Commissioner Street Rail Expansion
Environmental Noise and Vibration Assessment

Prepared for:

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EXECUTIVE SUMMARY

Canadian Pacific (CP) is proposing to expand their existing railway infrastructure to improve fluidity along Commissioner Street and the adjacent Columbia Containers Terminal in the Port of Vancouver. The proposed expansion includes the addition of two new yard tracks to the north of CP's existing East L Yard. An environmental noise and vibration assessment was conducted for the Commissioner Street Rail Expansion Project (the Project) in support of the VFPA's Project and Environmental Review (PER) process. This Report describes the approach and findings of this environmental noise and vibration assessment.

The East L Yard serves as a staging area for grain and intermodal trains serving customer terminals in the South Shore area. The Project will provide additional capacity to the yard, allowing for dedicated track operations which will avoid the need for multiple switches, reducing shunting activity in the yard. Train volumes are not expected to increase as a result of the Project. The two new yard tracks will use vacated land from the realignment of Commissioner Street. Overall, the Project is anticipated to result in insignificant changes in noise levels at the nearest residences located south of the East L Yard.

Existing vibration levels are estimated to exceed general vibration criteria from the United States Federal Transit Administration at many of the nearest residences located south of the East L Yard, suggesting that vibration may be perceptible at these residences. The highest vibration levels relative to criteria are associated with CP freight locomotive passbys along the mainline track. Vibration levels associated with the two new yard tracks will be substantially lower than those associated with the existing mainline track. Therefore, vibration levels experienced at the nearest residences due to the Project are expected to remain the same as existing conditions and the Project is deemed to have no impact on vibration levels.

This work was performed in accordance with the Service Agreement #5600019939 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and CP (Client), dated April 30, 2020 (Contract). This Report has been prepared by Hemmera for sole benefit and use by CP. In performing this work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

This Executive Summary is not intended to be a stand-alone document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
CP	Canadian Pacific
PER	Project and Environmental Review
US FTA	United States Federal Transit Administration
VFPA	Vancouver Fraser Port Authority

LIST OF SYMBOLS AND UNITS OF MEASURE

Symbol / Unit of Measure	Definition
%	Percent
%HA	Percent highly annoyed
dB	Decibel
dBA	A-weighted decibel
L_d	Daytime noise level
L_{den}	Day-evening-night noise level
L_{dn}	Day-night noise level
L_n	Nighttime noise level
LLF	Low frequency noise level
VdB	Vibration decibel

1.0 INTRODUCTION

Canadian Pacific (CP) is proposing to expand their existing railway infrastructure to improve fluidity along Commissioner Street and the adjacent Columbia Containers Terminal in the Port of Vancouver. The proposed expansion includes the addition of two new yard tracks to the north of CP's existing East L Yard. The additional tracks, situated on CP property with sections that overlap lands under the jurisdiction of the Vancouver Fraser Port Authority (VFPA) and the City of Vancouver, are intended to increase storage capacity and improve operations for existing Port customers. Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc., was retained to conduct an environmental noise and vibration assessment of the Commissioner Street Rail Expansion Project (the Project) in support of the VFPA's Project and Environmental Review (PER) process.

This Work was performed in accordance with the Service Agreement #5600019939 between Hemmera and CP (Client), dated April 30, 2020 (Contract). This Report has been prepared by Hemmera for sole benefit and use by CP. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

2.0 PROJECT OVERVIEW

The East L Yard serves as a staging area for grain and intermodal trains serving customer terminals in the South Shore area. Train volumes vary but tend to peak in the fall with up to 12 movements per day (i.e., 6 trains in and 6 trains out). Train volumes during non-peak seasons average 8 movements per day (i.e., 4 trains in and 4 train out). Yard activities occur 24 hours per day with no differentiation between daytime and nighttime hours.

The Project extends from Mile 125.37 to Mile 127.00 of the Cascade Subdivision on the north side of the East L Yard, located south of Commissioner Street, in Vancouver, BC. The Project includes:

- Installation of two new yard tracks, L30 (2,400 metres in length) and L31 (1,300 metres in length)
- Adjustment of the existing Columbia Containers lead track to connect to the L31 track
- Track shift below the Commissioner Street overpass to maintain five tracks through the corridor
- Installation of a retaining wall along New Brighton Road
- Installation of a small locomotive storage track at the Williston Yard office
- Turnouts and crossovers connecting the CP mainline with the yard tracks and private customer trackage

Future yard operations will handle the same rail traffic into the South Shore area; train volumes are not expected to increase as a result of the Project. The addition of the two new yard tracks, L30 and L31, are intended to increase storage capacity, allowing the redistribution of track function within the yard. This allows the existing yard tracks to be utilized for more specific commodities and single customer blocks of cars, thereby requiring less switching within the yard.

A Project noise screening score sheet is included in Appendix A. As per the PER Application Submission Requirements and since the total weighted score is more than 30, an environmental noise and vibration assessment is required. This Report describes the approach and findings of this environmental noise and vibration assessment.

3.0 ASSESSMENT CRITERIA

3.1 Noise Criteria

In accordance with the VFPA's PER Guidelines for Environmental Noise Assessment (PMV 2015), this noise assessment is based on Project-related changes in annual average daily community noise exposures, quantified by the day-evening-night noise level (L_{den}). The L_{den} includes a 5-decibel (dB) penalty during evening hours (7:00 pm to 10:00 pm) and a 10-dB penalty during nighttime hours (10:00 pm to 7:00 am), as well as necessary adjustments for tonal and impulsive noise.

In addition to the L_{den} noise level, this noise assessment considers the percent of highly annoyed individuals (%HA), an aggregate indicator of assorted noise effects. The %HA is typically calculated from the day-night noise level (L_{dn}) based on the following equation, also known as the Shultz Curve.

$$\%HA = \frac{100}{1 + e^{(10.4 - 0.132 L_{dn})}}$$

As per the PER Guidelines, this noise assessment estimates %HA based on the L_{den} rather than the L_{dn}, which may overestimate the %HA due to the additional 5-dB penalty during evening hours, but is not expected to affect the predicted change in %HA to a significant degree.

Criteria for which mitigation measures may be warranted are as follows:

- An increase in community noise exposure, expressed as L_{den}, at a noise sensitive receptor
- An increase in %HA of 6.5% or more (Health Canada 2017)
- A post-project L_{den} exceeding 75 A-weighted decibels (dBA)

Since the dBA discounts lower frequency sounds to which the human ear is less sensitive, low frequency noise may be a concern even when the above criteria are met. In accordance with the PER Guidelines and with ANSI s12.9-2005, the low frequency noise level (LLF), defined as the sum of the sound levels in the 16, 31.5, and 63 hertz octave bands, should be less than 70 dB.

3.2 Vibration Criteria

The VFPA has not established vibration criteria for the PER process. This vibration assessment considers general vibration criteria from the United States Federal Transit Administration (US FTA 2018). The general vibration criteria are developed based on a study of occupant response to transit-induced residential

vibration. Overall, the vibration criteria are based on perception threshold as the data indicate that vibration in the “distinctly perceptible” range is unacceptable for a residence.

The US FTA vibration criteria, summarized in Table 3.1, vary by land use type and by the frequency of vibration events. For residential land uses in the Project area, the vibration criterion is 100 vibration decibels (VdB) for frequent events such as CP freight rail car passbys[1], 103 VdB for occasional events such as CP freight locomotive passbys, and 108 VdB for infrequent events such as West Coast Express passenger rail passbys.

Table 3.1 US FTA General Vibration Criteria

Land Use Category	Description	Vibration Criteria (VdB)[1]		
		Frequent Events	Occasional Events	Infrequent Events
High Sensitivity	Buildings where vibration can interfere with operations	93	93	93
Residential	Residences and buildings where people normally sleep	100	103	108
Institutional	Institutional land uses with primarily daytime use	103	106	111

Note:
(1) Based on the root-mean-square vibration velocity, referenced to 1×10^{-6} millimetres per second.

Where existing vibration levels exceed the general vibration criteria, a project is deemed to have no impact when the following conditions are achieved:

- There is not a significant increase (i.e., approximate doubling) in the number of vibration events
- The increase in vibration level between the existing and future scenarios is less than 3 VdB

The US FTA guideline also includes criteria for ground-borne noise. Ground-borne noise is typically only assessed at locations with subway or tunnel operations where there is no airborne noise path. As the rail operations for the Project are at-grade, the airborne noise levels are expected to be higher than ground-borne noise levels. Hence, ground-borne noise effects were not assessed.

[1] As per US FTA guidance, vibration from rail cars should be considered frequent events regardless of the number of events due to the length of time of a passby.

4.0 EXISTING ENVIRONMENTAL CONDITIONS

Baseline noise and vibration monitoring could not be conducted due to ongoing fire activity in the region, resulting in below normal rail activity and unrepresentative noise and vibration levels in the Project area. Existing noise levels in the Project area were characterized based on a review of historical noise monitoring data from the VFPA and Columbia Containers. Existing vibration levels in the Project area were estimated using the vibration model developed by the US FTA (see Section 6.0).

4.1 VFPA Noise Monitoring

The VFPA operates a noise monitoring program to better understand the source and intensity of Port-related noise and to help respond to community concerns regarding noise. A network of 11 noise monitoring terminals was implemented in 2014 using Bruel and Kjaer sound level monitors. In summer 2019, all Bruel and Kjaer sound level monitors were replaced with Larson Davis sound level monitors.

Of the 11 noise monitoring terminals, three are located near the Project area. A map of these three noise monitoring terminals is provided in Figure 1 attached. The 2019 Annual Noise Monitoring Report (VFPA 2020) was reviewed to characterize existing noise levels at these locations. A summary of measured noise levels from December 2016 to December 2019 is presented in Table 4.1. It should be noted that the noise monitoring terminals are not located at residential receptors and measured noise levels are not necessarily representative of community noise exposure in the Project area. An estimate of community noise levels, as documented in the 2019 Annual Noise Monitoring Report (VFPA 2020), is provided in Table 4.1.

Table 4.1 Measured Noise Levels at VFPA Noise Monitoring Terminals

Station ID	Station Name	Day-Evening-Night Noise Level, L_{den} (dBA)	Nighttime Noise Level, L_n (dBA)	Dominant Noise Sources	Community Noise Level Comparison
NMT6	VAN Semlin	73 to 74	66 to 67	Rail activity, truck traffic along Commissioner Street	Noise levels at NMT are similar to nearest residences
NMT7	VAN Nanaimo	74	66	Rail activity, truck traffic along Commissioner Street	Noise levels at NMT are noticeably (6 dBA) louder than nearest residences
NMT8	VAN Renfrew	74 to 75	66	Truck traffic (acceleration) along Commissioner Street, rail activity	Noise levels at NMT are slightly (3 dBA) louder than nearest residences

Source: VFPA 2020

4.2 Columbia Containers Noise Monitoring

Noise monitoring was conducted in 2015 to characterize pre-project noise levels in support of the Columbia Containers New Grain Transloading and Facility Silos Rebuild Project (Columbia Containers 2015). A summary of the noise monitoring results is presented in Table 4.2. Also shown in Table 4.2 are previous noise measurements taken in 2011 and 2005. The Columbia Containers noise monitoring locations are illustrated in Figure 1.

The implementation of the New Grain Transloading and Facility Silos Rebuild Project was projected to result in a small decrease (i.e., 1 dB or less) in noise levels at the three residential locations shown in Table 4.2. Therefore, measured noise levels presented in Table 4.2 are expected to be representative of existing noise levels at these locations.

Table 4.2 Measured Noise Levels Near Columbia Containers

Station ID	Address	Date	Daytime Noise Level, L_d (dBA)	Nighttime Noise Level, L_n (dBA)	Day-Night Noise Level, L_{dn} (dBA)	Day-Evening-Night Noise Level, L_{den} (dBA)
CC1	2615 Wall Street	January 22-27, 2015	64	62	69	69
		August 16-17, 2011	64	61	68	-
		August 17-18, 2011	64	60	67	-
		August 18-19, 2011	64	65	72	-
		September 22-23, 2005	63	60	67	-
CC2	2709 Wall Street	August 17-18, 2011	66	65	72	-
		August 18-19, 2011	65	69	75	-
CC3	2827 Wall Street	January 22-27, 2015	68	66	73	73
		August 17-18, 2011	65	64	71	-
		August 18-19, 2011	65	68	74	-
		September 21-22, 2005	64	63	70	-
		September 22-23, 2005	66	64	71	-

Source: Columbia Containers 2015

5.0 NOISE MODELLING

Modelling of Project-related noise was conducted using the DataKustik CadnaA noise prediction software which follows propagation equations from international standard ISO 9613-2. Noise modelling was completed for the following scenarios:

- **Calibration Case:** This is the scenario that currently exists and provides a direct comparison to measured noise levels at the VFPA and Columbia Containers noise monitoring locations. Road and rail traffic volumes are intended to capture 2019 to 2020 conditions. Adjustments are made to account for effects of the COVID-19 pandemic to ensure this scenario captures typical peak noise conditions.
- **Existing Case:** This is the same as the Calibration Case except with adjustments/penalties applied to tonal and impulsive noise to reflect the greater potential for intrusion and annoyance associated with these characteristics.
- **Future Case:** This scenario considers future conditions with the Project, including the proposed realignment of Commissioner Street. Road and rail traffic volumes remain unchanged from the Existing Case. Similar to the Existing Case, adjustments/penalties are applied to tonal and impulsive noise.

Project-related effects are based on the difference between the Future Case and the Existing Case. While the realignment of Commissioner Street is not part of this PER Application, it is considered as part of Project-related effects as the two are intertwined; the Project will use land vacated by the realignment of Commissioner Street to the north.

5.1 Identification of Prominent Noise Sources

A review of historical noise monitoring data in the Project area suggests that overall noise levels are primarily influenced by road traffic and rail activity. The following prominent noise sources are considered in the noise modelling:

- Facility operations at Columbia Containers Terminal
- Road traffic along Commissioner Street, Wall Street, and Powell Street
- Rail activity along the mainline track and within the East L Yard

5.1.1 Columbia Containers Terminal

Noise sources at the Columbia Containers Terminal include facility truck movements, rail loading/unloading activities, and facility equipment. Sound pressure levels and operating times for all noise sources at the Columbia Containers Terminal were obtained from the New Grain Transloading and Facility Silos Rebuild Project Environmental Noise Assessment (Columbia Containers 2015).

5.1.2 Road Traffic

Noise levels associated with road traffic were estimated using the NMPB-Routes-1996 model implemented within the CadnaA software.

Road traffic volumes for Wall Street and Powell Street in 2019 and 2020 were obtained from City of Vancouver traffic counts (City of Vancouver 2021). To account for impacts of the COVID-19 pandemic situation on road traffic volumes in 2020, 2019 data were used where available. Where 2019 data were not available, all 2020 traffic count data were increased by an average of 110% during daytime and nighttime hours, and by an average of 30% during evening hours based on available 2019 and 2020 traffic comparisons in the Project area.

Commissioner Street is closed to public traffic and traffic count data are not available from the City of Vancouver. Existing and projected future road traffic volumes along Commissioner Street were estimated based on traffic modelling, as used for the New Grain Transloading and Facility Silos Rebuild Project Environmental Noise Assessment (Columbia Containers 2015).

A summary of the road traffic volumes used in this assessment is presented in Table 5.1.

Table 5.1 Summary of Road Traffic Volumes

Road	Segment	Annual Average Daily Traffic		
		Daytime	Evening	Nighttime
Wall Street	East of Kaslo Street	1,282	91	101
	Slocan Street to Kaslo Street	1,536	148	116
	Penticton Street to Slocan Street	1,439	134	95
	Nanaimo Street to Penticton Street	1,722	165	125
	Trinity Street to Nanaimo Street	1,887	184	176
	McGill Street to Trinity Street	1,969	199	148
	Oxford Street to McGill Street	371	49	47
	Dundas Street to Oxford Street	2,474	340	284
Powell Street [(a)]	Salsbury Drive to Victoria Drive	16,214	1,803	2,302
Commissioner Street [(b)]	Victoria Drive to McGill Street	3,282	821	468

Notes:

[(a)] Road traffic volume based on 2015 traffic count data

[(b)] Road traffic volume interpolated based on 2010 and 2030 data. Traffic split for daytime versus evening assumes constant Port traffic between 7:00 am to 10:00 pm.

5.1.3 Rail Activity

Rail activity data with and without the Project were estimated based on information provided by CP.

The East L Yard currently consists of three tracks, L27 to L29. In general, L27 is used for spotting grain and intermodal trains arriving and departing South Shore customer terminals. This requires multiple switches, resulting in shunting noise every 1.5 to 2 hours. L28 and L29 is used for loaded and empty grain cars arriving and departing the terminal dumper. Trains of 80 cars are cut into blocks of 10 to 14 cars at a time, resulting in up to 8 switches per train.

CP intends to redistribute functions in the yard with the implementation of the Project. Current activities on L28 and 29 serving the terminal dumper will be moved one track north to L29 and L30. L28 will be used for spotting grain cars, while L27 will be used for spotting intermodal cars serving South Shore customer terminals. The added capacity and dedicated track operations will avoid the need for multiple switches, reducing shunting activity in the yard. Access to Columbia Containers will transition from L29 to L31.

A sound power level of 111 dBA was assumed for shunting (CTA 2011). A sound exposure level was then calculated based on the estimated number and duration of switches required for input into the noise modelling. In accordance with PER guidelines, a 12 dB adjustment/penalty was applied to account for the highly impulsive nature of shunting noise.

The Main Track is a through track along the south side of the East L Yard and is used by freight trains entering and exiting the yard as well as West Coast Express passenger trains. Noise levels associated with the Main Track were estimated using guidance developed by the US FTA (US FTA 2018). While the US FTA guidance was developed for public transportation projects, it also considers freight rail and is accepted by the Canadian Transportation Agency for use in federally-regulated railway noise assessments (CTA 2011). Calculated noise levels were then calibrated based on measured noise levels at the VFPA and Columbia Containers noise monitoring locations to account for additional noise from through trains and road switchers that operate on the Main Track as a route to get around cars that have been staged on the yard tracks.

5.2 Receivers

The assessment of noise levels is conducted at noise-sensitive receptors. Noise-sensitive receptors in the Project area include residences located south of the East L Yard. For this assessment, receivers were specified at the facades of the nearest residential buildings, at the approximate height of the top and most exposed storey where bedrooms are typically located. For two-storey residences that account for the bulk of noise-sensitive receptors in the Project area, an estimated receiver height of 4.5 m is used. Receivers are grouped into 10 groups of similar noise environments as illustrated in Figure 1.

5.3 Comparison of Calibration Case to Measured Noise Levels

Modelled noise levels for the Calibration Case are compared to measured noise levels at the VFPA and Columbia Containers noise monitoring locations in Table 5.2. Overall, the noise modelling reasonably captures existing noise levels in the Project area. Modelled noise levels are perceptibly lower at locations NMT6 and CC3 relative to measured noise levels and are likely attributed to site-specific differences not resolved in the noise modelling. Examples include potentially increased levels of shunting towards the west of the East L Yard, other Port and industrial activities not included in the noise modelling (e.g., Lafarge ready-mix facility, Viterra Terminals), and truck acceleration along Commissioner Street, towards the east of the Project area near the gate.

Table 5.2 Comparison of Modelled and Measured Noise Levels

Station ID	Daytime Noise Level, L_d (dBA)		Nighttime Noise Level, L_n (dBA)		Day-Evening-Night Noise Level, L_{den} (dBA)	
	Measured	Modelled	Measured	Modelled	Measured	Modelled
NMT6	-	66.0	66 to 67	60.9	73 to 74	68.4
NMT7	-	68.6	66	62.3	74	71.0
NMT8	-	74.9	66	68.1	74 to 75	77.0
CC1	64	68.1	62	63.6	69	70.9
CC2	66	69.7	65	65.5	-	72.7
CC3	68	62.8	66	57.4	73	65.3

5.4 Assessment of Project Noise Impacts

A summary of the average predicted noise levels for each of the receiver groups with and without the Project is shown in Table 5.3. The predicted change in noise levels at all receiver groups is insignificant (i.e., 1 dB or less), with residences in receiver group R10 receiving the largest noise increase. For reference, a change in 3 dB is typically the threshold at which the human ear can begin to perceive a difference. The post-Project noise exposure, expressed in L_{den}, is expected to remain below 75 dBA in all receiver groups.

The existing noise environment is associated with low frequency noise effects, with the LLF exceeding 70 dB at a number of residences in receiver groups R5 and R6. The Project may result in an additional two residences with an LLF above 70 dB.

Predicted noise levels at each receiver are provided in Table A attached. An isopleth figure of the Project-related change in L_{den} is illustrated in Figure 2.

Table 5.3 Summary of Project Noise Impacts

Receiver Group	Day-Evening-Night Noise Level, L_{den} (dBA)			Percent Highly Annoyed (%)		
	Existing Case	Future Case	Change	Existing Case	Future Case	Change
R1	73.7	73.8	0.0	33.9	34.1	0.1
R2	69.3	69.2	-0.1	22.5	22.2	-0.3
R3	58.5	58.7	0.3	6.4	6.6	0.2
R4	68.2	68.0	-0.2	20.1	19.7	-0.4
R5	65.7	65.5	-0.2	15.2	14.9	-0.3
R6	67.8	68.1	0.3	19.4	19.9	0.5
R7	66.6	66.3	-0.3	16.6	16.1	-0.5
R8	68.4	68.0	-0.3	20.1	19.5	-0.7
R9	68.3	68.1	-0.3	20.1	19.6	-0.5
R10	65.4	66.6	1.2	14.5	16.6	2.1

6.0 VIBRATION MODELLING

Existing vibration levels were estimated using the vibration model developed by the US FTA (US FTA 2018). The FTA guideline defines reference vibration curves for three different transit modes, including one for locomotive-powered passenger and freight rail. The reference vibration level is then adjusted based on the following factors:

- Speed
- Vehicle parameters (e.g., suspension stiffness)
- Track conditions (e.g., joints and crossovers)
- Track treatments
- Track configuration
- Ground-borne propagation effects (e.g., coupling to building foundation)
- Receiver effects (e.g., amplification due to resonances)

Vibration measurements near other CP rail lines have been used to validate this prediction methodology.

6.1 Identification of Prominent Vibration Sources

There are three sources of vibration in the Project area:

- West Coast Express passenger rail along the mainline track at an operational speed of 40 miles per hour
- CP freight rail along the mainline track at a maximum speed of 35 miles per hour
- CP freight rail within the East L Yard at a maximum speed of 15 miles per hour

Based on the US FTA vibration model, CP freight locomotive movements along the mainline track are expected to result in the highest vibration levels relative to the general vibration criteria. While vibration levels associated with West Coast Express passenger rail passbys may be approximately 1 VdB higher due to the higher operational speed of the trains, there are only 10 events per day and the general vibration criteria for such infrequent events are 5 VdB higher than for occasional events such as CP freight locomotive passbys. Vibration levels from CP freight rail operating within the East L Yard are expected to be substantially lower than vibration levels along the mainline track due to the lower train speeds within the yard.

6.2 Receivers

The assessment of vibration levels is conducted at vibration-sensitive receptors for which general vibration criteria have been developed. Vibration-sensitive receptors in the Project area include residences located south of the East L Yard as identified for the noise assessment and illustrated in Figure 1.

Receivers have been classified into three types for the purpose of estimating ground-borne propagation effects due to building construction and floor-to-floor attenuation:

- Lightweight wood-frame residential buildings
- 3 to 4 storey masonry residential buildings
- 3 to 4 storey masonry mixed-use buildings with commercial land use on the ground level

Vibration levels were predicted at the ground level of residential buildings and at the second storey of mixed-use buildings, representing the most exposed storey for residential use.

6.3 Assessment of Project Vibration Effects

Worst-case predicted vibration levels at each receiver are provided in Table B attached. Existing vibration levels are predicted to exceed the US FTA general vibration criteria at 74 of 89 receivers, suggesting that vibration may be perceptible at most of the residences located south of the East L Yard.

Predicted vibration levels with the Project are expected to be the same as for existing conditions given that operations along the mainline track, which dominate the overall vibration footprint, will not change. Vibration levels associated with the two new yard tracks are expected to be substantially lower than those associated with the mainline track. Furthermore, the number of vibration events (i.e., the number of train passbys) is not expected to change as a result of the Project. For these reasons, the Project is deemed to have no impact on existing vibration levels.

7.0 CONCLUSIONS

The Project is expected to redistribute track function and reduce train switching activities within the East L Yard. Noise levels are expected to change insignificantly at nearby residences. Due to the insignificant noise change associated with the Project, no mitigation measures are necessary. The VFPA will continue their noise monitoring program and measured noise levels in the Project area can be used to verify post-Project noise levels. No additional noise monitoring is required.

Vibration may be perceptible at many nearby residences but vibration levels are not expected to change as a result of the Project. The highest vibration levels relative to criteria are associated with CP freight locomotive passbys along the mainline track. Vibration levels associated with the two new yard tracks will be substantially lower than those associated with the mainline track.

8.0 CLOSURE

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

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TABLES

Table A Predicted Noise Levels at Receivers
Table B Predicted Vibration Levels at Receivers

Table A Predicted Noise Levels at Receivers

Receiver	Day-Evening-Night Noise Level, L_{den} (dBA)			Percent Highly Annoyed (%)			Low Frequency Noise Level, LLF (dB)	
	Existing Case	Future Case	Change	Existing Case	Future Case	Change	Existing Case	Future Case
R1_1	73.3	73.4	0.1	32.6	32.9	0.3	51.8	52.2
R1_2	73.6	73.6	0.0	33.5	33.5	0.0	52.5	52.4
R1_3	73.7	73.8	0.1	33.8	34.1	0.3	53.1	55.3
R1_4	74	74	0.0	34.7	34.7	0.0	55.4	55.6
R1_5	73.9	73.9	0.0	34.4	34.4	0.0	55.8	55.7
R1_6	73.9	74	0.1	34.4	34.7	0.3	55.7	55.7
R2_1	68	68.4	0.4	19.4	20.2	0.8	56.3	56.4
R2_2	68.1	68.4	0.3	19.6	20.2	0.6	56.5	56.7
R2_3	68.5	68.6	0.1	20.5	20.7	0.2	56.8	56.9
R2_4	70.2	70.2	0.0	24.3	24.3	0.0	57.1	57.2
R2_5	71.9	71.9	0.0	28.7	28.7	0.0	57.4	57.5
R2_6	67.6	67.4	-0.2	18.6	18.2	-0.4	57.0	57.2
R2_7	69.9	69.7	-0.2	23.6	23.2	-0.5	57.2	57.3
R2_8	70.2	70	-0.2	24.3	23.9	-0.5	57.2	57.3
R2_9	70.4	70.2	-0.2	24.8	24.3	-0.5	57.5	57.6
R2_10	72.4	72.2	-0.2	30.1	29.5	-0.6	58.1	58.2
R2_11	68.8	68.5	-0.3	21.1	20.5	-0.7	58.1	58.3
R2_12	66.8	66.4	-0.4	17.0	16.3	-0.7	58.0	58.2
R2_13	66.9	66.5	-0.4	17.2	16.5	-0.7	58.4	58.5
R2_14	68	67.6	-0.4	19.4	18.6	-0.8	59.0	59.1
R2_15	71.7	71.5	-0.2	28.2	27.6	-0.5	60.0	60.2
R3_1	57.9	58.2	0.3	6.0	6.2	0.2	57.3	57.5
R3_2	57.8	58.1	0.3	5.9	6.1	0.2	57.4	55.9
R3_3	57.8	58.2	0.4	5.9	6.2	0.3	58.4	58.8
R3_4	58.9	59.2	0.3	6.8	7.0	0.3	58.8	59.0
R3_5	58.9	59.1	0.2	6.8	6.9	0.2	58.8	59.0
R3_6	59.3	59.4	0.1	7.1	7.2	0.1	59.3	59.6
R3_7	57.5	57.8	0.3	5.7	5.9	0.2	58.7	58.9
R3_8	59.4	59.6	0.2	7.2	7.4	0.2	59.1	59.4
R3_9	57	57.3	0.3	5.3	5.5	0.2	58.6	58.9
R3_10	58.6	59	0.4	6.5	6.8	0.3	58.8	59.1
R3_11	58.8	59.1	0.3	6.7	6.9	0.3	58.9	59.2
R3_12	57.2	57.4	0.2	5.5	5.6	0.1	57.9	58.4
R3_13	60.2	60.3	0.1	7.9	8.0	0.1	58.1	58.5
R3_14	59.3	59.5	0.2	7.1	7.3	0.2	57.6	58.0
R4_1	71.6	71.4	-0.2	27.9	27.4	-0.5	61.4	62.1
R4_2	68.6	68.4	-0.2	20.7	20.2	-0.4	61.4	62.2
R4_3	68.3	68.1	-0.2	20.0	19.6	-0.4	62.7	64.2
R4_4	68	67.8	-0.2	19.4	19.0	-0.4	63.4	64.9
R4_5	67.1	66.9	-0.2	17.6	17.2	-0.4	65.9	68.1
R4_6	69.6	69.5	-0.1	22.9	22.7	-0.2	66.1	68.1
R4_7	68.9	68.7	-0.2	21.3	20.9	-0.4	64.3	65.8
R4_8	68.6	68.4	-0.2	20.7	20.2	-0.4	64.6	66.1
R4_9	66.3	66	-0.3	16.1	15.6	-0.5	64.6	66.1
R4_10	65.1	64.9	-0.2	14.1	13.8	-0.3	67.3	69.5

Table A Predicted Noise Levels at Receivers

Receiver	Day-Evening-Night Noise Level, L_{den} (dBA)			Percent Highly Annoyed (%)			Low Frequency Noise Level, LLF (dB)	
	Existing Case	Future Case	Change	Existing Case	Future Case	Change	Existing Case	Future Case
R5_1	64.7	64.3	-0.4	13.5	12.9	-0.6	64.8	66.8
R5_2	64.1	63.7	-0.4	12.6	12.0	-0.6	64.3	66.3
R5_3	64.5	64	-0.5	13.2	12.4	-0.7	64.4	66.3
R5_4	63.3	63	-0.3	11.5	11.1	-0.4	64.9	67.1
R5_5	64	63.6	-0.4	12.4	11.9	-0.6	66.7	68.9
R5_6	63.4	63.1	-0.3	11.6	11.2	-0.4	65.7	67.7
R5_7	66.8	66.4	-0.4	17.0	16.3	-0.7	69.7	72.0
R5_8	65.5	65.2	-0.3	14.8	14.3	-0.5	70.1	72.4
R5_9	65.4	65.1	-0.3	14.6	14.1	-0.5	70.9	73.4
R5_10	65.9	65.6	-0.3	15.4	14.9	-0.5	73.6	75.9
R5_11	64.9	64.8	-0.1	13.8	13.6	-0.2	73.8	76.1
R5_12	67.2	67.1	-0.1	17.8	17.6	-0.2	75.4	77.6
R5_13	66.7	66.7	0.0	16.9	16.9	0.0	76.2	78.6
R5_14	67	67	0.0	17.4	17.4	0.0	77.3	79.5
R5_15	67.2	67.3	0.1	17.8	18.0	0.2	78.2	80.3
R5_16	67.4	67.5	0.1	18.2	18.4	0.2	79.2	81.1
R5_17	68.3	68.6	0.3	20.0	20.7	0.6	80.8	82.7
R6_1	71.3	71.2	-0.1	27.1	26.9	-0.3	83.9	85.1
R6_2	71	71	0.0	26.3	26.3	0.0	84.0	85.2
R6_3	70	70.4	0.4	23.9	24.8	1.0	83.1	85.0
R6_4	70.1	70.3	0.2	24.1	24.6	0.5	83.1	84.9
R6_5	65.2	67.3	2.1	14.3	18.0	3.7	74.0	81.4
R6_6	68	68.5	0.5	19.4	20.5	1.1	80.0	82.5
R6_7	67.1	67.6	0.5	17.6	18.6	1.0	77.6	81.4
R6_8	66.2	66.9	0.7	16.0	17.2	1.3	74.8	80.2
R6_9	64.2	64.7	0.5	12.7	13.5	0.8	68.5	76.5
R6_10	65.7	66	0.3	15.1	15.6	0.5	71.9	77.9
R6_11	68.4	68.3	-0.1	20.2	20.0	-0.2	74.6	77.4
R6_12	68.4	68.3	-0.1	20.2	20.0	-0.2	73.9	76.7
R6_13	67.5	67.3	-0.2	18.4	18.0	-0.4	73.3	75.9
R6_14	66.5	66.4	-0.1	16.5	16.3	-0.2	70.2	75.2
R6_15	67.8	67.5	-0.3	19.0	18.4	-0.6	72.2	74.8
R7_1	66	65.7	-0.3	15.6	15.1	-0.5	60.0	62.9
R7_2	67.1	66.8	-0.3	17.6	17.0	-0.6	56.2	60.1
R8_1	68	67.7	-0.3	19.4	18.8	-0.6	53.0	59.9
R8_2	68.3	68	-0.3	20.0	19.4	-0.6	54.1	57.4
R8_3	68.4	68.1	-0.3	20.2	19.6	-0.6	55.1	57.3
R8_4	68.7	68.3	-0.4	20.9	20.0	-0.9	52.3	55.0
R8_5	68.3	68	-0.3	20.0	19.4	-0.6	51.8	54.0
R8_6	68.4	68.1	-0.3	20.2	19.6	-0.6	51.6	52.6
R9_1	69.3	69	-0.3	22.2	21.6	-0.7	54.5	56.4
R9_2	67.3	67.1	-0.2	18.0	17.6	-0.4	54.8	56.3
R10_1	65.7	66.8	1.1	15.1	17.0	2.0	54.8	55.6
R10_2	65	66.3	1.3	13.9	16.1	2.2	54.7	55.4

Table B Predicted Vibration Levels at Receivers

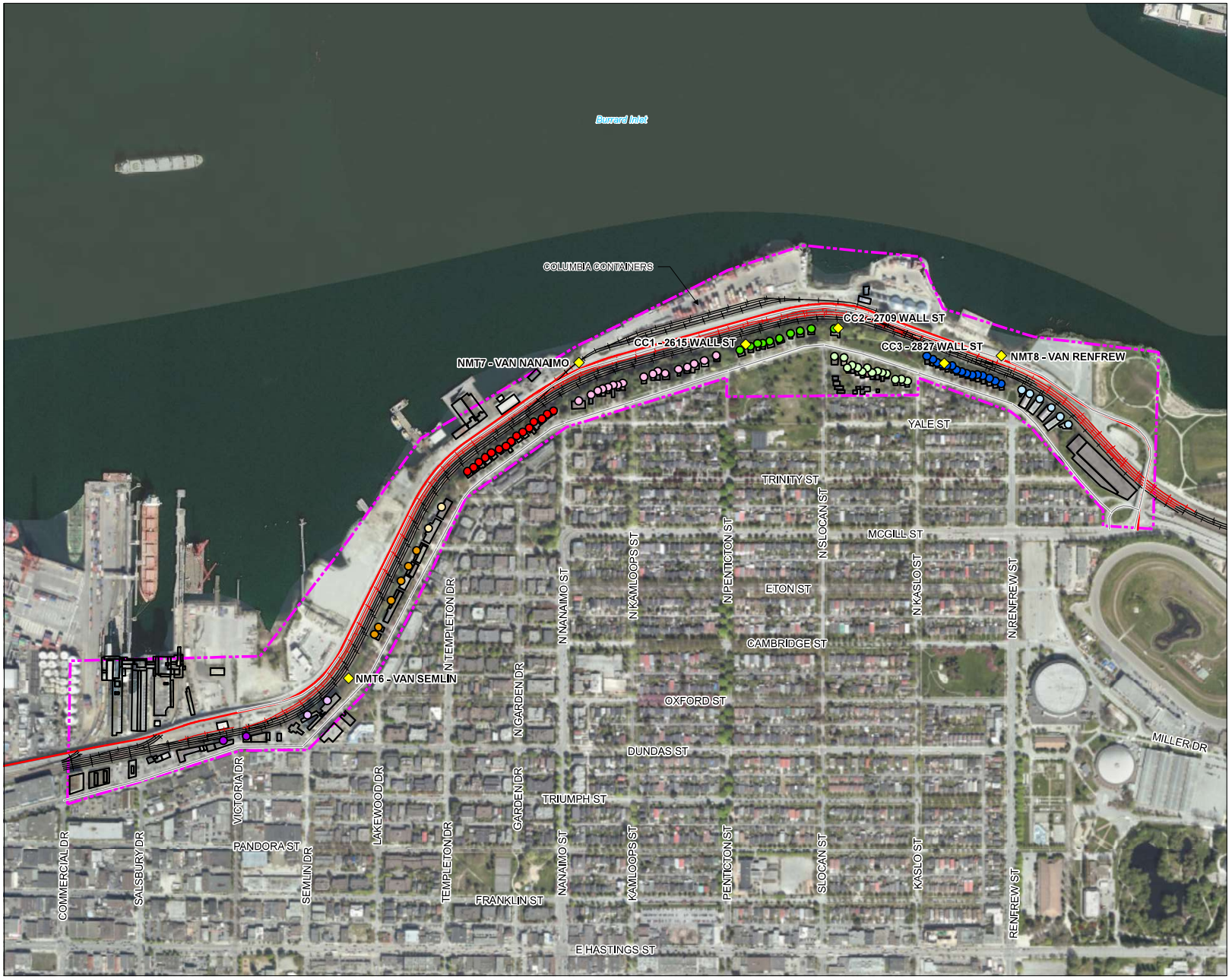
Receiver	Worst-Case Vibration Level (VdB)		
	Existing Case	Future Case	Change
R1_1	110.3	110.3	0.0
R1_2	110.9	110.9	0.0
R1_3	112.4	112.4	0.0
R1_4	112.9	112.9	0.0
R1_5	112.3	112.3	0.0
R1_6	111.9	111.9	0.0
R2_1	113.7	113.7	0.0
R2_2	113.9	113.9	0.0
R2_3	114.4	114.4	0.0
R2_4	114.5	114.5	0.0
R2_5	113.7	113.7	0.0
R2_6	111.9	111.9	0.0
R2_7	106.7	106.7	0.0
R2_8	106.3	106.3	0.0
R2_9	106.3	106.3	0.0
R2_10	108.6	108.6	0.0
R2_11	107.1	107.1	0.0
R2_12	106.6	106.6	0.0
R2_13	106.6	106.6	0.0
R2_14	108.0	108.0	0.0
R2_15	108.6	108.6	0.0
R3_1	94.5	94.5	0.0
R3_2	94.5	94.5	0.0
R3_3	93.8	93.8	0.0
R3_4	94.5	94.5	0.0
R3_5	94.3	94.3	0.0
R3_6	94.3	94.3	0.0
R3_7	93.4	93.4	0.0
R3_8	94.2	94.2	0.0
R3_9	92.8	92.8	0.0
R3_10	93.5	93.5	0.0
R3_11	93.6	93.6	0.0
R3_12	92.8	92.8	0.0
R3_13	95.2	95.2	0.0
R3_14	95.2	95.2	0.0
R4_1	108.5	108.5	0.0
R4_2	108.9	108.9	0.0
R4_3	108.2	108.2	0.0
R4_4	107.8	107.8	0.0
R4_5	106.2	106.2	0.0
R4_6	106.3	106.3	0.0
R4_7	105.9	105.9	0.0
R4_8	106.8	106.8	0.0
R4_9	106.2	106.2	0.0
R4_10	105.5	105.5	0.0

Table B Predicted Vibration Levels at Receivers

Receiver	Worst-Case Vibration Level (VdB)		
	Existing Case	Future Case	Change
R5_1	106.4	106.4	0.0
R5_2	105.3	105.3	0.0
R5_3	105.0	105.0	0.0
R5_4	104.1	104.1	0.0
R5_5	104.2	104.2	0.0
R5_6	104.1	104.1	0.0
R5_7	107.0	107.0	0.0
R5_8	105.8	105.8	0.0
R5_9	105.6	105.6	0.0
R5_10	105.5	105.5	0.0
R5_11	105.4	105.4	0.0
R5_12	106.4	106.4	0.0
R5_13	106.1	106.1	0.0
R5_14	106.3	106.3	0.0
R5_15	106.3	106.3	0.0
R5_16	105.5	105.5	0.0
R5_17	105.5	105.5	0.0
R6_1	108.3	108.3	0.0
R6_2	109.1	109.1	0.0
R6_3	108.3	108.3	0.0
R6_4	110.1	110.1	0.0
R6_5	107.9	107.9	0.0
R6_6	108.4	108.4	0.0
R6_7	108.3	108.3	0.0
R6_8	107.6	107.6	0.0
R6_9	106.8	106.8	0.0
R6_10	107.8	107.8	0.0
R6_11	109.4	109.4	0.0
R6_12	109.2	109.2	0.0
R6_13	109.2	109.2	0.0
R6_14	108.5	108.5	0.0
R6_15	109.1	109.1	0.0
R7_1	106.9	106.9	0.0
R7_2	103.0	103.0	0.0
R8_1	108.8	108.8	0.0
R8_2	109.2	109.2	0.0
R8_3	104.4	104.4	0.0
R8_4	110.0	110.0	0.0
R8_5	109.7	109.7	0.0
R8_6	110.4	110.4	0.0
R9_1	109.1	109.1	0.0
R9_2	109.8	109.8	0.0
R10_1	109.3	109.3	0.0
R10_2	115.9	115.9	0.0

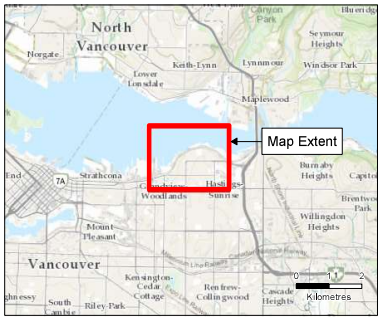
FIGURES

Figure 1 Map of Project Area
Figure 2 Project-Related Change in Day-Evening-Night Noise Levels



CP East L Yard Environmental Noise Assessment
Vancouver, BC

Project Area



Legend

- Noise Monitoring Location
- Existing Railway
- Proposed Railway
- Existing Road
- Proposed Road
- Study Area
- Building

Receiver Group

- R1
- R2
- R3
- R4
- R5
- R6
- R7
- R8
- R9
- R10

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:7,500

0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

106126-01	Production Date: Aug 26, 2021	Figure 1

Hemmera
An Ausenco Company

CP

CP East L Yard Environmental Noise Assessment
Vancouver, BC

Project-Related Change in Day-Evening-Night Noise Levels

Legend

- Existing Railway
- Proposed Railway
- Existing Road
- Proposed Road
- Study Area
- Building

Change in Day-Evening-Night Noise Levels (dB)

- < 0
- 0 to 4
- 4 to 8
- 8 to 12
- 12 to 16
- > 16

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Aerial Image: ESRI World Imagery

N

1:7,500

0 50 100 150 200 250

Metres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

106126-01	Production Date: Aug 26, 2021	Figure 2

Hemmera
An Ausenco Company

CP

APPENDIX A

Project Noise Screening Score Sheet

APPENDIX II – NOISE ASSESSMENT PROJECT SCORE

This worksheet should be used together with the questionnaire in Appendix I – Noise Assessment Screening Worksheet. For each of the ten questions, this worksheet applies a weighting factor that is reflective of the relative importance of that attribute in forecasting noise impact potential. The overall noise impact potential of the project is determined by tallying the weighted values of all response scores to obtain a *Total Weighted Project Score* as follows:

1. Complete the questionnaire as provided in Appendix I – Noise Assessment Screening Worksheet, scoring each of the ten items.
2. Transfer the ten questionnaire scores into the Weighted Project Screening Scorecard provided below.
3. Apply the *Importance Weighting* factor (multiplying the weighting factor by the questionnaire score) and determine a *Weighted Score* for each item.
4. Tally the *Weighted Scores* and determine the *Total Weighted Project Score*
5. Submit a completed project score worksheet as part of the PER project permit application

No.	Attribute of Project or Project Setting	Questionnaire Score (Appendix I)	Importance Weighting	Weighted Score
1	New Activity, Replacement or Expansion	3	1.2	3.6
2	Noise Levels Expected on Project Site	4	1.8	7.2
3	Presence of Undesirable Characteristics	5	1.6	8.0
4	Presence of High Energy Impulsiveness Noise	0	1.6	0.0
5	Hours/Days of Operation	5	1.2	6.0
6	Proximity to Noise Sensitive Areas	5	1.6	8.0
7	Presence of Noise Shielding or Reflection	4	1.8	7.2
8	Baseline Noise Environment	1	1.6	1.6
9	Population Potentially Exposed to Project Noise	5	1.0	5.0
10	Level of Community Concern About Noise	3	1.2	3.6
			Total Weighted Project Score :	50.2