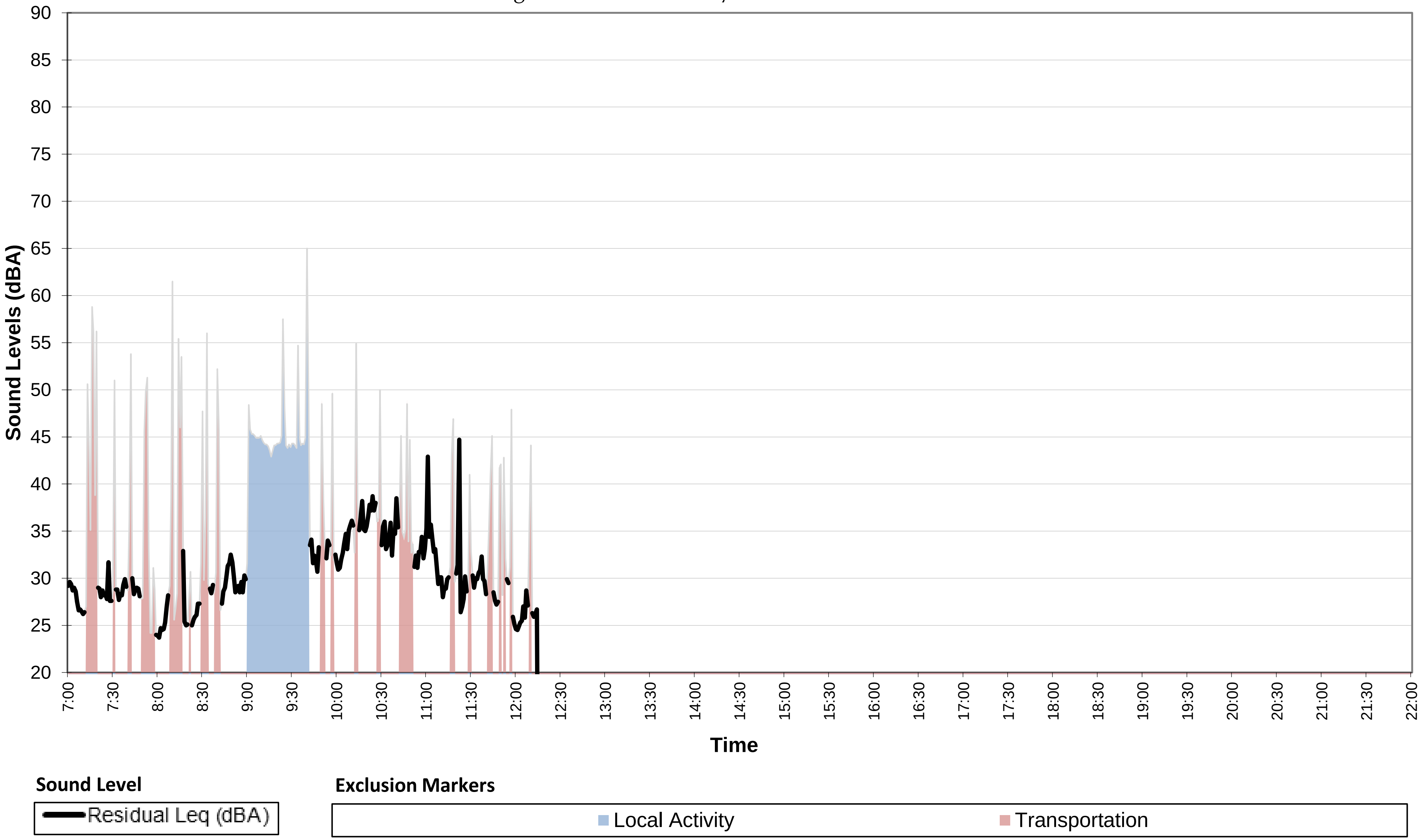
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E6 Night 3 Feb 22 - Feb 23



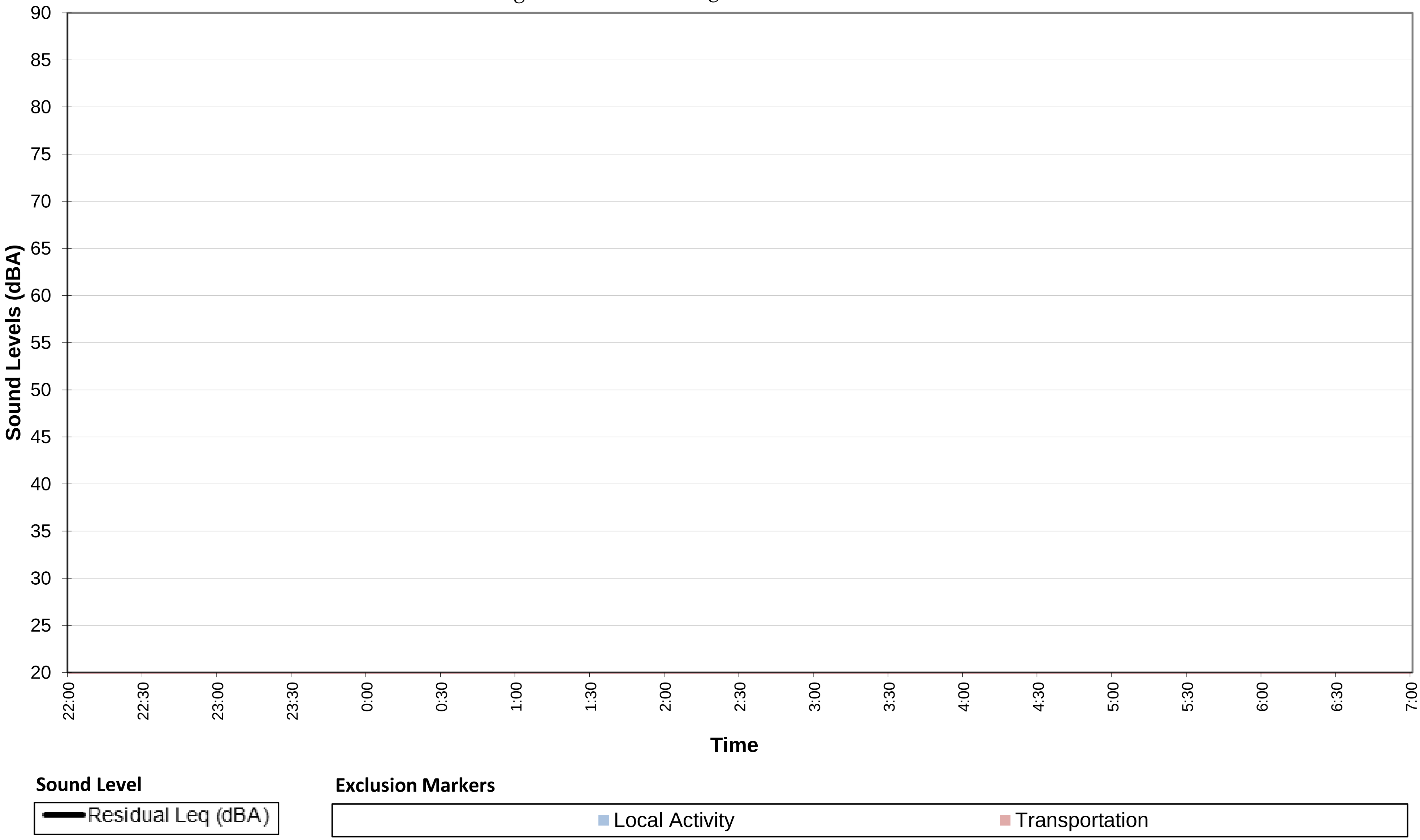
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E7 Day 4 Feb 23



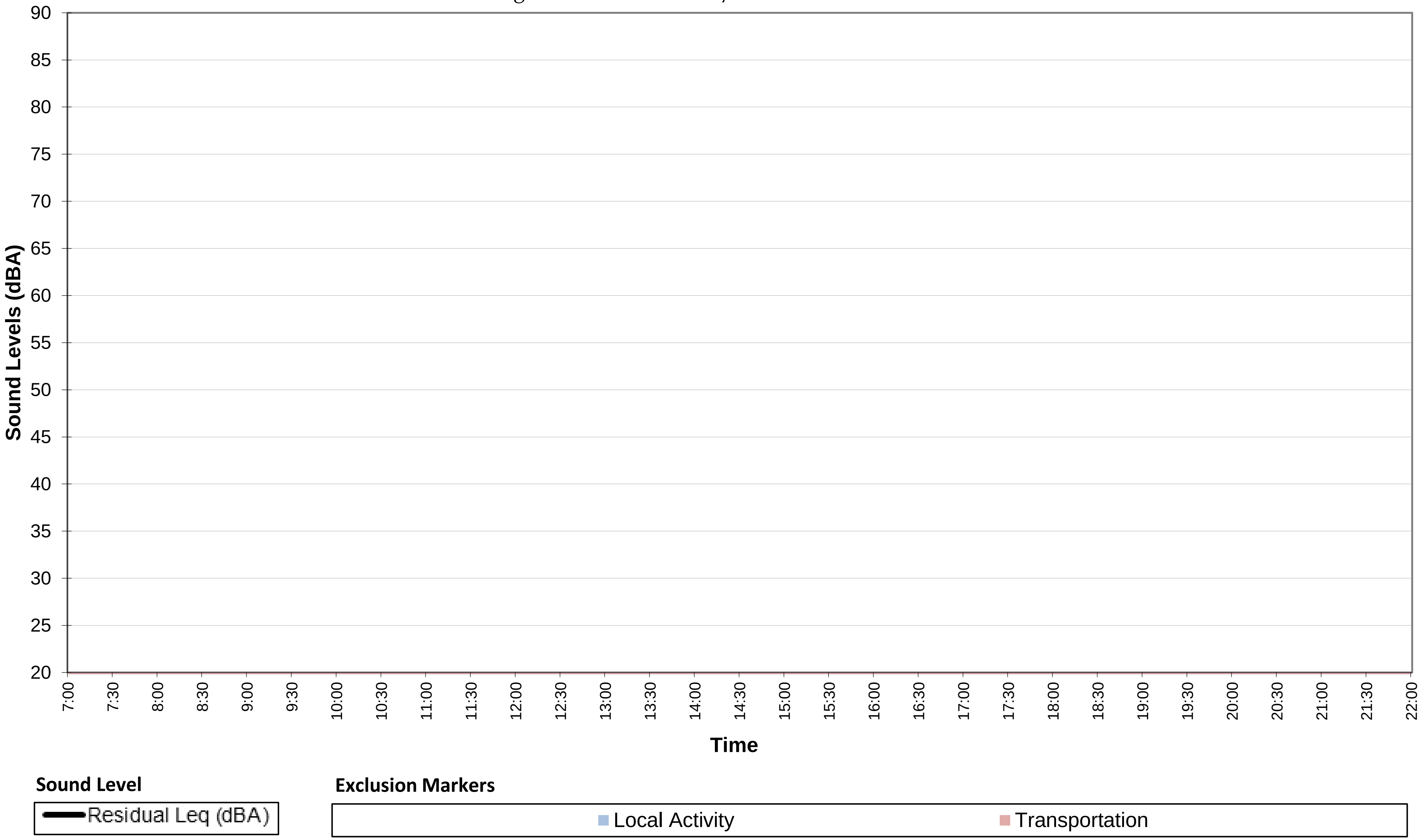
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E8 Night 4 Feb 23 - Feb 24



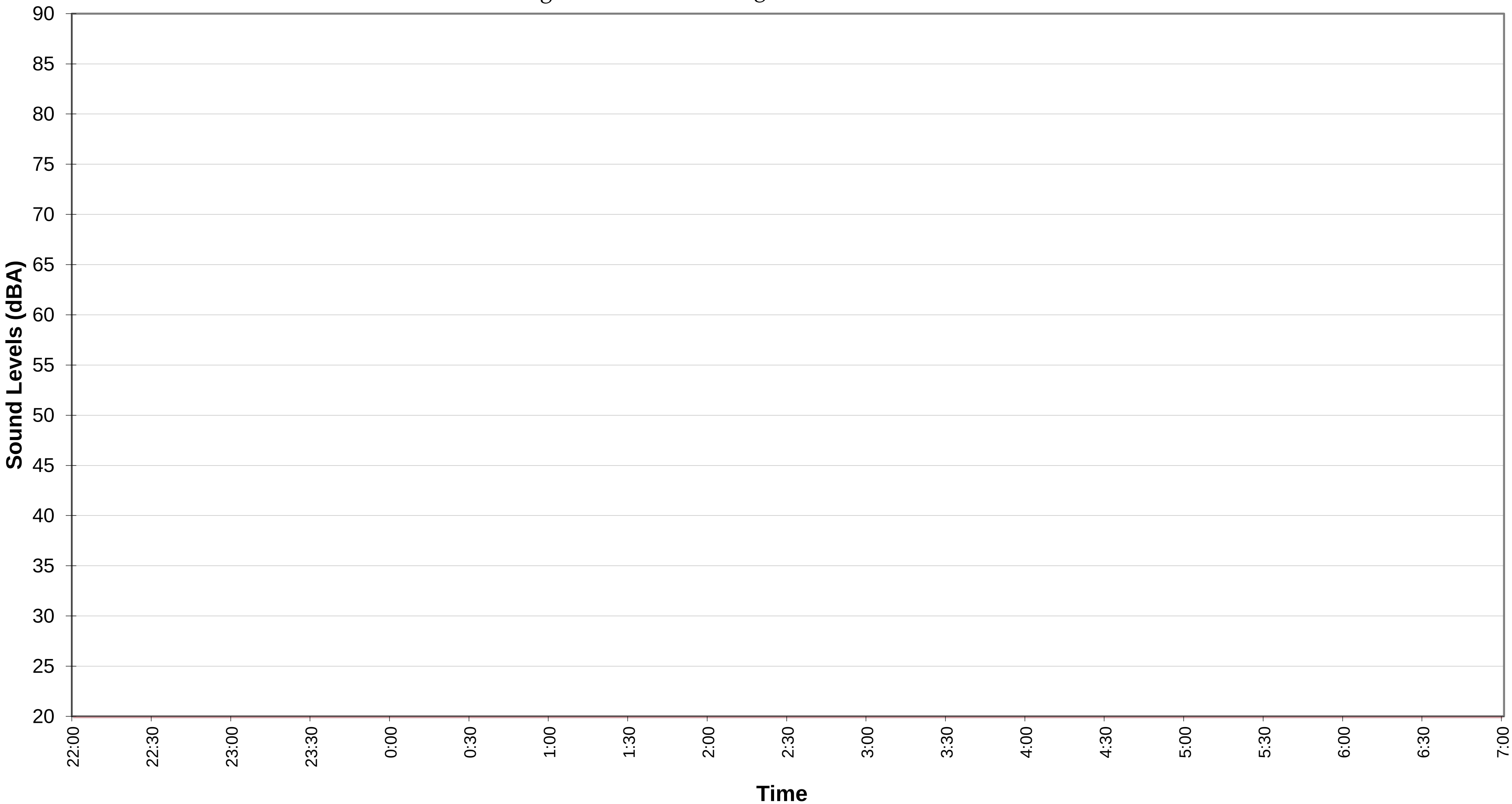
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E9 Day 5 Feb 24



Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E10 Night 5 Feb 24 - Feb 25



Sound Level

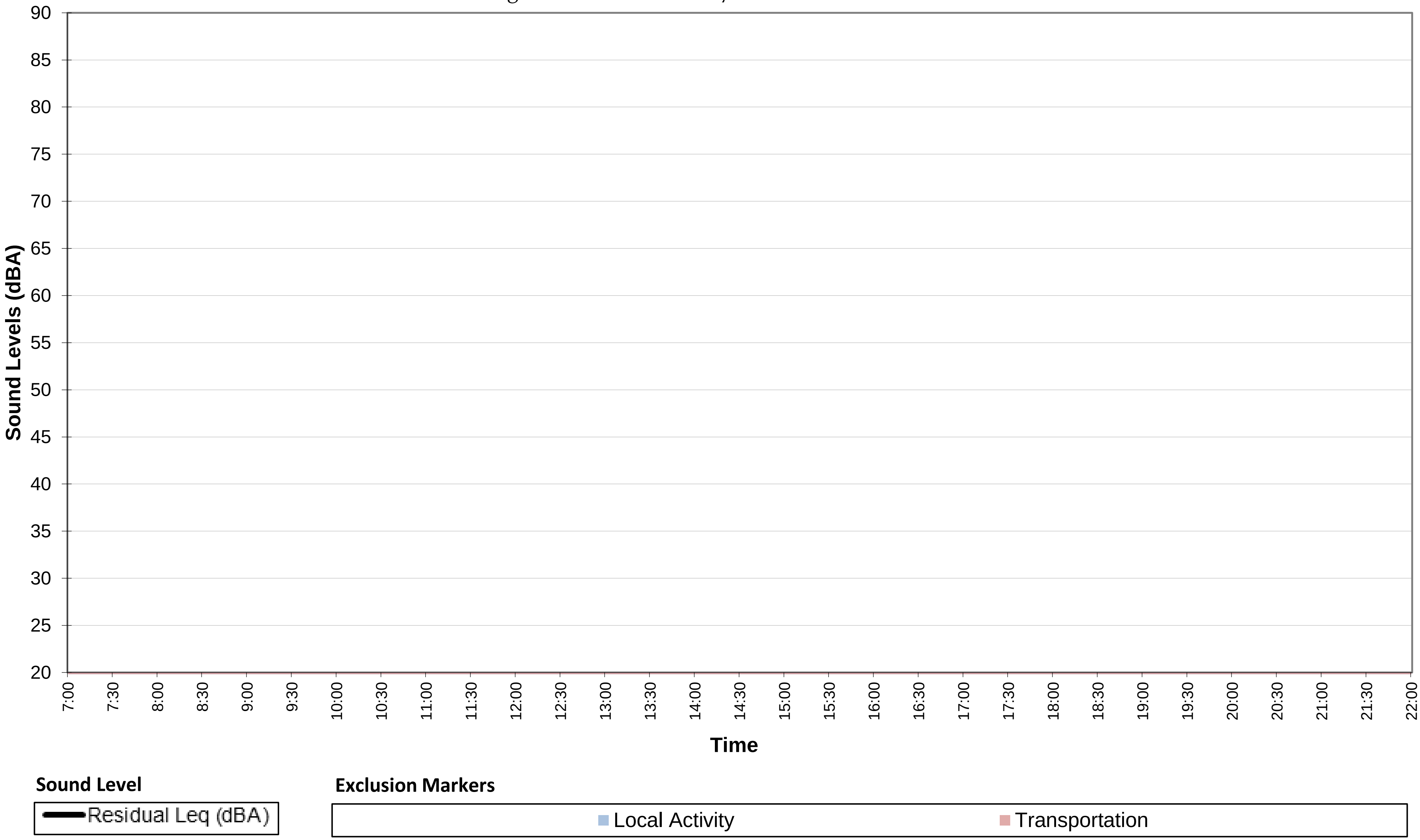
Residual Leq (dBA)

Exclusion Markers

Local Activity Transportation

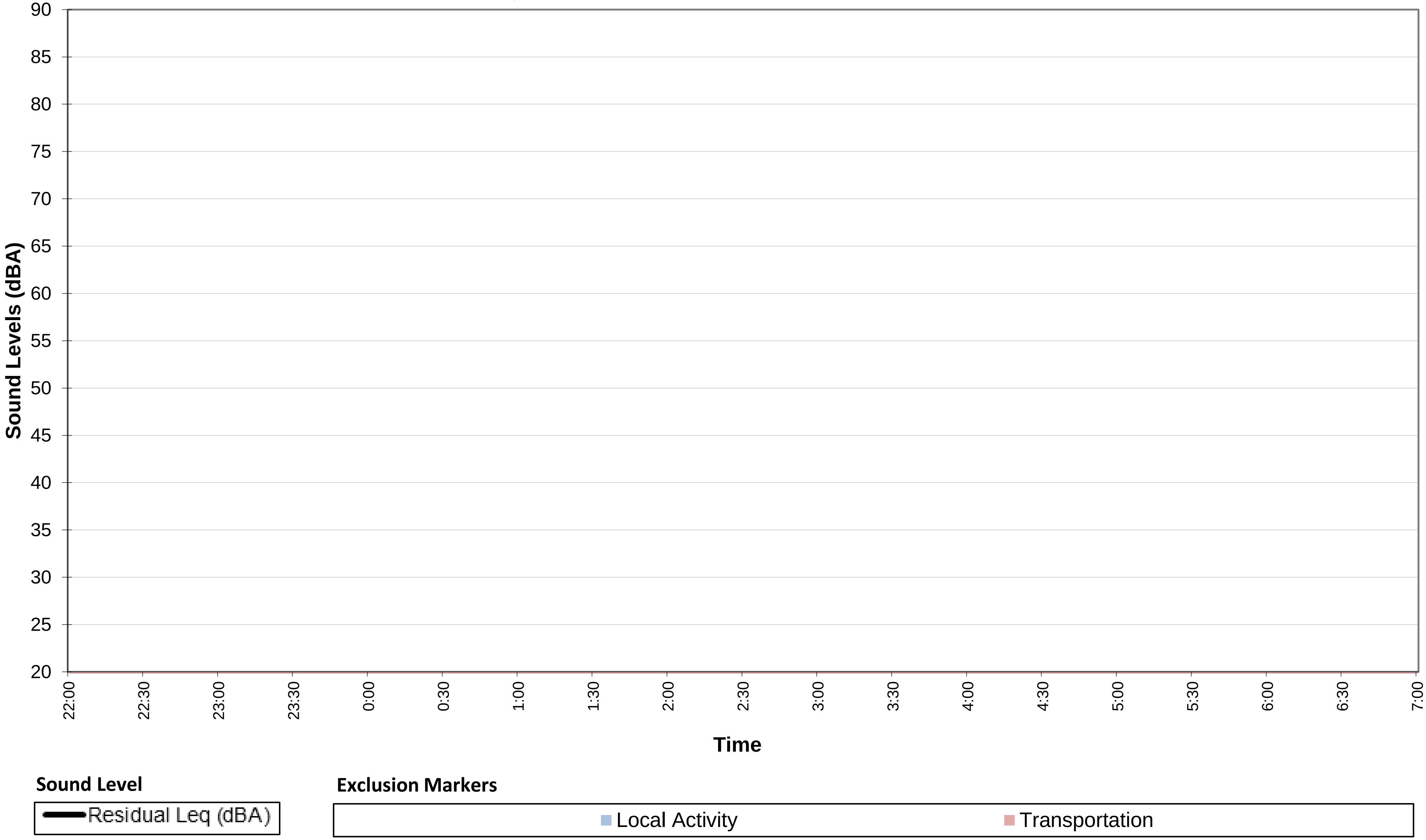
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E11 Day 6 Feb 25



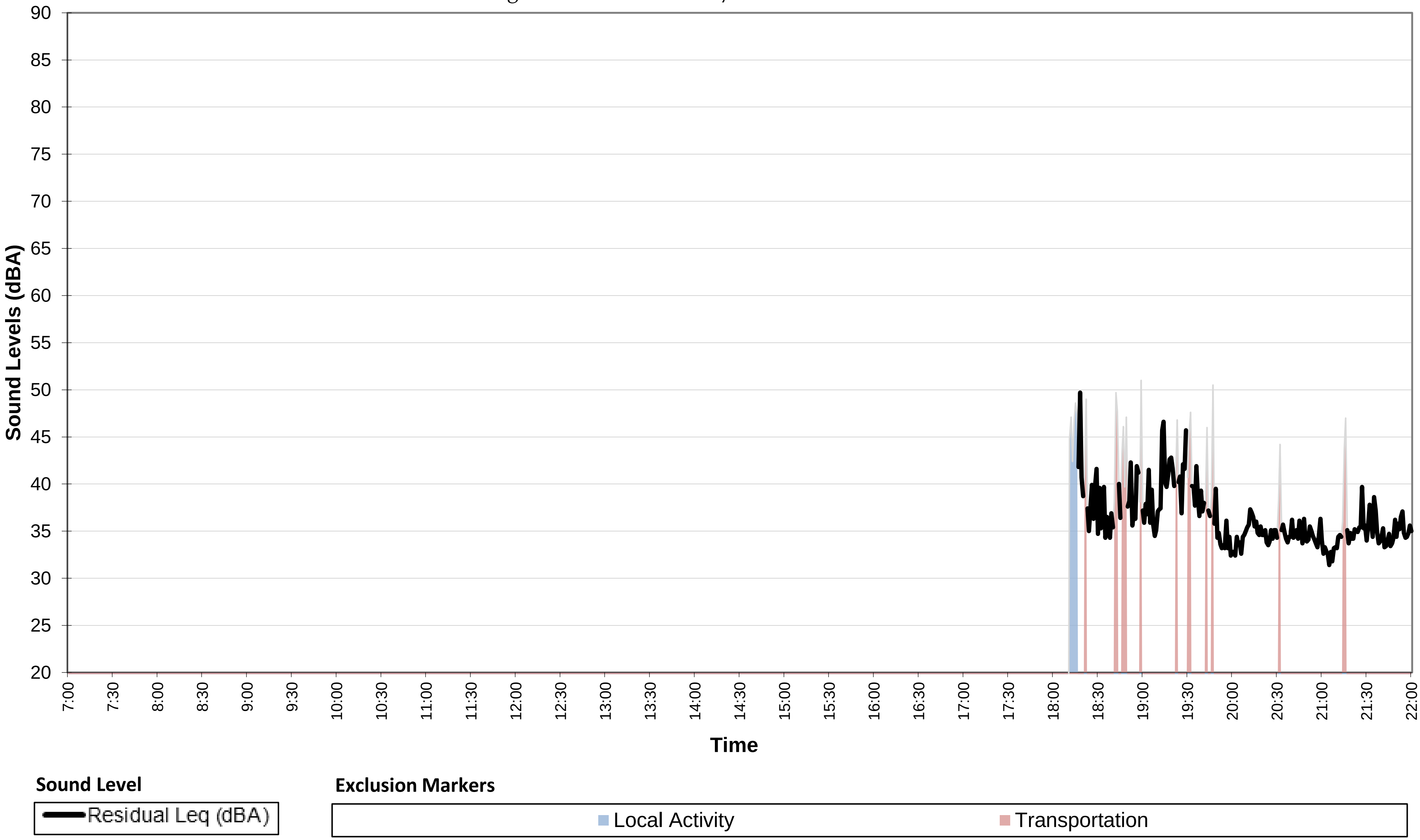
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E12 Night 6 Feb 25 - Feb 26



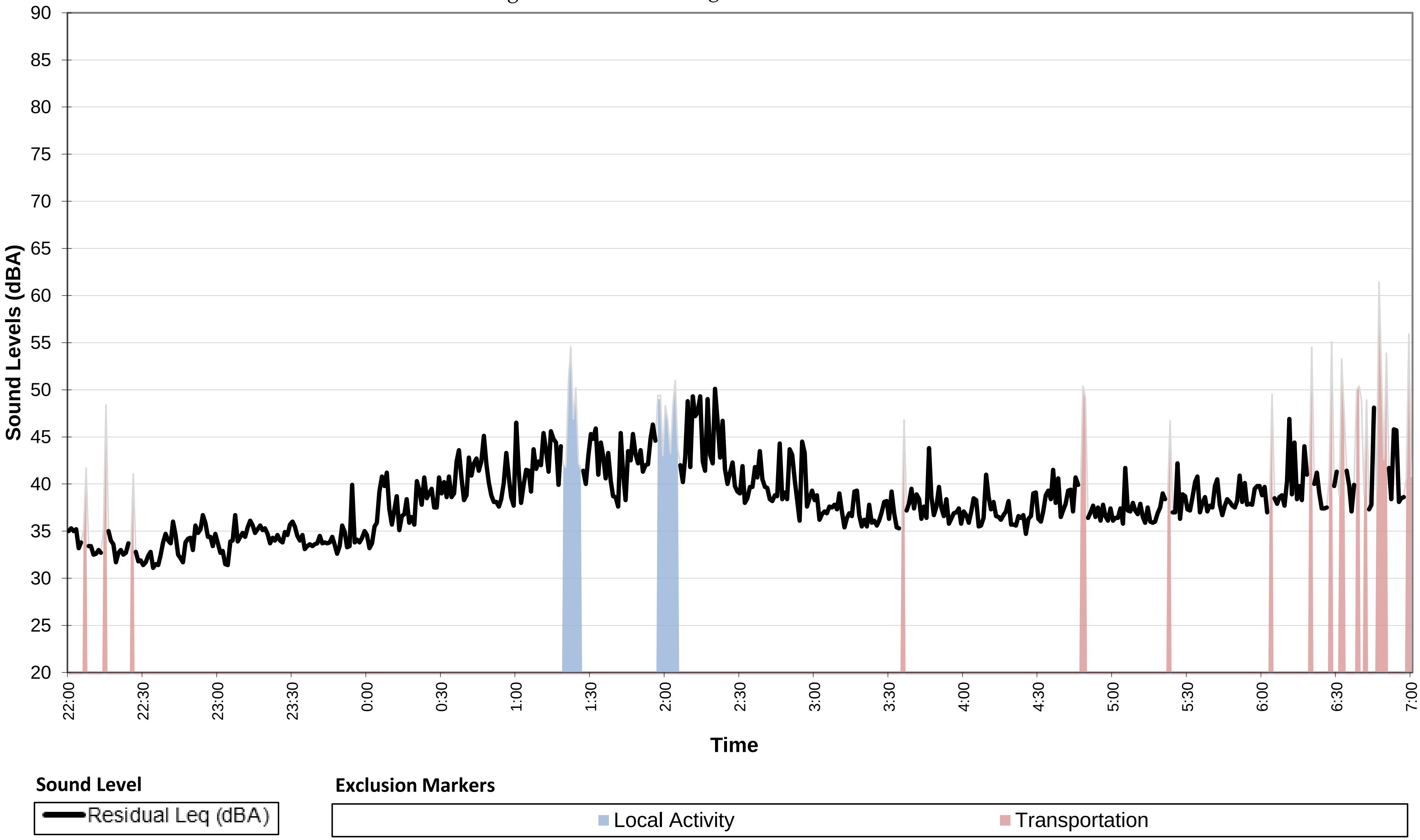
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E13 Day 7 Feb 26



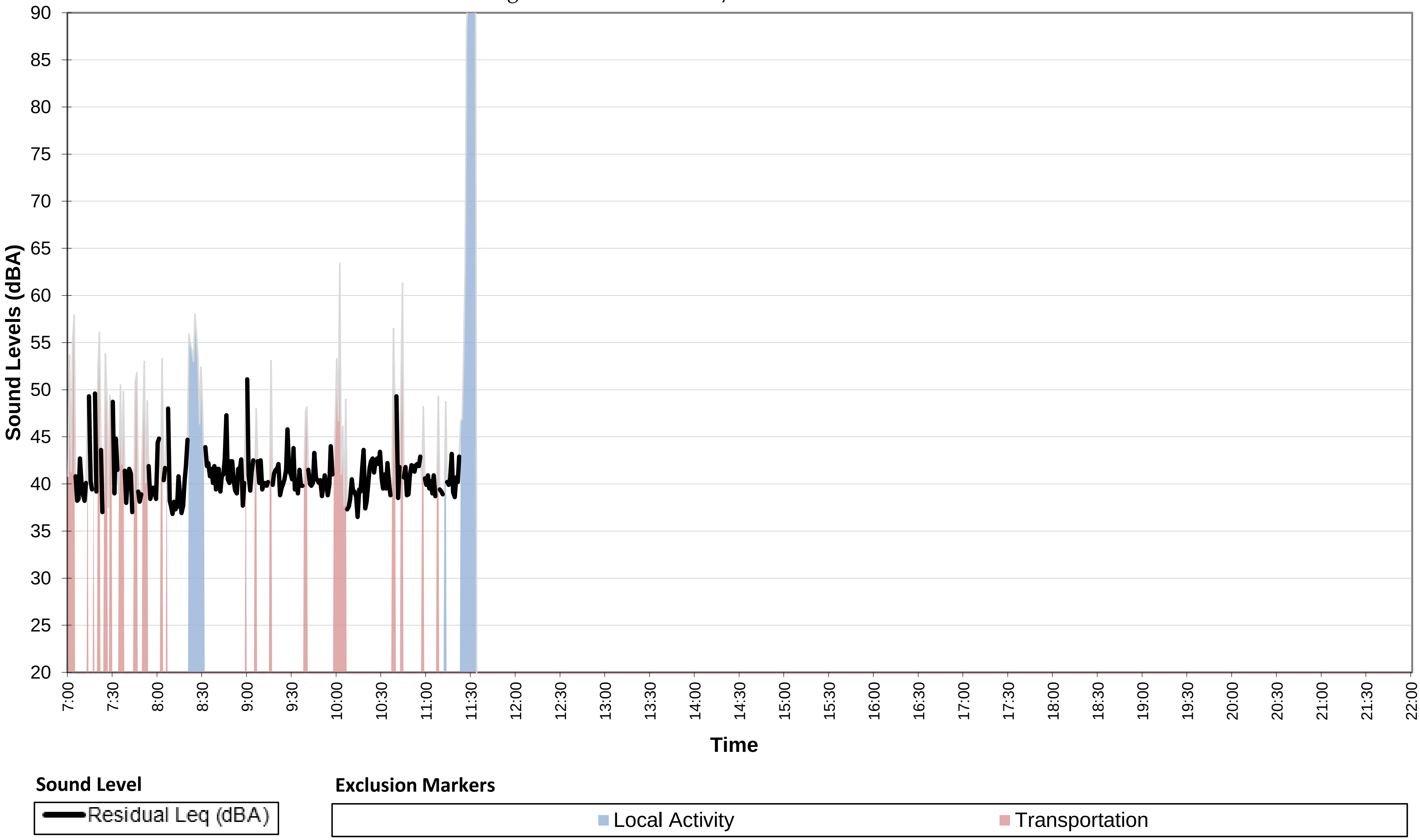
Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E14 Night 7 Feb 26 - Feb 27



Comprehensive Sound Survey - Tower Lake 69 m Monitor

Figure E15 Day 8 Feb 27



APPENDIX F

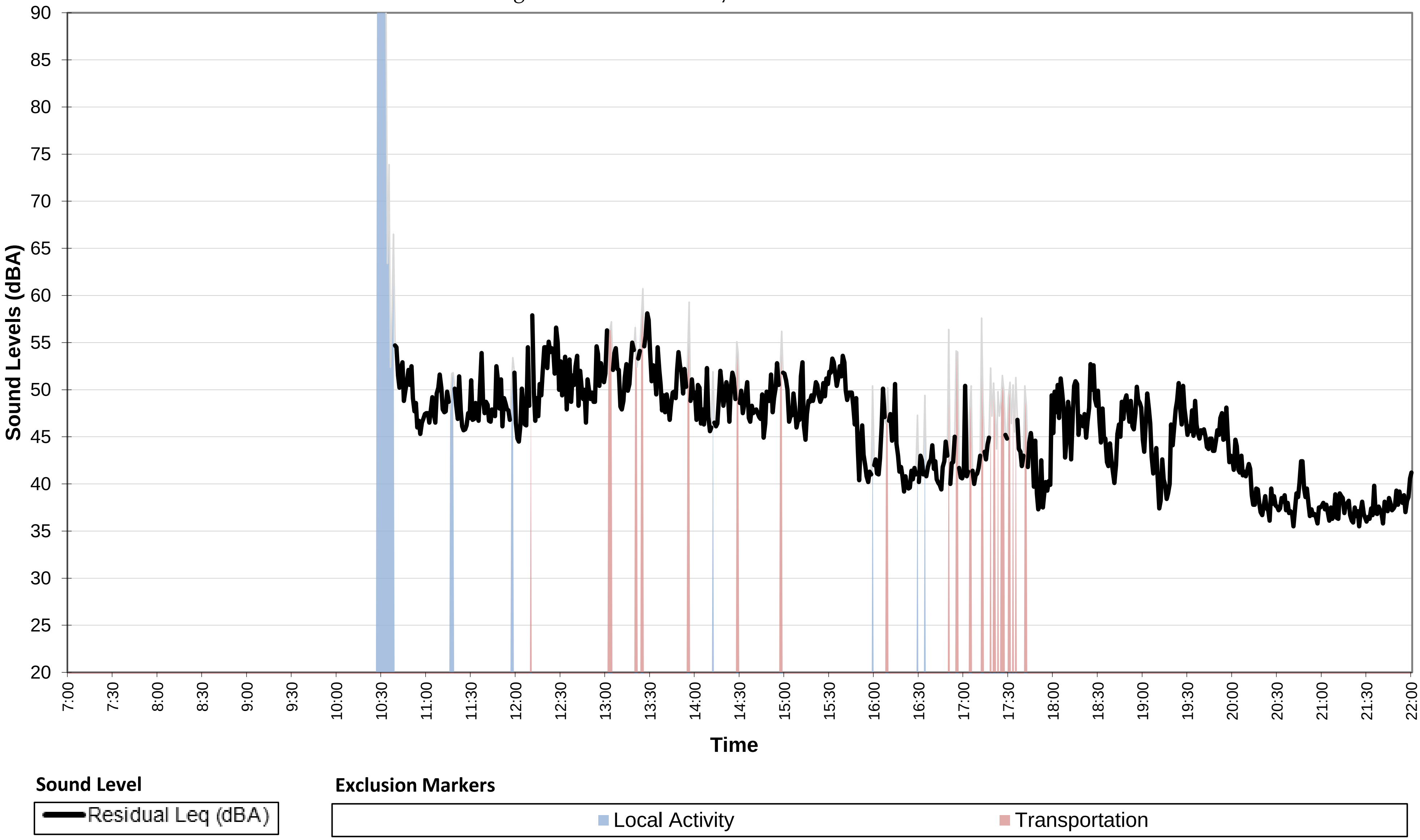
Sound Level Measurements
Sound Monitor TL 2
300m South from Tower Lake Road

Table F: Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Period	Date (2020)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Feb 20	73.5	11.6	48.3	10.6
Night 01	Feb 20 - Feb 21	46.1	9.0	44.5	8.8
Day 02	Feb 21	51.6	15.0	51.6	14.5
Night 02	Feb 21 - Feb 22	39.9	9.0	36.9	8.9
Day 03	Feb 22	47.2	15.0	46.9	14.0
Night 03	Feb 22 - Feb 23	35.2	9.0	34.8	8.7
Day 04	Feb 23	35.6	15.0	30.1	12.3
Night 04	Feb 23 - Feb 24	39.4	9.0	30.0	8.5
Day 05	Feb 24	48.7	15.0	37.4	10.3
Night 05	Feb 24 - Feb 25	38.1	9.0	34.2	8.8
Day 06	Feb 25	44.5	15.0	38.4	11.0
Night 06	Feb 25 - Feb 26	41.6	9.0	36.9	6.9
Day 07	Feb 26	48.0	15.0	47.7	9.3
Night 07	Feb 26 - Feb 27	42.3	9.0	41.3	8.7
Day 08	Feb 27	75.3	15.0	44.4	2.8

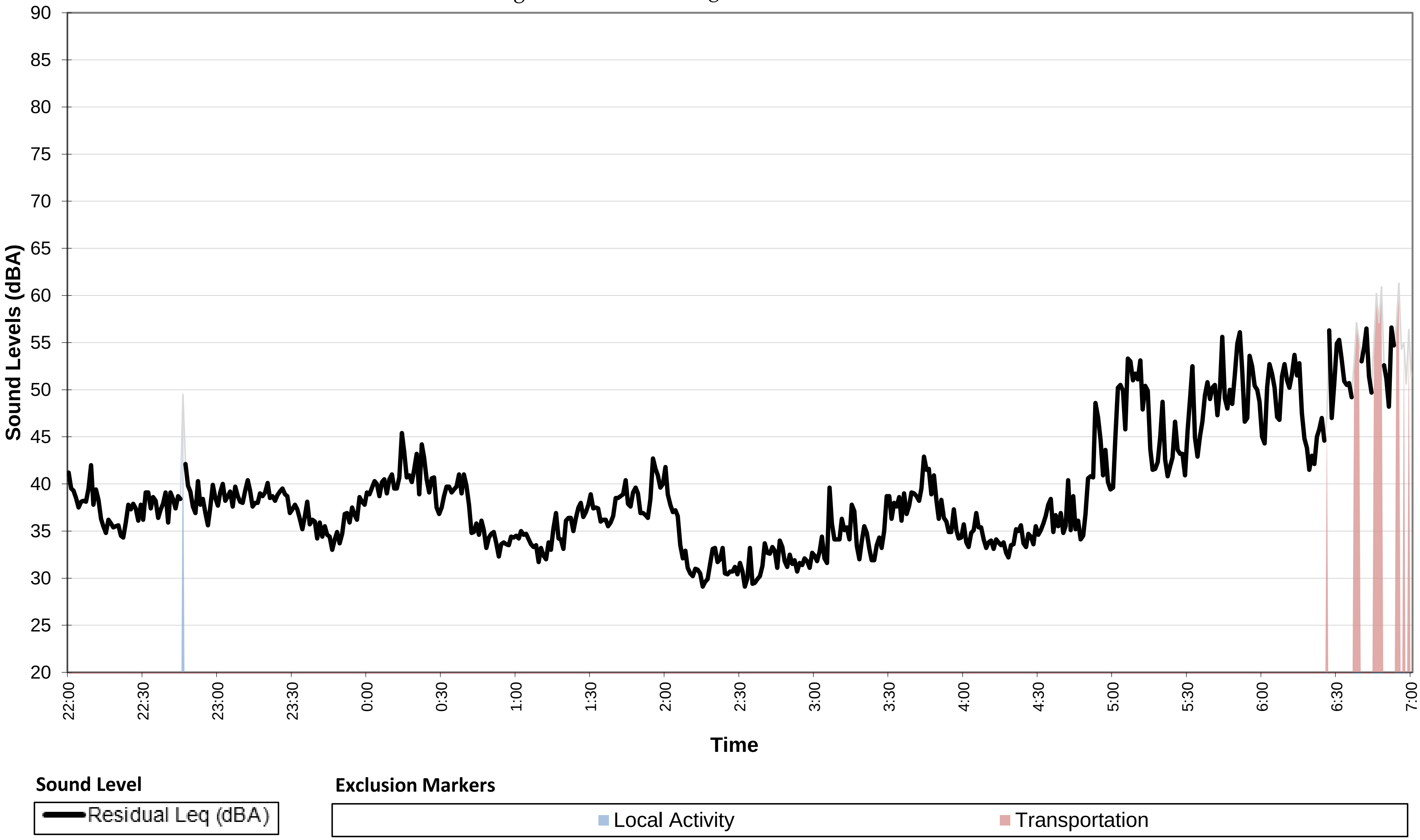
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F1 Day 1 Feb 20



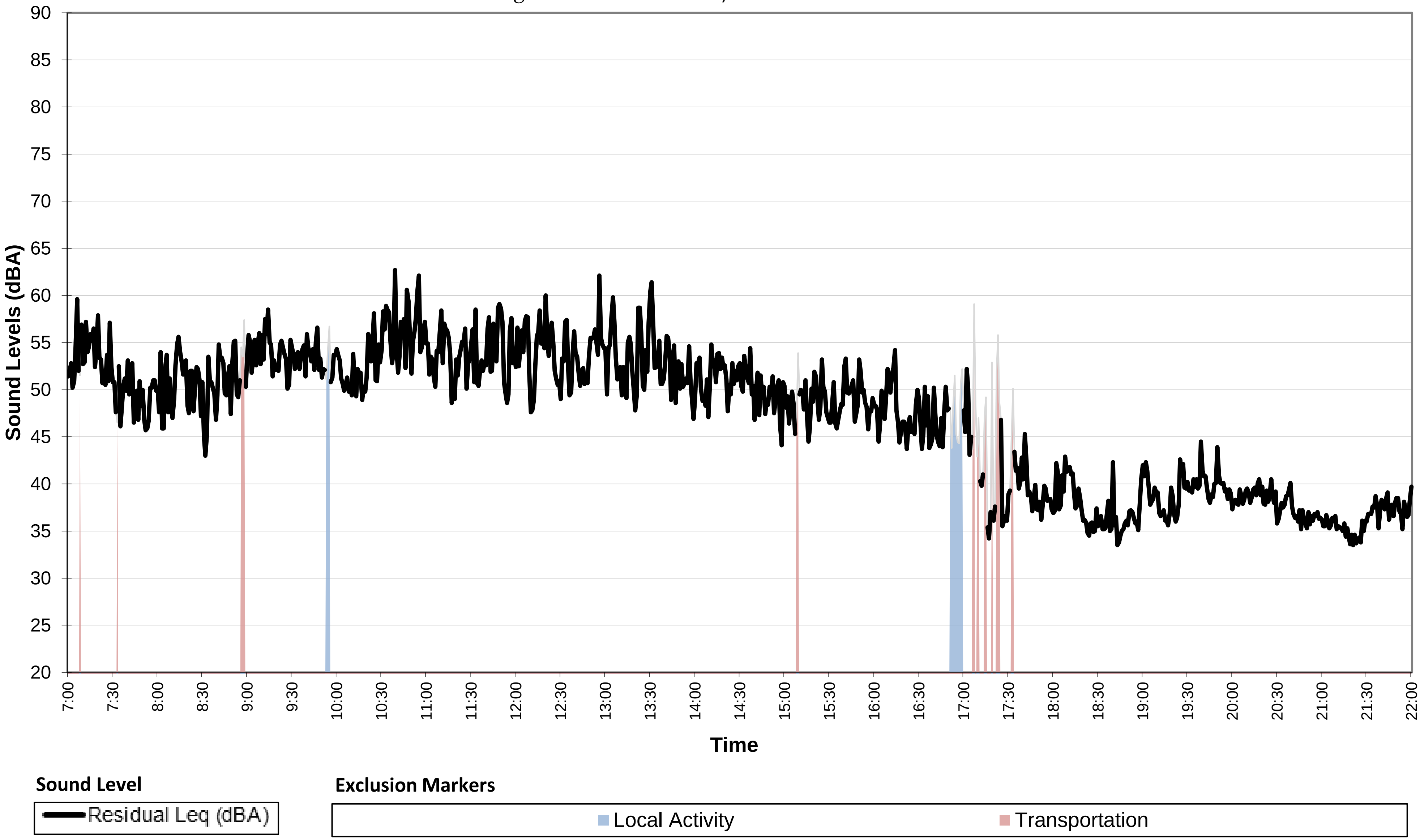
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F2 Night 1 Feb 20 - Feb 21



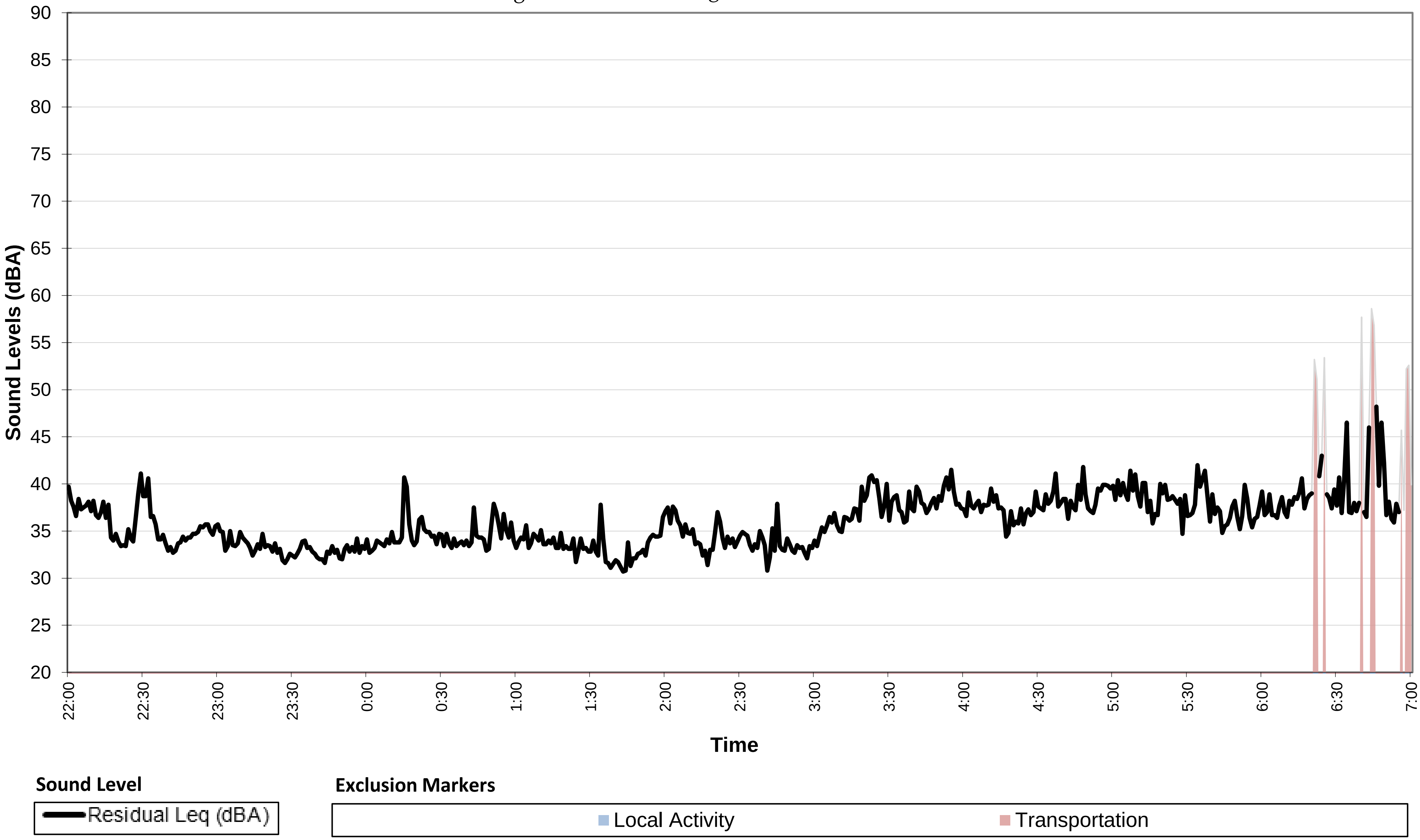
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F3 Day 2 Feb 21



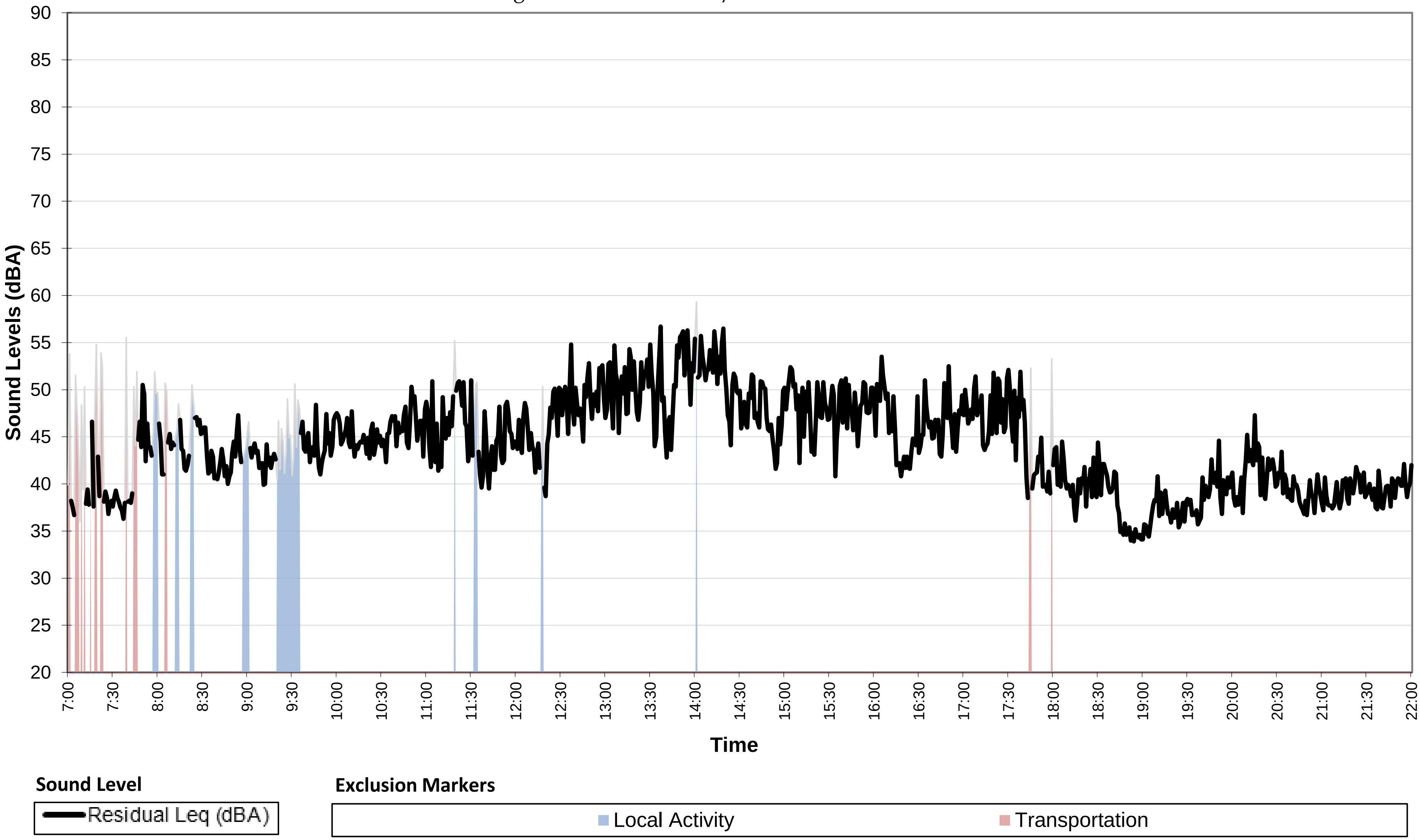
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F4 Night 2 Feb 21 - Feb 22



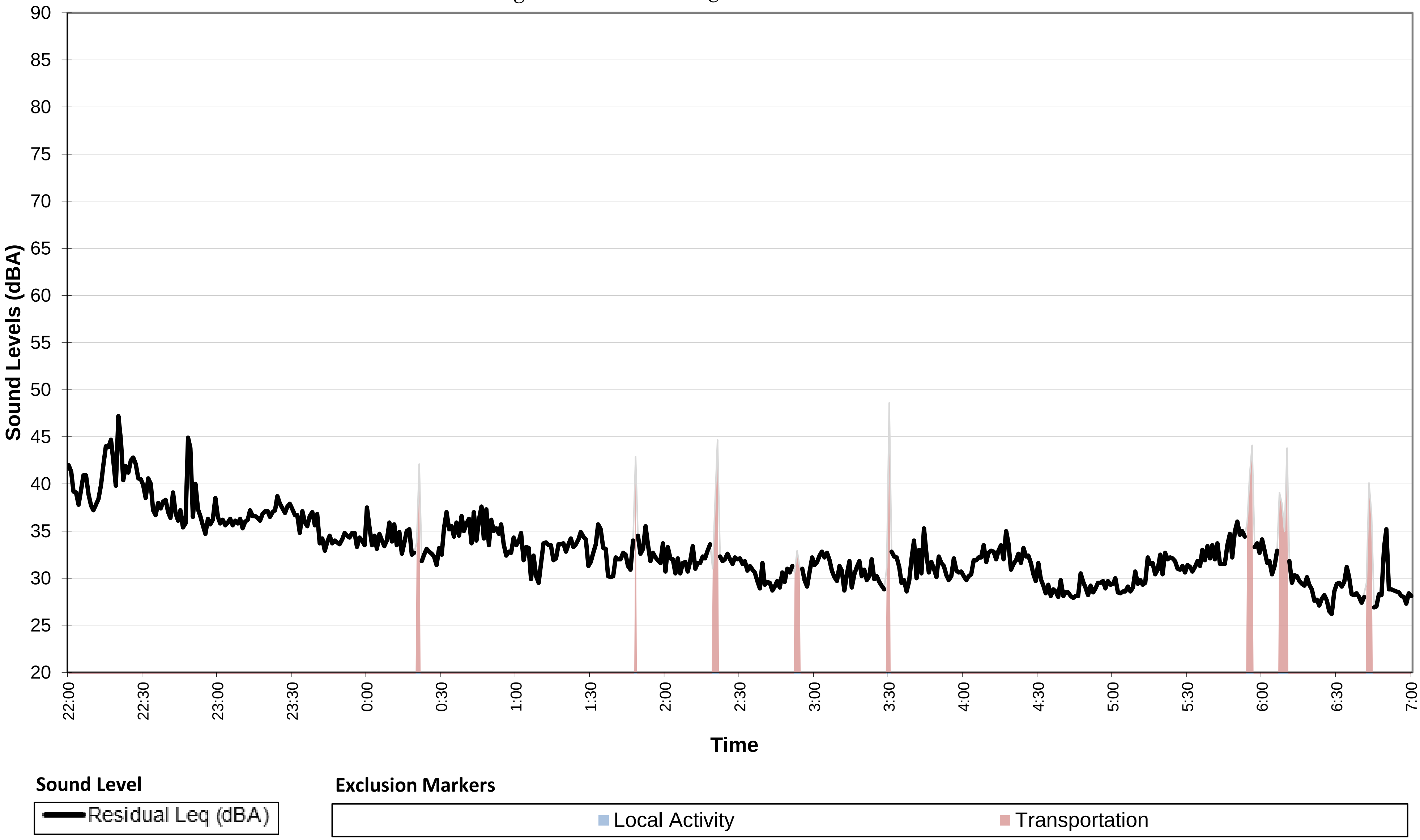
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F5 Day 3 Feb 22



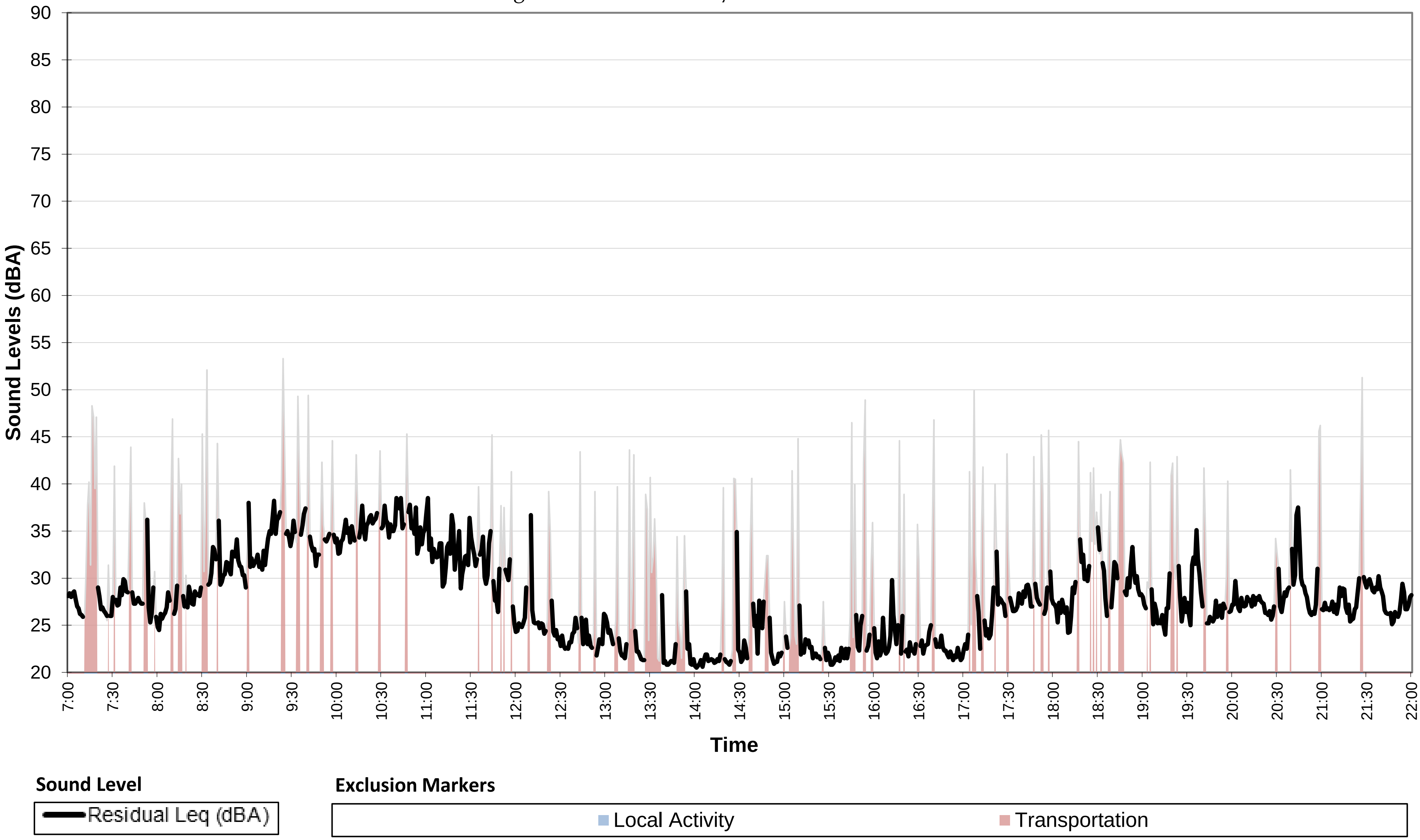
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F6 Night 3 Feb 22 - Feb 23



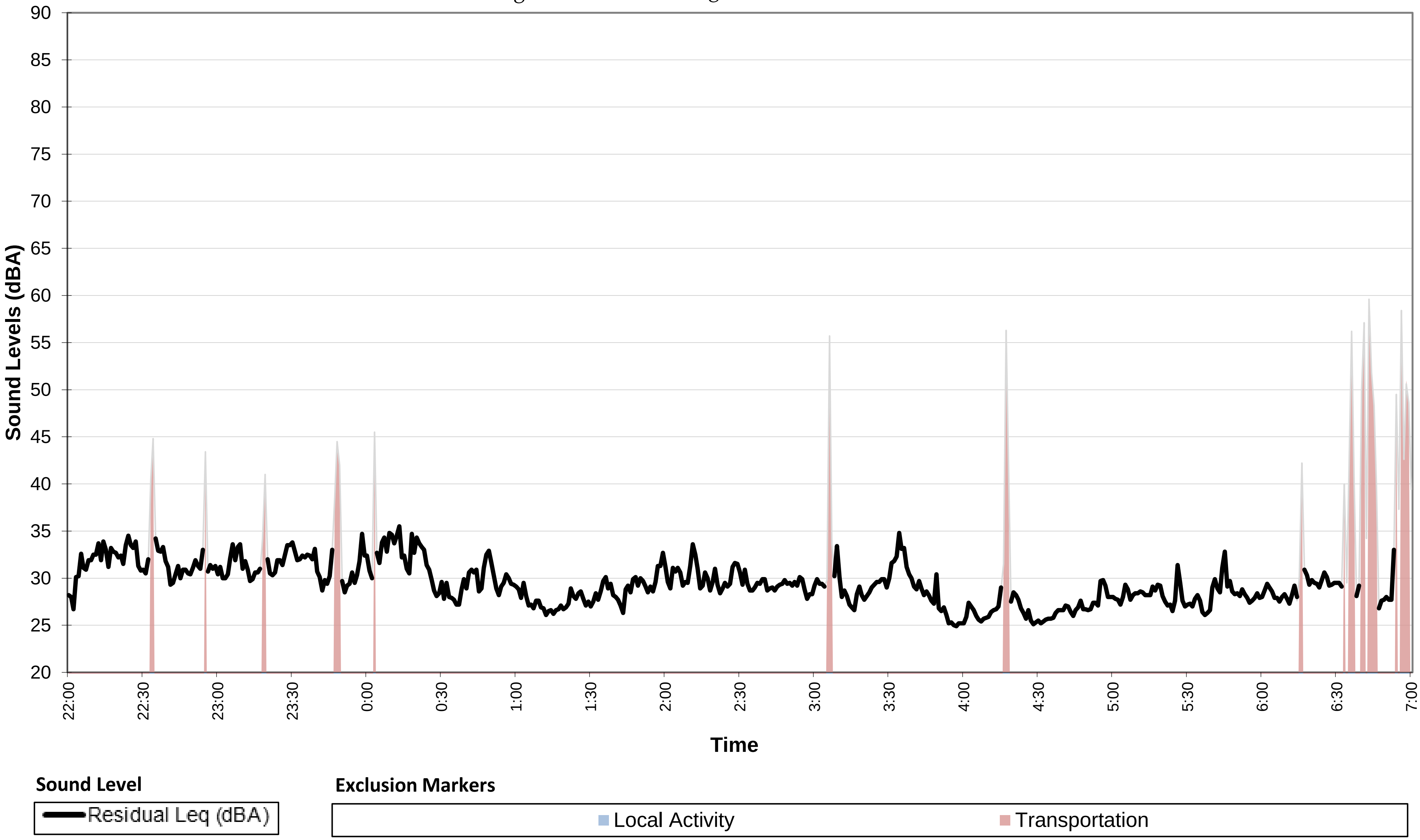
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F7 Day 4 Feb 23



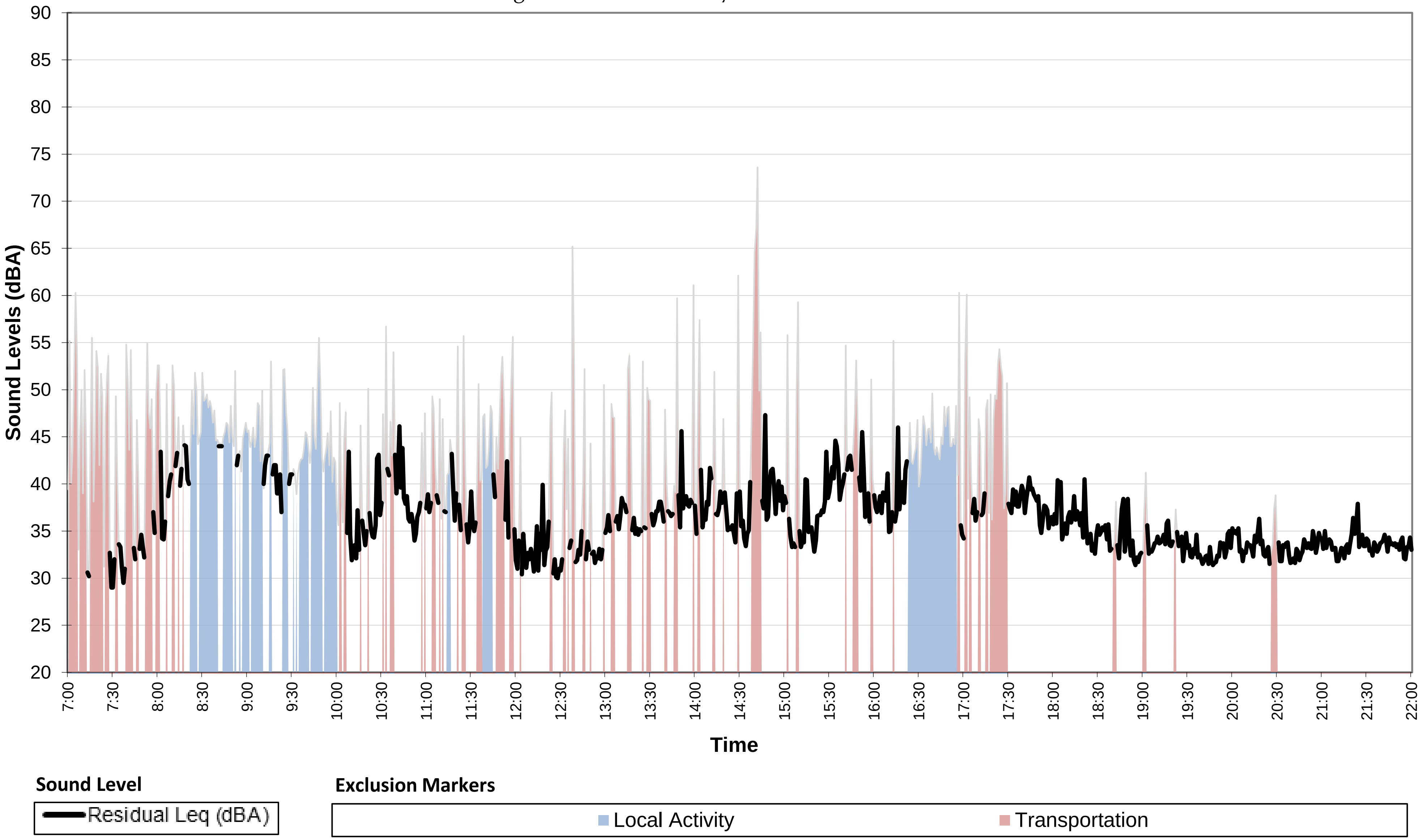
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F8 Night 4 Feb 23 - Feb 24



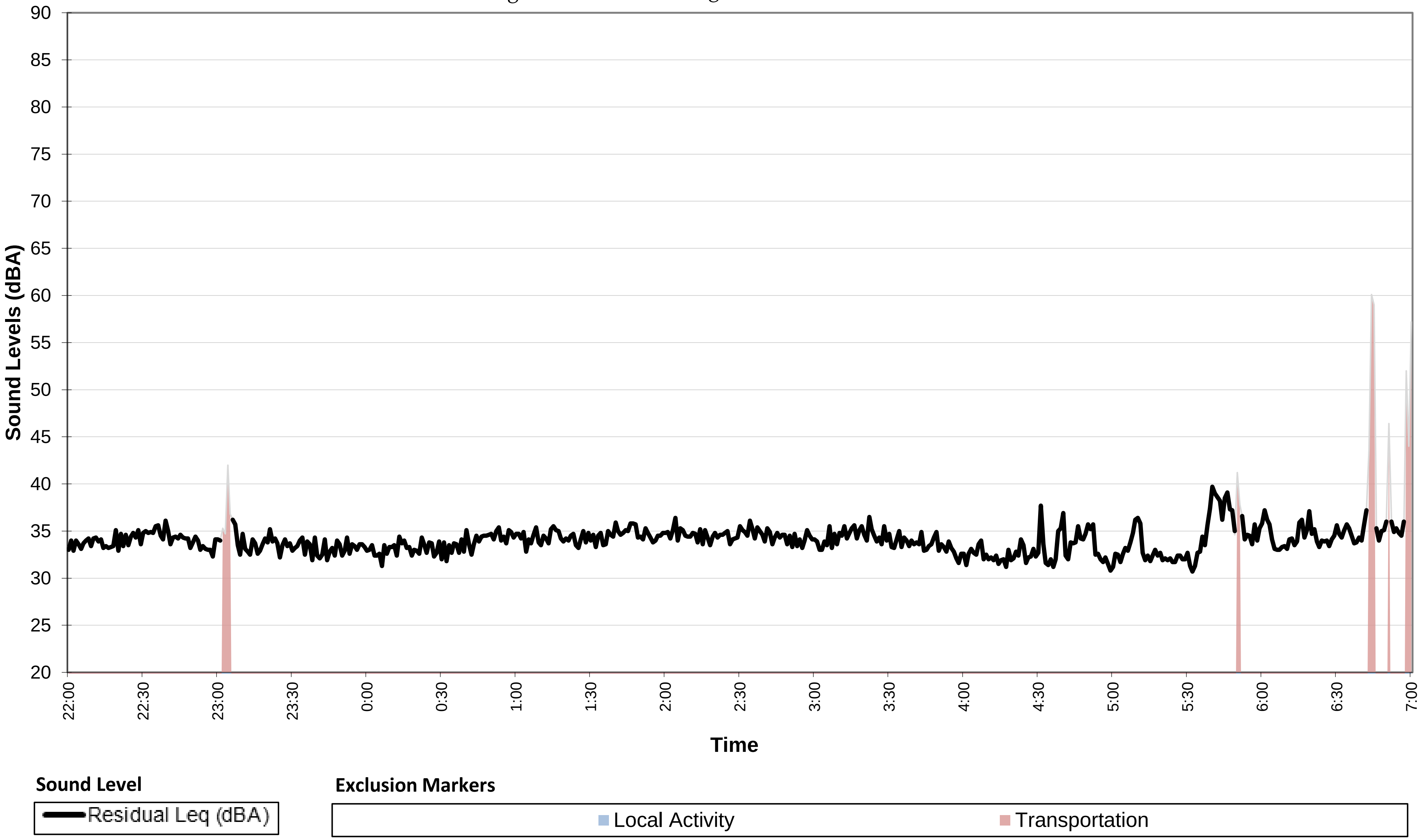
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F9 Day 5 Feb 24



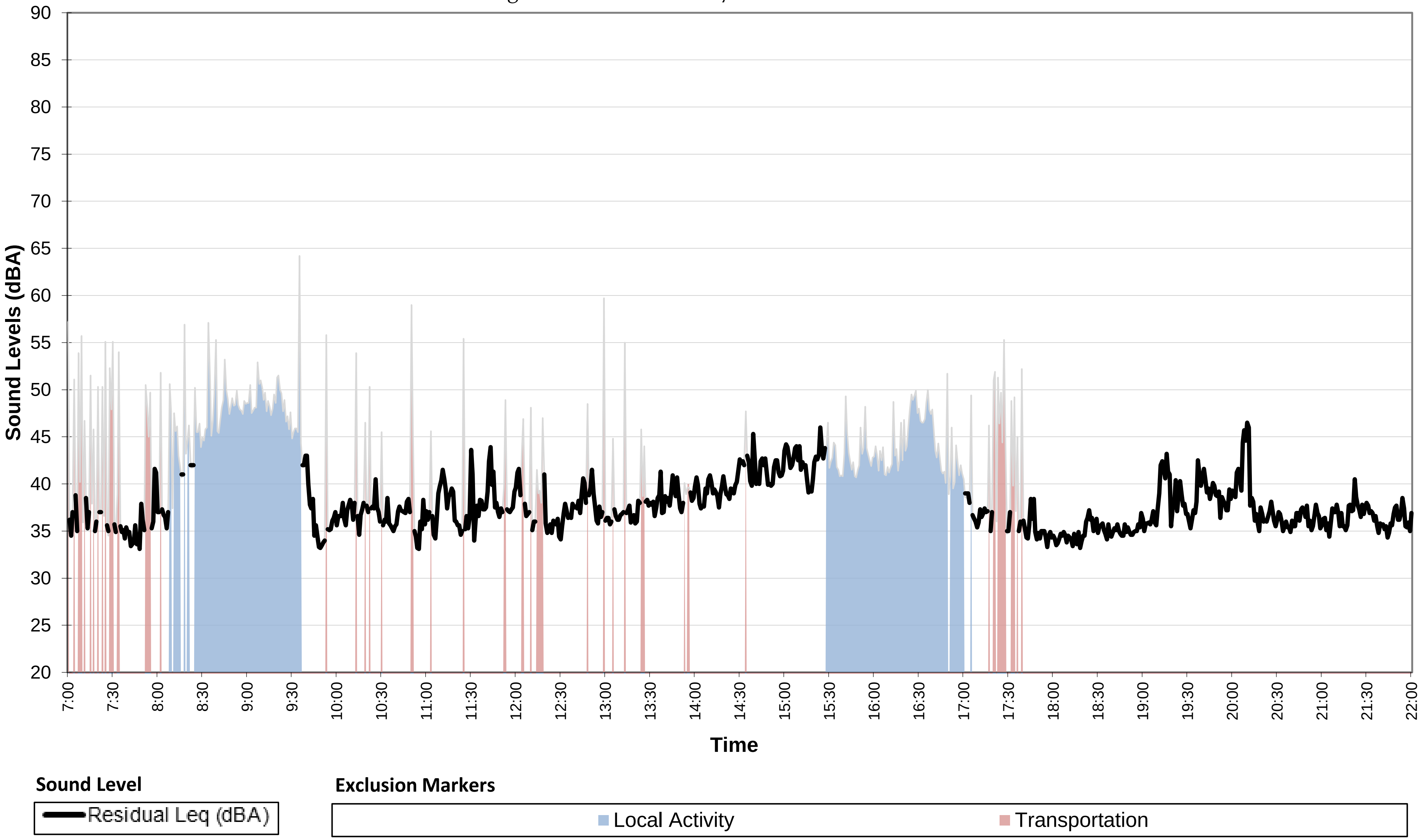
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F10 Night 5 Feb 24 - Feb 25



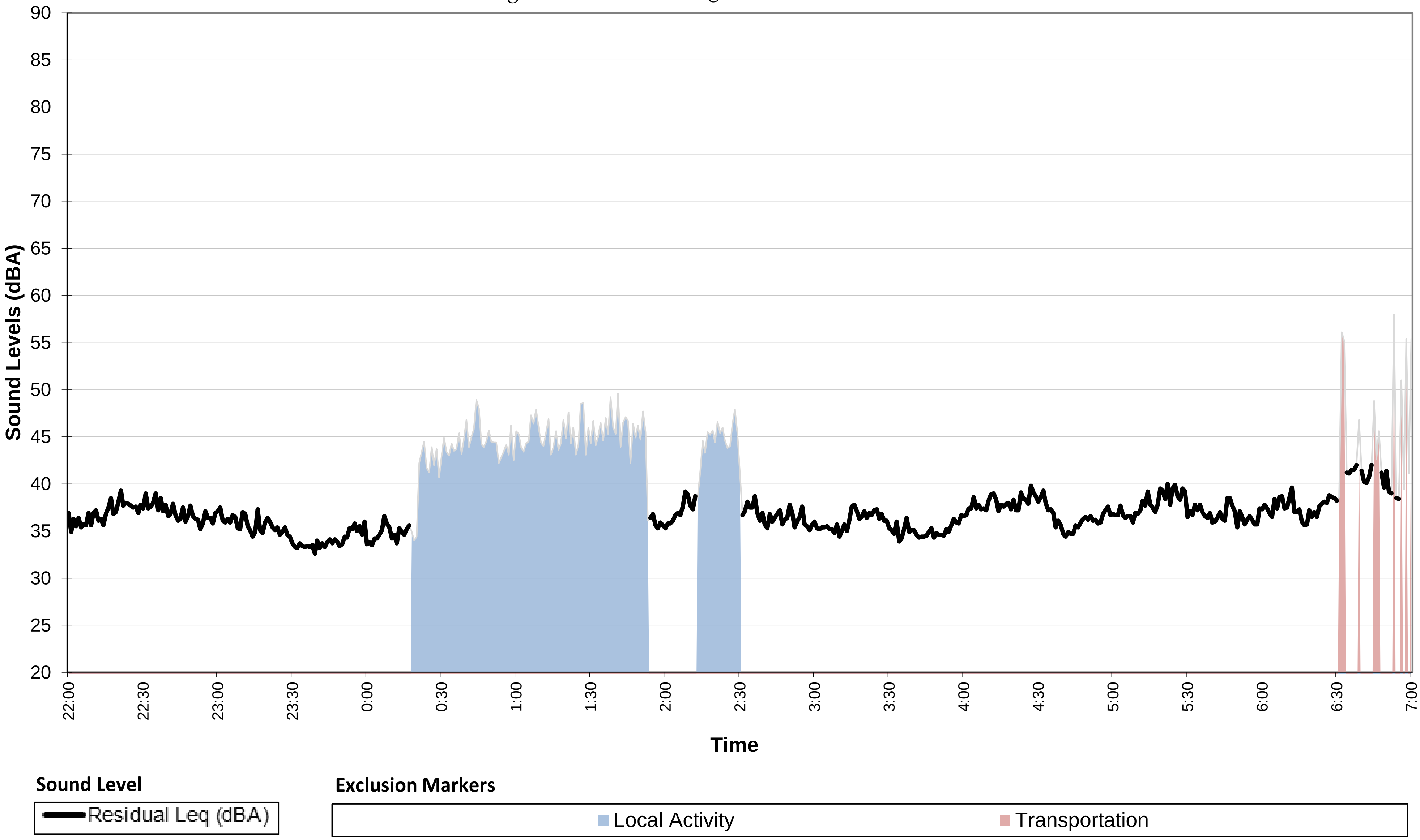
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F11 Day 6 Feb 25



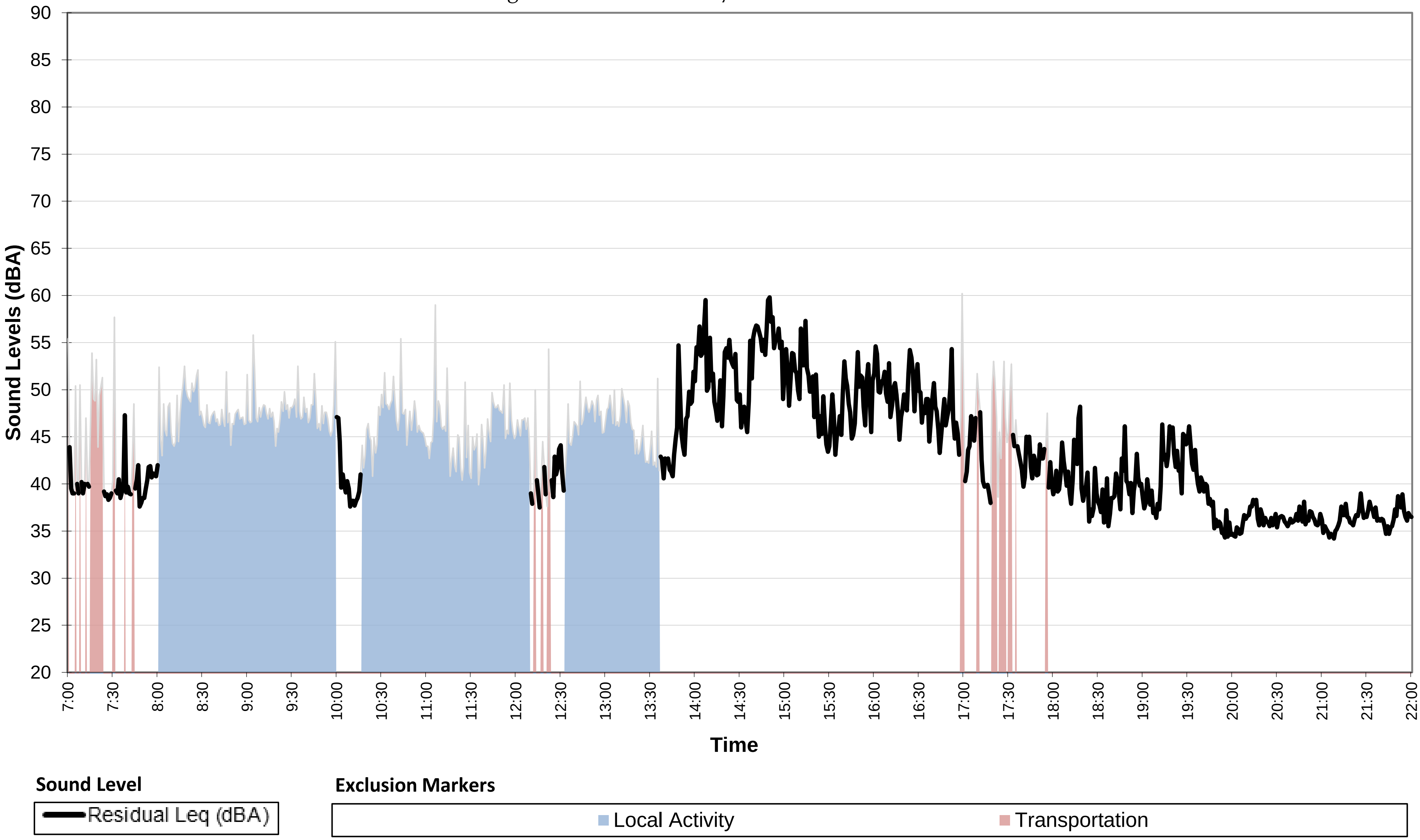
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F12 Night 6 Feb 25 - Feb 26



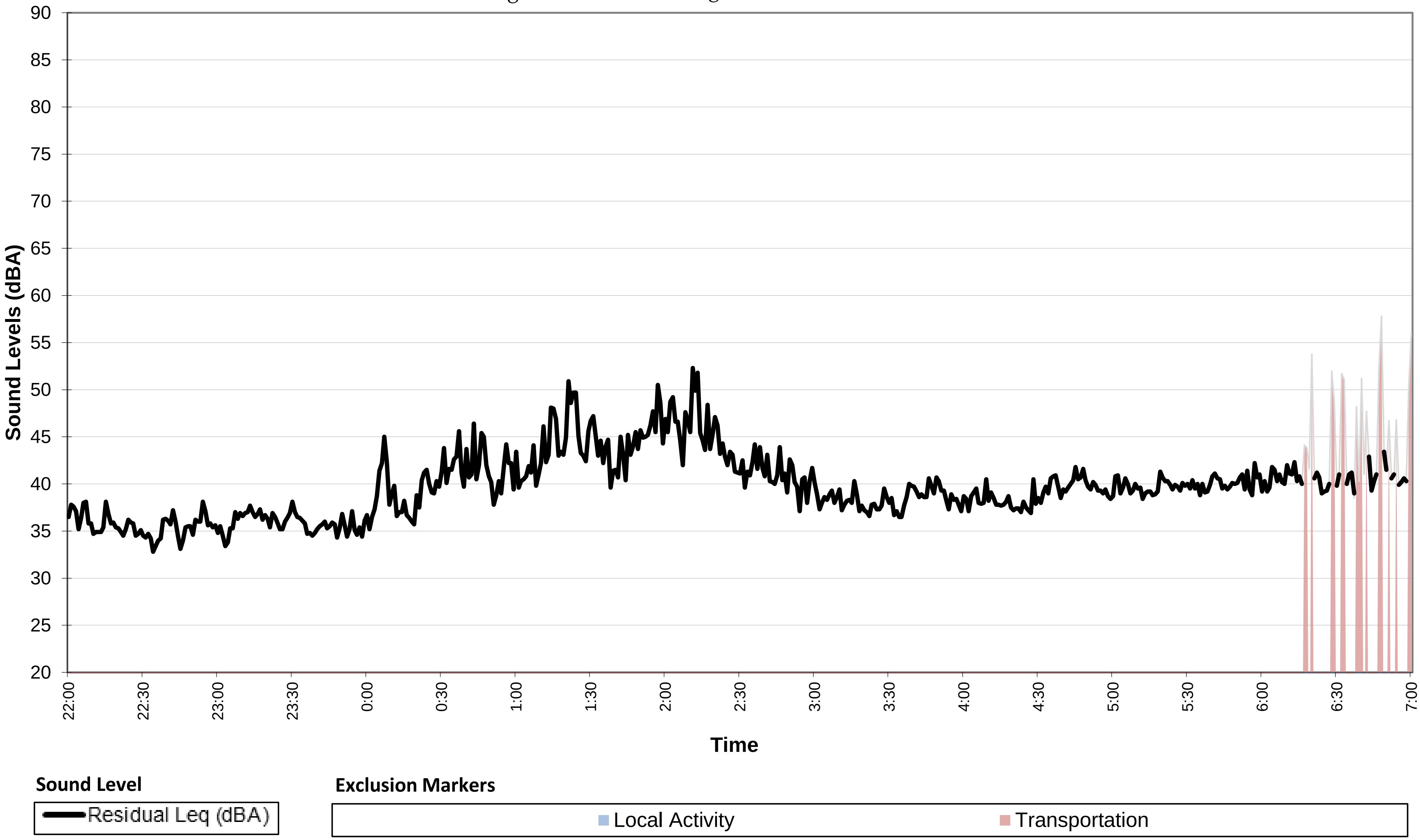
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F13 Day 7 Feb 26



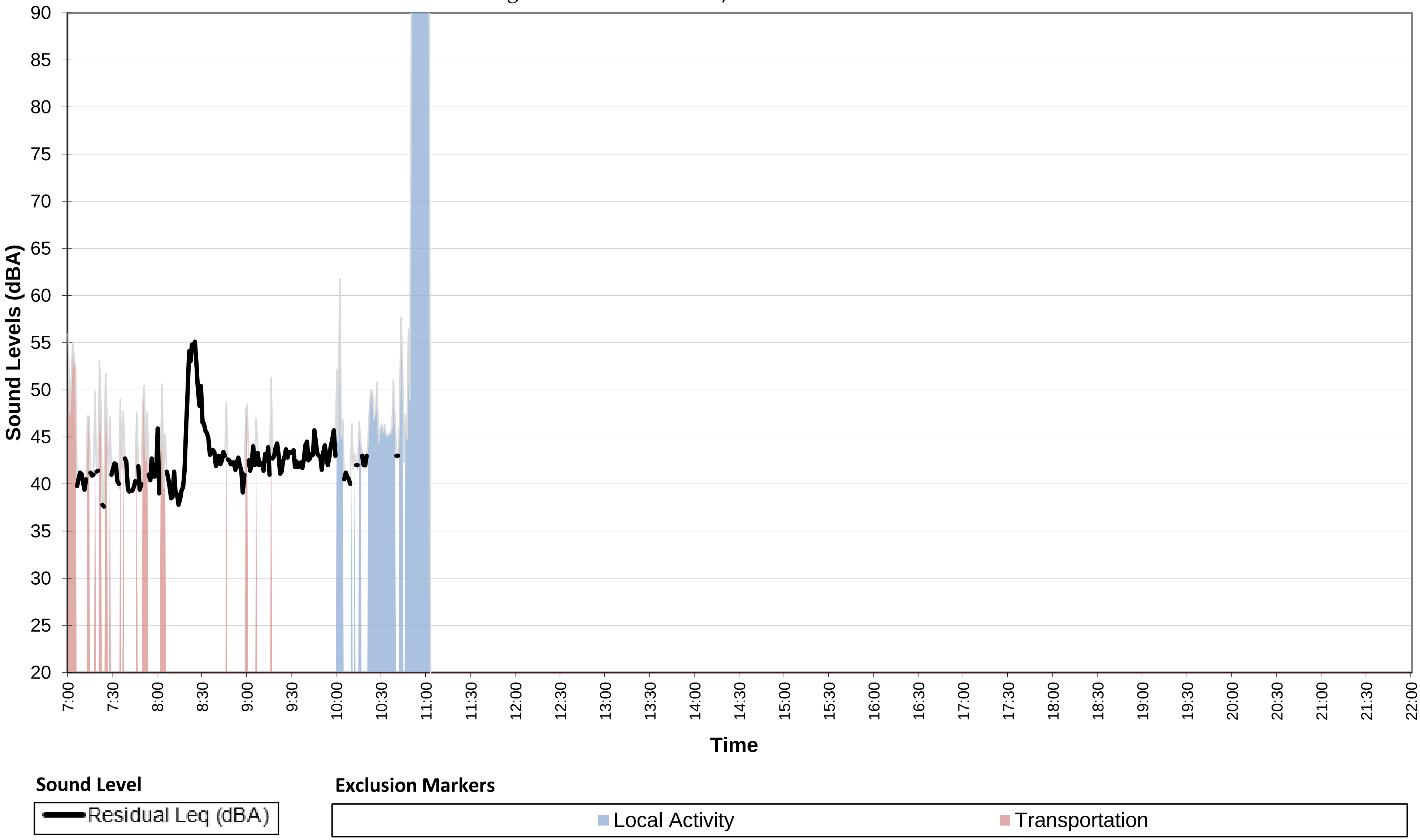
Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F14 Night 7 Feb 26 - Feb 27



Comprehensive Sound Survey - TowerLake Rd. 300 m Monitor

Figure F15 Day 8 Feb 27



APPENDIX G

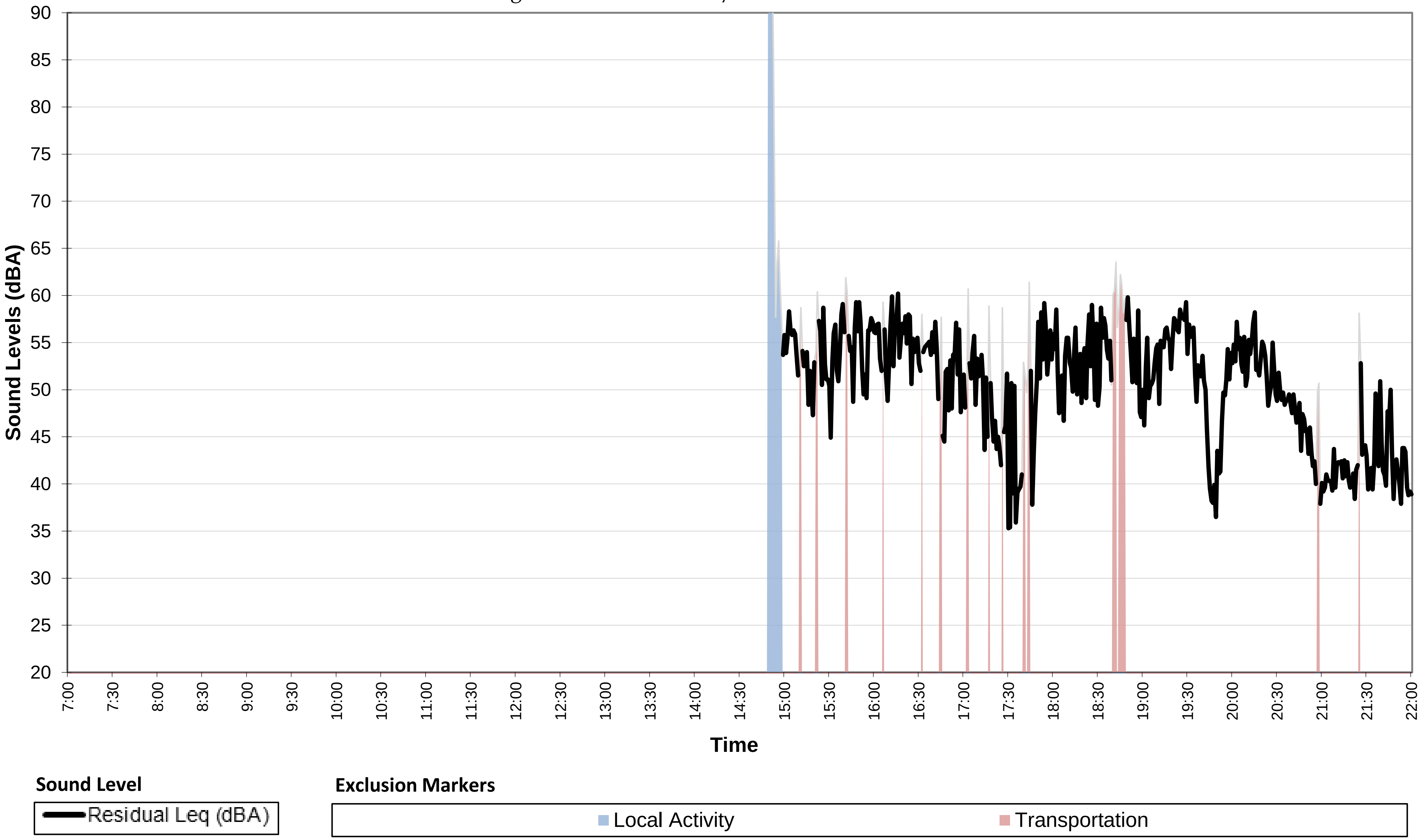
Sound Level Measurements
Sound Monitor SW
50m North from Sweetwater Road

Table G: Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Period	Date (2020)	Measured Leq (dBA)	Measured Hours	Residual Leq (dBA)	Residual Hours
Day 01	Feb 20	73.5	7.2	53.3	6.5
Night 01	Feb 20 - Feb 21	53.9	9.0	52.4	8.6
Day 02	Feb 21	56.6	15.0	55.9	12.6
Night 02	Feb 21 - Feb 22	49.8	9.0	49.0	8.7
Day 03	Feb 22	54.0	15.0	53.9	13.8
Night 03	Feb 22 - Feb 23	46.1	9.0	41.9	7.8
Day 04	Feb 23	48.3	15.0	33.1	10.4
Night 04	Feb 23 - Feb 24	44.4	9.0	27.1	8.1
Day 05	Feb 24	56.1	15.0	37.7	9.4
Night 05	Feb 24 - Feb 25	48.5	9.0	37.3	7.7
Day 06	Feb 25	56.0	15.0	36.9	9.7
Night 06	Feb 25 - Feb 26	48.9	9.0	48.0	8.5
Day 07	Feb 26	57.4	15.0	51.6	11.4
Night 07	Feb 26 - Feb 27	51.0	9.0	50.4	8.5
Day 08	Feb 27	69.7	15.0	51.8	4.4

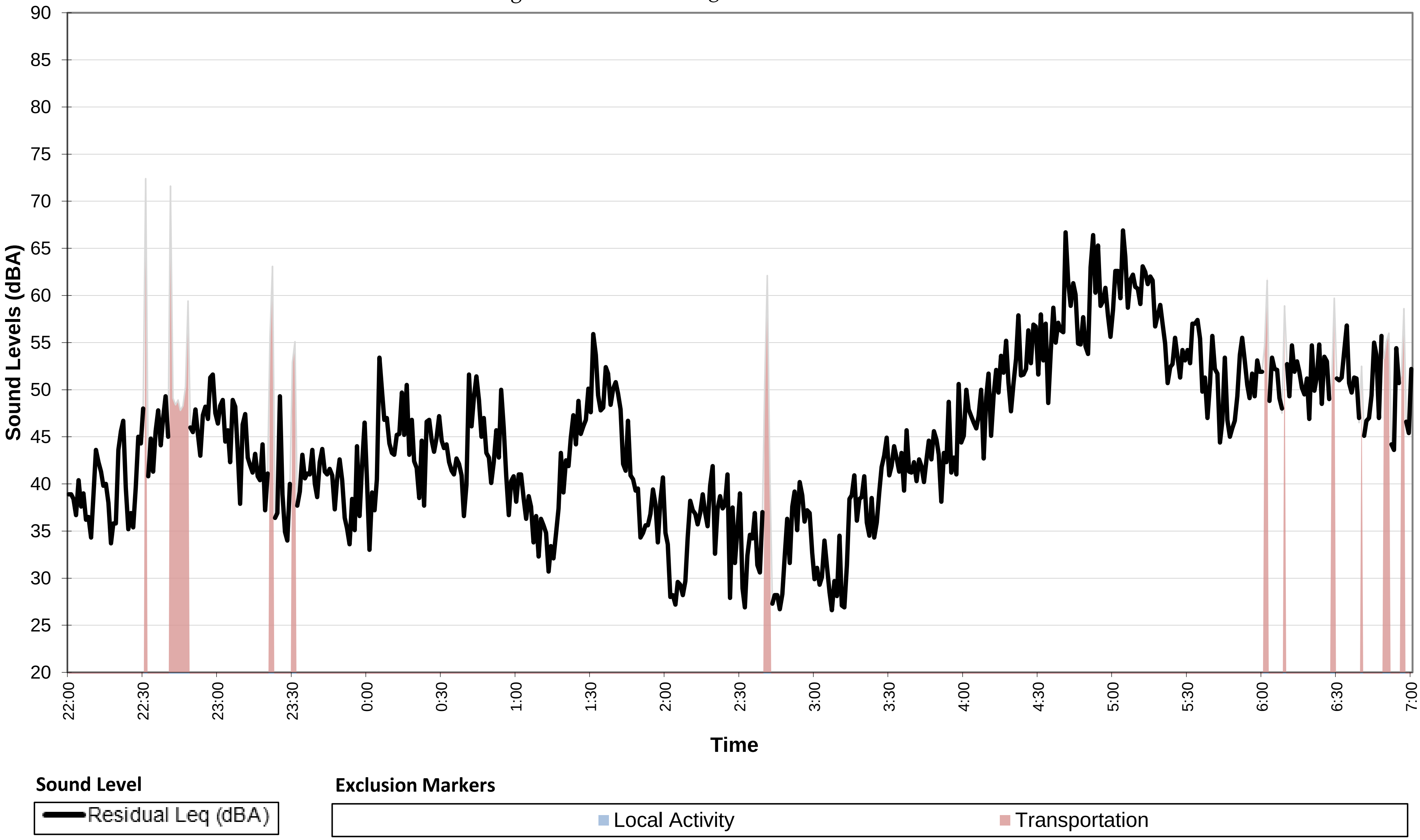
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G1 Day 1 Feb 20



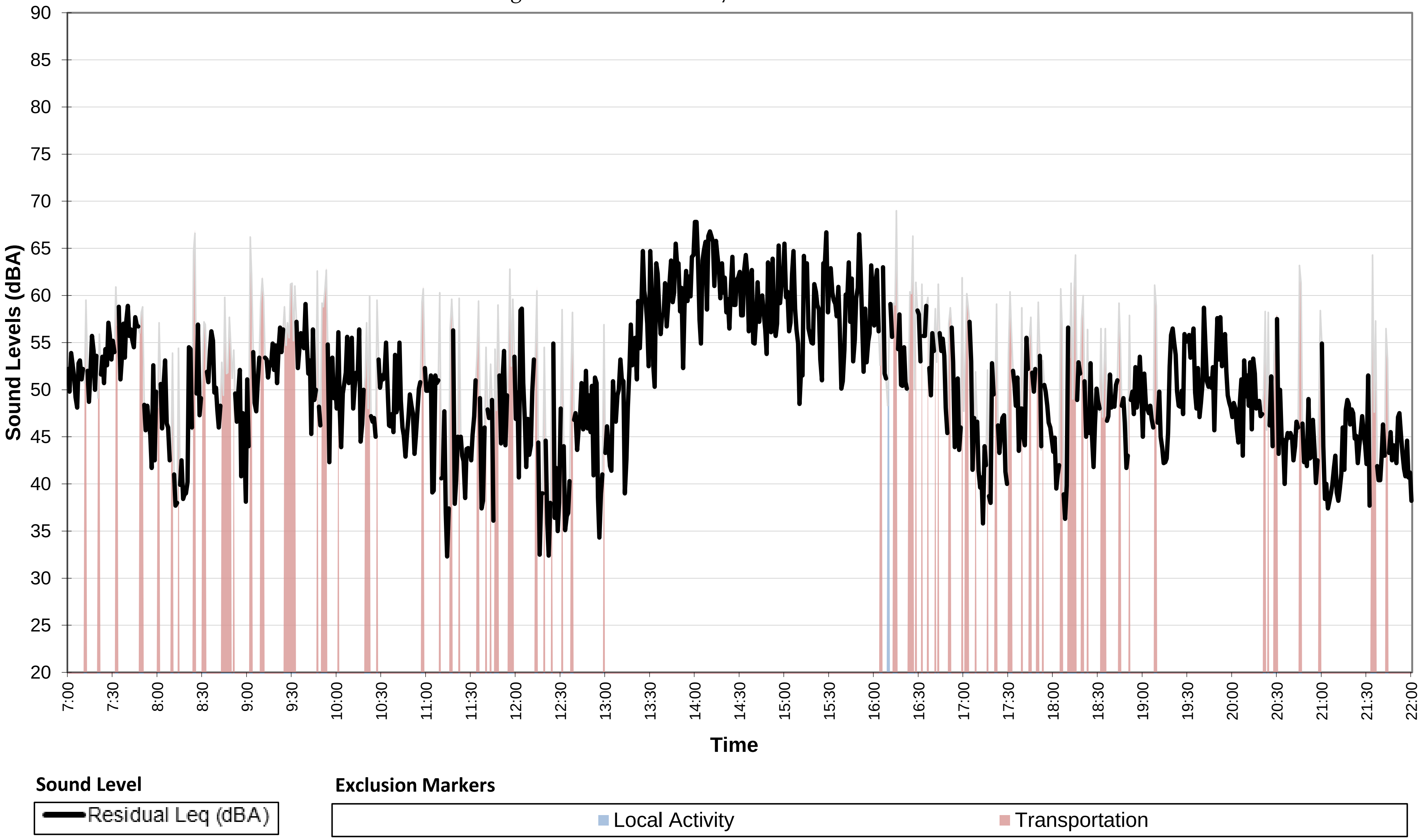
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G2 Night 1 Feb 20 - Feb 21



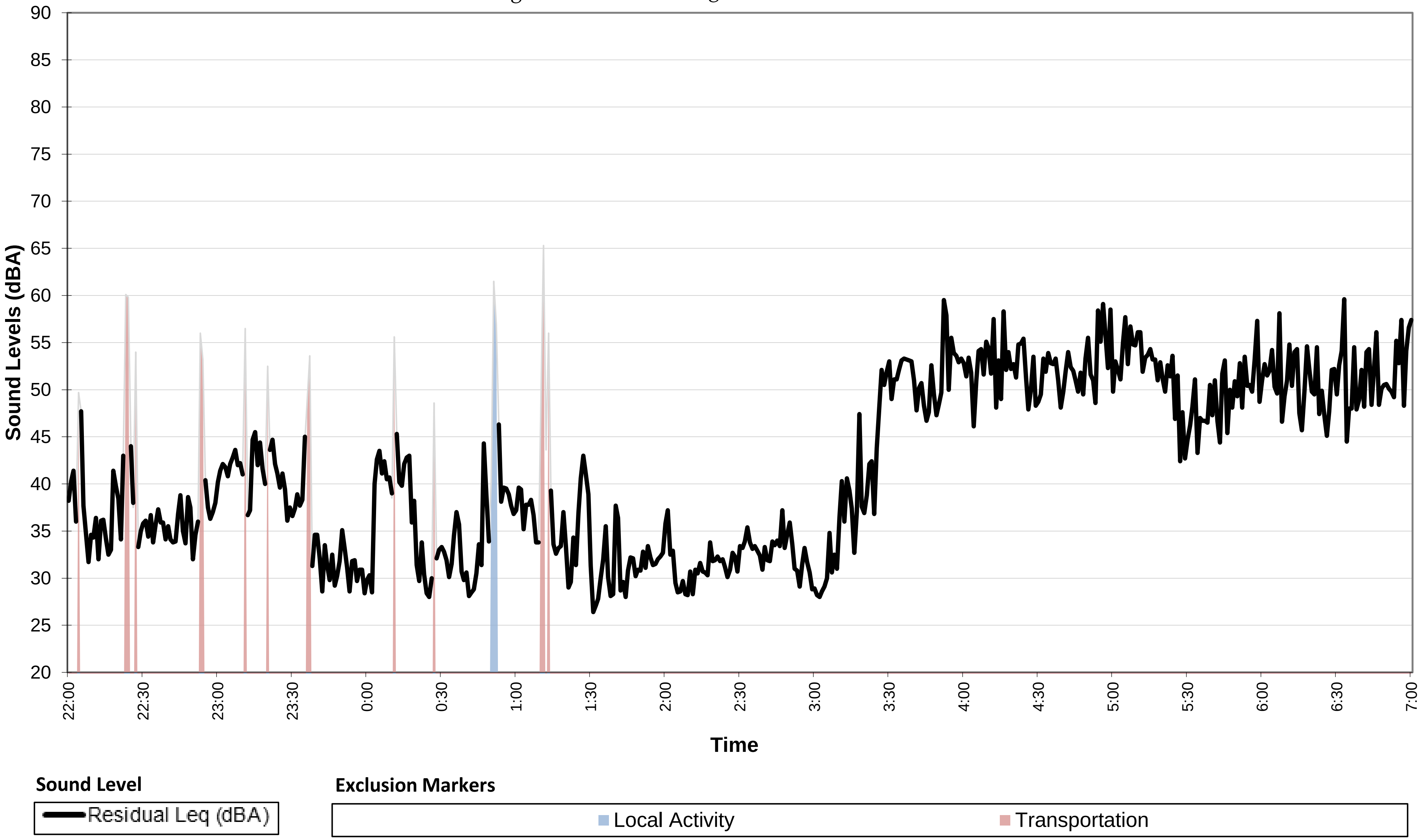
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G3 Day 2 Feb 21



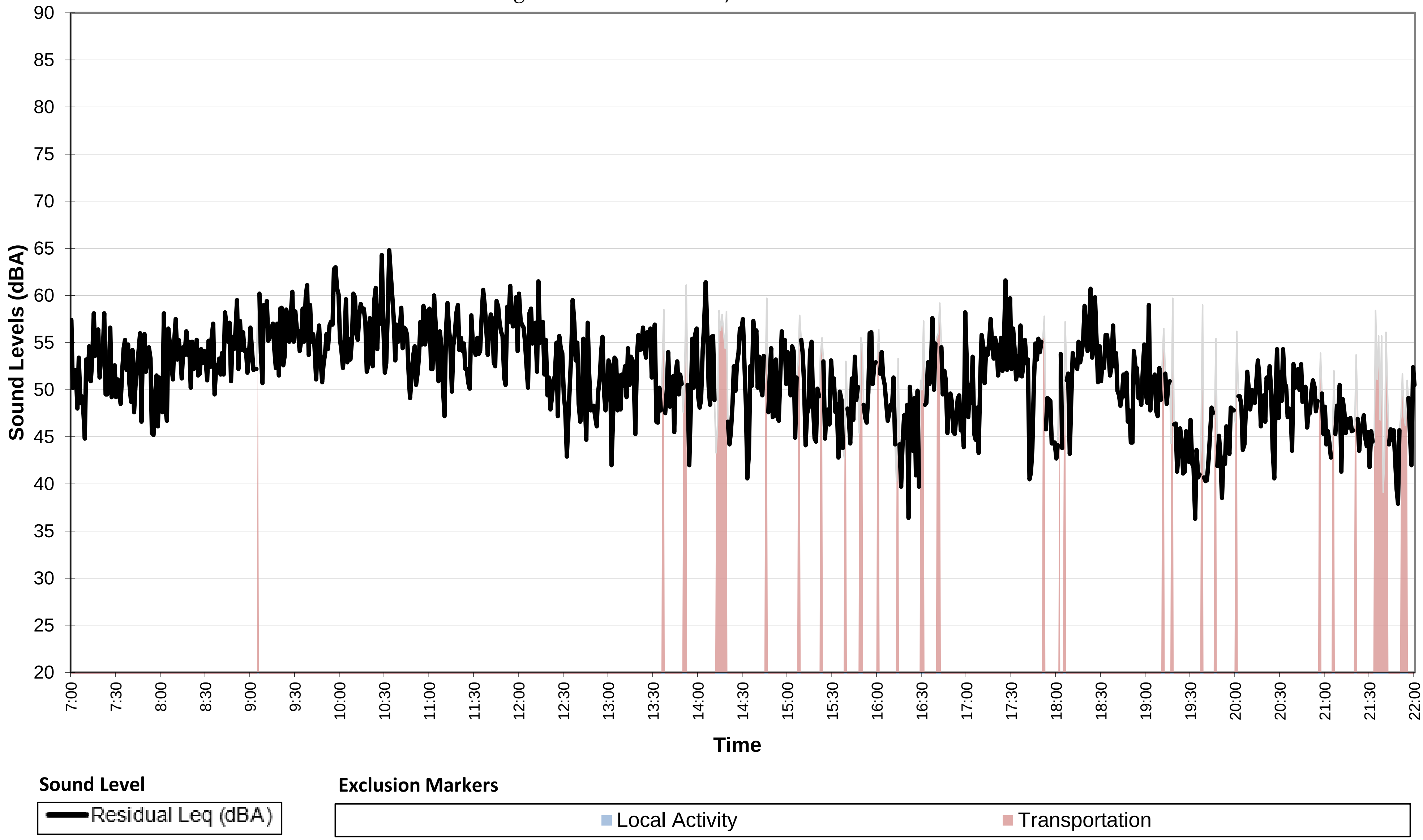
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G4 Night 2 Feb 21 - Feb 22



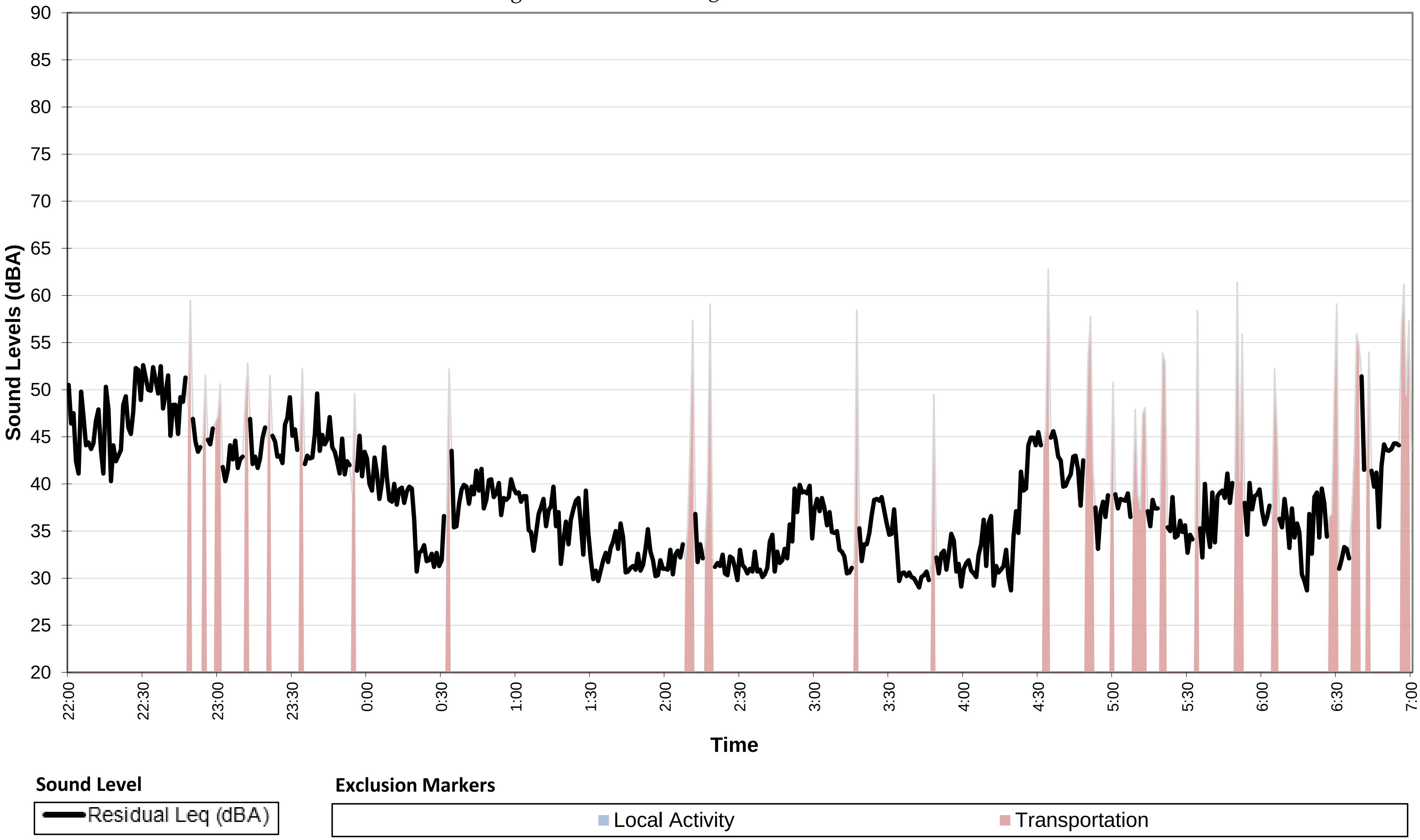
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G5 Day 3 Feb 22



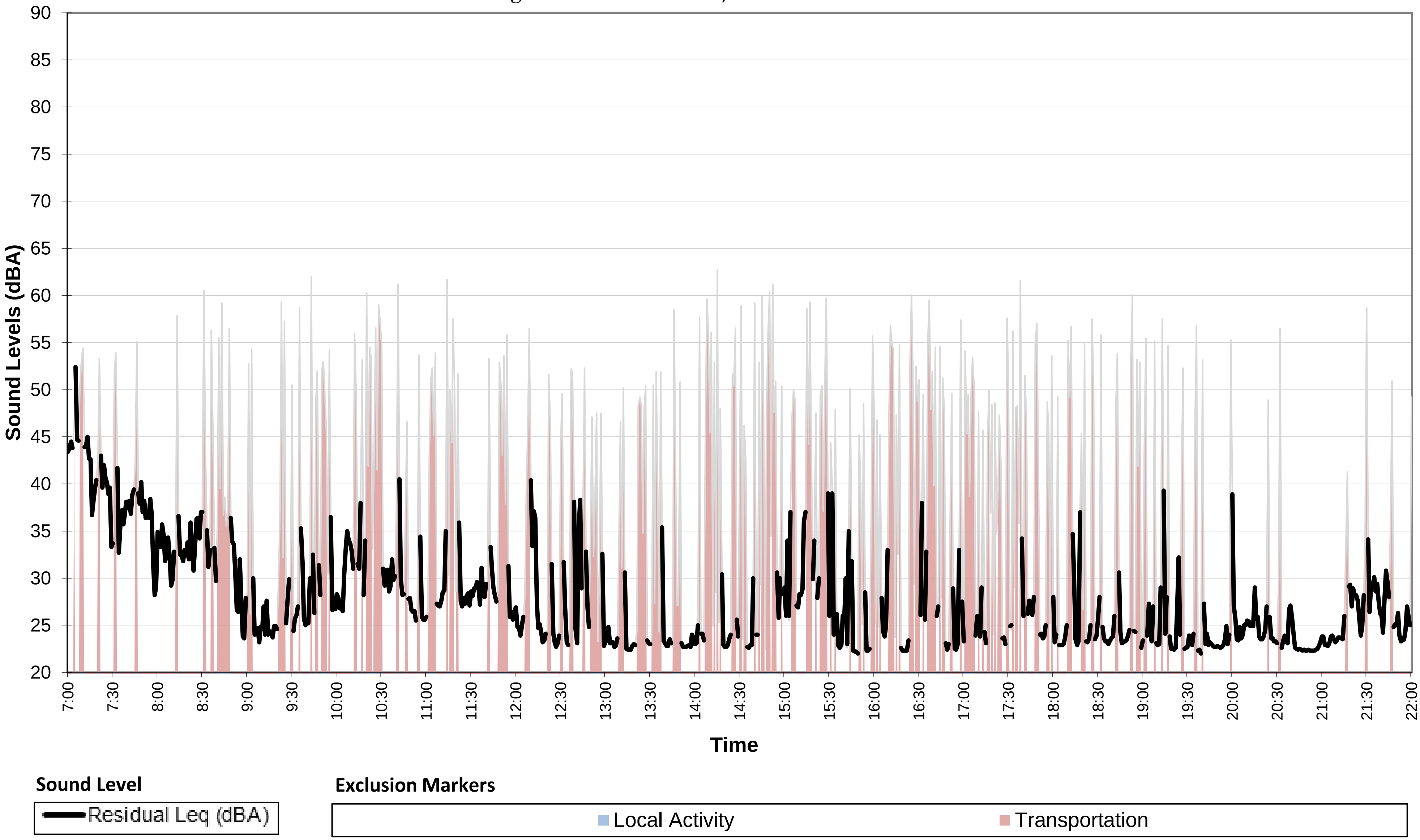
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G6 Night 3 Feb 22 - Feb 23



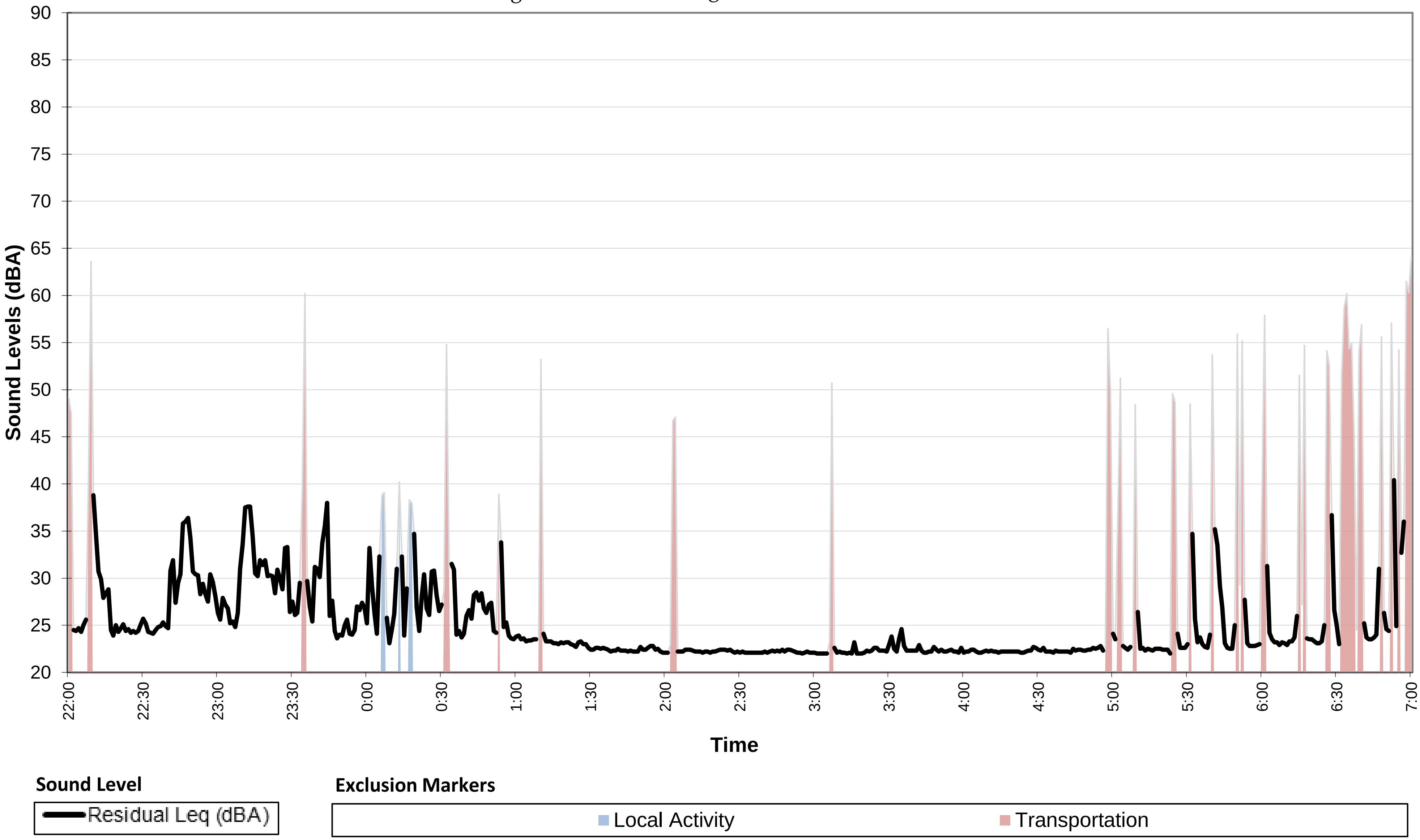
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G7 Day 4 Feb 23



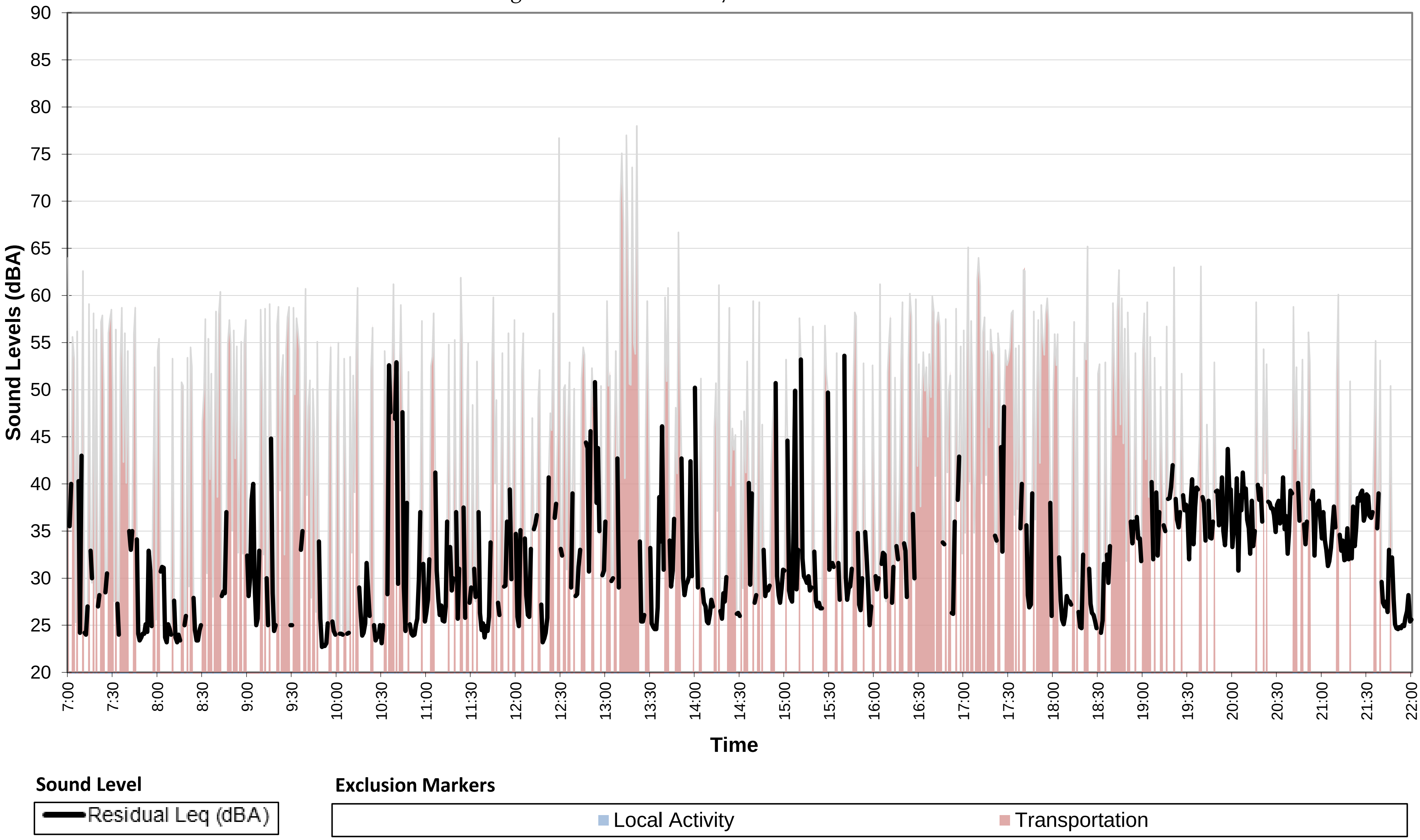
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G8 Night 4 Feb 23 - Feb 24



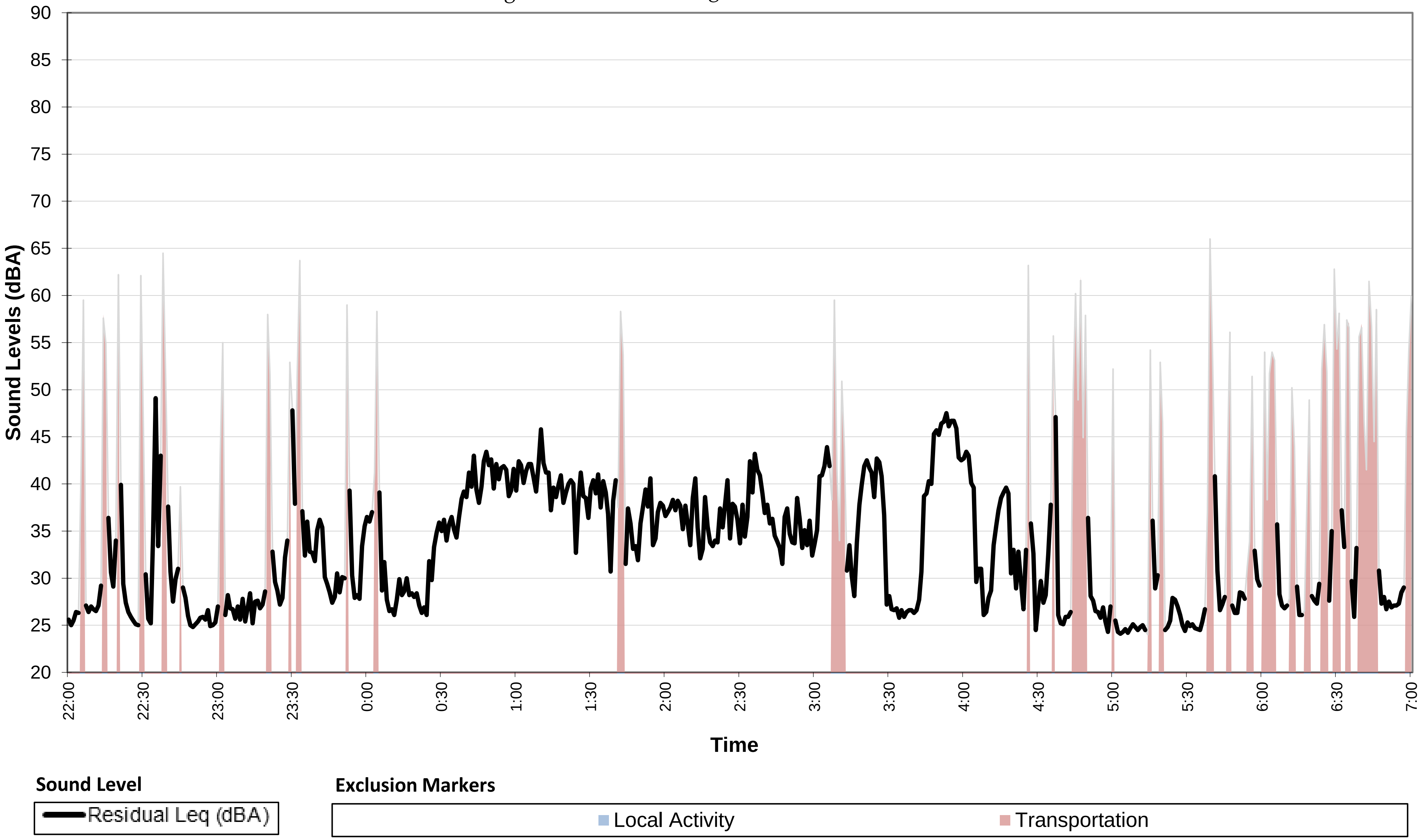
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G9 Day 5 Feb 24



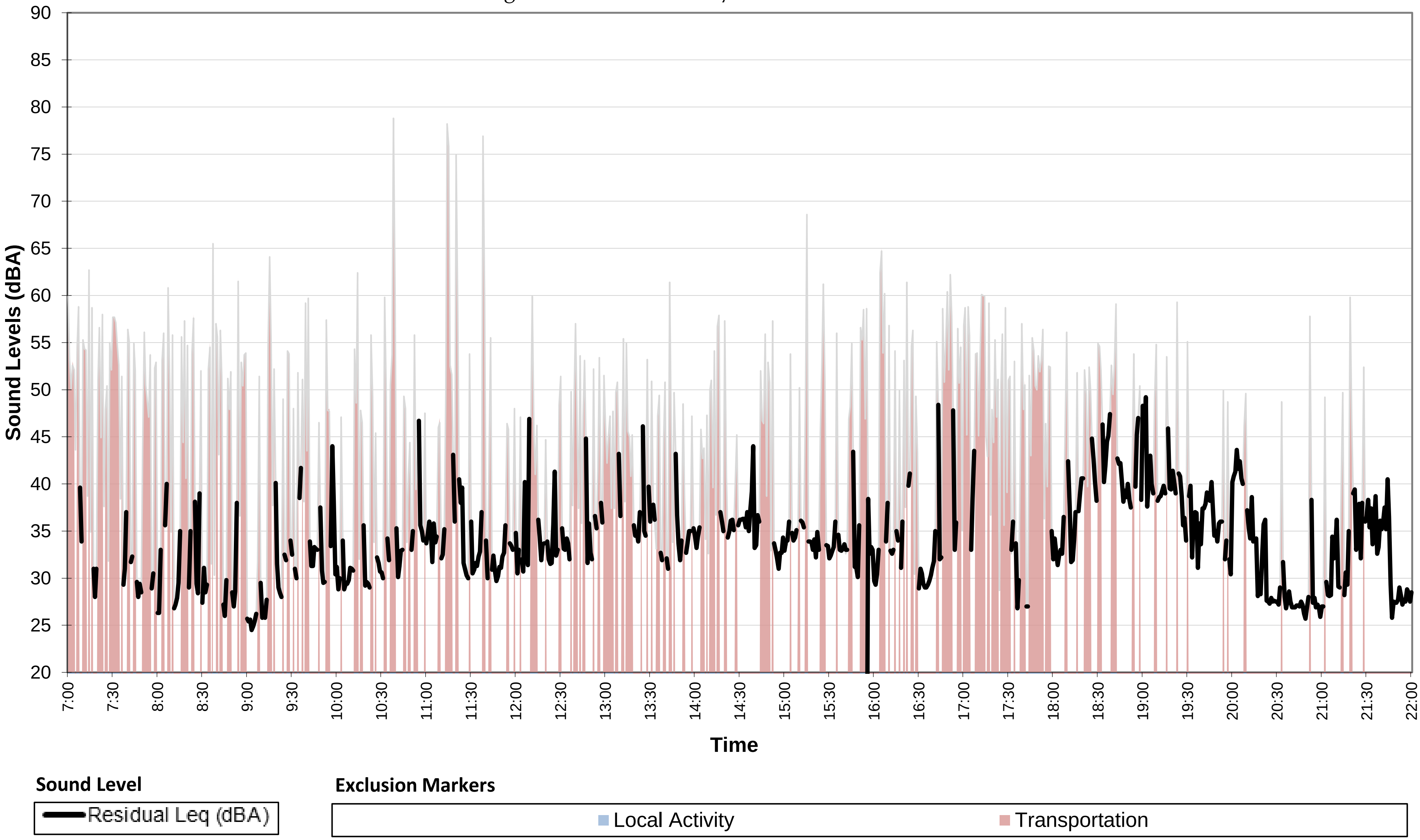
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G10 Night 5 Feb 24 - Feb 25



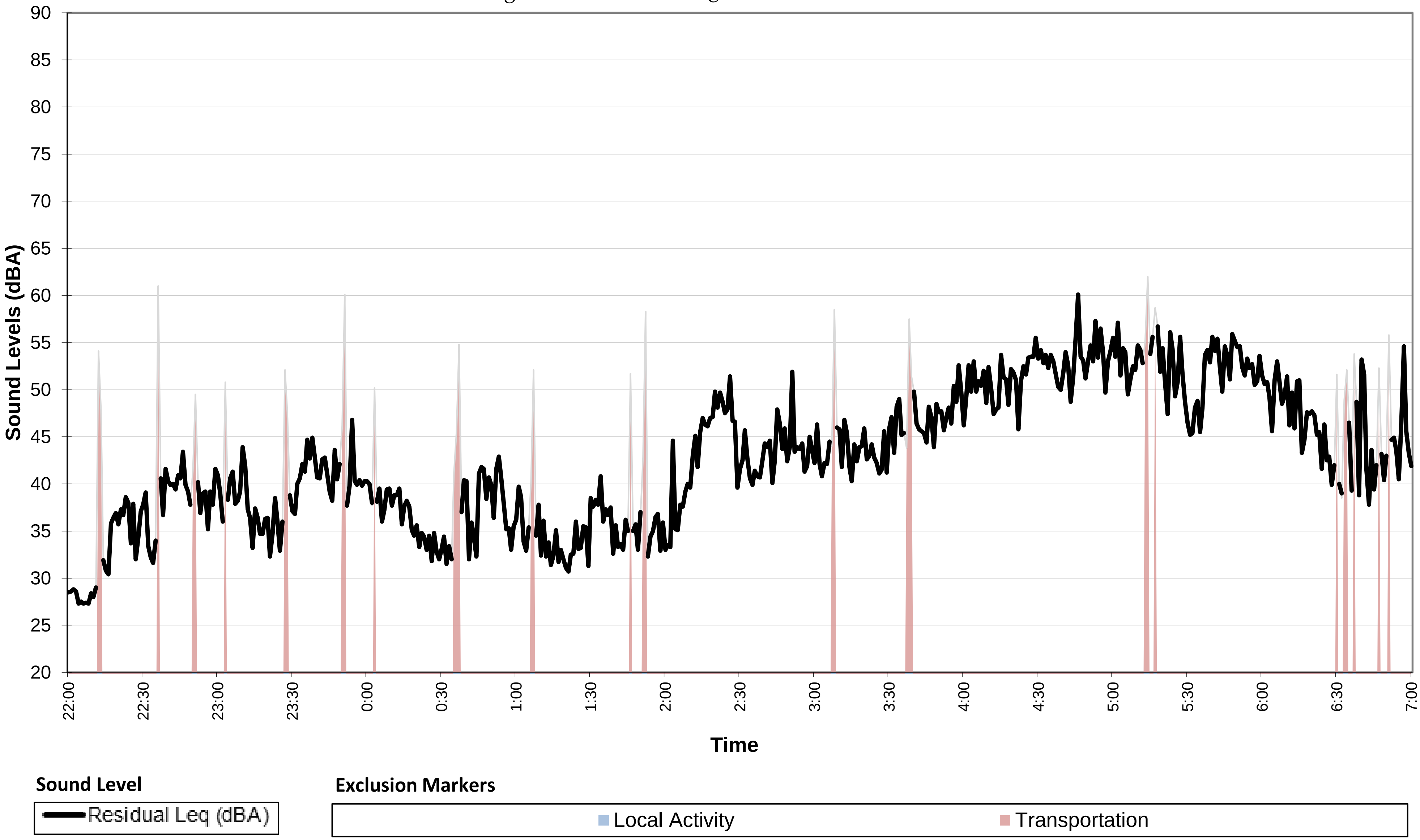
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G11 Day 6 Feb 25



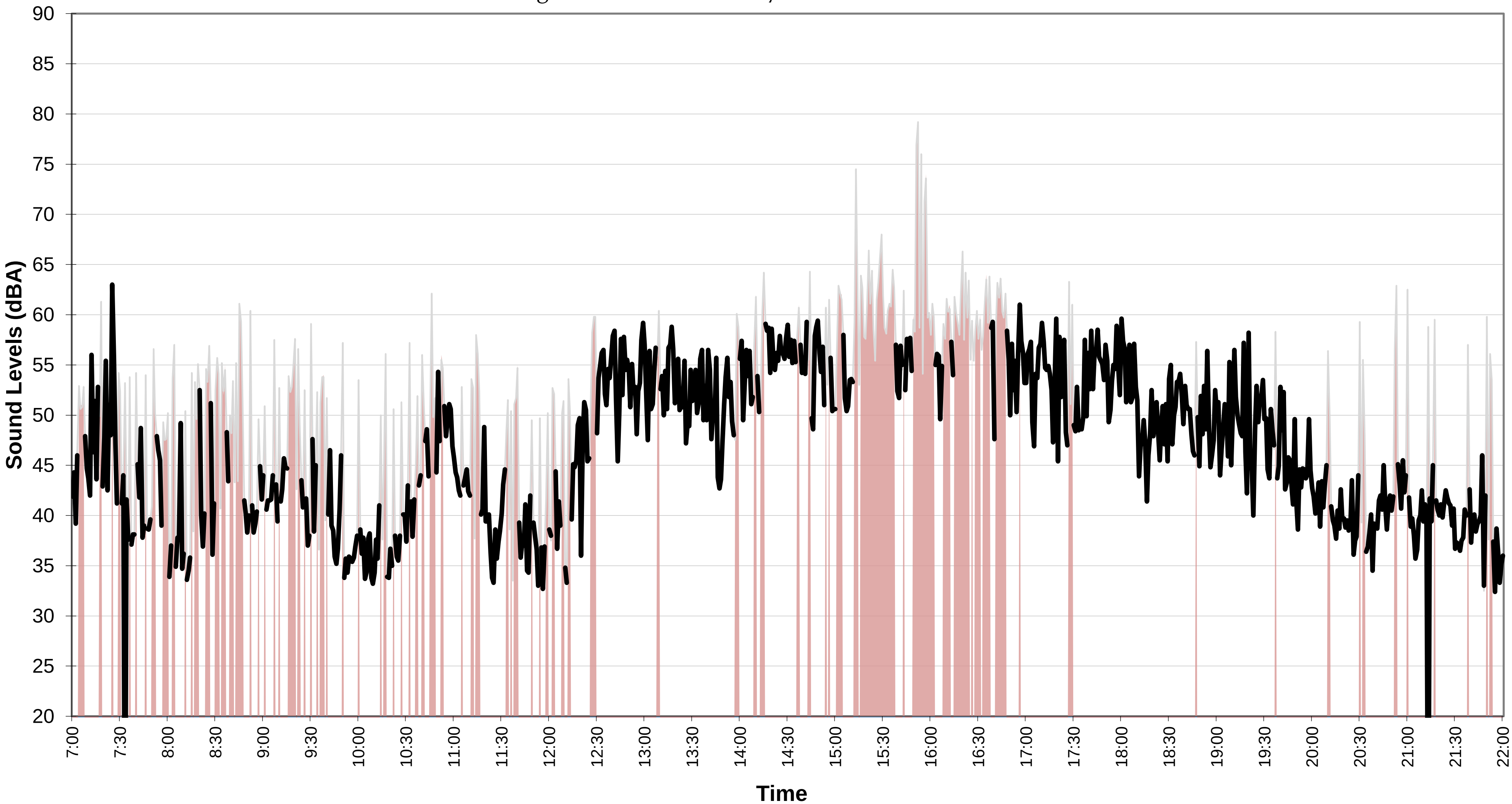
Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G12 Night 6 Feb 25 - Feb 26



Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G13 Day 7 Feb 26



Sound Level

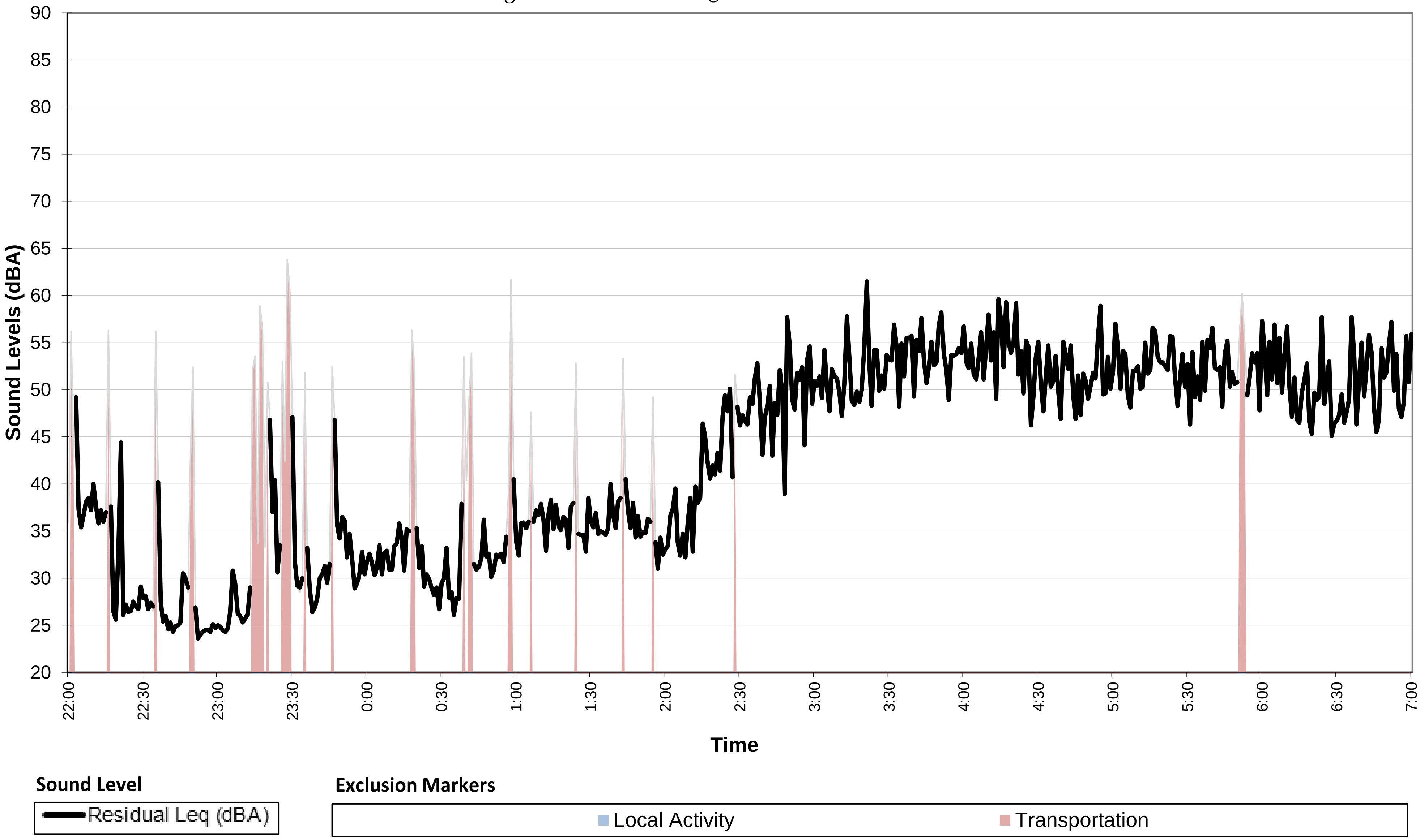
Residual Leq (dBA)

Exclusion Markers

Local Activity Transportation

Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G14 Night 7 Feb 26 - Feb 27



Comprehensive Sound Survey - Sweetwater 223 Rd. 50 m Monitor

Figure G15 Day 8 Feb 27