May 15, 2012

Project
772600
Rev 1

Cargill

North Vancouver Grain Terminal

Assessment & Specifications for Noise Controls

ATCO Structures & Logistics

TABLE OF CONTENTS

TABLES AND FIGURES

1. INTRODUCTION

Cargill is concerned with noise emission from dust collection systems at its North Vancouver grain terminal. The noise management group at ATCO Structures and Logistics was retained to conduct a measurement survey and determine noise source sound power levels of the dust collection systems and make recommendations for noise controls to reduce the sound level at nearby residences. This report contains the results of this effort and the conceptual noise control recommendations and their acoustic performance specifications.

1.1 Background

The dust collection systems at the North Vancouver Grain Terminal have been identified as strong contributors to the environmental noise level at nearby residences in a prior environmental noise monitoring survey. Long term noise monitoring and a coordinated shut-down procedure identified the contributions from Annex 1 and the contributions from the Trackshed and Annex 2 as having a roughly equivalent contribution to the overall sound level at nearby houses. At the most affected residence, the L_{90} sound level with all dust collection systems operating was found to be 67 dBA, which is well above the limit of 55 dBA (daytime) and 45 dBA (nighttime) limits for quiet areas under the City of Vancouver noise bylaw as well as the background nighttime ambient sound level of L_{90} 52 dBA.

1.2 Site Description

The North Vancouver Grain Terminal sits on the waterfront on the north side of Burrard Inlet at 801 Low Level Road, North Vancouver. The most affected residence is on the north side of the facility on a hillside above the noise sources. The distance from the facility to the most affected receiver is approximately 150m. The ground cover in the vicinity is treed and paved, however noise propagation from the dust collection systems to the receiver is not over a horizontal plane due to the relatively large elevation differences between the source, receiver, and along the propagation path. The dust collection systems sit on the rooftops of the grain terminal buildings in four areas: Annex 1, Annex 2, Annex 3, and Trackshed. The workhouse, Annex1, and Annex 2 buildings act as a reflective surface for noise from the systems on the Trackshed roof. A multitude of other sources of sound exist in the acoustic environment in the vicinity, notably road and rail traffic between the facility and residences as well as sound from other equipment and facilities in the area. An aerial photo of the area is shown in Figure 1 for reference.

Figure 1: North Vancouver Grain Terminal Area

2. SOUND LEVEL MEASUREMENTS

Sound level measurements were taken of the dominant sources of sound associated with the dust collector systems for the purpose of determining the sound power level of each source. Many of the sources were determined to be nearly identical to each other, therefore specific measurements were taken which were the most isolated from other noise sources to reduce measurement contamination. Sound level measurements were taken in accordance with measurement methodology described in ISO 3744 "*Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plant*" to the extent practicable given the limitations of the test environment. Sound level measurements were later evaluated for contamination & suitability for sound power calculations. The sound pressure levels measured on the rooftop varied between 72 dBA and 105 dBA depending on the proximity to the noise generating equipment. Sound pressure levels, however are not suitable for evaluating the noise propagation of a source to sensitive receivers. The sound power level, based on the size of the radiating surface and the surface sound pressure level, is necessary to evaluate environmental noise propagation.

2.1 Sound Power Levels

The sound power levels for dominant noise equipment noise sources are shown in Table 1. The sound power levels shown are for the dominant sources of sound emitted from the dust collection system. Since the sources are somewhat repetitive, a single representative sound power level is calculated for each. The sound power level from sub-dominant sources such as sound radiated from piping and through some bag house casings could not be determined due to measurement contamination from the dominant sources.

Table 1: Equipment Sound Power Levels (dB re 10^{-12} W)

Source	Octave Band Center Frequency, Hz									dBA
	31.5	63	125	250	500	1000	2000	4000	8000	
Fan Inlet (Pulsaire Filter Type)	118	108	107	106	114	109	105	99	91	114
Fan Exhausts (Trackshed Roof)	109	111	114	106	104	101	97	92	91	107
Baghouse Exhausts (Annex 3 Type)	101	100	103	92	94	98	97	95	94	103
Fan Scroll & Motor Casing Noise Breakout	98	99	104	98	100	94	91	90	86	101
Baghouse Casing (Annex 3 Type)	113	112	109	96	93	91	86	88	85	98
Bag House Exhaust (Pulsaire Type)	103	102	101	94	93	94	93	92	92	100
Vacuum Blower	94	95	106	95	94	96	90	89	85	100

2.2 Environmental Noise Propagation

The calculated sound level at residential location B from these three areas is 64BA based these sound power levels and the respective distance from each cluster of noise sources to the residence. This agrees with the observed sound level of 67 dBA at location B during an earlier noise survey. It is expected that ambient noise and secondary noise sources make up the difference. The approximate contribution of each area to the overall sound level at location B is shown in Table 2. A noise propagation model is recommended for more detailed analysis of noise propagation.

Table 2: Dust Collector Area Contribution Ranking

Area	Sound Level Contribution at Residential Location B, dBA
Dust Complex B/C (Dripshed/Trackshed Roof)	62
Annex 2 Roof	58
Workhouse Dust System/Annex 1	57
Annex 3 Roof	48
Total	64

3. NOISE CONTROL RECOMMENDATIONS

The following section outlines recommendations and acoustic specifications for noise controls to reduce noise from the dust collection system at nearby residences. The noise control performance specifications are based on reducing the contribution of the dominant sources to 52 dBA during the nighttime including a 3 dB design margin. Although this target is above the 45 dBA bylaw limit, matching the ambient background sound level will make the dust collectors less discernable in the acoustic environment and achieving a lower emission level would not make an appreciable difference in the local acoustic environment. Using 52 dBA as a reduction target sound level does not preclude further noise reduction in the future.

The noise control recommendations for the various dust collection system sources based on their suitability, effectiveness, and cost.

3.1 Fan Inlet and Exhaust & Dust Collector exhaust silencers

The un-silenced fan exhausts in the Annex 2 (Figure 2) and two un-silenced fan exhausts in the Trackshed roof area (Figure 3) should be treated to reduce their noise emission. The Annex 2 fan exhaust is slated for decommissioning in the short term. Silencers are recommended for the two un-silenced fan exhausts in the Trackshed roof area. Exhaust silencers are also recommended for the dust collectors (Figure 5, Figure 6). The silencers should be designed to achieve the minimum insertion loss values shown in Table 3.

Table 3: Silencer Insertion Loss Values, dB

Source Type	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Fan Exhaust (Trackshed)		13	27	24	29	33	28	18	8
Dust Collector Exhaust (pulseaire type)		7	16	16	21	26	26	18	9
Dust Collector Exhaust (older type)			5	8	12	12	12	8	5

Figure 2: Annex 2 un-silenced fan exhaust

Figure 3: Trackshed roof fan exhausts

Figure 4: Pulsaire type dust collector

Figure 5: Older type dust collector

3.2 Acoustic Noise Barriers

Noise barriers are recommended for the Trackshed, Annex 2, and Workhouse areas. The barriers should be constructed using an acoustic wall system or sandwich panel. The barriers should have a sound transmission class rating of at least STC 35 and be acoustically absorptive on their interior surface to reduce reflected sound and improve their performance. The absorptive surface should have a rating of NRC 0.85 or higher. The recommended acoustic performance is shown in Table 4. The described performance can typically be achieved using an outer steel skin and at least 4" of mineral wool insulation over a perforated metal liner. Interlocking acoustic sandwich panels are commonly used for this type of application. The barriers should be approximately 18' high. The desired coverage and locations are marked up in Figure 6 through Figure 8.

Table 4: Acoustic Performance Specifications

Acoustic Performance Specification	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Transmission Loss, dB	10	16	17	24	32	41	49	52	57
Absorption Coefficient α	0.2	0.3	0.5	0.8	0.9	0.9	0.8	0.6	0.5

Figure 6: Annex 2 3-sided Acoustic Barrier Coverage

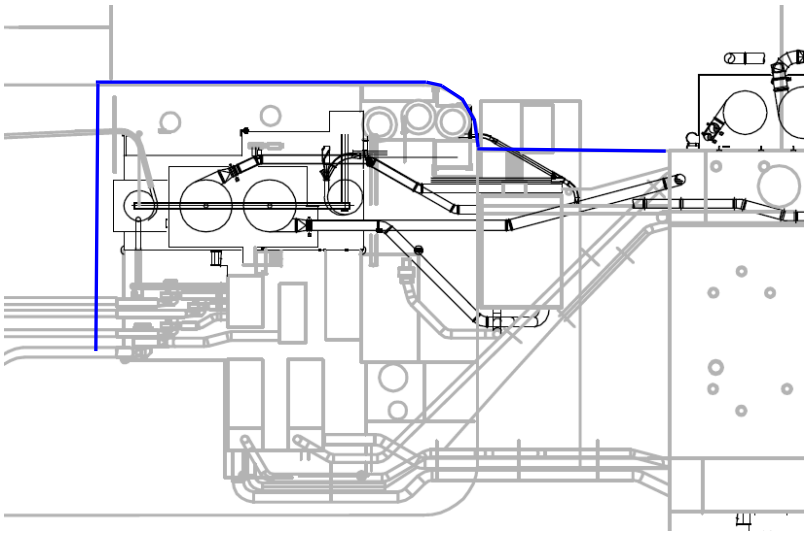

Figure 7: Workhouse Roof Acoustic Barrier Footprint

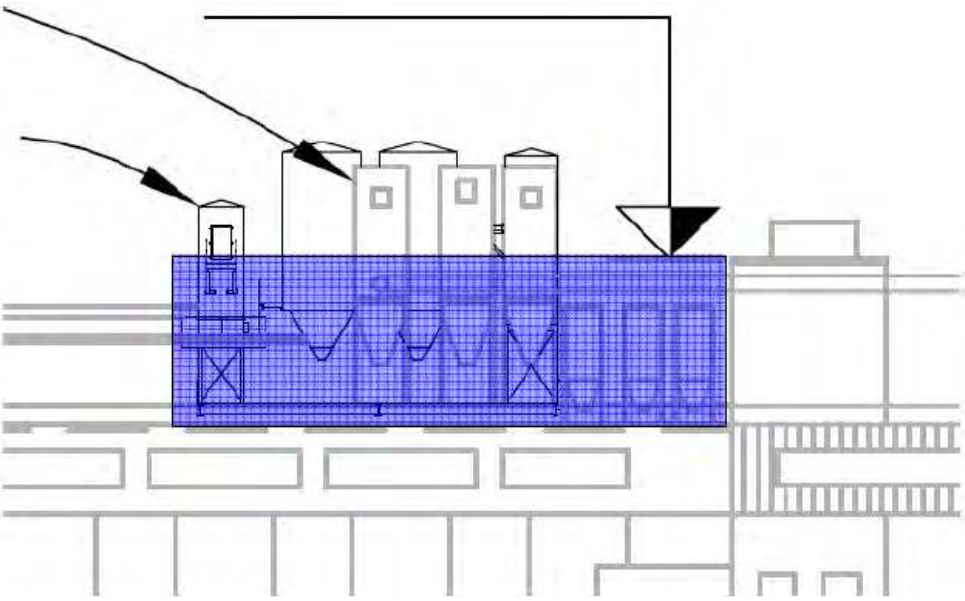

Figure 8: Workhouse Roof Acoustic Barrier Coverage

Figure 9: Trackshed / Dripshed Roof Acoustic Barrier Coverage

3.3 Acoustic Shrouds

Acoustic shrouds are recommended for treating noise from fan casing and motors in dust complex B/C on the trackshed roof. Due to sound reflection off of the main building behind the fans a four sided shroud with open top is recommended given the maintenance and safety constraints. The shrouds should be absorptive on their interior surface. An acoustic construction with the same performance of the barrier systems described in section 3.2 should accomplish this if leakage and noise flanking are controlled. **Error! Reference source not found.** shows the necessary coverage of the enclosures.

Alternatively an acoustic barrier blanket applied over the fan scroll, belt drive, and motor may achieve adequate performance. Acoustic barrier blankets should not be used in situations where they must be removed and replaced frequently as their performance is contingent on a good fit.

Figure 10: Fan Shroud Coverage

3.4 Lagging / Dampening

Acoustic lagging or a dampening compound coating is recommended for the older filter houses on the Annex 3 roof and work house roof (Figure 5). The structures outer surface should be completely covered using a lagging system consisting of outer cladding and insulation attached to the existing structure. In the case of a dampening compound, the coating would be brushed or sprayed to the manufacturers recommended thickness for maximum dampening performance.

The noise reduction performance of dampening compound varies from application to application. If this option is selected over acoustic lagging, ASL recommends testing and verifying the noise reduction achieved on the Annex 3 dust collector, prior to applying the compound to the workhouse dust collectors as the attenuation necessary for the Annex 2 dust collectors is marginally higher than for the workhouse dust collectors. The dust collector exhaust silencers should be installed prior to testing.

4. NOISE REDUCTION

This section shows the effect of installing the noise mitigation measures outlined in Section 3. These contours were generated using CadnaA noise propagation modeling software. The outdoor noise propagation model is based on ISO 9613, Part 1: "Calculation of the absorption of sound by the atmosphere", (1993) and Part 2: "General method of calculation", (1996). The results presented in this section are the calculated contribution of the dominant noise sources from dust collection systems in the four areas studied and do not constitute a comprehensive noise propagation model for the area.

Sources in the model are expressed by their decibel sound power level ($L_{w,}$ dB) in Octave Bands from 31.5 Hz to 8000 Hz. Buildings and other obstacles are modeled as solid barrier elements. The reflective characteristic of the structure is quantified by its absorption coefficient, which is specified based on the construction material used. Terrain between the source and the receptor affects noise propagation and is modeled using topographic information from the site.

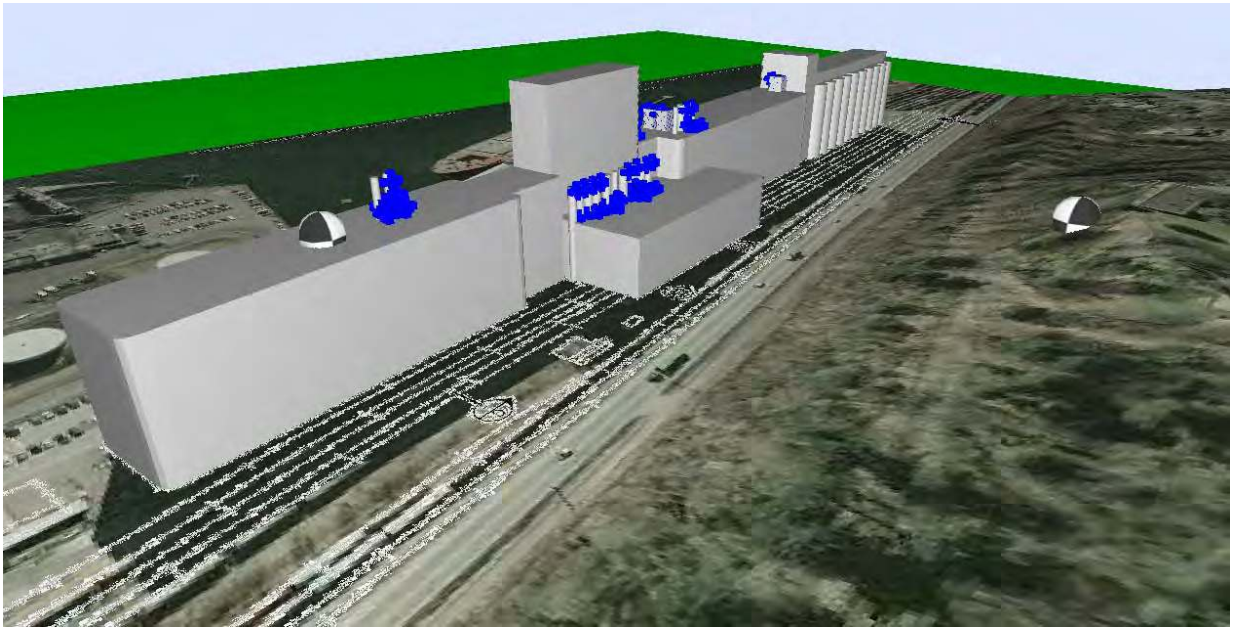

Figure 11: Noise Propagation Model 3D View

4.1 Phased Approach

The effects of installing the recommended noise controls are shown in two incremental phases in Figures 12 through 14. The order of installation of noise controls is based on a balance between the priority of attenuating dominant noise sources, and cost effective construction planning. The noise controls modeled in each phase are as follows:

Phase 1:

- Trackshed / Dripshed fan exhaust silencers (2)
- Trackshed / Dripshed fan acoustic shrouds (2)
- Trackshed / Dripshed Acoustic barriers (2)
- Trackshed / Dripshed Dust collector exhaust silencers (8)
- Annex 2 Dust Collector Exhaust Silencer (1)

The calculated contribution of the dust collection systems at the nearest affected receptor (location B) after Phase 1 noise mitigation is: 57 dBA.

Phase 2:

- Workhouse Acoustic Barrier (1)
- Annex 2 Acoustic Barrier (1)
- Workhouse dust collector exhaust silencers (6)
- Annex 3 dust collector exhaust silencers (2)
- Workhouse dust collectors (old type) lagging / dampening
- Annex 3 dust collectors (old type) lagging / dampening

The calculated contribution of the dust collection systems at the nearest affected receptor (location B) after Phase 2 noise mitigation is: 49 dBA.

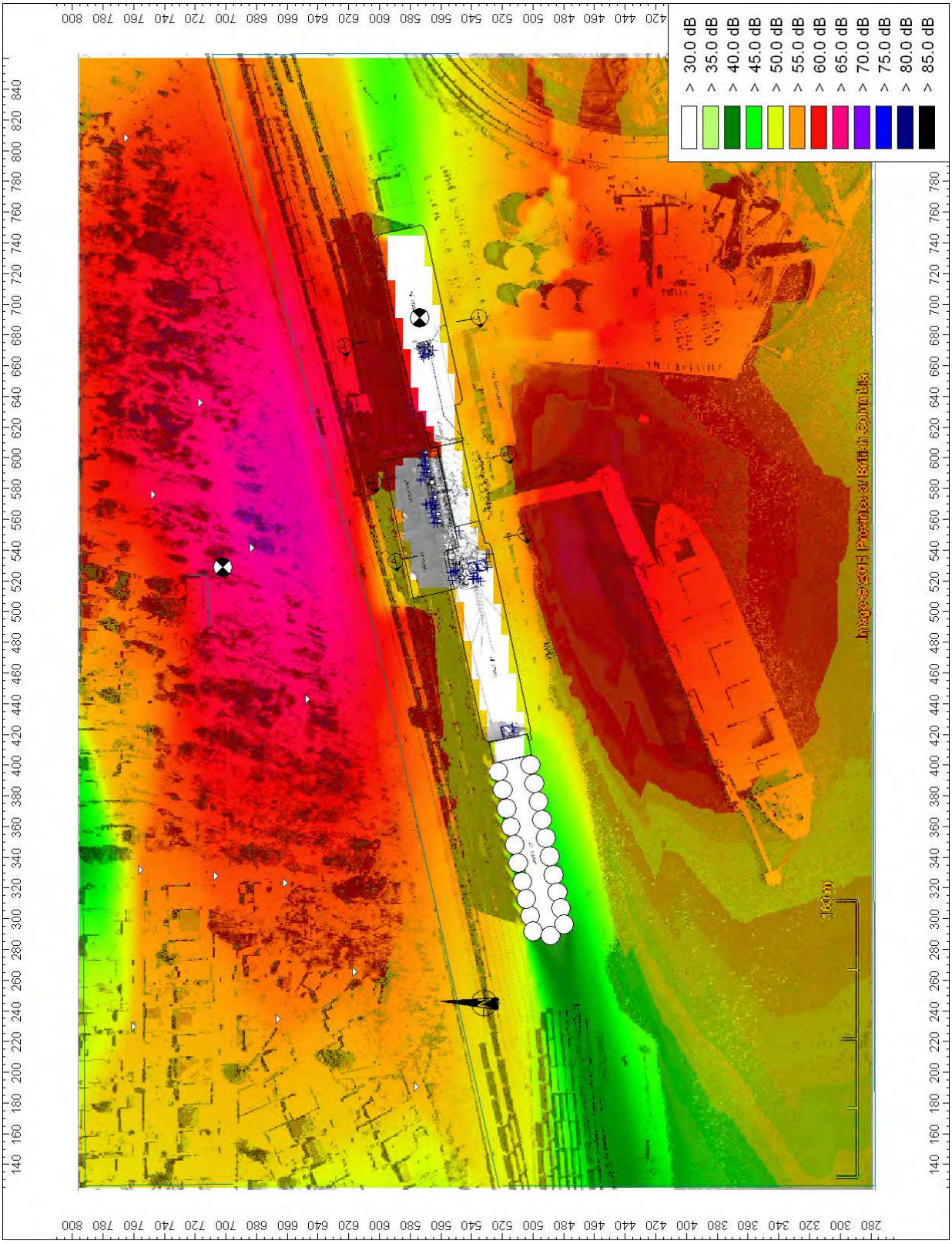

Figure 12: Existing Facility Noise Propagation

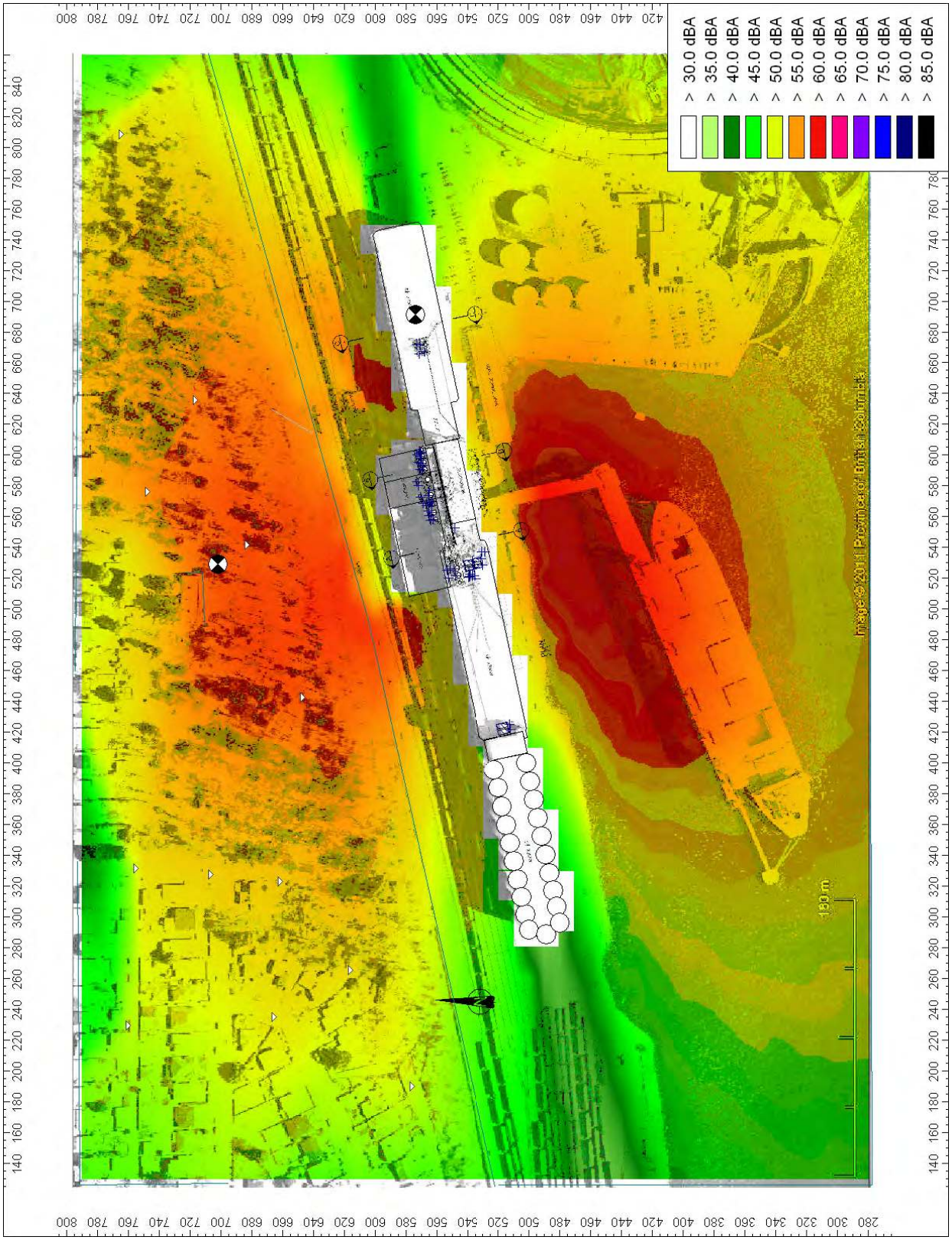

Figure 13: Phase 1 Mitigated Facility Noise Propagation

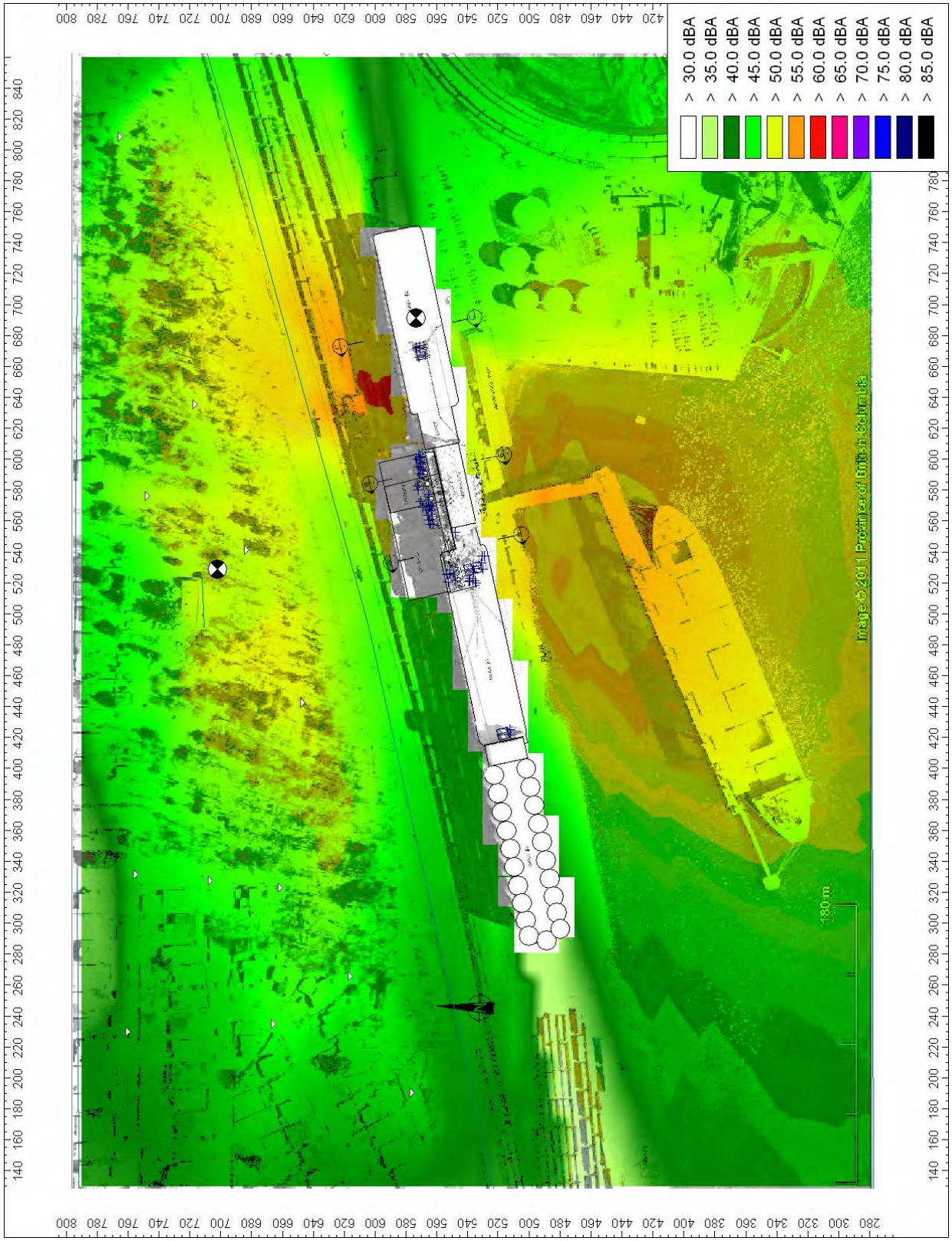

Figure 14: Phase 2 Mitigated Facility Noise Propagation

5. CONCLUSIONS

The dust collector systems on the North Vancouver Grain Terminal are a dominant source of sound in the local environment, including at nearby residences. The sound power levels calculated for different types of dominant noise source associated with the dust collector systems is sufficiently high to contribute to an ambient sound level as high as 64-67 dBA at the most affected residence. In order to lower noise emissions from the dust collector systems to match the existing ambient sound level to reduce the likelihood of complaints from the community and to move towards the 45 dBA nighttime limit for quiet areas specified by the City of Vancouver Noise Bylaw, a number of noise controls will be necessary. Successful implementation of the noise control recommendations from this report will make substantial progress towards this target by treating the dominant sources of noise.

A phased approach has been developed to implement noise reduction measures which balances the order of priority to achieve incremental noise reduction with cost effective construction planning.

6. DISCLAIMER

This "Assessment", which is reported in the preceding pages, has been prepared in response to a specific request for service from the Client to whom it is addressed. The information contained in this "Assessment" is not intended for the use of, nor is it intended to be relied upon, by any person, firm, or corporation other than the Client to whom it is addressed, with the exception of the applicable regulating authority to whom this document may be submitted for planning permission purposes. We deny any liability whatsoever to other parties who may obtain access to the information contained in this "Assessment" for any damages or injury suffered by such third parties arising from the use of this "Assessment" by them without the express prior written permission from ATCO and its Client who has commissioned this "Assessment".

ATCO STRUCTURES & LOGISTICS
NOISE MANAGEMENT GROUP

Field Measurements Conducted By:

Chris Giesbrecht P.Eng, INCE

Manager, Acoustical Engineering

Report Prepared by:

Chris Giesbrecht P.Eng, INCE

Manager, Acoustical Engineering

Appendix A GLOSSARY

Ambient sound level – the background sound level. It is the sound level that is present in the acoustic environment of a defined area. Aircraft fly over and rail noise may be excluded in some jurisdictions.

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.

Frequency – the number of cycles per unit interval of time. *Units Hz (Hertz).*

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 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.

dB (Decibel) – the standard unit of measure, in acoustics, for level or level difference. The decibel scale is based on the ratio 101/10; multiplying a power-like quantity (such as sound power or mean square) by this factor increases its level by 1 decibel. If a power-like quantity is increased by a factor $10^n/10$, its level goes up by n decibels. *Unit symbol for dB.*

Equivalent Sound Level (L_{eq}) – the prime descriptor used in assessing most types of sounds heard in a community. The L_{eq} is an average of sounds measured over time. It is strongly influenced by occasional loud, intrusive noises.

Sound Power – the rate of acoustic energy flow across a specified surface, or emitted by a specified sound source. *Units W (Watt).*

Sound Power Level (PWL, L_W) – the level of sound power expressed in decibels relative to a stated reference value. The quantity L_w is defined by $L_w = 10\ \mathrm{Log10}(W/W_{ref})$. Here W_{ref} is the reference sound power. *Units dB re 1pW.*

Sound Pressure (Pa) – the difference between the instantaneous pressure at a fixed point in a sound field, and the pressure at the same point with the sound absent. *Units Pa (Pascal).*

Sound Pressure Level (SPL, L_p) – or sound pressure-squared level, at a given point the quantity L_p defined by $L_p = 10\ \mathrm{Log10}(P_{rms}/P_{ref})2 = 20\ \mathrm{Log10}(P_{rms}/P_{ref})$. Here P_{rms} is the root mean square sound pressure, and P_{ref} is the reference rms sound pressure, 20µPa. *Units dB re 20µPa.*