PROPOSED RICHARDSON GRAIN STORAGE PROJECT

NOISE MONITORING PLAN

PREPARED FOR:

MMM GROUP

MMM GROUP LTD.

MARCH 2013

REVISION 0

BKL Consultants in Acoustics

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EXECUTIVE SUMMARY

BKL Consultants Ltd. (BKL) has been retained by MMM Group Ltd. (MMM) to provide an environmental noise monitoring plan (NMP) for the Proposed Richardson Grain Storage Project (the Project) at Richardson International's North Vancouver Port Terminal. The Project includes the construction of an 80,000 metric tonne concrete grain silo with associated distribution and dust filtration equipment to increase the terminal's capacity from 3 to 5 million metric tonnes per annum (MMTPA).

An environmental noise impact assessment was previously completed by BKL for this project in January 2013. No net increase in daily noise was anticipated with the incorporation of the recommended mitigation. Potential increases in awakenings due to nighttime shunting events were also found to be below the criteria level. Therefore, it was predicted that there would be no significant adverse effects from the Project.

The objectives of the noise monitoring plan are to communicate how noise monitoring will be performed to demonstrate whether construction noise levels comply with the intentions set out in Richardson's *Proposed Grain Storage Project Mitigation Plan* and whether the noise predictions made in the environmental noise impact assessment have been achieved for the following two milestones:

1. Within the first year after substantial Project completion.
2. Once rail car processing achieves 5 MMTPA.

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List of Abbreviations and Acronyms

Abbreviation/Acronym	Definition
ANSI	American National Standards Institute
BC	British Columbia
BKL	BKL Consultants Ltd.
CN	Canadian National
CNV	City of North Vancouver
dB	Decibel
dBA	A-weighted decibel
EA	Environmental Assessment
Hz	Hertz
IEC	International Electrotechnical Commission
L_{Aeq}	A-weighted equivalent sound level
L_d	Daytime (07:00 to 22:00) equivalent sound level
L_{dn}	Day-night equivalent sound level
L_{eq}	Equivalent sound level
L_n	Nighttime (22:00 to 07:00) equivalent sound level
LLR	Low Level Road
m	Metre
MT	Metric tonnes
MMM	MMM Group Ltd.
MMTPA	Million Metric Tonnes per Annum
NoMEPorts	Noise Management in European Ports
PMV	Port Metro Vancouver
Project	The Proposed Richardson Grain Storage Project
Richardson	Richardson International
SEL	Sound exposure level

1 INTRODUCTION

BKL Consultants Ltd. (BKL) has been retained by MMM Group Ltd. (MMM) to provide an environmental noise monitoring plan for the Proposed Richardson Grain Storage Project (the Project).

An environmental noise impact assessment was previously completed by BKL for this project in January 2013 (BKL 2013). No net increase in daily noise was anticipated with the construction of the recommended mitigation. Potential increases in awakenings due to nighttime shunting events were also found to be below the criteria level. Therefore, it was predicted that there would be no significant adverse effects from the Project.

Relevant information regarding acoustics fundamentals and terminology is presented in Appendix A.

2 PROJECT DESCRIPTION

Richardson International's North Vancouver Port Terminal is located on the north shore of Burrard Inlet, at 375 Low Level Road, North Vancouver, BC, within Port Metro Vancouver (PMV) lands. It is serviced by CN Rail. Figure 2.1 shows its location on Burrard Inlet, and Figure 2.2 shows a plan view of the nearby roadways and residences to the north. Figure 2.3 shows the terminal with the residences to the north from Burrard Inlet and Figure 2.4 shows a view of the residences from the terminal.

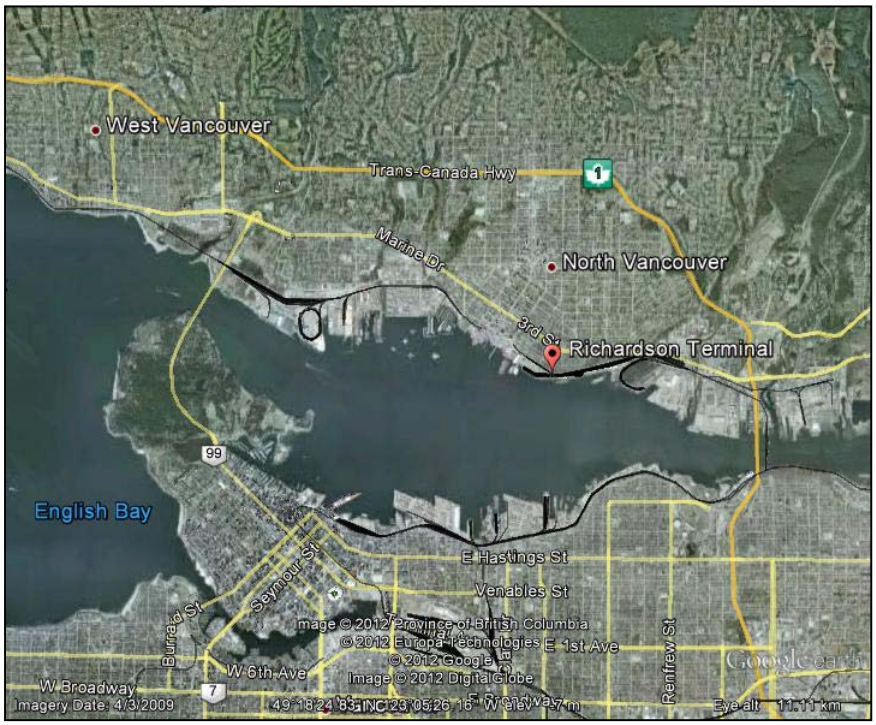

Figure 2.1 Richardson Terminal Location on Burrard Inlet

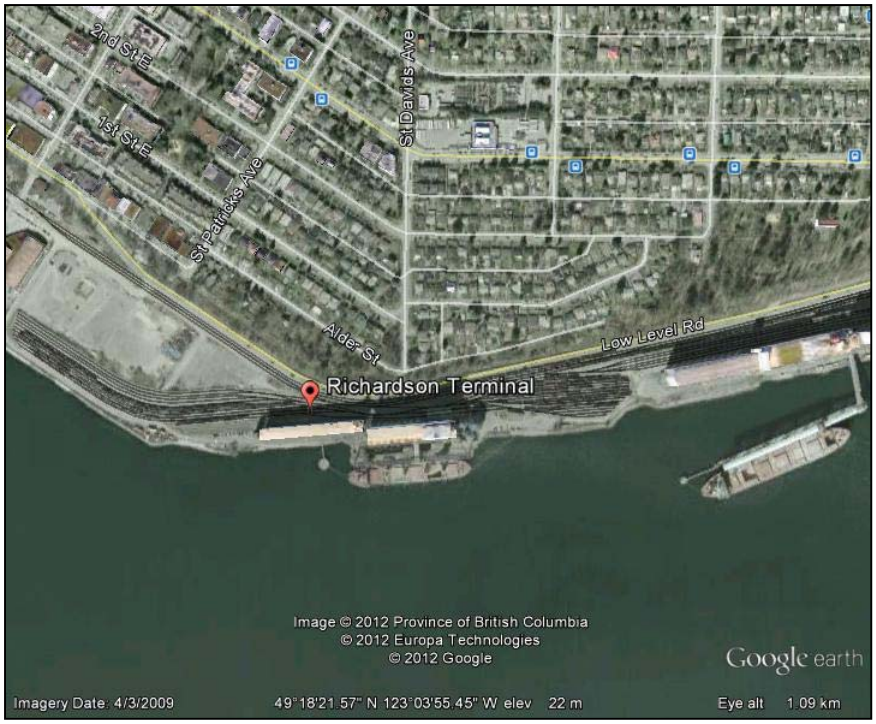

Figure 2.2 Richardson Terminal with Nearby Roadways & Residences

Figure 2.3 View of Terminal from Burrard Inlet

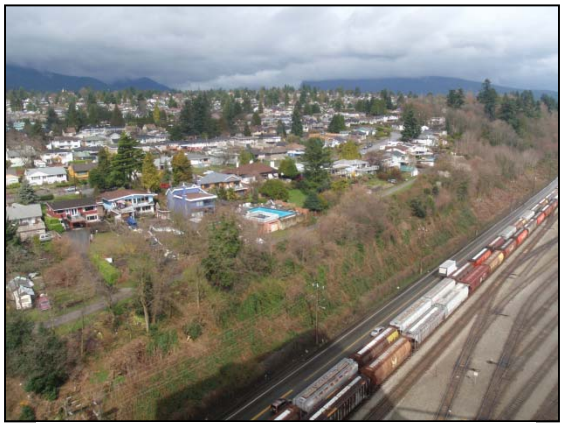

Figure 2.4 View of Residences from Terminal

Currently, the Richardson Terminal operates 24 hours per day from Monday to Friday and overtime on weekends as required, with an annual average processing of 119 railcars per day. The terminal has operated on a 24 hour seven day per week basis in the past and will revert back to these hours of operation when warranted by the workload. Today, the terminal typically shuts down at 00:00 hours on Saturdays and re-starts operation on Mondays at 00:00 hours.

There are two Richardson improvement projects which post date the Low Level Road Project and were therefore included in the noise impact assessment, which together involve an upgrade to Richardson Terminal grain handling and storage operations.

2.1 Grain Storage Project

The goal of the Proposed Grain Storage Project is to increase throughput from 3 to 5 million metric tonnes per annum (MMTPA) and involves the following:

- Demolition of existing pellet storage bins that currently exist in the Project location
- Rail yard upgrades
- Construction of an 80,000 metric tonne (mt) concrete grain silo (Annex 3)
- Installation of distribution equipment
- The placement of steel conical bin bottoms
- The incorporation of an automated dust filter system

Figure 2.5 and Figure 2.6 show renderings of the proposed layout.

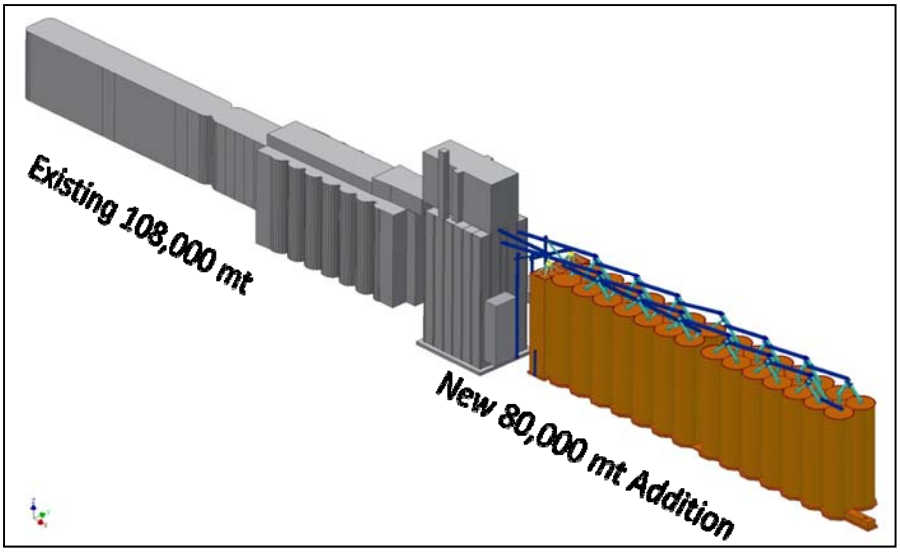

Figure 2.5 Rendering of Annex Layout

Figure 2.6 View of New Annex from Burrard Inlet

2.2 Rail Unloading Improvements Project

The Richardson facility has recently completed a number of improvements related to its grain receiving system and handling process. These upgrades allow the facility to unload railcars over two receiving pits using indexers that automatically advance a string of 5-7 railcars without the need for a locomotive. Previous to these upgrades, the facility had only one of these indexers and was required to use a locomotive to process single railcars at a time over one of the pits. As a result of the improvements, Richardson has been able to reduce the number of rail impact events as well as the number of locomotives operating on site from two to one.

The permitted Rail Unloading Improvements Project involved the following:

- Upgrading of the Receiving System and installation of a New Railcar Indexer
- Reconfiguration of a portion of the current rail yard - track and switches
- Construction of new state of the art, environmentally considerate Locomotive Warehouse and Fuel Dispensing Station
- Demolition of an aged Locomotive Warehouse and Fuel Dispensing Station

Each time railcars are coupled or when the movement of a string of railcars is stopped/started, a "shunting" noise event occurs (banging of railcars). Indexing a string of railcars instead of using a locomotive to unload single cars provides a significant reduction in noise and noise events. This project was in construction at the time that the baseline noise monitoring was performed so the single car unloading process had to be simulated in order to assess noise level differences.

A more detailed explanation of the past and present processes, based on site observations of current operations and simulated past operations, is summarized below:

Railcar unloading using the locomotive to position single cars for unloading required the following procedure:

1. Collect a string of 4-5 cars from the east rail yard and pull towards unloading pit.
2. Pull the car string until the first car is located a few meters before the unloading pit.
3. Disconnect the car to be unloaded from the rest of the string and pull the single car until it is in the unloading pit.
4. Disconnect the single car from the locomotive, and drive the locomotive away from the unloading pit.
5. Weigh, unload and re-weigh the car in the unloading bay.
6. During the unloading of the first car, drive the locomotive to the rear of the string of cars being unloaded, and join onto the string.
7. Push the rest of the string forwards, hook up the empty car and continue to push the string until the next car is a few meters past the unloading pit.
8. Disconnect the empty car and reverse until the next car is above the unloading pit.
9. Disconnect the car to be unloaded from the string and reverse the rest of the string backwards a few meters.
10. Weigh, unload and re-weigh the car in the unloading bay.

11. Push the rest of the string forwards, hook up the empty cars and continue to push the string until the next car is a few meters past the unloading pit.
12. Repeat steps 7 through 11 until the entire string has been unloaded.
13. Push the empty string of cars into one of the west rail yard sidings, potentially connecting to a string of other empty cars.
14. Disconnect the empty string of cars and drive the locomotive to collect another string of loaded cars from the east rail yard.
15. Repeat from step 1.

Railcar unloading using the indexer requires the simpler procedure:

1. Collect a string of 5-6 cars (pit #2) or 6-7 cars (pit #1) from the east rail yard and pull towards unloading pit.
2. Pull the loaded car string until the first car is located a few meters before the unloading pit, pushing the previously emptied string of cars out of the unloading bay on the way through.
3. Disconnect the loaded string for unloading – from here the rail car indexer will move the string of cars through the unloading pit for weighing and unloading as required.
4. Push the empty string of cars into one of the west rail yard sidings, potentially connecting to a string of other empty cars.
5. Disconnect the empty string of cars and drive the locomotive to collect another string of loaded cars from the east rail yard.
6. Repeat from step 1.

According to Richardson, the single car unloading process was used for 20-25% of railcars when operating in the previous configuration.

It is important to note that additional rail noise events are created by CN on or in front of the Richardson property when CN delivers and collects railcars from Richardson and Cargill.

2.3 Low Noise Initiatives

Noise mitigation measures have been incorporated into the Project design. These include:

- Elimination of one of the two locomotives
- New Filter 21 on south side of Work House with fan silencer and opening facing south
- Reduction in Filter 20 flow rate
- New railcar indexer
- High efficiency conveyor motors and direct drive gearboxes for proposed Annex
- Added cladding to the new upper conveyance system
- Extending the north side of the new conveyance cladding down to the silos level
- Enclosing new conveyors
- Conveyor belt upgrades for the proposed Annex

- Install ceramic tile and hardened steel lining on spouting of proposed Annex to reduce grain flow noise
- Install automated dust collection system (which keeps fan size to minimum)
- Construction of concrete silos (as opposed to metal silos which would create additional noise during filling)

3 PROJECT REQUIREMENTS

3.1 Construction

Richardson's *Proposed Grain Storage Project Mitigation Plan* (Richardson 2013) references the City of North Vancouver *Noise Control Bylaw, 1987, No. 5819* (CNV 2011). This bylaw has the following clauses relating to construction noise level limits:

307 Construction and Power Gardening Equipment Sound

Notwithstanding the provisions of Sections 303, 304, 305, or 306 hereof; a person may use or cause or permit to be used, equipment which causes a continuous sound level;

a) resulting from construction which does not exceed a continuous sound level of 85 decibels when measured at a point of reception;

201.35 **"sound level"** means**:**

1. the average of the medians of 5 or more sets of lower and upper measurements of a series of A-weighted sound pressure levels read or recorded at a point of reception on the slow response of a sound level meter;

201.36 **"sound level meter"** is a device listed in A.N.S.I. Type 11 or I.E.C. 123, that is calibrated for the measurement of sound and includes Bruel and Kjaer's Precision Sound Level Meter Type 2215;

201.29 **"point of reception"** means:

4. for the purposes of Section 307(a) means any place in the municipality more than 15 metres from a source of sound where sound is received;

And from Schedule "B" of the same bylaw:

8. The sound generated by construction activity or the activity of construction equipment, is **permitted** during the following times only:

a) between the hours of 7:00 a.m. to 8:00 p.m., Monday through Friday;
b) between the hours of 9:00 a.m. and 7:00 p.m. on Saturdays.

Construction activity is **prohibited** on Sundays and public holidays.

3.2 Operation

PMV has requested that Richardson confirm whether Richardson-generated Noise Levels in the community have increased above the 2011 baseline levels documented in the noise impact assessment report within the first year after substantial Project completion and once railcar processing reaches 5 MMTPA.

4 OBJECTIVES

The objectives of the noise monitoring plan are to communicate how noise monitoring will be performed to demonstrate whether:

1. Construction noise levels comply with the intentions set out in the *Proposed Grain Storage Project Mitigation Plan*.
2. Operation daily noise levels show no net increase in Richardson-generated Noise from the 2011 baseline year.
3. Operation rail shunting event noise levels do not significantly impact sleep disturbance from the 2011 baseline year.

Construction noise levels will be assessed:

1. At the commencement of the Project construction piling activity.
2. In response to a validated noise complaint.

Operation noise levels will be re-assessed at two new baseline locations and during two future years:

1. Within the first year after substantial Project completion.
2. Once rail car processing achieves 5 MMTPA.

5 ROLES & RESPONSIBILITIES

Richardson will handle and validate noise complaints during the construction phase. Valid noise complaints are complaints that relate to the Project construction activities and have not been previously addressed through noise monitoring.

Richardson will contact BKL to perform monitoring at the commencement of piling activity and within 48 hours of the submission of a validated noise complaint.

Once the Project is substantially complete, Richardson will contact BKL so that BKL can perform operation noise measurements, analysis and reporting within one year. MMM would arrange to perform Low Level Road traffic volume counts, if necessary.

Richardson will again contact BKL to perform monitoring once railcars are being processed at a rate of 5 MMTPA. Richardson will provide rail car processing volume data for the baseline and future monitoring periods. MMM would arrange to perform Low Level Road traffic volume counts during the future monitoring periods.

BKL will employ best industry standard practices to monitor and assess noise levels to ensure environmental compliance with regulatory requirements and legal obligations concerning noise. Following each monitoring session, BKL will analyze the data and provide a report in a timely

fashion to Richardson indicating whether the Project requirements were likely being met at the time of monitoring.

Richardson will maintain contact with PMV and the public. BKL will provide support where requested by Richardson.

6 MONITORING

6.1 Approach & Metrics

During construction, BKL will perform measurements when requested. The A-weighted equivalent sound level, or L_{Aeq}, will be used as the more current and conventional approach to assessing the construction noise level, while still meeting the intent of the averaging procedure described in the CNV noise bylaw.

During operation, BKL intends to evaluate the change in the annual average day-night noise level, or L_{dn}, to provide the most accurate gauge of community disturbance (ANSI 2007, ISO 2003, NoMEPorts 2008). Therefore, monitoring will need to be performed at a time that is representative of annual average operating conditions at Richardson. This corresponds to a processing rate of 198 railcars/day at 5 MMTPA.

BKL will also evaluate the change in rail shunting event noise using the change in anticipated awakenings (ANSI 2008). This requires evaluating the sound exposure level, or *SEL*, of each shunting event and the number of shunting events in a night. Richardson shunting events will be distinguished from CN shunting events by reviewing spectral data before/after each event (CN locomotives produce much more low frequency noise than the Richardson locomotive). This approach should be accurate as long as Richardson and CN shunting events do not occur at the same time.

In order to accurately assess the change in operation noise, BKL will re-establish baseline noise levels (i.e. before construction begins) at two preferred post-construction measurement locations. This baseline monitoring must be scheduled to avoid measuring construction noise from the Low Level Road project. Since the second rail indexer has already been constructed, an additional correction would be applied to estimate the true 2011 baseline noise level, based on previous short-term measurements performed (BKL 2013) to simulate the difference between old and new rail car processing operations (see Section 2.2).

6.2 Location

During construction, noise monitoring will be performed at the nearest residential area during the commencement of piling and at complainant's properties.

During operation, the potential noise impact due to the Project will be the greatest in front of the proposed Annex due to the new mechanical noise sources on the top of the silos and the reflection of sound off the new silos, in combination with increased rail car handling noise generated throughout the Richardson rail yard. This is intuitive but was also confirmed with noise modelling. Since the vertical area of the silos is large, spanning a number of residences, the noise impact will be similar across multiple first row residences on 1st Street East. Two noise monitoring locations, in the backyards of two of the first row residences facing the proposed Annex (see Figure 6.1), will be used to assess whether Richardson-generated Noise has increased. The

location of the microphones will be chosen to best represent the noise exposure at the south façade of each residence.

Figure 6.1 Proposed Monitoring Location Area

The microphones will typically be 1.5 m above the ground and no closer than 3 m from any large sound reflecting surface (e.g. building façade).

6.3 Duration

During construction, the monitoring duration will be chosen to cover off all significant variations in noise emission and propagation (ISO 2007). This will typically require monitoring over a period of 15-60 minutes.

During operation, a monitoring duration of one week, if practical, will be used to determine the baseline and future annual average day-night noise level and number of nightly rail shunting events. Richardson rail car processing volume data will be reviewed to confirm that the monitoring was performed during representative periods.

6.4 Equipment & Calibration

The acoustic instrumentation system, comprised of a microphone, wind screen, cable and recorder, will conform to class 1 requirements as defined by the International Electrotechnical Commission (IEC) method IEC 61672-1 (IEC 2002).

Windscreens will always be used during outdoor measurements and will be clean, dry and in good condition.

The sound level meter will be calibrated before and after each noise measurement using a field calibrator conforming to class 1 requirements as defined by the International Electrotechnical Commission (IEC) method IEC 60942 (IEC 2003).

7 DATA ANALYSIS

If the Total Noise Level is dominated by Project activities, further analysis is not necessary. However, since a sound level meter cannot automatically distinguish between different sources, additional analysis may be required to determine whether the Richardson-generated Noise Level has increased above 2011 levels. The dominant noise sources in this area can be attributed to Richardson, CN rail traffic, Low Level Road roadway traffic and Cargill. Therefore, traffic volumes may need to be determined and the previously developed noise model may need to be used to determine Richardson-generated Noise Levels. Attended short-term noise measurements close to individual noise sources may also be required.

During construction, the Total Noise Level measured by the sound level meter will be compared to the bylaw criteria to determine compliance.

During the first year after Project substantial completion, the Total Noise Level measured will be compared with the adjusted 2013 baseline re-establishment Total Noise Level. If the Total Noise Level has not increased then further analysis will not be necessary. If the Total Noise Level has increased, further analysis will be performed to determine if the cause of the increase was due to Richardson-generated Noise or another source (e.g. CN or Low Level Road traffic noise).

Once rail car processing achieves 5 MMTPA, a detailed assessment, considering the change in Low Level Road traffic noise, CN rail traffic noise, etc. will be performed to determine the change in Richardson-generated Noise. The previously developed noise model will be used to comment on the expected change at other locations based on the calculated change at the monitoring locations.

Rail shunting event noise data analysis will be performed using the American National Standards Institute (ANSI) recommendations in *Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes* (ANSI 2008).

8 REPORTING

The report prepared by BKL will provide enough detail to permit repeating the measurement at a future time. All dates, times, observations, assumptions and analysis will be summarized in addition to the results and conclusions as to whether the Project requirements were likely being met at the time of the monitoring.

9 REFERENCES

American National Standards Institute (ANSI). 2007. Quantities and Procedures for Description and Measurement of Environmental Sound - Part 5: Sound Level Descriptors for Determination of Compatible Land Use. Reference No. ANSI/ASA S12.9-2007 Part 5. New York, Acoustical Society of America.

American National Standards Institute (ANSI). 2008. Quantities and Procedures for Description and Measurement of Environmental Sound - Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes. Reference No. ANSI / ASA S12.9-2008 / Part 6. New York, Acoustical Society of America.

BKL Consultants Ltd. (BKL). 2013. Richardson Grain Storage Project Environmental Noise Impact Assessment. Vancouver, MMM Group Ltd.

City of North Vancouver (CNV). 2011. Noise Control Bylaw, 1987, No. 5819. North Vancouver, City of North Vancouver.

International Electrotechnical Commission (IEC). 2002. Electroacoustics - Sound level meters - Part 1: Specifications. Reference No. IEC 61672-1:2002. Geneva, International Electrotechnical Commission.

International Electrotechnical Commission (IEC). 2003. Electroacoustics - Sound calibrators. Reference No. IEC 60942:2003. Geneva, International Electrotechnical Commission.

International Organisation for Standardization (ISO). 2003. *Acoustics - Description, measurement and assessment of environmental noise - Part 1: Basic quantities and assessment procedures.* Reference No. ISO 1996-1:2003. Geneva, International Organisation for Standardization.

Noise Management in European Ports (NoMEPorts). 2008. Good Practice Guide on Port Area Noise Mapping and Management. Amsterdam, Noise Management in European Ports.

Richardson International (Richardson). 2013. Proposed Grain Storage Project Mitigation Plan. Winnipeg, Richardson International.

APPENDIX A GLOSSARY

A-weighting – A standardised filter used to alter the sensitivity of a sound level meter with respect to frequency so that the instrument is less sensitive at low and high frequencies where the human ear is less sensitive. Also written as dBA.

Ambient/existing level – The pre-project noise or vibration level.

C-weighting – The C-weighting provides a more discriminating measure of the low frequency sound pressures than provided by A-weighting. Unlike the A-weighting, the C-weighting retains its sensitivity to sounds between 100 and 1000 Hz. Also written as dBC.

Continuous Sound Level – Generally defined by many BC municipal noise bylaws as the A-weighted sound level, measured using the "slow" time constant, for any sound occurring for a duration of more than three minutes in a fifteen minute period.

Cumulative – The summation of individual sounds into a single total value related to the effect over time.

Day-night equivalent sound level (L_{dn}) – The sound exposure level for a 24-hour day calculated by logarithmically adding the sound exposure level obtained during the daytime (L_d) (7:00 am to 10:00 pm) to 10 times the sound exposure level obtained during the nighttime (L_n) (10:00 pm to 7:00 am) to account for greater human sensitivity to nighttime noise.

Decibel – The standard unit of measurement for sound pressure and sound power levels. It is the unit of level which denotes the ratio between two quantities that are proportional to pressure or power. The decibel is 10 times the logarithm of this ration. Also written as dB.

Equivalent sound level - The steady level that would contain the same amount of energy as the actual time-varying level. Although it is, in a sense, an "average", it is strongly influenced by the loudest events because they contain the majority of the energy.

Frequency – The number of times that a periodically occurring quantity repeats itself in one second.

Frequency spectrum – Distribution of frequency components of a noise or vibration signal.

Hertz – The unit of acoustic or vibration frequency representing the number of cycles per second.

Impulsive Sound – Non-continuous sound characterised by brief bursts of sound pressure. The duration of a single burst of sound is usually less than one second.

Intermittent – Non-continuous or transient noise or vibration that occurs at regular or irregular time intervals with each occurrence lasting more than about five seconds.

Intervening terrain – The terrain in between the noise/vibration source and sensitive receiver.

Maximum sound level – The highest exponential time-averaged sound level, in decibels, that occurs during a stated time period, using a "slow" or "fast" time constant.

Metric – Measurement parameter or descriptor.

Non-Continuous Sound Level - Generally defined by many BC municipal noise bylaws as the maximum A-weighted sound level using the "slow" time constant.

Noise - Noise is unwanted sound, which carries no useful information and tends to interfere with the ability to receive and interpret useful sound.

Noise sensitive human receptors – A place occupied by humans with a high sensitivity to noise. These include residences, hospitals, schools, hotels etc.

Octave bands – A standardized set of bands making up a frequency spectrum. The centre frequency of each octave band is twice that of the lower band frequency. The bands are centred at standardized frequencies.

Receiver/Receptor – A stationary far-field position at which noise or vibration levels are specified.

Root Mean Square – The square root of the mean-square value of an oscillating waveform, where the mean-square value is obtained by squaring the value of amplitudes at each instant of time and then averaging these values over the sample time.

Shunting – Also called "switching", the process of sorting rolling stock into train sets, or the reverse.

Single event noise - Results from the occurrence of a singular intermittent or impulsive noise event such as from train whistling, rail car shunting or a vehicular pass-by. Single event noise is commonly described by the SEL and the Fast A-weighted sound pressure level.

Sound – The fluctuating motion of air or other elastic medium which can produce the sensation of sound when incident upon the ear.

Sound Exposure Level – Defined as the constant sound level which has the same amount of energy in one second as the original noise event.

Time constant (slow, fast) – Used to describe the exponential time weighting of a signal. The standardised time periods are 1 second for "slow" and 0.125 seconds for "fast" exponential weightings.

Tonal sound – Sound characterized by a single frequency component or multiple distinct frequency components that are perceptually distinct from the total sound.

Total noise – Results from a combination of multiple noise sources at multiple spatial locations and is typically described by a 24-hour equivalent sound level.

APPENDIX B INTRODUCTION TO SOUND AND ENVIRONMENTAL NOISE ASSESSMENT

B.1 General Noise Theory

The two principle components used to characterize sound are loudness (magnitude) and pitch (frequency). The basic unit for measuring magnitude is the decibel (dB), which represents a logarithmic ratio of the pressure fluctuations in air relative to a reference pressure. The basic unit for measuring pitch is the number of cycles per second, or Hertz (Hz). Bass tones are low frequency and treble tones are high frequency. Audible sound occurs over a wide frequency range, from approximately 20 Hz to 20,000 Hz, but the human ear is less sensitive to low and very high frequency sounds than to sounds in the mid frequency range (500 to 4,000 Hz). "A-weighting" networks are commonly employed in sound level meters to simulate the frequency response of human hearing, and A-weighted sound levels are often designated "dBA" rather than "dB".

If a continuous sound has an abrupt change in level of 3 dB it will generally be noticed while the same change in level over an extended period of time will probably go unnoticed. A change of 6 dB is clearly noticeable subjectively and an increase of 10 dB is generally perceived as being twice as loud.

B.2 Basic Sound Metrics

While the decibel or A-weighted decibel is the basic unit used for noise measurement, other indices are also used to describe environmental noise. The Equivalent Sound Level, abbreviated L_{eq}, is commonly used to indicate the average sound level over a period of time. The L_{eq} represents the steady level of sound which would contain the same amount of sound energy as the actual time-varying sound level. Although the L_{eq} is an average, it is strongly influenced by the loudest events occurring during the time period, because these loudest events contain most of the sound energy. Another common metric used is the L_{90}, which represents the sound level exceeded for 90% of a time interval and is typically referred to as the background noise level.

The L_{eq} can be measured over any period of time using an integrating sound level meter. Some common time periods used are 24 hours, noted as the L_{eq24}, daytime hours (07:00 to 22:00), noted as the L_d, and night time hours (22:00 to 07:00), noted as the L_n. As the impact of noise on people is judged differently during the day and during the night, 24 hour noise metrics have been developed that reflect this.

The day-night equivalent sound level (L_{dn}) is one metric commonly used to represent community noise levels. It is derived from the L_d and the L_n with a 10 dB penalty applied to the L_n to account for increased sensitivity to nigh time noise.