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MEMORANDUM

DATE:	2021-05-17	**RWDI Reference No.:** 2100904
TO:	Vincent Dénommé	**EMAIL:** vincent.denomme@claridgehomes.com
FROM:	Stefan Gopaul Gillian Redman	**EMAIL:** stefan.gopaul@rwdi.com gillian.redman@rwdi.com
RE:	**Vibration Consulting Services** **1040 Somerset** **Ottawa, Ontario**	

Dear Vincent,

RWDI was retained to conduct a Vibration Impact Study on behalf of Claridge Homes to supplement the environmental noise study previously conducted by other parties. The proposed development, located at 1040 Somerset Street in Ottawa, Ontario, is located within 75 m of the Trillium Line 2. At present, Trillium Line 2 is closed for construction and is not set to reopen until May 2022, and therefore vibration measurements could not be conducted. In the interim, screening level vibration calculations were completed. This calculation is intended to satisfy the requirements as set out by the land-use planning authority and should be followed with a site visit to confirm calculations in May 2022.

INFORMATION REVIEWED

Drawings provided for the site are as follows.

- 1040 Somerset St. W, Ottawa Site Plan Application & Zoning By Law Amendment (24 pages) dated November 27, 2020.

Information on the Trillium Line 2 was provided by the City of Ottawa:

- Track is continuously welded rail;
- Train maximum speed: 100 km/hr (between Bayview and Gladstone (Corso Italia / Little Italy))
- Operational train speed: 60 km/hr

CRITERIA

The generally accepted limit for sensitive land-uses is the threshold of perception for human exposure to vibration; a vibration velocity level of 0.14 mm/s RMS in any one-third octave band filtered frequencies of 4 Hz and 200 Hz. This limit is based on 1-second exponentially time-averaged maximum hold root-mean-square (RMS) vibration velocity level and is consistent with the Railway Associations of Canada (RAC, 2013) guideline, and the U.S. Federal Transit Authority (FTA, 2018) criterion for residential land-uses.

ANALYSIS

Vibration levels were predicted at the proposed residential development using the FTA source and propagation calculations (FTA, 201). The inputs for the calculation are provided in Table 1.

Table 1: Sample Trains

	Train Type	Speed	Track Type
Configuration 1 – theoretical maximum	Light Rapid Transit	100 km/hr	Continuous Welded Rail
Configuration 2 - operational	Light Rapid Transit	60 km/hr	Continuous Welded Rail

The sample FTA calculations are summarized in Table 2, with full calculations provided in Attachment A. Both scenarios show that vibration levels at the receptor are below the limit of 0.14 mm/s RMS. These results should be confirmed with a site visit once the rail line is in operation to take vibration measurements. Measurements should include a minimum of five train passes at two locations on site to confirm calculations.

Table 2: Predicted Vibration Levels

Speed	Distance	Predicted Vibration Level (mm/s RMS)	Vibration Limit (mm/s RMS)	Meets Limit?
100 km/hr	17.75 m	0.13	0.14	Yes
60 km/hr		0.08		Yes

CONCLUSION

An assessment of the potential vibration impact from trains on the Trillium Line 2 at the proposed development located at 1040 Somerset St. in Ottawa, Ontario was completed. The calculations show that vibration levels at the proposed development are below the limits, however RWDI recommends measurements be completed once the rail line is back in operation.

Yours truly,

RWDI AIR Inc.

Gillian Redman, P. Eng
Noise and Vibration Scientist Engineer

Attachment A:

Rail Vibration (FTA) – Theoretical maximum track speed - 100km/hr

Rail Vibration (FTA) – Operational track speed - 60km/hr

References:

1. Federal Transit Administration, U.S. Department of Transportation, Transit Noise and Vibration Impact Assessment, 2018 (FTA, 2018).
2. The Railway Association of Canada (RAC), Guidelines for New Development in Proximity to Railway Operations (RAC, 2013).

APPENDIX A

U.S. DoT Federal Transit Administration - "Transit Noise and Vibration Impact Assessment"

"FTA Vibration Screening Model"

Job No. 2100904
Job Name 1040 Somerset Street

Scenario Operational track speed - 60km/hr

Note: All vibration levels in dB are VdB re: 1 μin/s

1a. Define Train

			Resulting Adjustments
Train Type	L	(F) reight, (L)RT/Rapid Transit, (B)us	
Train Speed	60	km/h	-2.6
Stiff Suspension?	n	Vertical resonance frequency greater than 15 Hz (y/n, usually n)	0
Resilient Wheels?	n	No effect on vibration, included to match standard (y/n)	0
Worn wheels?	n	Worn wheels or wheels with flats (y/n, usually no for new or well maintained system)	0

1b. Define Track Type

Rail Type	CWR	Jointed Track (J) or Continuous Welded Rail (CWR)	0
Worn or Corrugated track?	n	Worn track (y/n, usually n for new or well maintained system)	0
Special Trackwork?	n	Crossovers, diamonds, frogs, etc. (y/n)	0

Mitigation Features

Floating slab trackwork?	n	Concrete floating slab on spring isolators (y/n)	0	
High Resilience Fasterners?	n	Used with concrete track slabs (y/n)	0	0
Resiliently Supported Ties?	n	Concrete ties on rubber blocks, with resilient fasteners (y/n)	0	
Ballast mats?	n	Rubber mat placed over concrete, under the ballast (y/n)	0	

TTC Streetcar System Only (Based on RWDI Measurements W07-5120C)

New Track Tech. Max vibration	n	For maximum vibration from TTC new track tech (apply no other mit feature)	Mutually exclusive choices	0
New Track Tech., Avg Vibration	n	For average vibration from TTC new track tech (apply no other mit feature)	May also both be "n"	0

Other Path Features

Elevated Structure?	n	On berm or bridge (y/n)	0
In open cut?	n	No effect on vibration, included to match standard (y/n)	0

Subway Systems Only

Relative to bored tunnel:

Station	n	0
Cut and Cover	n	0
Rock-Based	n	0

Base Vibration Level at 3 m	81.5	VdB, FTA base curve levels at 3 m from track
Total Train and Track Type Adjustments	-2.6	VdB
Adjusted Vibration Level at 3 m	**78.9**	VdB, including train type and track type adjustements above.

2. Define Path

Efficient propagation in soil	n	Accounts for clay soils or other mediums with efficient propagation (y/n)	Mutually exclusive choices	0
Propagation in rock layer	n	Accounts for lower attenuation with distance in rock versus soil (y/n)	May also both be "n"	0.0
Total Path Type Adjustments	0.0	VdB		

3a. Vibration Level at Given Receptor

Source-Receiver distance	**17.75**	m, from track to receptor (DISTANCE should be less than 100 m)		-9.4
Total distance and path adjustments	-9.4	VdB		
Vibration Level at distance	**69.6**	VdB	**0.077** mm/s r.m.s.	

Notes:

The above value can be used in general for rail vibration assessment, and represents the "free field" value of vibration at the foundation.
Vibration levels within the structure will depend on ground coupling to the building foundation, and effects within the structure (resonances, etc.).
For typical residential houses (woodframe buildings), these generally cancel out. (-5 VdB for coupling, -2 dB for 2nd storey, +6 dB for resonances = -1 VdB for typical bedroom)
For commercial buildings, hotels, hospitals, etc., these effects can be significant.

U.S. DoT Federal Transit Administration - "Transit Noise and Vibration Impact Assessment"

"FTA Vibration Screening Model"

Job No. 2100904
Job Name 1040 Somerset Street

Scenario Theoretical maximum track speed - 100km/hr

Note: All vibration levels in dB are VdB re: 1 μin/s

1a. Define Train

			Resulting Adjustments
Train Type	L	(F) reight, (L)RT/Rapid Transit, (B)us	
Train Speed	100	km/h	1.9
Stiff Suspension?	n	Vertical resonance frequency greater than 15 Hz (y/n, usually n)	0
Resilient Wheels?	n	No effect on vibration, included to match standard (y/n)	0
Worn wheels?	n	Worn wheels or wheels with flats (y/n, usually no for new or well maintained system)	0

1b. Define Track Type

Rail Type	CWR	Jointed Track (J) or Continuous Welded Rail (CWR)	0
Worn or Corrugated track?	n	Worn track (y/n, usually n for new or well maintained system)	0
Special Trackwork?	n	Crossovers, diamonds, frogs, etc. (y/n)	0

Mitigation Features

Floating slab trackwork?	n	Concrete floating slab on spring isolators (y/n)	0	
High Resilience Fasterners?	n	Used with concrete track slabs (y/n)	0	0
Resiliently Supported Ties?	n	Concrete ties on rubber blocks, with resilient fasteners (y/n)	0	
Ballast mats?	n	Rubber mat placed over concrete, under the ballast (y/n)	0	

TTC Streetcar System Only (Based on RWDI Measurements W07-5120C)

New Track Tech. Max vibration	n	For maximum vibration from TTC new track tech (apply no other mit feature)	Mutually exclusive choices	0
New Track Tech., Avg Vibration	n	For average vibration from TTC new track tech (apply no other mit feature)	May also both be "n"	0

Other Path Features

Elevated Structure?	n	On berm or bridge (y/n)	0
In open cut?	n	No effect on vibration, included to match standard (y/n)	0

Subway Systems Only

Relative to bored tunnel:

Station	n	0
Cut and Cover	n	0
Rock-Based	n	0

Base Vibration Level at 3 m	81.5	VdB, FTA base curve levels at 3 m from track
Total Train and Track Type Adjustments	1.9	VdB
Adjusted Vibration Level at 3 m	**83.4**	VdB, including train type and track type adjustements above.

2. Define Path

Efficient propagation in soil	n	Accounts for clay soils or other mediums with efficient propagation (y/n)	Mutually exclusive choices	0
Propagation in rock layer	n	Accounts for lower attenuation with distance in rock versus soil (y/n)	May also both be "n"	0.0
Total Path Type Adjustments	0.0	VdB		

3a. Vibration Level at Given Receptor

Source-Receiver distance	**17.75**	m, from track to receptor (DISTANCE should be less than 100 m)		-9.4
Total distance and path adjustments	-9.4	VdB		
Vibration Level at distance	**74.0**	VdB	**0.128** mm/s r.m.s.	

Notes:

The above value can be used in general for rail vibration assessment, and represents the "free field" value of vibration at the foundation.
Vibration levels within the structure will depend on ground coupling to the building foundation, and effects within the structure (resonances, etc.).
For typical residential houses (woodframe buildings), these generally cancel out. (-5 VdB for coupling, -2 dB for 2nd storey, +6 dB for resonances = -1 VdB for typical bedroom)
For commercial buildings, hotels, hospitals, etc., these effects can be significant.