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Rail Noise & Vibration Feasibility Study
Proposed Residential Conversion
108 St. Claire Avenue
Komoka, Ontario

Prepared for:

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1 INTRODUCTION AND SUMMARY

HGC Engineering was retained to conduct a noise and vibration feasibility study for a proposed residential conversion of an existing church located on the south side of St. Claire Avenue and west of Delaware Street North in Komoka, Ontario. The CN railway line is located approximately 40 m to the north of the subject property. The study is required by the municipality as part of the planning and approvals process and follows Ministry of the Environment, Conservation and Parks (MECP) and CN guidelines for the assessment of environmental noise.

Rail traffic data was obtained from CN personnel for a past project. This obtained data was used to predict future traffic sound levels at the proposed residential dwellings. There is minimal road traffic on St. Claire Avenue and Delware Street and road traffic noise has not been considered in the analysis.

Future unmitigated sound levels due to rail pass-bys will exceed the MECP criteria at the proposed dwelling. Central air conditioning will be required for all units. The proposed dwelling has been designed such that there are no windows to noise sensitive space on the north façade, facing the CN railway line. Upgraded glazing construction are required for the east and west facades and brick/masonry exterior walls are required for the north, east and west. Any exterior building façade constructions meeting the requirements of the Ontario Building Code will provide adequate sound insulation for the indoor spaces for the south facade. Noise warning clauses are required to inform future occupants of the traffic noise impacts.

Ground-borne vibration levels from the rail pass-bys were measured in the basement and on the ground floor. Minor exceedances occurred only momentarily during each pass-by. A warning clause is recommended to inform the future resident that ground-borne rail vibration may be perceptible at times.

2 SITE DESCRIPTION AND NOISE SOURCES

The subject site is located on the south side of St. Claire Avenue and west of Delaware Street North in Komoka, Ontario. The existing church will be converted to residential uses and consist of 3 units. An aerial photograph showing the location is included as Figure 1.

Site visits were performed by HGC Engineering personnel in August 2021 to make observations of the acoustical environment, investigate the acoustic features of the site and measure ground-borne vibration. The subject site is flat. The railway tracks are elevated by approximately 1 – 1.5 m above the grade of the site as there is an overpass bridge above Delaware Street. During the site visit, it was observed that rail traffic from passbys are the dominant sources of noise. Road traffic on St. Claire Avenue and Delaware Street was observed to be minimal and has not been included in the analysis. There are existing residences surrounding the site.

3 TRAFFIC NOISE ASSESSMENT

3.1 Traffic Noise Criteria

Guidelines for acceptable levels of rail traffic noise impacting residential developments are given in the MECP publication NPC-300, "Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning", Part C release date October 21, 2013, and are listed in Table I below. The values in Table I are energy equivalent (average) sound levels [L_{EQ}] in units of A-weighted decibels [dBA].

Table I: MECP Rail Traffic Noise Criteria (dBA)

Area	Daytime L_{EQ} (16 hour)	Nighttime L_{EQ}(8 hour)
Outdoor Living Area	55 dBA	--
Inside Living/Dining Room	40 dBA	40 dBA
Inside Bedroom	40 dBA	35 dBA

Daytime refers to the period between 07:00 and 23:00, while nighttime refers to the period between 23:00 and 07:00. The term "Outdoor Living Area" (OLA) is used in reference to an outdoor patio, a backyard, a terrace or other area where passive recreation is expected to occur. Balconies that are less than 4 m in depth are not considered to be outdoor living areas under MECP guidelines.

The MECP guidelines allow the sound level in an Outdoor Living Area to be exceeded by up to 5 dBA, without mitigation, if warning clauses are placed in the purchase and sale agreements to the property. Where OLA sound levels exceed 60 dBA physical mitigation is required to reduce the OLA sound level to below 60 dBA.

Indoor guidelines are 5 dBA more stringent for rail noise than for road noise, to account for the low frequency (rumbling) character of locomotive sound, and its greater potential to transmit through exterior wall/window assemblies.

A central air conditioning system as an alternative means of ventilation to open windows is required for dwellings where nighttime sound levels outside bedroom and living/dining room windows exceed 60 dBA or daytime sound levels outside bedroom and living/dining room windows exceed 65 dBA. Forced-air ventilation with ducts sized to accommodate the future installation of air conditioning as an alternative means of ventilation to open windows is required when nighttime sound levels at bedroom and living/dining room windows are in the range of 51 to 60 dBA or when daytime sound levels at bedroom and living/dining room windows are in the range of 56 to 65 dBA.

Building components such as walls, windows and doors must be designed to achieve indoor sound level criteria when the nighttime sound level at the plane of bedroom and living/dining room windows is greater than 55 dBA and daytime sound level is greater than 60 dBA due to rail traffic

noise.

Warning clauses are required to notify future residents of possible excesses are also required when nighttime sound levels exceed 50 dBA at the plane of the bedroom and the living/dining room windows and daytime sound levels exceed 55 dBA in the outdoor living area and at the plane of the bedroom and living/dining room windows due to rail traffic.

MECP guidelines recommend brick veneer or masonry equivalent exterior walls from foundation to rafters as a minimum construction for any dwellings with a 24 hour L_{EQ} that is greater than 60 dBA, and which are within 100 m of the right of way of the railway. CN also recommends brick in the first row of units regardless of distances or sound levels.

The railways also provide minimum requirements for safety as well as sound and vibration for proposed residential developments located adjacent to their rights-of-way. The reader is referred to a copy of CN requirements for a new development adjacent to principal main line, which is in Appendix A.

3.2 Rail Traffic Data

Rail traffic data for typical operations of the CN railway line was obtained from CN for a development to the east of the subject site and is provided in Appendix B. In conformance with CN assessment requirements, these maximum speeds, number of cars and locomotives per train were used in the traffic noise analysis to yield a worst-case estimate of train noise. The data was projected to the year 2031 using a 2.5% per year growth rate. Table II summarises the CN rail traffic data used in the analysis.

Table II: Projected Rail Traffic Data for 2031

Type of Train	Projected Daytime (07:00-23:00) trains	Projected Night-time (23:00-07:00) train	Maximum Number of Locomotives	Number of Cars	Maximum Speed (km/h)
Freight	15	5	4	140	97
Way Freight	3	0	4	25	97
Passenger (VIA Trains)	11	0	2	10	129

3.3 Rail Traffic Noise Predictions

Traffic sound levels were predicted at the proposed residence. Sound levels were predicted at the façade of the future building during daytime hours to investigate ventilation and building façade requirements and in the rear yard amenity area to determine the need for acoustic barriers. The dwelling has been designed such that there are no windows to noise sensitive spaces directly facing the CN railway line.

Train whistle noise was included in the predictions at the dwelling facades to determine indoor sound levels as per MECP/CN guidelines. The traffic noise predictions were made using STAMSON version 5.04, a computer algorithm developed by the MECP. Sample STAMSON output is included in Appendix C. The results of the predictions are presented in Table III.

Table III: Predicted Sound Levels at Dwelling due to Rail Traffic [dBA]

Prediction Location	Building Facade	Daytime – At Façade+, L_{EQ} (16 Hours)	Nighttime – At Façade+, L_{EQ} (8 Hours)
A	North	70	66
B	East	69	65
C	West	65	61
D	South	58	54
E	East	67	63

Note: + Train whistle noise included

3.4 Discussion and Recommendations

The results indicate that rail traffic sound levels are expected to exceed MECP and CN guideline limits at the façades of the building. The following discussion outlines preliminary recommendations for ventilation requirements, building façade constructions, and warning clauses to achieve the noise criteria stated in Table I.

3.4.1 Outdoor Living Areas

There are no outdoor living areas proposed as the existing parking lot will remain.

3.4.2 Indoor Living Areas

Future rail traffic sound levels at the future dwelling will exceed 65 dBA during the day and 60 dBA at night. All units will require central air conditioning.

3.4.3 Building Facade Constructions

Exterior Wall Construction

MECP guidelines recommend brick exterior walls from foundation to rafters as a minimum construction for any dwellings with a 24-hour L_{EQ} that is greater than 60 dBA which are within 100 m of the right of way of the railway. CN guidelines typically recommend brick/masonry or an acoustical masonry equivalent exterior walls from foundation to rafters as a minimum construction for any dwellings that are in the first row of dwellings adjacent to a mainline. For the proposed dwelling, brick/masonry exterior walls or acoustic masonry equivalent walls are required for the north, west and east facades.

Glazing Construction

Future sound levels at windows will exceed 60 dBA during the daytime and 55 dBA during nighttime hour. MECP guidelines recommend that the windows, walls, and doors be designed so that the indoor sound levels comply with MECP noise criteria.

Floor plans and building elevations dated May 11, 2021 as attached in Appendix D were reviewed. It is noted that there are no windows on the north façade facing the railway line. The window-to-floor areas were calculated and found to be up to 13% for the bedrooms and 12% for living rooms. The calculation methods were developed by National Research Council (NRC). They are based on the predicted future sound levels at the building facades and the anticipated area of the façade components (walls, windows and doors) relative to the floor area of the adjacent room. All exterior doors should include good weather seals to reduce air (and noise) infiltration to the minimum achievable levels. The minimum acoustical requirement for the basic window glazing, including glass in fixed sections and operable windows, is provided in Table IV.

Table IV: Required Minimum Glazing STC for Each Unit

Unit No.	Space	Glazing STC[1, 2]
1	Living/Dining	STC-32
	Bedroom	STC-33
2	Living/Dining	STC-30
	Bedroom	STC-30
3*	Living/Dining	STC-30
	Bedroom	STC-30

Note: *Window requirements only apply to east and west facades of Unit 3

Any glazing construction and exterior wall construction meeting the requirements of the Ontario Building Code will provide adequate sound insulation for the windows on the south façade for Unit 3.

4 RAIL VIBRATION ASSESSMENT

4.1 Ground-borne Vibration Limits

CN guidelines require measurements of ground-borne vibration when residential dwelling units are to be located within 75 metres of a principal mainline such as the CN Welland Subdivision.

Vibration is typically measured in terms of oscillatory velocity or acceleration. The CN guidelines recommend that ground-borne vibration be limited to a vibratory velocity of 0.14 mm/s (-17 dB) between 4 and 200 Hz. The limits are also presented as a curve of maximum allowable vibratory acceleration versus frequency. The CN criteria have been overlaid on the graphs of the measured vibration for easy reference as attached in Appendix E.

4.2 Ground-borne Vibration Assessment

Measurements were performed on the ground floor and in the basement of the building on August 18, 2021, as shown on Figure 3. The results of the measurements are presented in Appendix E. Table V shows the maximum vibration levels measured during each of the train pass-bys.

Table V: Maximum Instantaneous RMS Vibration Velocity Measurements of Train Pass-bys at 65 m from Right-of-Way

Train Pass-by	Criteria (mm/s)	Maximum Measured Level (mm/s)	
		Ground Floor	Basement
1	0.14	0.18	0.08
2		0.17	0.07
3		0.21	0.07
4		0.13	0.06
5		0.08	--

As shown in the graphs attached in Appendix E, vibration levels momentarily (1 second) exceeded the CN limit of 0.14 mm/s during the freight train pass-bys. Spectral analysis indicated that there were minor excesses on the ground floor during the passbys which occurred at the frequency range of 50 Hz. Due to the very short duration in which the excesses occurred and, in our experience, the

required flexibility of the support structure to mitigate may create additional structural concerns, particularly for light structures such as a single-family dwelling and as such is not recommended. A vibration warning clause should be included in the property and tenancy agreements to inform the future residents that groundborne vibration due to rail activities may be perceptible.

5 WARNING CLAUSES

Noise warning clauses should be included in all offers of purchase and sale and property and tenancy agreements regarding the presence of the rail line.

Suggested wording for future dwellings with sound level excesses of the MECP criteria.

Type A:

> Purchasers/tenants are advised that, despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing road traffic may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the noise criteria of the Municipality and the Ministry of the Environment, Conservation and Parks.

Suitable wording for future dwellings requiring central air conditioning systems is given below.

Type B:

> This dwelling unit has been supplied with a central air conditioning system which allows windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the noise criteria of the Municipality and the Ministry of the Environment, Conservation and Parks.

Suggested wording to inform the future residents that groundborne vibration due to rail activities may be perceptible on occasion.

Type C:

> Purchasers/tenants are advised that due to the proximity of this dwelling to the nearby railway tracks, vibration from rail passbys may occasionally be perceptible within this unit.

Since the lands are within 300 m of the CN railway line, they require that the following warning clause be included in all property agreements and offers of purchase or sale for all lots within 300 m of their Right of Way.

Type D:

> Warning: Canadian National Railway Company or its assigns or successors in interest has or have a right-of-way within 300 metres from the land the subject hereof. There may be alterations to or expansions of the railway facilities on such rights-of-way in the future including the possibility that the railway or its assigns or successors as aforesaid may expand its operations, which expansion may affect the living environment of the residents in the vicinity, notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the individual dwelling. CNR will not be responsible for any complaints or claims arising from use of such facilities and/or operations on, over or under the aforesaid rights-of-way."

These clause are provided by the MECP as an example and can be modified by the Municipality/CN as required.

6 SUMMARY OF RECOMMENDATIONS

The following list and Table VI summarize the recommendations made in this report.

1. All units shall be provided with central air conditioning.

2. Brick/masonry exterior wall constructions are required for the west, north and east facades of the building.

3. Upgrade glazing constructions are required for the east and west facades and windows should be selected to meet the minimum STC Ratings as summarized below.

4. Noise warning clauses should be included in all offers of purchase and sale and property and tenancy agreements to inform future resident of the property of the presence of the rail line and that ground-borne rail vibration may occasionally be perceptible.

Table VI: Summary of Noise Control Requirements and Noise Warning Clauses

Unit No.	Acoustic Barrier	Ventilation Requirements*	Type of Warning Clause	Glazing Construction	Exterior Wall Construction
1	--	Central A/C	A, B, C, D	LR/DR: STC-32 BR: STC-33	Brick/Masonry
2	--	Central A/C	A, B, C, D	LR/DR: STC-30 BR: STC-30	Brick/Masonry
3	--	Central A/C	A, B, C, D	LR/DR: STC-30[1] BR: STC-30[1]	Brick/Masonry[1]

Notes: -- no specific requirement
* The location, installation and sound rating of the air conditioning condensers must be compliant with MECP Guideline NPC-300.
1- For East and West Facades only, any exterior wall constructions meeting the Ontario Building Code Requirements will be sufficient for the south façade

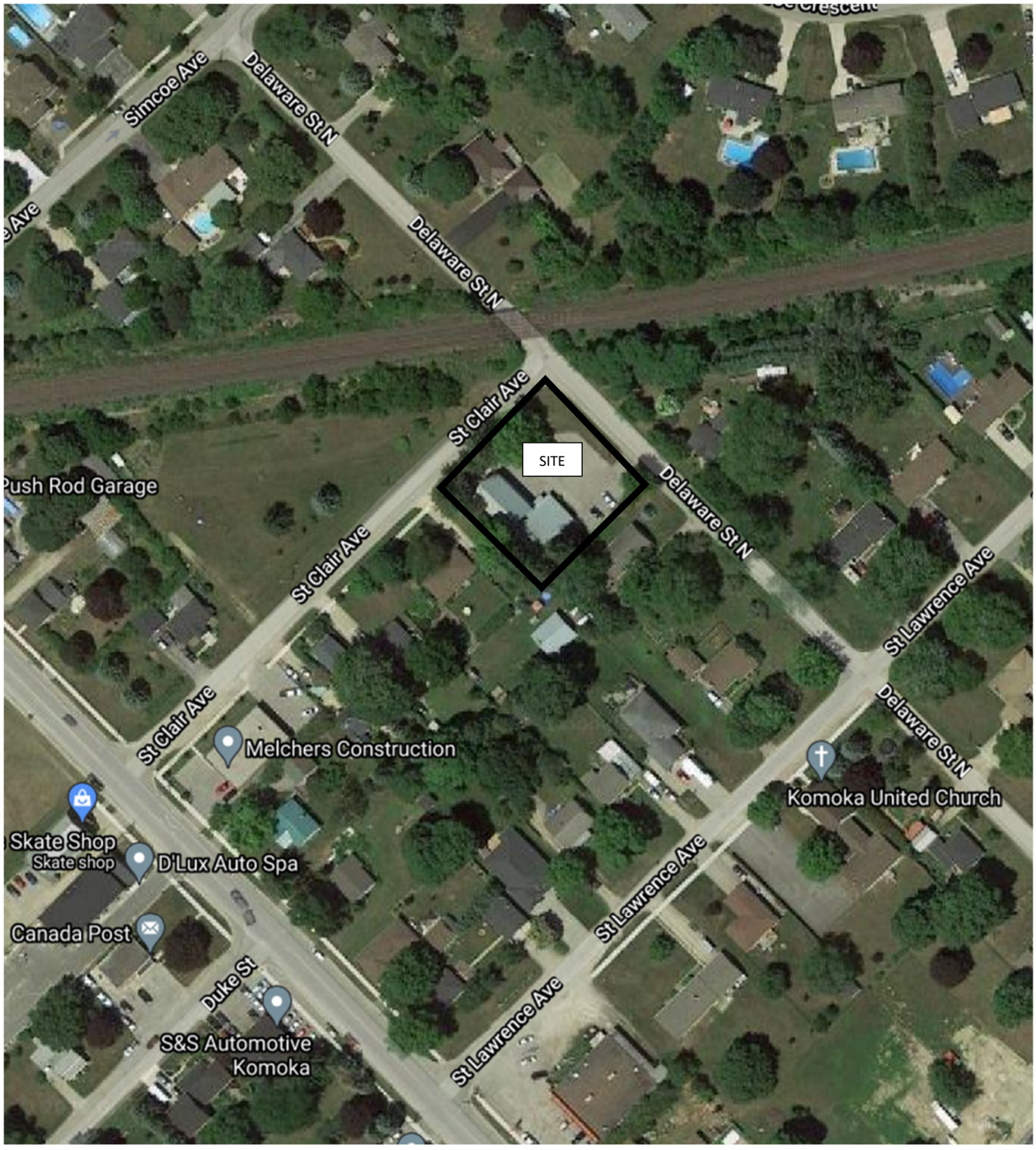

Figure 1: Aerial Photo

APPENDIX A

CN Principal Mainline Requirements

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Propriétés ferroviaires du Canadien National Inc.

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PRINCIPAL MAIN LINE REQUIREMENTS

A. Safety setback of dwellings from the railway rights-of-way to be a minimum of 30 metres in conjunction with a safety berm. The safety berm shall be adjoining and parallel to the railway rights-of-way with returns at the ends, 2.5 metres above grade at the property line, with side slopes not steeper than 2.5 to 1.

B. The Owner shall engage a consultant to undertake an analysis of noise. At a minimum, a noise attenuation barrier shall be adjoining and parallel to the railway rights-of-way, having returns at the ends, and a minimum total height of 5.5 metres above top-of-rail. Acoustic fence to be constructed without openings and of a durable material weighing not less than 20 kg. per square metre of surface area. Subject to the review of the noise report, the Railway may consider other measures recommended by an approved Noise Consultant.

C. Ground-borne vibration transmission to be evaluated in a report through site testing to determine if dwellings within 75 metres of the railway rights-of-way will be impacted by vibration conditions in excess of 0.14 mm/sec RMS between 4 Hz and 200 Hz. The monitoring system should be capable of measuring frequencies between 4 Hz and 200 Hz, ±3 dB with an RMS averaging time constant of 1 second. If in excess, isolation measures will be required to ensure living areas do not exceed 0.14 mm/sec RMS on and above the first floor of the dwelling.

D. The Owner shall install and maintain a chain link fence of minimum 1.83 metre height along the mutual property line.

E. The following clause should be inserted in all development agreements, offers to purchase, and agreements of Purchase and Sale or Lease of each dwelling unit within 300m of the railway right-of-way: "Warning: Canadian National Railway Company or its assigns or successors in interest has or have a rights-of-way within 300 metres from the land the subject hereof. There may be alterations to or expansions of the railway facilities on such rights-of-way in the future including the possibility that the railway or its assigns or successors as aforesaid may expand its operations, which expansion may affect the living environment of the residents in the vicinity, notwithstanding the inclusion of any noise and vibration attenuating measures in the design of the development and individual dwelling(s). CNR will not be responsible for any complaints or claims arising from use of such facilities and/or operations on, over or under the aforesaid rights-of-way."

F. Any proposed alterations to the existing drainage pattern affecting railway property must receive prior concurrence from the Railway and be substantiated by a drainage report to the satisfaction of the Railway.

G. The Owner shall through restrictive covenants to be registered on title and all agreements of purchase and sale or lease provide notice to the public that the safety berm, fencing and vibration isolation measures implemented are not to be tampered with or altered and further that the Owner shall have sole responsibility for and shall maintain these measures to the satisfaction of CN.

H. The Owner enter into an Agreement stipulating how CN's concerns will be resolved and will pay CN's reasonable costs in preparing and negotiating the agreement.

I. The Owner may be required to grant CN an environmental easement for operational noise and vibration emissions, registered against the subject property in favour of CN.

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