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Appendix B-4

Noise and Vibration Impact Study

SS WILSON ASSOCIATES
Consulting Engineers

NOISE AND VIBRATION IMPACT STUDY
TRANSIT PROJECT ASSESSMENT PROCESS
SCARBOROUGH SUBWAY EXTENSION (SSE)
MCCOWAN ALIGNMENT FROM KENNEDY STATION TO SCARBOROUGH TOWN CENTRE

SUBMITTED TO:

TORONTO TRANSIT COMMISSION
AND THE CITY OF TORONTO C/O
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TORONTO

EXECUTIVE SUMMARY

This report summarises the results of the noise/vibration impact study conducted for the proposed Scarborough Subway Extension (SSE) from the existing Kennedy Station to the Scarborough Town Centre. It is specific to the “McCowan” alignment option.

Ground-borne vibration produced by underground rail transit systems can be perceived by nearby building occupants when they experience some combination of perceptible vibration and re-radiated sound (noise). Therefore, throughout the report vibration and the resulting noise are not separated in their analysis.

There are several potential sources of noise and vibration. These include subway line ground-borne vibration, subway line noise generated inside buildings as a result of ground-borne vibration, miscellaneous sources of noise such as subway electrical substations, subway line air ventilation shafts’ noise, and bus movements within planned Bus Terminals/Stations. Each source was evaluated independently because the unique applicable sound/vibration criteria.

The noise and vibration impact assessment in this EA study thus includes the documentation and assessment of the changes in sound and vibration as well as a comparison of any added sound/vibration with the applicable criteria. From a regulatory viewpoint, the Ontario Ministry of the Environment and Climate Change (MOECC) worked closely with the TTC on the early development and implementation of several noise/vibration criteria for transit and subway projects. This led to the publication of several standards and acceptability criteria for subway systems and other associated transit modes such as bus stations/terminals. The Toronto Transit Commission (TTC) is one of the early pioneer transit authorities in North America that dealt with the issues of effective isolation of subway noise and vibration according to published technical reports in North America by Canadian and US acoustics and vibration experts. The applicable criteria used for noise and vibration are included in the MOE/TTC “Protocol for Noise and Vibration Assessment for the proposed Yonge-Spadina Subway Loop”, June 16, 1993, which is applicable to the proposed SSE McCowan Corridor Alignment.

Noise and Vibration Impact Assessments have been carried out using comprehensive models based on SSWA’s extensive database of previous

subway projects in Toronto. These empirical models were used to predict the sound/vibration levels at a variety of receptor points along the McCowan corridor. The primary focus was on sensitive land uses, including residential properties and any other identified noise/vibration sensitive land uses in close proximity to the proposed alignment, for example, the hospital at Lawrence Avenue and McCowan Road. The predictions at the selected receptors were compared to the Ministry of the Environment and Climate Change criteria for subway vibration levels as well as with the TTC’s recommendations that have been established in connection with other subway projects. For example, the TTC has recommended the use of a threshold for indoor sound level for residential receptors of 35 dBA, which is just above a soft whisper. This represents a best management and proactive approach that is over and above what the Ministry is recommending.

Existing Sound/Vibration Levels:

Currently, the main source of ambient noise in the subject area is vehicular traffic on McCowan Road and the main source of vibration is from truck and bus movements on McCowan Road. The potential for higher levels of ground vibration and a low frequency “rumble”, as a result of the vibration within a given structure are two of the most important factors that have been considered for sensitive land uses located close to the McCowan alignment.

Selected Receptors:

To assess the effects of noise and vibration on various residences and businesses along the subway alignment SSWA identified 50 receptors. A receptor is a group of buildings along the subway alignment that have similar conditions for the following:

- The limiting distances at which predicted subway sound and vibration levels comply with the applicable criteria.
- Type of Land use (Residential, Commercial, Industrial, etc.)
- Horizontal Distance to Subway Alignment
- Depth to Subway Alignment
- Distance to Cross-Over Tracks
- Other special factors that may affect the sound and vibration levels

The receptors included 25 house/townhouse groups of receptors, 7 apartment buildings or similar structures (included in this category are a combined Senior's Home and Church, condominiums, and a YMCA), the library located at Danforth Rd. and McCowan, 7 commercial buildings and 9 sensitive commercial and industrial areas, as well as a highly sensitive and special case - the Scarborough General Hospital[1].

The results of the noise and vibration predictions were adjusted to account for the TTC's railway vibration isolation design standard, specifically referred to as "floating slab" construction, throughout the entire system. Floating slabs consist of a second/independent tier of concrete slabs supported on resilient elements, usually rubber or similar elastomers supported on the concrete floor of the subway structure itself.

Summary Conclusions:

It is the study conclusion that there will be no location where the subway would create an unacceptable noise and vibration impact. For the Scarborough General Hospital and dwellings units located directly above the alignment added caution is recommended in the form of further investigation of the residual impact on these buildings.

While the noise and vibration model has been applied at these receptor locations and has resulted in a prediction of no excesses (when including the effects of the floating slab mitigation measure) SSWA recommends further investigation during the detailed design phase to verify that the model is valid in these unique situations.

It should be noted that the floating slab currently in use the TTC, as originally designed by WIA in California USA, is based on a fixed isolation efficiency for the bonded metal-rubber isolators.[2] The final design should therefore be based on the following recommended criteria:

- For Houses and Townhouses directly above the proposed subway alignment: The maximum recommended vibration velocity level is to be 72 dB or less and the maximum recommended indoor sound level criteria is to be 35 dBA (As per section 2.1).
- For the Scarborough General Hospital: The maximum recommended vibration velocity level should not exceed the existing measured vibration levels reported herein and the resulting sound levels are expected to be 30 dBA or less (As per section 2.1).

[1] Sensitive uses internal to SGH include: X-ray rooms, nuclear rooms, Angio room, CT Scan room, Sleep Study rooms, Endoscopy rooms, Cisto Operating rooms, and others on the East side of the Hospital.
[2] The details of the acoustic efficiency and vibration isolation characteristics of the current design are no published by WIA, for example the expected static and dynamic deflections.

While the floating slab solution is widely regarded as the best recommendation for noise and vibration control throughout the entire alignment, further detailed consideration for the design of this floating slab should also be considered near the residential dwelling receptors that are located immediately above the proposed alignment. The other receptor of concern is the Scarborough General Hospital (the names of the critical areas within have been previously defined). In these locations, the floating slab design may also incorporate the use of slightly higher vibration isolation efficiency for the rubber isolation pads under the floating concrete slabs, subject to the findings of the detailed design phase verification at these noted receptors.[3]

As previously stated, the model predicted no noise or vibration excesses at all 50 receptors throughout the proposed alignment. Aside from the two noted areas for caution and future verification, SSWA has full confidence in the validity and accuracy of the no excesses result of the model at all other receptors.

In addition to using the "floating slab" system, the study is acknowledging the importance of the TTC continuing to follow their practice of routine maintenance of train wheels to eliminate "wheel flats" which will further reduce the vibration/noise associated with the subway operation. As to the ground mode of transportation, the proposed Scarborough Town Centre bus terminal will have no impacts on the nearby residential land uses due to a combination of distance setbacks and high ambient noise levels from existing traffic.

Regarding construction noise and vibration, the preliminary analysis of the noise during the construction phase indicates a potential for concern in the residential areas, and other areas adjacent to possible construction mobilization sites, as well as the use of the Tunnel Boring Machines (TBM) in proximity to a limited number of buildings. Several recommendations have been made to comply with the MOECC Protocol requirements as well as with

[3] Other vibration isolation measures may include the use of a vibration isolation trench, application of special insulating liner on the outside wall of the subway structure, speed reduction, and the use of tracks without any discontinuities.

the City of Toronto noise/vibration Codes/By-Laws.

1.0 INTRODUCTION

1.1 BACKGROUND

The services of SS Wilson Associates (SSWA) were retained by AECOM to carry out a Noise and Vibration Impact Assessment Study as part of the Transit Project Assessment Process (TPAP) for the proposed Scarborough Subway Extension (SSE) of the current Bloor-Danforth Subway to Scarborough Centre. This subway extension will replace and improve the carrying capacity of the aging Scarborough Rapid Transit line (Line 3) and eliminate the need for Line 3 customers to transfer to and from the subway at Kennedy Station.

Noise is generally defined as any unwanted sound or as sound whose level and quality exceed preset sound level limit(s) set by the authority having jurisdiction (MOECC for operational noise and the City of Toronto noise/vibration policies and By-Laws for construction in this case).

The noise under consideration is the noise associated with the proposed SSE. The Glossary section in Attachment 1 provides definitions of technical terms to assist in understanding the principles and terminology used in this report. The report considers two main sources of concern, the ground-borne noise and vibration due to movements of the trains along the underground tracks and the exterior environmental noise due to bus/car movements/idling within the proposed Bus Terminal/Stations.

Figure 1 (Page 40) illustrates the general location of the proposed SSE and Figures 2.1 to 2.6 illustrate the considered and assessed final alignment details.

The proposed Scarborough Subway Extension will generate varying levels of sound and vibration. Firstly, between the proposed underground subway stations, the subway trains will be moving in tunnels, which will radiate ground-borne vibration and sound that propagate through the soil to the nearby buildings. The resulting vibration can cause intrusions in the form of motion or audible sound within those nearby buildings.

Secondly, the proposed bus terminal station, and in particular the bus movements within the station, will produce stationary noise (as defined by the Ministry of the Environment and Climate Change (MOECC)) that propagate through the air to the nearby buildings. This is in addition to the conventional “transportation noise” created by the additional bus traffic heading to and from the bus terminal stations when moving along major bus transit routes on the nearby municipal arterial roads where noise-sensitive buildings could be found.

This study is based on the collective efforts of SSWA as well as of AECOM. Overall direction on issues related to engineering and the environment were also provided by AECOM. That being the case, this study is best read in conjunction with the Environmental

Assessment (EA) Report and other background reports prepared by other Study Team members.

1.2 OVERVIEW OF THE APPROACH

The key steps in the sound and vibration impact assessments of the McCowan subway alignment are summarized as follows:

- Identify the potential noise and vibration sensitive land uses.
- Investigate the subway station's stationary noise sources, including bus activities within the terminal, Traction Power transformers, as well as construction operations (a future site specific investigation).
- Determine the existing ambient sound and vibration levels in the vicinity of the McCowan SSE alignment.
- Predict the approximate sound and vibration levels generated by the alignment and proposed Subway Station.
- Calculate the potential sound and vibration impacts due to the proposed alignment at all selected points of reception.
- Study the feasibility of applying noise and vibration mitigation measures, where warranted recommend the necessary noise and vibration mitigation measures, and future actions related to detailed noise assessment.

In general, sound and vibration impacts are comparative evaluations of the new or intruding noise/vibration versus the existing or ambient sound/vibration in the area. Noise/vibration impact is also a comparative evaluation of the new or intruding levels versus pre-set sound/vibration level limit/criteria. The degree of noise impact varies depending on the difference between the new and existing levels, i.e. the higher the new level is above the existing level, the higher the impact.

To present the results of this study, a combination of quantitative and qualitative approaches to sound and vibration impact assessment have been used to enable the Study Team and the public to understand the potential effects. In this study, the hourly Leq in dBA (equivalent sound level) descriptor is used in the analysis and assessment of noise impacts while the Lv in dB (maximum vibration velocity level) descriptor is used in the prediction and assessment of vibration impacts.

Due to the nature of the potential sources of noise and vibration, the applicable sound/vibration criteria for the undertaking necessitated evaluation of each source independently is as follows:

1. Subway line ground-borne vibration level
2. Subway line sound level generated inside buildings as a result of ground-borne vibration
3. Miscellaneous sources of noise such as subway Traction Power electrical substation and subway line air ventilation shafts noise
4. Bus movements within planned Bus Terminals/Stations.

The noise and vibration impact assessment in this EA study thus includes the documentation and assessment of the changes in sound and vibration levels as well as a comparison with the applicable criteria in accordance with the following general principles:

1. Assess the existing or future "do-nothing" environment; if applicable.
2. Predict the future sound and vibration levels of the specific part of the undertaking using a reliable prediction model based on empirical data.[4]
3. Assess the impact relative to the applicable criteria.
4. Recommend noise and vibration control measures, where warranted and where technically and economically feasible.

1.3 BRIEF DESCRIPTION OF STUDY AREA AND PROPOSED UNDERTAKING

The Overall Study Area of the Selected SSE Alignment:

The overall Study Area is bounded by the areas adjacent to the McCowan alignment shown in Figure 1 – via Eglinton, Danforth and McCowan – from Kennedy Station to immediately south of Highway 401.

The Current Subway Line:

The current Line 2, Bloor-Danforth subway extends from Kennedy Road and terminates at the Kennedy Station (Eglinton Avenue and Kennedy Road). The current Scarborough Rapid Transit (SRT), Line 3 extends from Kennedy Station to Scarborough Town Centre (STC) at McCowan Road and Town Centre Court. The proposed SSE will extend from the Line 2 Bloor-Danforth subway (at Kennedy Station) to STC.

The Proposed Corridors:

Several alternative corridors for the SSE have been proposed and assessed by the Study Team. Each corridor alternative included a combination of below grade tracks and different alternative alignments and station locations. The preferred McCowan Corridor is the subject of this study.

Figures 2.1 to 2.6 illustrate an overall view of the proposed SSE Corridor Alignment, the proposed subway/bus terminal/station, the existing/future transit and road systems as well as the existing land uses.

Subway Line

[4] The model used for prediction of the subway vibration levels and the ensuing low frequency rumble noise inside nearby structures is based on numerous actual sound and vibration subway measurements undertaken by the TTC and other consultants during the period of 1970-1990. Additionally, actual vibration levels undertaken by SSWA in connection with new residential buildings in proximity to the existing subway lines and specific sound level readings taken on vacant lands or structures in connection with this project as described in the references and attachments of this report.

The Bloor-Danforth Subway line presently terminates at the Kennedy/Eglinton Station. The project calls for the extension of the subway from its current terminus northward to just south of Highway 401 at the STC.

Subway/Bus Terminal Stations

Two subway bus terminal/stations (one existing and one proposed) are as follows:
- Kennedy Station (existing, will remain the same)
- Scarborough Town Centre Station (expansion)

2.0 NOISE AND VIBRATION CRITERIA

The proposed SSE generates two distinct sources of sound and/or vibration:

1. Ground-borne vibration - the subway trains will be moving in tunnel(s) which radiate ground-borne vibration signals that propagate through the soil to the near-by buildings where the issue to the residents is manifested in two components, structural vibration and generated noise. The resulting building vibration can cause intrusions in the form of motion or audible sound within the buildings. Therefore, throughout this report reference to subway vibration is typically coupled with "noise" as both signals are inseparable.

2. Air-borne noise - the proposed bus terminal stations, traction power substations and air shafts will produce noise that propagates through the air to the nearby buildings.

For the purposes of meeting the Ministry of the Environment and Climate Change (MOECC) and the Toronto Transit Commission (TTC) guidelines for the assessment of noise and vibration due to the proposed subway undertaking, three different criteria have been considered which are addressed in the following subsections.

Train movements on the subway line are considered as a rail transit system which will be assessed on the basis of the MOE/TTC Protocol as well as other generally acceptable criteria.

The bus terminal stations, subway traction power substation and ventilation shafts are considered by the MOECC as "Stationary Sources" and the relevant MOECC sound level criteria included in Publication NPC-300 will apply.

The general noise and vibration assessment methodology rely on the use of specific sound/vibration level criteria/metrics above which the new source's noise/vibration level are compared with. In addition, should the prevailing or established ambient noise/vibration level be higher than the specific criteria/metric, then the ambient is then used as the established criteria to assess the new source.

2.1 MOE/TTC SUBWAY NOISE AND VIBRATION CRITERIA

The applicable criteria for noise and vibration are included in the MOE/TTC "Protocol for Noise and Vibration Assessment for the proposed Yonge-Spadina Subway Loop", June 16, 1993, and are applicable to the proposed SSE McCowan Corridor Alignment. Attachment 2 includes a copy of the MOE/TTC Protocol.

Wayside noise and vibration criteria provide a basis for assessing impacts and determining the type and extent of mitigation measures necessary to minimize any general community annoyance or to minimize interference with any particularly nearby sensitive land use or activity.

Noise sensitive land uses generally include existing residential developments, proposed residential developments which have received municipal approval, nursing homes, group homes, hospitals and institutional land uses where noise impact may be detrimental to the functions conducted within such buildings.

For the purposes of this assessment and in accordance with the MOE/TTC Protocol, noise and vibration impacts on commercial and industrial areas generally need not be considered, except where there are buildings that have vibration sensitive equipment. It should be noted, however, that the MOE/TCC protocol does not provide any sound and vibration level criteria to be met for such uses and instead SSWA relied on the best engineering management practices to provide protective criteria for such uses.

In general, for at-grade rail transit operations, both wayside airborne noise and ground-borne vibration impacts need to be examined, although the ground-borne noise is generally masked by the wayside airborne noise. In areas where the rail transit line is underground, both ground-borne noise and vibration may be perceptible.

The recommended criterion for the maximum ground-borne vibration velocity (r.m.s) level due to rail transit train operations applicable to noise/vibration sensitive land uses is 0.10 mm/sec (Equivalent to 71.9 dB reference 10^{-6} inch/second). The criterion applies to the vertical vibration of the ground surface or floor surface, and it should be applied <u>outdoors</u> and referenced to the building or area under consideration. Ground-borne vibration which complies with the recommended design criterion will hardly be perceptible in most cases. However, the level will be sufficiently low so that no significant intrusion or annoyance should occur.

The vibration levels predicted/reported in this Report are, however, presented in Lv dB re 10^{-6} inch/second (A vibration velocity level, Lv, of 0.1 mm/second is equivalent to approximately 71.9 dB[5] reference 10^{-6} inch/second).

Due to the presence of noise-sensitive areas in close proximity to the proposed subway, we are recommending that the objective criteria for ground-borne noise due to transit train operations applicable to noise-sensitive land uses be 35 dBA. This objective level is based on several TTC case studies, several USA based study recommendations for various transit authorities, generally accepted sound level criterion by numerous consultants and sound levels found in other Canadian references (see references section). Ground-borne sound levels, which meet this criterion, are likely to be audible, but should be low enough that no significant intrusion or annoyance would occur.

[5] Or 72 dB after rounding

Note that:

i) With regards to the application of the vibration criterion, the MOE/TTC Protocol specifically excludes vibration due to maintenance activities on the subway line.
ii) While the MOE/TTC Protocol recognizes that ground-borne vibration can produce air-borne noise inside a structure, it does not provide any direction on what noise criteria is to be used and instead, the Protocol relies on the above-noted vibration criterion.
iii) Ground-borne noise impact on general non-sensitive commercial and industrial areas need not be considered as per the MOECC direction.

<u>Other Recommended Subway Line Noise and Vibration Criteria</u>

As stated above, the MOE/TTC June 16, 1993 Protocol does not address any details on noise assessments of ancillary facilities (such as bus stations, commuter car park lots, Traction Power substations and ventilation shafts/fans) since the Provincial standards for stationary noise apply to ancillary facilities. For subway construction, which may be of concern with respect to this project, the Provincial criteria and the City of Toronto sound/vibration level codes apply.

In addition, and to supplement the MOECC and the City criteria, the past practices of the TTC and other jurisdictions in North America were researched. Based on this research we are recommending the use of supplementary noise and vibration levels criteria applied to some project elements to reduce the potential impacts on buildings that are sensitive to subway vibration and noise.

The following table lists the recommended supplementary criteria used in this study:

RECOMMENDED SUPPLEMENTARY SUBWAY LINE NOISE AND VIBRATION CRITERIA

Land Use	Recommended Vibration Velocity Level Criteria MOECC/TTC	Recommended Vibration Velocity Level Criteria, Lv in dB reference to 10^{-6} in/sec	Recommended Indoor Sound Criteria (Not an MOECC criteria)
Houses and Townhouses	0.1mm/s	≡ 71.9 dB ≈ 72 dB	Not Applicable (SSWA Recommends 35 dBA)
Apartment / Condominium Building	0.1mm/s	≡ 71.9 dB ≈ 72 dB	Not Applicable (SSWA Recommends 35 dBA)
Institutional	0.1mm/s	≡ 71.9 dB ≈ 72 dB	Not Applicable (SSWA Recommends 35 dBA)
Commercial	Not Applicable (≡ 0.18mm/s)	77 dB SSWA standard	Not Applicable (SSWA Recommends 40 dBA)
Industrial	Not Applicable (≡ 0.32mm/s)	82 dB SSWA standard	Not Applicable (SSWA Recommends 45 dBA)
Sensitive Buildings	Not Applicable (≡ 0.06mm/s)	67 dB SSWA standard	Not Applicable (SSWA Recommends 30 dBA)

2.2 SOUND LEVEL CRITERIA FOR STATIONARY SOURCES

All sources of noise that are considered as “Stationary Sources” must be subject to the MOECC's criteria included in their Publication NPC-300 (i.e. the higher of either the prevalent ambient sound levels or the exclusion limits for hourly Leq sound levels included in NPC-300). The criteria are based on the Environmental Noise Guideline, Stationary and Transportation Sources – Approval and Planning document prepared by the MOECC for the assessment of planned "Stationary Sources" of sound, 2013.

Attachment 2 includes relevant criteria extracted from the MOE/TTC protocols in the document named “MOEE/TTC Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop – June 16th 1993”. For stationary sources, reference should be made to the MOECC Publication NPC-300.

The predicted and/or measured 1-hour equivalent sound level (Leq) of existing road traffic is normally compared with the predicted and/or measured 1-hour equivalent sound level (Leq) from the source. Other applicable criteria are also referred to in MOECC Publication NPC-300.

In situations where the ambient is not significant, then the Ministry exclusion limits (i.e. the lowest hourly Leq sound levels) in Publication NPC-300 would apply.

2.3 GENERAL IMPACT ASSESSMENT GUIDELINES FOR NOISE

The logarithmic scale used for noise assessment relies on the human perception and the following assessment/interpretation of the significance of a noise signal. From a physics viewpoint, a 3dB increase in a sound level means exactly doubling of the acoustic energy emitted by the source. However, on a human scale of perception the same 3dB increase does not correspond to doubling of the loudness experienced. Instead, the research of many organizations lead to the relationship outlined below.

The sound level criteria are also dependent on the existing level of ambient noise. The ambient noise in the context of this project is simply the prevailing sound level at a receptor location that is not related to the proposed project. For example, exposure to traffic noise, or generally continuous noise from other sources (not associated with the subway project) is considered as the prevailing ambient above which the subway noise may be perceived.

For stationary noise sources, the MOECC does not generally accept excesses above the applicable sound level criteria. However, should the projected undertaking sound level at a given location exceed the ambient level, the subjective impact on a noise-sensitive receptor may be determined by comparing the projected undertaking levels with the established ambient levels.

The following table outlines the subjective impact assessment ratings developed by the MOECC of established excess or increases above an existing ambient sound level.

NOISE IMPACT ASSESSMENT RATINGS[6]

IMPACT ASSESSMENT TABLE	
EXCESS/CHANGE, dB	**SUBJECTIVE IMPACT RATING**
0 TO <3	Low
=>3 TO <5	Noticeable
=5 TO <10	High
=>10	Very High

2.4 GENERAL IMPACT ASSESSMENT GUIDELINES FOR VIBRATION

The general vibration assessment methodology also relies on the use of specific vibration level criteria/metrics above which the new source's vibration level is compared with. In addition, should the prevailing or established ambient vibration level be higher than the specific criteria/metric, then the ambient vibration is used as the established criteria to assess the severity of a new source of vibration.

It is important to note that the noise impact assessment ratings (referred to in the above table) do not apply to vibration impact assessment. Simply stated, any excess above the

[6] References 1) Environmental Noise :Certificate Course Manual 1998 Ministry of the Environment, 2) Environmental Noise Assessment in Land Use Planning Manual, 1999, Ministry of the Environment

vibration level criteria is considered as perceptible with varying degrees of reaction and acceptability by humans. The use of vibration level criteria that should not be exceeded is the generally accepted practice for assessment and design of projects involving vibration due to a specific source irrespective of whether the vibration signal can or cannot be sensed by humans.

3.0 PRELIMINARY ASSESSMENTS OF THE INDICATORS FOR NOISE/VIBRATION

3.1 INTRODUCTION

At the outset of the project, and in the absence of detailed and site-specific information on the proposed alignment/locations, the potential sources of noise, receptor locations and to assist members of the Study Team, a set of quantifiable "indicators" were developed based on preliminary or rough estimates only of the resulting sound/vibration levels. The use of such indicators for noise became necessary in order to compare alternative alignments/locations of the various components of the proposed SSE Subway undertaking.

With knowledge of the applicable sound/vibration level criteria, typical sound/vibration emission levels from each system component, and typical sound/vibration propagation factors, the indicators were presented in the form of conservative or "first-cut" distance setbacks to meet the objectives. It must be emphasized, however, that such distances were intended <u>for comparative evaluations</u> only.

3.2 EARLY APPLICATION OF THE PRELIMINARY ASSESSMENT CRITERIA.

Prior to the alignment selection, the noise and vibration study team was involved in providing a very general indication of what sensitive land uses were in the vicinity of the various alignments that were under consideration. This assessment was performed at a cursory level as the relevant details such as the type of subway cars, location of special track work, and precise location of the track had not yet been determined.

This assessment was performed to provide the TTC subway study team responsible for selecting the alignment with an initial indication of the noise and vibration concerns associated with each alignment alternative. For example, the number of homes within a specific distance setbacks of various hypothetical alignments assisted the decision making process by providing a metric by which to account for the potential number of homes impacted before detailed assessment of the impact was ever possible.

With the selection of the McCowan Road alignment, the necessary details for reliable predictions of the sound and vibration levels became available. As such, all preliminary assessment work has been set aside and is not included in this report. It should be noted that the background information leading to the assessment described above is documented in progress reports to the study team.

3.3 VIBRATION IMPACT

Building vibrations caused by rail and road traffic are not a health and safety concern in the majority of cases. They are more of a problem of annoyance. High levels of vibration may be unacceptable to occupants because of annoying physical sensations produced in the human body, potential interference with activities such as concentration while undertaking some important tasks, conversation, rattling of windowpanes and loose objects.

The goals of the vibration assessment are to inventory sensitive land uses that may be adversely impacted by the ground-borne vibration and noise from the proposed project as well as to determine the mitigation measures that may be required to eliminate or minimize the impact. This requires projecting the levels of ground-borne vibration and sound levels, comparing the projections with the criteria, and developing a list of suitable mitigation measures for further consideration.

3.4 SURVEY OF EXISTING VIBRATION LEVELS AT CRITICAL RECEPTORS

For assessing the potential noise and vibration impacts on critical receptors located within potential subway influence areas, it is important to have knowledge about such critical buildings/spaces as well as the types of equipment or functions being conducted in such buildings. For example, there are certain types of equipment that are considered extremely sensitive to structure-borne vibration such as electron microscopes, certain precision manufacturing operations, metrology/calibration, and medical equipment (MRI). In these cases, knowledge of their locations relative to the alignment is important.

Occasionally, there are cases that may require site/area specific measurements of ambient sound and vibration levels within the locations that are perceived as being critical, however, due to their internally generated ambient noise or vibration, such cases can be dismissed as not being sensitive based on the measurements survey.

There are other additional situations that may warrant special field measurements. Such field measurements would include taking actual sound and vibration levels at proxy locations for data gathering purposes to enable more accurate predictions of the future subway sound/vibration levels within the sought alignment.

Knowledge of the existing levels of ground-borne vibration is usually preferred for the assessment of subway vibration impact at receptor locations that are considered critical receptors. There are times when a survey of the existing/ambient vibration levels is valuable, for example for documenting existing background vibration at critical buildings due to internally generated vibration levels for a variety of commonly found sources of vibration. An example of such critical uses include the aforementioned hospitals and special clinics, metrology and calibration laboratories, research facilities and certain electronics manufacturing facilities.

For this proposed alignment, an extensive vibration survey was conducted inside one of the most critical receptors which is the Scarborough General Hospital building located in close proximity to the proposed alignment, the results of which are included in Attachment 6. Proxy vibration level measurements of typical subway train pass-bys were also taken at ground locations located directly above an existing subway line in order to gain appreciation of the extent of the vibration levels due to subway train pass-bys for technical confirmation purposes (refer to Attachment 6).

4.0 ANALYSIS AND RESULTS

4.1 AMBIENT NOISE AND VIBRATION – SUBWAY LINE IMPACT ASSESSMENT

For a subway project, the potential for higher levels of ground-borne vibration levels and the resulting low frequency “rumble” are two of the most important factors to consider for noise/vibration sensitive land uses located in close proximity to the subway alignment. Therefore, reference to the potential impact of the subway alignment will require assessment of both the vibration component and the resulting noise component as addressed both independently and then collectively in this study.

The MOECC and the joint MOE/TTC Protocol as well as the general EA practices for noise/vibration rely on a series of absolute and relative noise/vibration criteria. The relative criteria recognize the importance of the “existing” background/ambient noise/vibration conditions for impact assessment purposes.

The dominant sources of ambient noise in the Study Area are highways and major arterial and collector roads. Of less significance (more local in nature) is the noise due to the commercial/industrial buildings themselves.

The dominant sources of vibration in the area are the heavy vehicle and bus movements on the arterial and collector roads. Of less significance are internally generated vibration levels in industrial buildings and offices.

Existing ambient conditions, or background noises/vibrations, due to roads are defined by the volume of traffic, traffic mix, speed, and proximity to points of reception.

McCowan Road provides the highest ambient sound levels for any nearby receptors. The other major arterial roads, which provide high ambient sound levels, include Eglinton Ave. E, Danforth Rd., Lawrence Ave., McCowan Rd. and Ellesmere Rd. Other major collector roads in the subject area also provide lower ambient sound levels.

Road traffic along any of the major arterial roads listed above will be major contributors to the background vibration levels at any nearby receptors. The Scarborough Rapid Transit line, which crosses McCowan Road north of Ellesmere Road, would also be a source of ambient vibration.

Attachment 3 includes the road traffic data used to establish the ambient noise for the proposed bus terminal/station, while Attachment 4 includes sample ambient sound calculations performed using the MOECC ORNAMENT model for traffic noise prediction.

4.2 POINTS OF RECEPTION

The existing land uses in the selected SSE alignment area show that the majority of the Study Area consisting of well-established low-density residential neighbourhoods, while the remaining area consists of apartment/condominium buildings and commercial properties. The Study Area also contains a library, the Scarborough General Hospital, Scarborough Town Centre shopping centre, and numerous low and high-rise residential apartment/condominium buildings.

For the purpose of this study, 50 receptors[7], denoted R1 to R50 have been selected which represent all of the noise and vibration sensitive areas that are immediately adjacent to the McCowan alignment; which were used for assessment of the noise/vibration impacts.

The choice of the receptor locations is based on reasonable knowledge of the type of land use, the expected outdoor and indoor activities, the type of equipment or instruments found in such properties and their relative sensitivity to sound and vibration due to subway movements. For example, land uses that are known to generate indoor noise and vibration levels due to a variety of sources including mobile equipment, deliveries, large heating ventilation and air conditioning (HVAC) or refrigeration equipment, movements of people, and generally high indoor ambient sound levels are not considered as noise sensitive receptors.

Summary of the Noise/Vibration Sensitive Receptors:

The most important factors for subway sound/vibration assessment at the selected sensitive receptors are the distance setback and depth to the subway rail track. The distance setback is evaluated from the nearest subway track centerline to the façade of a given structure. The depth of track is evaluated from the existing ground level to the subway track invert[8]. This information is based on the vertical and horizontal alignment drawings of the proposed subway relative to the adjoining neighbourhoods.

Although basements in dwellings along the subway alignment are closer to the subway tube than the depth values used in the prediction model would indicate, it is more conservative to evaluate the first story (ground level). The primary reason for this statement is that the noise and vibration levels generated by the subway have been predicted to be higher at the ground floor level as the prediction model incorporates a conservative structural amplification factor. It follows that the predicted sound/vibration levels presented in this report for the ground level locations are expected to be at or higher than the levels that would be predicted for the basement levels.

In terms of the subway influence area for the selection of the receptor locations, the lateral distance setback is the only factor that dictates how far the points of reception are to be

[7] The choice of the selected receptor evaluation points is discussed in the upcoming paragraphs

[8] Track invert is the height of the internal useable ground surface within the tunnel. The tracks would be laid at this height.

selected. If we exclude the presence of special subway track work (such as tracks crossovers) and any vibration mitigation measures, the general observations based on the previous case histories, and the results of the noise modeling, is that the expected area where an impact may be predicted is up to a range of 30-70m depending on land use and sensitivity. Exceptions include very critical structures. Accordingly, this study considered all structures within the above noted influence area specific to land use.

Most of the 50 selected receptors are intended to represent a group of nearby locations of similar type and land-use. However, there are also several receptors that represent one structure only. These structures were unique such that they could not be reasonably grouped into another larger receptor group. Seven categories of receptors have been considered for prediction of subway sound and vibration and each with their own distance setback threshold for consideration.

The result of the above method for receptor selection is the selection of 50 receptor locations representing a much more considerable number of properties along the proposed SSE alignment. Furthermore, each receptor group is composed of a unique number of receptor buildings with similar characteristics (land use, lateral distance, subway elevation, proximity to special track work and subway operating speed). For the calculation process, each receptor group's worst case characteristics were used in the sound and vibration prediction model the results of which are presented in Tables 1 and 2.

Using the worst case for each of the above noted characteristics means that for the vast majority of the receptors there is no single point of evaluation. For a receptor which is representative of 30 structures, the structure with the minimum lateral distance is not necessarily the structure with the minimum depth to the subway track. By selecting the worst case instance of each noise/vibration evaluation parameter, a factor of safety is built into the model for receptors composed of multiple structures. Furthermore, by not selecting one structure to be the point of evaluation for a multi-structure receptor, it is expected that no evaluation parameter has been preferred in the selection of the evaluation points, which could possibly lead to an underestimation of the impact at a more vulnerable location.

The following is a brief overview of the seven categories of selected receptor locations:

1. Houses and Townhouses: 25 house/townhouse receptors were selected as points of reception from the first row of houses along the subway alignment. A setback of up to 50m was the threshold for consideration. These receptors are each representative of a group of residences of either a townhouse or regular detached family dwelling with a common horizontal distance to the subway alignment. All of these dwellings are located on Eglinton Ave., Danforth Rd., McCowan Rd. or a residential side street connecting to, or backing onto one of the former major roads. It is to be noted that the first row represents the most conservative location for sound/vibration assessment of the subway line, beyond which the impact becomes progressively less.

2. Apartment Buildings: 7 apartment buildings, condominiums or similar structures

have been selected as points of reception along the subway alignment. A setback of up to 50m was the threshold for consideration. Some of these receptors represent a group of similarly oriented apartments relative to the subway alignment. Included in this category are a combined Senior's Home and Church (R14), all condominiums, and a YMCA (R49), all of which function as apartment-like residences.

3. Institutional: The library located at Danforth Rd. and McCowan is the only institutional receptor along the subway alignment (R23). Institutional receptors are also considered for a setback of up to 50m.

4. Commercial: 7 commercial buildings have been selected as points of reception. A setback of up to 30m was the threshold for consideration. Most of these receptors were chosen to reflect a group of businesses similarly oriented around the subway alignment.

5. Industrial: There are no industrial areas along the subway alignment for consideration within the selected setback limit of 30m.

6. Sensitive Commercial and Industrial: 9 sensitive commercial and industrial areas, as outlined below have been selected as points of reception. A setback of up to 50m was used for the threshold for consideration. Although, the preliminary assessment (red flagging process) is based on the use of 100-200m potential influence area, a 50m threshold was selected based on site specific examination of the existing commercial and industrial land uses. An exception was made for the Scarborough Town Centre (R50), which was considered at a distance setback of 70m because of the proximity to a track change due to the sensitive nature of the movie theatre, which is the closest commercial area in the S.T.C. to the subway alignment. Other sensitive commercial areas considered were a daycare centre (R3), a funeral home (R4), medical centres (R5 and R18), a fire station (R6), a hearing clinic (R7), a plastic surgery clinic (R25), and an oral surgery clinic (R29).

7. Very sensitive and special cases: The Scarborough General Hospital (R30) was considered as a very sensitive receptor. It is the only very sensitive area located within the setback of 70m for these cases.

a. <u>Receptors along the Subway Line</u>

In predicting the expected ground borne vibration levels at a receptor location, there are numerous factors that control the accuracy of the prediction including the type of building (light-frame or heavy-frame construction), the type of soil between the subway tube and the point of reception, the exact train speed in the area of influence for a receptor, the type of subway car, and other inherent parameters that are difficult to account for at this preliminary stage. Accordingly, the lower and upper bounds of the predicted ground borne vibration levels and the associated noise generated inside the structure have been calculated based on an expected range for the prediction model. In summary, the "worst case" impact at all the receptor locations have been selected for noise and vibration. The

decision for mitigation is solely based on the worst case impact assessment.

For the purposes of this study, a conservative approach was selected by making decisions on the significance of the results using the upper limit, therefore, the assessment presented herein should be considered as a reasonably conservative estimation of the vibration/noise levels.

Table 1 includes all of the properties selected for noise and vibration investigation along with the vibration and noise analysis for each property <u>without including mitigation</u>. Table 2 includes the same, but with the use of floating slabs for mitigation. The receptor locations are as shown in Figures 4.1 - 4.5. These Figures provide only a visual indication of which buildings are grouped under a given receptor name. The annotations detailing which receptor name is applied to a group is not intended to indicate the specific location for which the calculation was performed. As previously discussed, the worst case of each relevant parameter was taken for the entire receptor, therefore in many instances there is no single calculation point but the calculation represents a conservative reflection of the entire receptor.

The results of the predictions with the recommended noise control mitigation measures presented in Table 2 indicate no predicted excesses above the applicable sound and vibration level criteria for all receptor locations. However, for three of the selected receptors, namely R30 (Hospital), R43, and R44 (Stanwell Drive residences) it is recommended that further detailed consideration be given for the following reasons:

- For R30-Hospital, the results of the actual ambient vibration levels in the hospital's critical rooms located in eastern sections facing the subway line (Attachment 6) show fairly low ambient vibration levels which, when compared with typical attenuated and un-attenuated subway levels show a potential for exceeding the existing and measured ambient vibration levels. Several of the rooms surveyed have very critical functions such as: Angio, CT Scan, Endoscopy, Cisto-operation rooms.

- For R43 and R44, the concern is the validity of the vibration prediction model for instances where the receptor is located directly above a vibration isolated subway line (specifically, the Sheppard Line has no such instances).

- Site specific factors that may affect the rate of vibration propagation.

For these cases, further consideration may warrant the use of different types of rubber isolation designs under the concrete floating slab.

b. Receptors near Subway Bus Terminal/Station

For the purpose of studying the impacts of the sources of noise and vibration associated with the proposed subway line extension, the worst-case receptors having wide exposure and close proximity to these sources were selected for impact assessment purposes.

4.3 POTENTIAL SOURCES OF AIR-BORNE NOISE

This section describes the potential sources of environmental (air-borne) noise associated with the subway line.

i. Bus Terminal/Station

In general, bus stations are potential sources of noise when located in the proximity of noise-sensitive buildings.

Certain ancillary facilities will be provided at subway stations in order to facilitate passenger arrivals and departures. The types of facilities proposed include bus platforms, terminals and passenger pick-up/drop off areas. The extents of these facilities are described below:

Scarborough Town Centre Bus Terminal/Station

This terminal is existing, however, it will be significantly expanded and will become busier.
Input Data/Parameters:

a) Future number of busses/hr: 171
b) Assumed idling time of each bus: 3 minutes
c) Typical/average bus speeds: 15 km/hr
d) The point of reception to the station property line: Approximately 100m
e) Applicable MOECC sound level criteria B7.1: Leq 1hr day/evening 50 dBA & night 45 dBA or ambient sound levels due to road traffic

Effect of Ambient/Background Noise Due to Nearby Road Traffic

f) Given that the road traffic sound levels (which establishes the ambient sound levels) near the proposed bus terminal are quite high, applying noise mitigation to the bus terminal would be ineffective at providing any noticeable improvement to the acoustic environment at the closest receptors (i.e. southwest corner of McCowan Road and Bushby Drive). That is to say, the road noise is so dominant in this area that noise from the proposed bus station will be masked by the noise of traffic on the nearby major roads.

Predicted Hourly Ambient Sound Levels (McCowan Road)

Lowest Daytime Ambient (7am-7pm) : 67 dBA
Lowest Evening Ambient (7pm-11pm) : 65 dBA
Lowest Night Ambient (11pm-7am): 56 dBA
Attachment 4 includes the predicted hourly ambient sound levels using the MOECC's ORNAMENT model.

Noise Prediction Model Details:

A 3-D computer program for multiple point and line sources and multiple receivers developed by SS Wilson Associates was used to calculate the sound levels. The model used by SSWA to predict the sound levels due to Stationary Sources in this report is a proprietary prediction spreadsheet program developed by SSWA and is primarily based on the ISO 9613-2 publication recognized by the MOECC as an acceptable method for sound level predictions. The program takes into account:

- Reference sound levels and reference distances for the equipment working in each area of the subject development, i.e. sound emission levels.
- The Cartesian co-ordinates (x, y & z) of all sources and receivers.
- The number of events or occurrences of the noise in a given time period and the time period of each event.
- Spherical divergence factor.
- Additional attenuation due to sound barriers; natural or man-made types.
- Additional attenuation due to ground (as modified by sources/receiver elevations, the presence of intervening barriers and the type of ground).
- Atmospheric attenuation due to air molecular absorption.
- Other adjustments included acoustical shielding due to the presence of intervening buildings between a specific source and the receptor as well as adjustments due to the directivity of the sources.

Results:

TABLE A
SCARBOROUGH TOWN CENTRE BUS STATION
PREDICTED WORST CASE UNATTENUATED HOURLY Leq

Worst Case Selected Receptor Code	Predicted Bus Station Noise Leq 1 hr.	Predicted Ambient Noise Leq 1 hr.	Predicted Excess Sound Level	Significance of the Noise Impact
3rd Storey Window- 75 Town Centre Court	63 dBA day 56 dBA night	67 dBA day 56 dBA[9]night	--	nil

Attachment 5 illustrates the predicted sound levels at the worst-case point of reception.

[9] Nighttime bus movements assumed to be 25% of the AM peak hour during the day.

Conclusions:

Based on the above assessment, there is no expected subway noise impact on the closest residential receptors due to the high ambient and vehicular traffic on the nearby roads.

ii. Emergency Exits

Emergency Exits (EE) or structures are commonly associated with subway projects for use during emergencies only where the subway riders and others are directed to the outside through specific stairwells, hallways, etc. During regular operational conditions, such structures are usually closed without any significant openings to the outside to radiate or discharge noise to the nearby structures. It is only in unique situations that such exit doors are located in close proximity to dwellings or other noise sensitive land uses where noise control measures may be warranted subject to detailed assessment during the detailed design process.

The mechanisms for noise emissions from EEs include reverberant sound fields emitted through the emergency doors, and to a lesser extent, from the walls of the above ground EE structures. Other sources of noise emission may include openings directly to the outside for ventilation purposes, if applicable. The commonly used techniques for the control of such noise includes one or more of the following measures as deemed appropriate for the design specific case:

a) Application of sound absorbing materials to the walls and ceilings inside the EE structure portions located close to the outside doors.
b) The use of sound-rated doors (for example, doors providing a minimum value of Sound Transmission Class, STC)
c) Should special openings for ventilation purposes be needed where such openings are directly exposed to noise sensitive land uses, then several noise control options are available including: directivity factors, acoustical liners, acoustic louvers, etc.

It is important to note that noise emissions from EEs are considered stationary noise and are therefore evaluated independently from the subway noise itself (transportation noise). During the detailed design phase, when the specifications of the EE structures have been determined, the possibility of a need for noise control measures will be evaluated on a case by case basis. The assigned locations of the EEs will not be a concern at that stage as the available mitigation options are diverse enough to address any excesses.

iii. Ventilation Shafts

Dedicated ventilation shafts are commonly associated with construction of subway tunnels and they serve a variety of purposes including introduction of ventilation air during underground emergency situations as well as during certain construction operations within the subway tunnels. In such cases, ventilation fans are turned on to provide the necessary ventilation requirements for the subway tunnels, the results of which will include emission of noise through openings located above ground. If such openings are located in proximity

to noise sensitive land uses, then consideration will have to be given by the TTC and its detailed design consultants for the potential noise emissions by such fans depending on their exact location relative to the points of reception.

The operations of such fans, when used in emergency situations, is not subject to the MOECC Environmental Approval Process. However, when designed to act for general ventilation, and also during construction process, the fans will be subject to the MOECC NPC-300 noise standards at the points of reception.

Therefore, during the detailed engineering design process, consideration should be given to the commonly used techniques for the control of such noise which includes one or more of the following measures as deemed appropriate for the design specific case:

a) Selection of fans with specific limited sound power levels.
b) Application of sound absorbing materials to the ducts inside the ventilation shafts.
c) The use of sound-rated louvers, and/or silencers.
d) The design of the opening direction as part of the noise control package. i.e. directivity factor.
e) Taking advantage of high ambient noise locations.

Similarly to the EEs, noise emissions from Ventilation Shafts are considered stationary noise and are therefore evaluated independently from the subway noise itself (transportation noise). The potential need for mitigation measures on the Ventilation Shafts will be considered following the detailed design phase.

iv. Traction Power Substations (Transformers)

In general, the source of noise may include 1 or more of the cores of the transformers as well as cooling fans (if applicable). Transformer noise not only generates a steady noise, but also has a buzzing/humming character which is considered annoying by the MOECC and the they require that a 5 dB penalty be applied (which represents almost a doubling of the noise). Transformers can be purchased with or without enclosures, but for the TTC, our observations indicated that for the larger transformers all of them are not enclosed.

MOECC treats transformer noise as stationary sources and thus applies the NPC-300 sound level criteria to these facilities. The technical MOECC criteria for dealing with substations are three sound levels during the day, evening, and night. The sound level criteria for residential land uses are Leq 1 hr: 50/50/45 dBA during the day, evening, and night respectively. If the ambient noise due to traffic is higher than the above sound levels, then the ambient sound levels become the applicable criteria. Prediction of transformer noise should follow the ISO-9613 procedures.

Electrical power will be distributed from the local hydro authority to both the stations and the track work system. In order to facilitate this, several indoor and outdoor electrical substations are being planned along the route to serve the system's power requirements. With a typical traction power noise level of 68 dBA @ 1 metre, the calculated sound level is approximately 60 dBA at 10 metres (which includes a 5 dB correction for the tonal character of the transformer noise). This sound level may be audible at night during traffic lulls. The actual sound levels from the future transformer stations are dependent on the exact location of the stations, as well as their design and layout. Any consideration for noise mitigation, where found necessary, could be easily accommodated during the detailed design process, when the transformer specifications and location are established.

The use of sound barriers, equipment orientation and distance setback are examples of such controls, if required.

In cases where it is not possible to provide a location for a proposed traction power substation further away from existing noise sensitive uses, there are other measures that are technically and economically feasible to achieve the MOECC stationary noise criteria. For example, control of noise due to substations can be successfully accomplished with the use of appropriate building products, proper orientation of certain openings in the walls (if required), the application of sound absorbing products/materials, etc. all of which are considered as standard and feasible mitigation measures.

When the transformer substation is surrounded by 1-2 storey residential dwellings on several sides, it may be necessary to have 4-sided walls or a structure without a roof in addition to the use of barrier walls that are acoustically absorbent of the transformer noise (120 Hz).

When the transformer substation is surrounded by higher storey residential apartments on several sides, it may be necessary to have 4-sided walls or a structure with a roof in addition to the use of barrier walls that are acoustically absorbent of the transformer noise (120 Hz). In such a case, there will be the need to add air intake and discharge openings for cooling purposes, which will require acoustical treatment of some sort.

4.4 SITE-SPECIFIC ASSESSMENT OF POTENTIAL SOURCES OF AIRBORNE NOISE

The following are our specific comments and recommendations respecting the Emergency Exit buildings (EE) some of which also contain ventilation shafts using mechanical equipment:

The locations of the EE buildings are seen in Figure 2.

- EE at Winter Avenue and Eglinton Avenue: The area is predominately commercial in all directions and the existing ambient due to traffic on Eglinton is fairly high, therefore, there will be no noise impact. No noise mitigation is necessary.

- EE along the west side of Danforth Road immediately north of Eglinton Avenue: The EE structure is located adjacent to a commercial building which will not be impacted by the noise emitted through such structure. There are residential dwellings further

north and across Danforth Avenue to the east at an approximate distance of 20m. In addition, the EE building exit doors will face either north or south therefore the directivity factor for noise will result in further sound level reductions for these residents. The ambient due to traffic on Danforth is expected to be significant. During the detailed design process, if it is found that there is the possibility for residual noise impact, the use of sound absorptive materials on the walls and the ceiling, in addition to the use of a properly sealed exit door, will eliminate any noise concerns.

- EE along the west side of Danforth Road to the south of Thichetwood Drive: The EE structure is located in an open area within 25-20m of an existing apartment building. There are also residential dwellings to the east across Danforth Avenue at an approximate distance of 20m. At this location the ambient is high from the traffic from Danforth Avenue. During the detailed design process, if it is found that there is the possibility for residual noise impact, the use of sound absorptive materials on the walls and the ceiling in addition to the use of a properly sealed exit door will eliminate any noise concerns.

- EE on the Public Library property at Danforth and McCowan: The EE structure will be located in what is now open space on the library property. The library property itself is not a noise sensitive land use. The surrounding residential lands will not be impacted due to the distance setback and the high ambient due to Danforth Road.

- EE North of the Scarborough General Hospital along McCowan: This EE Structure is located on the hospital property. The hospital itself and all other surrounding residents are located at a great enough distance setback to not be impacted. This is in addition to the fact that the hospital indoor environment is controlled with closed/sealed windows.

  Regarding the ventilation shaft associated with this EE, the expected ECA submission to the MOECC will need to address the potential for the use of noise controls for the planned fans and reference should be made to the general recommendations for the control of such equipment in this report.

- EE on the property of 25 Durrington Crescent and along McCowan: For this EE structure, despite the high ambient due to traffic on McCowan Road controls will be needed to eliminate the residual noise impacting the nearby residents. With the use of complementary noise control measures in the form of acoustic insulation inside the structure, as well as acoustically sealed doors, there will be no resulting noise issues.

- EE on the property of 1072 McCowan Road: For this EE structure, despite the high ambient due to traffic on McCowan Road, controls will be needed to eliminate the residual noise impacting the nearby residents. With the use of complementary noise control measures in the form of acoustic insulation inside the structure, as well as acoustically sealed doors, will result in no noise issues.

- EE at the end of the line near Progress Avenue and Corporate Drive: This EE Structure is located at a great distance setback from all receptors. No mitigation will be necessary at this location. As to the ventilation shaft associated with this EE, there will be no need for controls as the same applies.

The following are our specific comments and recommendations respecting the Traction Power Substations (TPS):

- TPS 1 is likely to be located in a medium to high-density residential area along Danforth Avenue. While the exact location has not yet been finalized, it is likely that the minimum distance setback will be between 10 and 20 metres from the nearest apartment or condominium building. The ambient sound level of Danforth Avenue will be considered when determining the extent of noise controls that may be required during detailed design stage.

- TPS 2 is likely to be located within an existing low density residential area along McCowan Road. Again, the exact location has not yet been finalized, but it is likely that there will be houses within 15 to 25 metres on three sides of the structure. The ambient sound level of McCowan Road will be considered when determining the extent of noise control that may be required during detailed design stage.

- TPS 3 is likely to be located at the Scarborough Centre Station at the north end of the proposed extension. While the exact location has not yet been finalised, it is likely that the minimum distance setback will be between 30 and 50m from the nearest apartment or condominium building. The ambient sound levels created by traffic on McCowan Road will be considered when determining the extent of noise control measures that may be required during the detailed design phase. In general, the location of TPS 3 is considered far less critical that all other TPS locations due to the very high ambient noise levels from traffic on the major roads nearby to the STC as well as the absence of residential receptors in the general vicinity. In all cases, the most important consideration will be the fairly high ambient traffic noise due to McCowan Road, Town Centre Court, Triton Road, Progress Avenue, Borough Drive, and the ambient due to HVAC equipment on nearby structures.

A general summary of the noise control measures available to mitigate the TPS noise emissions have been covered in Section 4.3 iv).

The approximate locations of the three TPS' are shown in Figure 2.

4.5 ANALYSIS OF SUBWAY GROUND-BORNE SOUND AND VIBRATION LEVELS

1. Preamble

For a subway project, the potential for higher levels of ground-borne vibration levels and the resulting low frequency “rumble” are two of the most important factors to consider for noise/vibration sensitive land uses located in close proximity to the subway alignment. Therefore, reference to the potential impact of the subway alignment will require assessment of both the vibration component and the resulting noise component as addressed both independently and then collectively in this study.

2. Introduction

Operations of subway rail transit systems result in ground-borne vibration which is transmitted from the track through the tunnel structure to the adjacent buildings through the intervening geological strata. The vibration of the rail is transmitted through the fastener into the transit structure and the vibration radiated from the structure propagates through the soil to the buildings located close to the subway.

The ground-borne vibration originates at the wheel/rail interface as a result of the vibration generated by the wheels rolling on the rails. Several factors affect the level of vibration including the degree of roughness or smoothness of the wheels and rails, the characteristic dynamics of the transit vehicle and its primary suspension, the speed of the train, the type of track fixation and the type of soil through which the vibration propagates.

The resulting building vibration can cause intrusions either because the motion itself is perceptible or because of an audible low frequency rumble caused by the sympathetic vibration of the building walls, ceilings, and floors.

In areas where the transit line is in a subway, both ground-borne noise and vibration may be perceptible.

Other important factors which affect the level of generated ground-borne vibration and noise include the presence of switches, normally used at crossovers due to the inherent gap and the presence of joints; if any, between adjoining sections of a track.

3. Evaluation of Ground-Borne Noise and Vibration Levels

The evaluation of ground-borne noise and vibration impact along the proposed subway is based on actual extensive operational data measured and reported by the TTC and the measurements previously taken by SS Wilson Associates along other TTC subway lines. Supplementary data reported by others was also reviewed including noise/vibration complaint investigation reports and other research work related to the subway system in Toronto. The References Section include the details of these documents.

The reviewed and utilized studies provided valuable data related to the characteristics of the ground-borne vibration using information on the wheel/rail interface area relative to several factors including; the type of subway structure[10], type of train, reported train speeds, geological conditions, distance setbacks from the subway, noise radiation characteristics of adjacent buildings, dynamics of the rail/structure and rolling stock, possible effects of rail and wheel conditions and the effects of vibration isolation measures.

The following paragraphs summarize the parts of the previous study results[11], which enabled prediction of the ground-borne vibration levels and radiated low frequency noise (subway rumble) for the proposed undertaking and for demonstration and prediction of the effectiveness of the various investigated vibration control measures:

a. The ground-borne noise/vibration from subway train operation has a very narrow band frequency characteristic indicating that the transmission path from the subway trains to the buildings has a filter like characteristic with maximum transmission at about 50 Hz.
b. Measurements of ground-borne vibration levels showed that one of the differences in the levels of vibration was the effect of subway structure type. Higher levels were measured adjacent to the lighter weight tunnel structure compared to the concrete double box structure. The results in terms of vibration velocity levels showed these variations to be somewhat insignificant at most of the distances of concern.
c. The vibration levels reduce with distance from the tunnel in a normal manner out to 45 metres which then propagate with relatively little further reduction from the 45m to 60m area to about 120m. Beyond 120m, the levels then continue to reduce with distance in an expected manner. In terms of velocity levels, the results showed an average reduction of 4 dB per doubling of distance when measured horizontally along the ground and approximately 5.5 to 6 dB per doubling of distance using the actual distance to the rail invert.
d. There is generally a good correlation between measurements taken on the ground surface and in the buildings; the vertical vibration levels showed the most consistent and repeatable correlation with in-house sound levels. There are some cases where the building/ground coupling, building structure radiation characteristics, room shape and acoustical absorption, could result in some differences from those predicted. The coupling loss or amplification between the buildings and the ground are also dependent on the season of the year or ground condition; e.g. moist or frozen soil.
e. The rate of increase in the level of ground-borne vibration due to an increase in train speed is 4 dB for doubling of train speed.
f. With regards to ground-borne vibration/noise control, the previous studies provided the following results:
    - The use of double thickness rail fastener pads resulted in an overall reduction of 5 to 8 dB in the ground-borne vibration for the lighter weight tunnel structure.
    - The Double Tie System is expected to reduce ground-borne noise and vibration levels by 12 to 14 dB.
    - The Continuous Floating Slab is expected to reduce ground-borne noise and vibration levels by 14 to 20 dB.
g. The subway train vibration is several orders of magnitude below the vibration levels which causes damage or potential physical damage to the buildings.
h. Sample Calculations of the Subway Vibration Levels at 25m lateral distance to the centre of the TTC subway alignment:
    - Lateral distance to the Subway: 25m
    - Vertical distance to the track invert: 10m
    - Train Speed: 60 kph
    - Distance to X-over track: 200m
    - Type of Dwelling: Apartment Building
    - Amplification due to structure: No
    - Mitigation: None
    - Predicted Outdoor Vibration Level, Lv: 63 in dB re 10E-6 in/sec
    - Projected Indoor Sound Level: 33 dBA
i. Sample Calculations of the Subway Vibration Levels at 50m lateral distance to the centre of the TTC subway alignment:
    - Lateral distance to the Subway: 50m
    - Vertical distance to the track invert: 15m
    - Train Speed: 80 kph
    - Distance to X-over track: 50m
    - Type of Dwelling: Low Density Residential
    - Amplification due to structure: Yes (2 dB)
    - Mitigation: None
    - Predicted Outdoor Vibration Level, Lv: 62 in dB re 10E-6 in/sec
    - Projected Indoor Sound Level: 32 dBA

[10] Types of subway structure encompasses box structures, twin circular tunnels, and singular circular tunnel.
[11] See references 5-8,10,13,14, and 18

4. The Subway Ground-Borne Vibrations Prediction Model and Results

The extensive collection of TTC reference data is available in form of vibration acceleration levels in 1/1 or 1/3 Octave Bands. However, the proposed TTC/MOE vibration criteria are specified in terms of overall vibration velocity in units of mm/s. For the purposes of this study, however for convenience and for the available measurement instruments reliance is made on the use of vibration velocity re 10^{-6} in/s (soft conversion tables to mm/s are also presented). The TTC data was therefore converted to appropriate vertical vibration velocity levels using a computer model that took into consideration the detailed frequency spectrum of subway train pass-bys. It should be noted that the sound and vibration prediction model used in this study is based on the empirical data gathered around subway tunnels having a twin circular design and box tunnels encompassing two way subway movements.[12]

The TTC data sets were re-analyzed and regression analyses were performed on the entire data sets and also on sub-sets of data for comparison purposes.

The prediction methodology has taken into account the effects of distance, rail

[12] Based on the geometrics of the proposed single circular tunnel design, we do not expect significant variations in the received sound and vibration levels.

discontinuities at crossover and turnout special track work, train speed, and any vibration control measures. The end result is the estimated vibration levels at the sensitive building or area under consideration which can then be compared to the applicable criteria to determine the acceptability of the subway induced ground-borne noise and vibration.

Vibration sensitive land uses, mostly residential land uses, are the primary focus of the analysis. In addition, vibration impacts on commercial and institutional properties have also been addressed based on our detailed field examination of the sensitivity of some of these uses.

As to the design speed of subway trains, it is a well known technical fact that as train speeds increase, the sound and vibration levels subsequently increase incrementally by certain amounts in accordance with the model results. It is also a fact that train speeds while entering and leaving the stations may also vary from the maximum, depending on the traffic conditions and the time of day, which may result in lower speeds and consequently lower sound and vibration levels.

For the purposes of this study however, the analysis is based on subway trains traveling at a speed of 80 km/h[13] on standard track with standard TTC resilient direct fixation fasteners. Near/at the station areas, maximum speeds of 55 km/h have been assumed. It is important to note that the TTC advises that the resilient tracks using floating slab system be used for this subway alignment.

Table 1 includes the ground-borne vibration and noise analysis, results and assessment of the proposed subway line. The results summarize the projected maximum ground-borne noise and vibration levels from train pass-bys without mitigation. Table 1 also shows the applicable ground-borne noise and vibration acceptability criterion, type of structure, distance from the centerline of the nearest set of tracks invert, expected train speed, distance from the receptor to cross-over switches, and other pertinent information.

Table 2 includes the effect of the floating slab systems as the primary means for vibration/noise control. Based on the data included in Table 2, it is concluded that there are no adverse ground-borne vibration or noise impacts anticipated at all receptors within the Study Area as a result of the proposed subway line.

5. Assessment of Ground-Borne Noise and Vibration Impacts

Table 1 summarizes the predicted ground-borne vibration levels as well as the regenerated low frequency train noise (rumble) inside the investigated receptor locations based on the use of a regular track system (direct fixation system).

Based on the results of Table 1 the TTC has advised that the they will be using a floating slab system throughout the proposed subway line. This installation will decrease the vibration levels (and consequently reduce the noise levels) by a significant reduction and

[13] The has been done to be consistent with the MOECC direction to using the “worst-case predictable scenario”

improvement over the standard rail system. Accordingly, Table 2 reflects the anticipated vibration and sound level reductions with this initiative. With reference to the predicted levels listed in Table 2, there are no predicted noise and vibration excesses above the applicable criteria.

Therefore, with the application of the above noted vibration isolation measures, it is our finding that the subway noise and vibration levels will be significantly reduced and that no receptors will be exposed to adverse noise and vibration impacts.

5.0 CONSTRUCTION NOISE AND VIBRATION IMPACTS

5.1 GENERAL

This section deals with the potential environmental noise and vibration impacts during the construction phase of the proposed undertaking. The sources of noise and vibration may operate above or below ground or within tunnels.

Unlike operational noise, construction noise and vibration, in general, are temporary in nature depending on the type of work required and its location relative to the sensitive receptors. A description of the potential receptors has been provided in Tables 1 and 2 and their locations are shown in Figures 4.1 to 4.5. Although considered temporary, the duration of the "Construction Staging Area" could be prolonged for an extended period of time (up to several years), causing increased sensitivity due to construction noise. The exact location and details of the construction staging areas are presently unavailable.

5.2 SOURCES OF NOISE AND VIBRATION

The primary sources of noise during construction are general excavation, construction activities, vehicular truck traffic and pile drivers; if utilized.

The tunneling method using a Tunnel Boring Machine (TBM) is expected to transmit lower levels of noise and vibration to the adjacent buildings than the cut and cover method. However, the cut and cover method will be used for the station structures regardless of the method chosen to construct the running track sections.

The TBM produces steady state variations in the vibration levels at each receptor location where the levels gradually rise over a few days, remaining steady for another few days before the levels start to slowly fade away. The timing of the boring process at each receptor and the resulting sound levels depend on the depth of the subway tunnel near the receptor, the lateral distance from the tunnel, the type of soil, the operational characteristics of the TBM, and in particular, the thrust being applied by the TBM on the area to be excavated. The presence of high ambient noise, due to the proximity to the major roadways and the internally generated noise inside buildings, influence the degree of human audibility of the ground-borne noise due to TBM's.

In general, except for activities at the access shaft(s) serving the tunnel construction, the general public in urban areas are not likely to be aware of the ongoing tunneling work since TBM excavation does not produce any audible "environmental" noise at street level. Community impacts, however, depend on the access shaft(s) locations.

Tunnel construction impacts are concentrated at the shaft(s) and can include the noise from mobile construction equipment (dozers, loaders, dump trucks, etc.) as well as more-

or-less fixed construction equipment at or near the shaft (cranes, generators, pumps, etc.). The noise generated around the shafts can be controlled using several noise control measures which include physical and administrative controls. The physical measures include the use of fixed and/or temporary sound barrier walls/partial enclosures, traffic management and the use of quieter equipment.

Pile drivers used for construction at the station areas should be of the "quiet" hydraulic type rather than the noisier drop weight type; if operationally feasible.

One of the sources of concern is the potential impact of "mobilization sites" on the adjoining noise-sensitive land uses as such sites may be the centre for the following activities:

- Driving shafts
- Crane operations
- Construction equipment operated by gasoline, diesel and electric engines
- Stockpiling of construction materials
- Removal and stockpiling of excavated materials
- Areas for truck loading and unloading
- Parking facilities and other vehicle movements

Of particular importance for construction noise assessment will be the detailed examination, as well as the detailed design, of the construction staging areas to be selected at a later date. The construction work associated with the staging area includes several stages that entail the use of different types of construction machinery with significant sound levels and durations. This includes surface work, piling, excavating, final shaft completion, and TBM support. Each stage requires separate noise assessments due to the varied types of equipment, locations, heights, etc.

5.3 IMPACT ASSESSMENT

The significance of the construction noise impact depends on the number of pieces of equipment, their types, time of operation and their proximity to the receptors in question.

For the project under consideration, the existing high ambient sound levels are likely to reduce the significance of the noise during construction although such noise will be clearly audible during peak periods of construction.

One of the effective ways for mitigation of the noise impact due to mobilization sites is to construct an effective temporary sound barrier to protect the residences based on knowledge of the expected construction equipment sound levels and the prevailing ambient noise due to vehicular traffic on nearby roads.

5.4 CONTROL OF CONSTRUCTION NOISE

The following is a brief outline of the procedures to be followed in handling construction noise during the Detailed Design and Construction phases:

a. Noise sensitive receptors to be identified.
b. The most up-to-date provisions of the City of Toronto Municipal Noise Code (By-Laws) will be examined. Where timing constraints or any other provisions of the municipal by-law may cause hardship to the TTC and its Contractors; an explanation of this will be outlined in a submission to the MOECC and the City and an exemption from such by-law will be sought directly from the City.
c. "General noise control measures" (other than sound level criteria) will be referred to, or placed into contract documents.
d. Should the TTC or the Contractor receive any complaints from the public, the Contractor's staff should verify that the "general noise control measures" agreed to are in effect. The Contractor should investigate any noise concerns, the TTC should warn the contractor of any problems and enforce its contract.
e. If the "general noise control measures" are complied with, but the public still complain about noise, the TTC should require the contractor to comply with the MOECC sound level criteria for construction equipment contained in the MOECC's Model Municipal Noise Control By-Law and the applicable provisions in the City Noise Code. Subject to the results of a field investigation, alternative noise control measures would be required, where these are reasonably available.
f. In selecting the appropriate construction noise control and mitigation measures, the TTC and the Contractor should give consideration to the technical, administrative, and economic feasibility of the various alternatives.
g. Construction Staging Areas will require detailed examination as a separate noise assessment case especially when located within close proximity to noise sensitive land uses that more or less resembles a long term but temporary stationary source of noise.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 SUMMARY

This study has been carried out to examine all aspects related to the potential noise and vibration impacts of the proposed SSE Subway line extension on the noise and vibration sensitive receptors located along the subway line and around the bus terminal station. The study dealt with the documentation of the existing and future noise and vibration levels by a combination of procedures, actual measurements and computer prediction models.

The potential sources of noise and vibration addressed in the study included bus terminal noise and subway train movements.

The following are the conclusions itemized for each potential source of noise and vibration addressed in this study:

Subway Ground-Borne Noise and Vibration

The predicted sound and vibration levels, without the application of any track vibration isolation measures, at 50 selected receptor locations indicate the potential for exceeding the recommended criteria, thus triggering the need to consider the application of track isolation measures.

The noise and vibration predictions were then adjusted to account for the use of railway track vibration isolation measures, specifically floating slabs throughout the entire system with the application of a typical reduction factor to the vibration levels.

It is our conclusion that with the planned application of track vibration isolation there will be no impact for all of the selected points of reception. Additionally, added caution is recommended regarding the possible residual impact at the hospital and the residents located directly above the subway alignment (Receptors 30, 43 and 44) which have been identified for further investigation at the detailed design phase. In particular, for the hospital structure it is highly recommended that the existing ground borne vibration levels measured and reported herein be maintained and not be materially exceeded.

While the floating slab solution is regarded as an excellent recommendation for noise and vibration control throughout the entire alignment, further detail consideration for the design of this floating slab should also be considered near the noted receptors, where the floating design may also incorporate the use of slightly higher vibration isolation efficiency of the rubber isolation pads under the floating concrete slabs.

The model predicted no noise or vibration excesses at all 50 receptors throughout the proposed alignment. Aside from the two noted areas for caution and future verification.

SSWA has full confidence in the validity and accuracy of the no excesses result of the model at all other receptors.

Bus Terminal

The Scarborough Town Centre bus terminal will have no impacts on the nearby residential land uses due to a combination of distance setbacks and high ambient noise levels from existing traffic.

Construction Noise and Vibration

The preliminary analysis of the noise during the construction phase indicates the potential for concern in the residential and other areas adjacent to possible construction mobilization sites and possibly due to the use of the Tunnel Boring Machines (TBM) in proximity to a limited number of buildings.

6.2 MITIGATION RECOMMENDATIONS AND FUTURE WORK PROGRAMS

1. In order to reduce the ground-borne vibration and noise created by the train movements a resilient track system, specifically a "floating slab" system, should be installed in sections of the subway line where noise/vibration impacts are predicted at the identified sensitive receptors. Special attention would have to be given to the detail design of the rubber/neoprene isolation design in particular in proximity to the residential receptors located directly above the alignment and the hospital area where the potential for residual vibration impact was identified.

2. TTC to continue to follow their practices of routine maintenance of train wheels to eliminate "wheel flats" based on their remote "wheel flats" monitoring stations or based on routine inspections of subway train wheels.

3. Implementation of noise control measures for the subway transformer substations predicted to exceed the MOECC sound level criteria at any point of reception to include one or a combination of the following:
   - Specifying low sound emission transformer system, for example:
     - Transformers core: maximum 59 dBA @ 15m
     - Cooling fans: maximum 64 dBA @ 15m
   - The use of partial sound barriers or enclosures
   - Orientation of the equipment and structures

4. In situations where the Emergency Exit buildings (EEs) and ventilation shafts are predicted to have noise impacts, including marginal noise concerns as previously discussed, the detailed design phase of the finally approved subway alignment shall also take into consideration the following general recommendations for specific applications:

   Application of acoustical treatment to ventilation shafts. The acoustical treatment may include the use of acoustically lined turns and bends, partial barriers/enclosure near the ground surface and the application of special sound absorbing material to the inside walls of the shaft. Alternatively, ventilation fans could be located near the tracks rather than at street level especially if there are turns in the shafts. The issue of noise in this case is considered as a routine technical matter for detailed design purposes.

5. The following is a summary of the potential stationary sources of noise that will require functional and detailed design with one of the objectives being to obtain MOECC approvals, Environmental Compliance Approval (ECA) under the authority of the Environmental Protection Act (EPA):
   - Bus Terminal
   - Ventilation shafts serving station boxes and associated HVAC equipment
   - Fire ventilation shafts and associated HVAC equipment
   - Ventilation shafts with grating at grade and associated HVAC equipment
   - Diesel work-car ventilation fan modes
   - Equipment that serves emergency exits
   - HVAC equipment associated with subway and/or bus stations
   - Electrical substations that feed the subway

6. The proponent to also enforce and monitor noise and vibration during construction in accordance with the City of Toronto Noise By-Law (Chapter 591) and the City of Toronto By-Law No. 514-2008 with respect to regulation of vibrations from construction activity.

TABLES

Special Note for Tables 1-2:

The lower and upper bounds of the predicted ground borne vibration levels and the associated noise generated inside the structure in Tables 1 and 2 have been calculated based on an expected range for the prediction model. In summary, the “worst case” impact at all the receptor locations have been selected for noise and vibration

Mitigation Effects NOT Included

TABLE 1 - (1 of 2)

SS WILSON ASSOCIATES

Consulting Engineers

Richmond Hill, Ontario

Developed September 21 2015

Today : April 29, 2016

Date Saved: **April 27, 2016**

1 Houses and Townhouses
2 Apartment Building (concrete)
3 Institutional
4 Commercial
5 Industrial
6 Sensitive Comm/Indust
7 Very Sensitive- Special Use

PREDICTION AND ASSESSMENT OF TTC SUBWAY VIBRATION AND NOISE
SCARBOROUGH SUBWAY EXTENSION (SSE), TORONTO

Text ....
Text ....

Without Mitigation
WA14-040

Line #	Consider: Y or N	Receptor Code Name	Address(s) Represented By Receptor Code	Alignment Drawing Station Numbers From	To	Select Type of Land Use	Type of Land Use, Select	Horiz'l Distance to Nearest Subway C.L., m	Depth of Track Invert, m	Dist. to Tracks Invert, m	Approx Subway Train Speed, Km/Hr	Dist. to X-over Switch, m	Added Effect of Tracks X-over, dB	Consider Amplif'n Due to Structure, Yes or No	Potential Amplif'n Due to Structure, dB	Addit'l Red'n Due To Rail Vib'n Isolation, dB	Additional Reduction, dB, Specify		VIBRATION IMPACT ASSESSMENT: Predicted Outdoor Vibration Level, Lv in dB re 10E-6 in/sec From-To	MOECC and Other Recom'd Vibration Criteria, Lv in dB re 10E-6 in/sec (based on MOE-TTC)	Excess Above Vibration Level Criteria, dB re 10E-6 in/sec From - To	NOISE IMPACT ASSESSMENT: Projected Indoor Sound Level, dBA From - To	Recom'd Indoor Sound Level Criteria, dBA	Excess Above Indoor Sound Level Criteria, dBA From To
1	Y	R1	110 Town Haven Place area	10+200	10+300	1	Houses and Townhouses	13	7	15	80	500	0	Yes	2	0	0	Specify if applicable	69 to 74	72	0 to 2	39 to 44	35	4 to 9
2	Y	R2	2493-2495 Eglinton Ave E	10+300		2	Apartment Building (concrete)	5	13	14	80	500	0	No	0	0	0	Specify if applicable	68 to 73	72	0 to 1	38 to 43	35	3 to 8
3	Y	R3	2493-2495 Eglinton Ave E	10+300		6	Sensitive Comm/Indust	5	13	14	80	500	0	No	0	0	0	Specify if applicable	68 to 73	72	0 to 1	38 to 43	35	3 to 8
4	Y	R4	815 Midland Ave	10+400	10+500	6	Sensitive Comm/Indust	37	17	40	80	500	0	No	0	0	0	Specify if applicable	59 to 64	72	0 to 0	29 to 34	35	0 to 0
5	Y	R5	2555 Eglinton Ave E	10+500		6	Sensitive Comm/Indust	22	18	28	80	500	0	No	0	0	0	Specify if applicable	62 to 67	72	0 to 0	32 to 37	35	0 to 2
6	Y	R6	2575 Eglinton Ave E	10+600	10+700	6	Sensitive Comm/Indust	24	21	32	80	500	0	No	0	0	0	Specify if applicable	61 to 66	72	0 to 0	31 to 36	35	0 to 1
7	Y	R7	2640 Eglinton Ave E	11+000	11+100	6	Sensitive Comm/Indust	35	18	39	80	500	0	No	0	0	0	Specify if applicable	59 to 64	72	0 to 0	29 to 34	35	0 to 0
8	Y	R8	2684 Eglinton Ave E	11+200	11+300	4	Commercial	28	20	34	80	500	0	No	0	0	0	Specify if applicable	60 to 65	77	0 to 0	30 to 35	40	0 to 0
9	Y	R9	2739 Eglinton Ave E	11+200	11+300	4	Commercial	10	20	22	80	500	0	No	0	0	0	Specify if applicable	64 to 69	77	0 to 0	34 to 39	40	0 to 0
10	Y	R10	1229 Danforth Rd	11+450	11+650	1	Houses and Townhouses	16	17	23	80	500	0	Yes	2	0	0	Specify if applicable	66 to 71	72	0 to 0	36 to 41	35	1 to 6
11	Y	R11	1250-1266 Danforth Rd & 35 Wetherby Dr	11+500	11+650	1	Houses and Townhouses	12	18	22	80	500	0	Yes	2	0	0	Specify if applicable	66 to 71	72	0 to 0	36 to 41	35	1 to 6
12	Y	R12	1275-1299 Danforth Rd	11+700	11+850	2	Apartment Building (concrete)	16	17	23	80	500	0	No	0	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4
13	Y	R13	1284 Danforth Rd	11+750	11+800	2	Apartment Building (concrete)	28	17	33	80	500	0	No	0	0	0	Specify if applicable	61 to 66	72	0 to 0	31 to 36	35	0 to 1
14	Y	R14	1290-1300 Danforth Rd	11+800	11+850	2	Apartment Building (concrete)	38	18	42	80	500	0	No	0	0	0	Specify if applicable	59 to 64	72	0 to 0	29 to 34	35	0 to 0
15	Y	R15	1325 Danforth Rd	11+950	12+050	1	Houses and Townhouses	27	19	33	80	500	0	Yes	2	0	0	Specify if applicable	63 to 68	72	0 to 0	33 to 38	35	0 to 3
16	Y	R16	1308-1360 Danforth Rd	11+950	12+300	2	Apartment Building (concrete)	19	24	31	80	500	0	No	0	0	0	Specify if applicable	61 to 66	72	0 to 0	31 to 36	35	0 to 1
17	Y	R17	1 Savarin St	12+050	12+100	1	Houses and Townhouses	20	23	30	80	500	0	Yes	2	0	0	Specify if applicable	63 to 68	72	0 to 0	33 to 38	35	0 to 3
18	Y	R18	1359 Danforth Rd	12+200		6	Sensitive Comm/Indust	25	26	36	80	500	0	No	0	0	0	Specify if applicable	60 to 65	72	0 to 0	30 to 35	35	0 to 0
19	Y	R19	152 & 155 Thicketwood Dr	12+250	12+300	1	Houses and Townhouses	13	26	29	80	500	0	Yes	2	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4
20	Y	R20	1431-1505 Danforth Rd. & other nearby homes	12+350	12+900	1	Houses and Townhouses	16	21	26	80	500	0	Yes	2	0	0	Specify if applicable	65 to 70	72	0 to 0	35 to 40	35	0 to 5
21	Y	R21	1438-1500 Dandorth Rd. & other nearby homes	12+350	12+900	1	Houses and Townhouses	13	21	25	80	500	0	Yes	2	0	0	Specify if applicable	65 to 70	72	0 to 0	35 to 40	35	0 to 5
22	Y	R22	1510-1514, 600-614 Danforth Rd.& 2,38 Furlong Crt.	12+900	13+200	1	Houses and Townhouses	17	24	29	80	80	0	Yes	2	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4

Mitigation Effects NOT Included

TABLE 1 - (2 of 2)

Line #	Consider: Y or N	Receptor Code Name	Address(s) Represented By Receptor Code	Alignment Drawing Station Numbers From	To	Select Type of Land Use	Type of Land Use, Select	Horiz'l Distance to Nearest Subway C.L., m	Depth of Track Invert, m	Dist. to Tracks Invert, m	Approx Subway Train Speed, Km/Hr	Dist. to X-over Switch, m	Added Effect of Tracks X-over, dB	Consider Amplif'n Due to Structure, Yes or No	Potential Amplif'n Due to Structure, dB	Addit'l Red'n Due To Rail Vib'n Isolation, dB	Additional Reduction, dB, Specify		Predicted Outdoor Vibration Level, Lv in dB re 10E-6 in/sec From-To	MOE and Other Recom'd Vibration Criteria, Lv in dB re 10E-6 in/sec (based on MOE-TTC)	Excess Above Vibration Level Criteria, dB re 10E-6 in/sec From - To	Projected Indoor Sound Level, dBA From - To	Recom'd Indoor Sound Level Criteria, dBA	Excess Above Indoor Sound Level Criteria, dBA From To
23	Y	R23	1515 Danforth Rd	12+950	13+000	3	Institutional	21	32	38	80	500	0	No	0	0	0	Specify if applicable	59 to 64	72	0 to 0	29 to 34	35	0 to 0
24	Y	R24	585-599 McCowan Rd.	12+950	13+050	1	Houses and Townhouses	32	30	44	80	500	0	Yes	2	0	0	Specify if applicable	60 to 65	72	0 to 0	30 to 35	35	0 to 0
25	Y	R25	601-605 McCowan Rd.	13+050	13+120	6	Sensitive Comm/Indust	28	30	41	80	500	0	No	0	0	0	Specify if applicable	59 to 64	72	0 to 0	29 to 34	35	0 to 0
26	Y	R26	615 McCowan Rd	13+200		4	Commercial	24	30	38	80	100	0	No	0	0	0	Specify if applicable	59 to 64	77	0 to 0	29 to 34	40	0 to 0
27	Y	R27	637-659 McCowan Rd	13+200	13+300	4	Commercial	30	30	42	80	35	4	No	0	0	0	Specify if applicable	63 to 68	77	0 to 0	33 to 38	40	0 to 0
28	Y	R28	622-642 McCowan Rd	13+250	13+400	1	Houses and Townhouses	19	30	36	80	19	8	Yes	2	0	0	Specify if applicable	70 to 75	72	0 to 3	40 to 45	35	5 to 10
29	Y	R29	685-697 McCowan Rd	13+350	13+400	6	Sensitive Comm/Indust	14	29	32	80	14	10	No	0	0	0	Specify if applicable	71 to 76	72	0 to 4	41 to 46	35	6 to 11
30	Y	R30	3040-3060 Lawrence Ave E (Hospital)	13+500	13+750	7	Very Sensitive-Special Use	23	27	35	80	500	0	No	0	0	0	Specify if applicable	60 to 65	67	0 to 0	30 to 35	30	0 to 5
31	Y	R31	865-871 McCowan Rd	13+750	13+850	4	Commercial	59	20	62	80	500	0	No	0	0	0	Specify if applicable	55 to 60	77	0 to 0	25 to 30	40	0 to 0
32	Y	R32	920-976 McCowan Rd, Other nearby homes	14+000	14+450	1	Houses and Townhouses	16	29	33	80	500	0	Yes	2	0	0	Specify if applicable	63 to 68	72	0 to 0	33 to 38	35	0 to 3
33	Y	R33	1-2 Belchasse St	14+050	14+150	1	Houses and Townhouses	16	30	34	80	500	0	Yes	2	0	0	Specify if applicable	62 to 67	72	0 to 0	32 to 37	35	0 to 2
34	Y	R34	2-58 Brantwood Dr	14+150	14+550	1	Houses and Townhouses	21	20	29	80	500	0	Yes	2	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4
35	Y	R35	23-41 Durrington Cres, 123 Brimorton Dr	14+450	14+600	1	Houses and Townhouses	27	19	33	80	500	0	Yes	2	0	0	Specify if applicable	63 to 68	72	0 to 0	33 to 38	35	0 to 3
36	Y	R36	150, 151 Brimorton Dr	14+550	14+650	1	Houses and Townhouses	11	17	20	80	500	0	Yes	2	0	0	Specify if applicable	67 to 72	72	0 to 0	37 to 42	35	2 to 7
37	Y	R37	122 Brimorton Dr	14+650		1	Houses and Townhouses	17	17	24	80	500	0	Yes	2	0	0	Specify if applicable	65 to 70	72	0 to 0	35 to 40	35	0 to 5
38	Y	R38	15-55 Flintwick Dr	14+650	15+000	1	Houses and Townhouses	29	16	33	80	500	0	Yes	2	0	0	Specify if applicable	63 to 68	72	0 to 0	33 to 38	35	0 to 3
39	Y	R39	16-36 Acre Heights Cres, 12-18 Denver Pl	14+650	14+950	1	Houses and Townhouses	24	16	29	80	500	0	Yes	2	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4
40	Y	R40	1-2 Huronia Gate	14+950	15+050	1	Houses and Townhouses	15	18	23	80	500	0	Yes	2	0	0	Specify if applicable	66 to 71	72	0 to 0	36 to 41	35	1 to 6
41	Y	R41	1066-1072 McCowan Rd	15+000	15+100	1	Houses and Townhouses	22	16	27	80	500	0	Yes	2	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4
42	Y	R42	72-82 Lynnbrook Dr, 6-28 Stoneton Dr	15+050	15+300	1	Houses and Townhouses	21	16	26	80	500	0	Yes	2	0	0	Specify if applicable	65 to 70	72	0 to 0	35 to 40	35	0 to 5
43	Y	R43	45-51 Stanwell Dr.	15+200		1	Houses and Townhouses	5	15	16	80	500	0	Yes	2	0	0	Specify if applicable	69 to 74	72	0 to 2	39 to 44	35	4 to 9
44	Y	R44	53-63 Stanwell Dr.	15+250	15+300	1	Houses and Townhouses	1	16	16	80	500	0	Yes	2	0	0	Specify if applicable	69 to 74	72	0 to 2	39 to 44	35	4 to 9
45	Y	R45	1575-1593 Ellesmere Rd	15+350		4	Commercial	19	17	25	80	500	0	No	0	0	0	Specify if applicable	63 to 68	77	0 to 0	33 to 38	40	0 to 0
46	Y	R46	61 Town Centre Crt	15+600		2	Apartment Building (concrete)	12	19	22	80	90	0	No	0	0	0	Specify if applicable	64 to 69	72	0 to 0	34 to 39	35	0 to 4
47	Y	R47	65-71 Town Centre Crt	15+650		1	Houses and Townhouses	15	19	24	80	30	6	Yes	2	0	0	Specify if applicable	71 to 76	72	0 to 4	41 to 46	35	6 to 11
48	Y	R48	55 Town Centre Crt	15+650		4	Commercial	19	19	27	80	40	3	Yes	0	0	0	Specify if applicable	65 to 70	77	0 to 0	35 to 40	40	0 to 0
49	Y	R49	230 Town Centre Crt	15+700	15+750	2	Apartment Building (concrete)	12	18	22	55	12	10	No	0	0	0	Specify if applicable	72 to 77	72	0 to 5	42 to 47	35	7 to 12
50	Y	R50	300 Borough Dr	15+850	15+900	6	Sensitive Comm/Indust	73	18	75	55	90	0	No	0	0	0	Specify if applicable	52 to 57	72	0 to 0	22 to 27	35	0 to 0

Mitigation Effects Included

TABLE 2 - (1 of 2)

SS WILSON ASSOCIATES

Consulting Engineers

Richmond Hill, Ontario

Developed September 21 2015

Today : April 29, 2016

Date Saved: **April 27, 2016**

1 Houses and Townhouses
2 Apartment Building (concrete)
3 Institutional
4 Commercial
5 Industrial
6 Sensitive Comm/Indust
7 Very Sensitive- Special Use

PREDICTION AND ASSESSMENT OF TTC SUBWAY VIBRATION AND NOISE
SCARBOROUGH SUBWAY EXTENSION (SSE), TORONTO

Text .... With Mitigation

Text WA14-040

Line #	Consider: Y or N	Receptor Code Name	Address(s) Represented By Receptor Code	Alignment Drawing Station Numbers From	To	Select Type of Land Use	Type of Land Use, Select	Horiz'l Distance to Nearest Subway C.L., m	Depth of Track Invert, m	Dist. to Tracks Invert, m	Approx Subway Train Speed, Km/Hr	Dist. to X-over Switch, m	Added Effect of Tracks X-over, dB	Consider Amplif'n Due to Structure, Yes or No	Potential Amplif'n Due to Structure, dB	Addit'l Red'n Due To Rail Vib'n Isolation, dB	Additional Reduction, dB, Specify		VIBRATION IMPACT ASSESSMENT: Predicted Outdoor Vibration Level, Lv in dB re 10E-6 in/sec From-To	MOECC and Other Recom'd Vibration Criteria, Lv in dB re 10E-6 in/sec (based on MOE-TTC)	Excess Above Vibration Level Criteria, dB re 10E-6 in/sec From - To	NOISE IMPACT ASSESSMENT: Projected Indoor Sound Level, dBA From - To	Recom'd Indoor Sound Level Criteria, dBA	Excess Above Indoor Sound Level Criteria, dBA From To
1	Y	**R1**	110 Town Haven Place area	10+200	10+300	1	Houses and Townhouses	13	7	15	80	500	0	Yes	2	-12	0	Specify if applicable	57 to 62	72	0 to 0	27 to 32	35	0 to 0
2	Y	**R2**	2493-2495 Eglinton Ave E	10+300		2	Apartment Building (concrete)	5	13	14	80	500	0	No	0	-12	0	Specify if applicable	56 to 61	72	0 to 0	26 to 31	35	0 to 0
3	Y	**R3**	2493-2495 Eglinton Ave E	10+300		6	Sensitive Comm/Indust	5	13	14	80	500	0	No	0	-12	0	Specify if applicable	56 to 61	72	0 to 0	26 to 31	35	0 to 0
4	Y	**R4**	815 Midland Ave	10+400	10+500	6	Sensitive Comm/Indust	37	17	40	80	500	0	No	0	-12	0	Specify if applicable	47 to 52	72	0 to 0	17 to 22	35	0 to 0
5	Y	**R5**	2555 Eglinton Ave E	10+500		6	Sensitive Comm/Indust	22	18	28	80	500	0	No	0	-12	0	Specify if applicable	50 to 55	72	0 to 0	20 to 25	35	0 to 0
6	Y	**R6**	2575 Eglinton Ave E	10+600	10+700	6	Sensitive Comm/Indust	24	21	32	80	500	0	No	0	-12	0	Specify if applicable	49 to 54	72	0 to 0	19 to 24	35	0 to 0
7	Y	**R7**	2640 Eglinton Ave E	11+000	11+100	6	Sensitive Comm/Indust	35	18	39	80	500	0	No	0	-12	0	Specify if applicable	47 to 52	72	0 to 0	17 to 22	35	0 to 0
8	Y	**R8**	2684 Eglinton Ave E	11+200	11+300	4	Commercial	28	20	34	80	500	0	No	0	-12	0	Specify if applicable	48 to 53	77	0 to 0	18 to 23	40	0 to 0
9	Y	**R9**	2739 Eglinton Ave E	11+200	11+300	4	Commercial	10	20	22	80	500	0	No	0	-12	0	Specify if applicable	52 to 57	77	0 to 0	22 to 27	40	0 to 0
10	Y	**R10**	1229 Danforth Rd	11+450	11+650	1	Houses and Townhouses	16	17	23	80	500	0	Yes	2	-12	0	Specify if applicable	54 to 59	72	0 to 0	24 to 29	35	0 to 0
11	Y	**R11**	1250-1266 Danforth Rd & 35 Wetherby Dr	11+500	11+650	1	Houses and Townhouses	12	18	22	80	500	0	Yes	2	-12	0	Specify if applicable	54 to 59	72	0 to 0	24 to 29	35	0 to 0
12	Y	**R12**	1275-1299 Danforth Rd	11+700	11+850	2	Apartment Building (concrete)	16	17	23	80	500	0	No	0	-12	0	Specify if applicable	52 to 57	72	0 to 0	22 to 27	35	0 to 0
13	Y	**R13**	1284 Danforth Rd	11+750	11+800	2	Apartment Building (concrete)	28	17	33	80	500	0	No	0	-12	0	Specify if applicable	49 to 54	72	0 to 0	19 to 24	35	0 to 0
14	Y	**R14**	1290-1300 Danforth Rd	11+800	11+850	2	Apartment Building (concrete)	38	18	42	80	500	0	No	0	-12	0	Specify if applicable	47 to 52	72	0 to 0	17 to 22	35	0 to 0
15	Y	**R15**	1325 Danforth Rd	11+950	12+050	1	Houses and Townhouses	27	19	33	80	500	0	Yes	2	-12	0	Specify if applicable	51 to 56	72	0 to 0	21 to 26	35	0 to 0
16	Y	**R16**	1308-1360 Danforth Rd	11+950	12+300	2	Apartment Building (concrete)	19	24	31	80	500	0	No	0	-12	0	Specify if applicable	49 to 54	72	0 to 0	19 to 24	35	0 to 0
17	Y	**R17**	1 Savarin St	12+050	12+100	1	Houses and Townhouses	20	23	30	80	500	0	Yes	2	-12	0	Specify if applicable	51 to 56	72	0 to 0	21 to 26	35	0 to 0
18	Y	**R18**	1359 Danforth Rd	12+200		6	Sensitive Comm/Indust	25	26	36	80	500	0	No	0	-12	0	Specify if applicable	48 to 53	72	0 to 0	18 to 23	35	0 to 0
19	Y	**R19**	152 & 155 Thicketwood Dr	12+250	12+300	1	Houses and Townhouses	13	26	29	80	500	0	Yes	2	-12	0	Specify if applicable	52 to 57	72	0 to 0	22 to 27	35	0 to 0
20	Y	**R20**	1431-1505 Danforth Rd. & other nearby homes	12+350	12+900	1	Houses and Townhouses	16	21	26	80	500	0	Yes	2	-12	0	Specify if applicable	53 to 58	72	0 to 0	23 to 28	35	0 to 0
21	Y	**R21**	1438-1500 Dandorth Rd. & other nearby homes	12+350	12+900	1	Houses and Townhouses	13	21	25	80	500	0	Yes	2	-12	0	Specify if applicable	53 to 58	72	0 to 0	23 to 28	35	0 to 0
22	Y	**R22**	1510-1514, 600-614 Danforth Rd.& 2,38 Furlong Crt.	12+900	13+200	1	Houses and Townhouses	17	24	29	80	80	0	Yes	2	-12	0	Specify if applicable	52 to 57	72	0 to 0	22 to 27	35	0 to 0

Conversion Chart

Vibration Velocity in dB level re 10^-6 in/sec	Equivalent Vibration Velocity in mm/s
50	0.01
51	0.01
52	0.01
53	0.01
54	0.01
55	0.01
56	0.02
57	0.02
58	0.02
59	0.02
60	0.03
61	0.03
62	0.03
63	0.04
64	0.04
65	0.05
66	0.05
67	0.06
68	0.06
69	0.07
70	0.08
71	0.09
72	0.10
73	0.11
74	0.13
75	0.14
76	0.16
77	0.18
78	0.20
79	0.23
80	0.25

Mitigation Effects Included

TABLE 2 - (2 of 2)

	Line #	Consider: Y or N	Receptor Code Name	Address(s) Represented By Receptor Code	Alignment Drawing Station Numbers From	To	Select Type of Land Use	Type of Land Use, Select	Horiz'l Distance to Nearest Subway C.L., m	Depth of Track Invert, m	Dist. to Tracks Invert, m	Approx Subway Train Speed, Km/Hr	Dist. to X-over Switch, m	Added Effect of Tracks X-over, dB	Consider Amplif'n Due to Structure, Yes or No	Potential Amplif'n Due to Structure, dB	Addit'l Red'n Due To Rail Vib'n Isolation, dB	Additional Reduction, dB, Specify		Predicted Outdoor Vibration Level, Lv in dB re 10E-6 in/sec From-To			MOE and Other Recom'd Vibration Criteria, Lv in dB re 10E-6 in/sec (based on MOE-TTC)	Excess Above Vibration Level Criteria, dB re 10E-6 in/sec From - To			Projected Indoor Sound Level, dBA From - To			Recom'd Indoor Sound Level Criteria, dBA	Excess Above Indoor Sound Level Criteria, dBA From To		
	23	Y	R23	1515 Danforth Rd	12+950	13+000	3	Institutional	21	32	38	80	500	0	No	0	-12	0	Specify if applicable	47	to	52	72	0	to	0	17	to	22	35	0	to	0
	24	Y	R24	585-599 McCowan Rd.	12+950	13+050	1	Houses and Townhouses	32	30	44	80	500	0	Yes	2	-12	0	Specify if applicable	48	to	53	72	0	to	0	18	to	23	35	0	to	0
	25	Y	R25	601-605 McCowan Rd.	13+050	13+120	6	Sensitive Comm/Indust	28	30	41	80	500	0	No	0	-12	0	Specify if applicable	47	to	52	72	0	to	0	17	to	22	35	0	to	0
	26	Y	R26	615 McCowan Rd	13+200		4	Commercial	24	30	38	80	100	0	No	0	-12	0	Specify if applicable	47	to	52	77	0	to	0	17	to	22	40	0	to	0
	27	Y	R27	637-659 McCowan Rd	13+200	13+300	4	Commercial	30	30	42	80	35	4	No	0	-12	0	Specify if applicable	51	to	56	77	0	to	0	21	to	26	40	0	to	0
	28	Y	R28	622-642 McCowan Rd	13+250	13+400	1	Houses and Townhouses	19	30	36	80	19	8	Yes	2	-12	0	Specify if applicable	58	to	63	72	0	to	0	28	to	33	35	0	to	0
	29	Y	R29	685-697 McCowan Rd	13+350	13+400	6	Sensitive Comm/Indust	14	29	32	80	14	10	No	0	-12	0	Specify if applicable	59	to	64	72	0	to	0	29	to	34	35	0	to	0
★	30	Y	R30	3040-3060 Lawrence Ave E (Hospital)	13+500	13+750	7	Very Sensitive-Special Use	23	27	35	80	500	0	No	0	-12	0	Specify if applicable	48	to	53	67	0	to	0	18	to	23	30	0	to	0
	31	Y	R31	865-871 McCowan Rd	13+750	13+850	4	Commercial	59	20	62	80	500	0	No	0	-12	0	Specify if applicable	43	to	48	77	0	to	0	13	to	18	40	0	to	0
	32	Y	R32	920-976 McCowan Rd, Other nearby homes	14+000	14+450	1	Houses and Townhouses	16	29	33	80	500	0	Yes	2	-12	0	Specify if applicable	51	to	56	72	0	to	0	21	to	26	35	0	to	0
	33	Y	R33	1-2 Belchasse St	14+050	14+150	1	Houses and Townhouses	16	30	34	80	500	0	Yes	2	-12	0	Specify if applicable	50	to	55	72	0	to	0	20	to	25	35	0	to	0
	34	Y	R34	2-58 Brantwood Dr	14+150	14+550	1	Houses and Townhouses	21	20	29	80	500	0	Yes	2	-12	0	Specify if applicable	52	to	57	72	0	to	0	22	to	27	35	0	to	0
	35	Y	R35	23-41 Durrington Cres, 123 Brimorton Dr	14+450	14+600	1	Houses and Townhouses	27	19	33	80	500	0	Yes	2	-12	0	Specify if applicable	51	to	56	72	0	to	0	21	to	26	35	0	to	0
	36	Y	R36	150, 151 Brimorton Dr	14+550	14+650	1	Houses and Townhouses	11	17	20	80	500	0	Yes	2	-12	0	Specify if applicable	55	to	60	72	0	to	0	25	to	30	35	0	to	0
	37	Y	R37	122 Brimorton Dr	14+650		1	Houses and Townhouses	17	17	24	80	500	0	Yes	2	-12	0	Specify if applicable	53	to	58	72	0	to	0	23	to	28	35	0	to	0
	38	Y	R38	15-55 Flintwick Dr	14+650	15+000	1	Houses and Townhouses	29	16	33	80	500	0	Yes	2	-12	0	Specify if applicable	51	to	56	72	0	to	0	21	to	26	35	0	to	0
	39	Y	R39	16-36 Acre Heights Cres, 12-18 Denver Pl	14+650	14+950	1	Houses and Townhouses	24	16	29	80	500	0	Yes	2	-12	0	Specify if applicable	52	to	57	72	0	to	0	22	to	27	35	0	to	0
	40	Y	R40	1-2 Huronia Gate	14+950	15+050	1	Houses and Townhouses	15	18	23	80	500	0	Yes	2	-12	0	Specify if applicable	54	to	59	72	0	to	0	24	to	29	35	0	to	0
	41	Y	R41	1066-1072 McCowan Rd	15+000	15+100	1	Houses and Townhouses	22	16	27	80	500	0	Yes	2	-12	0	Specify if applicable	52	to	57	72	0	to	0	22	to	27	35	0	to	0
	42	Y	R42	72-82 Lynnbrook Dr, 6-28 Stoneton Dr	15+050	15+300	1	Houses and Townhouses	21	16	26	80	500	0	Yes	2	-12	0	Specify if applicable	53	to	58	72	0	to	0	23	to	28	35	0	to	0
★	43	Y	R43	45-51 Stanwell Dr.	15+200		1	Houses and Townhouses	5	15	16	80	500	0	Yes	2	-12	0	Specify if applicable	57	to	62	72	0	to	0	27	to	32	35	0	to	0
★	44	Y	R44	53-63 Stanwell Dr.	15+250	15+300	1	Houses and Townhouses	1	16	16	80	500	0	Yes	2	-12	0	Specify if applicable	57	to	62	72	0	to	0	27	to	32	35	0	to	0
	45	Y	R45	1575-1593 Ellesmere Rd	15+350		4	Commercial	19	17	25	80	500	0	No	0	-12	0	Specify if applicable	51	to	56	77	0	to	0	21	to	26	40	0	to	0
	46	Y	R46	61 Town Centre Crt	15+600		2	Apartment Building (concrete)	12	19	22	80	90	0	No	0	-12	0	Specify if applicable	52	to	57	72	0	to	0	22	to	27	35	0	to	0
	47	Y	R47	65-71 Town Centre Crt	15+650		1	Houses and Townhouses	15	19	24	80	30	6	Yes	2	-12	0	Specify if applicable	59	to	64	72	0	to	0	29	to	34	35	0	to	0
	48	Y	R48	55 Town Centre Crt	15+650		4	Commercial	19	19	27	80	40	3	No	0	-12	0	Specify if applicable	53	to	58	77	0	to	0	23	to	28	40	0	to	0
	49	Y	R49	230 Town Centre Crt	15+700	15+750	2	Apartment Building (concrete)	12	18	22	55	12	10	No	0	-12	0	Specify if applicable	60	to	65	72	0	to	0	30	to	35	35	0	to	0
	50	Y	R50	300 Borough Dr	15+850	15+900	6	Sensitive Comm/Indust	73	18	75	55	90	0	No	0	-12	0	Specify if applicable	40	to	45	72	0	to	0	10	to	15	35	0	to	0

★ The identified receptor locations will require further detailed investigations during the detailed design process.

Conversion Chart

Vibration Velocity in dB level re 10^-6 in/sec	Equivalent Vibration Velocity in mm/s
50	0.01
51	0.01
52	0.01
53	0.01
54	0.01
55	0.01
56	0.02
57	0.02
58	0.02
59	0.02
60	0.03
61	0.03
62	0.03
63	0.04
64	0.04
65	0.05
66	0.05
67	0.06
68	0.06
69	0.07
70	0.08
71	0.09
72	0.10
73	0.11
74	0.13
75	0.14
76	0.16
77	0.18
78	0.20
79	0.23
80	0.25

FIGURES

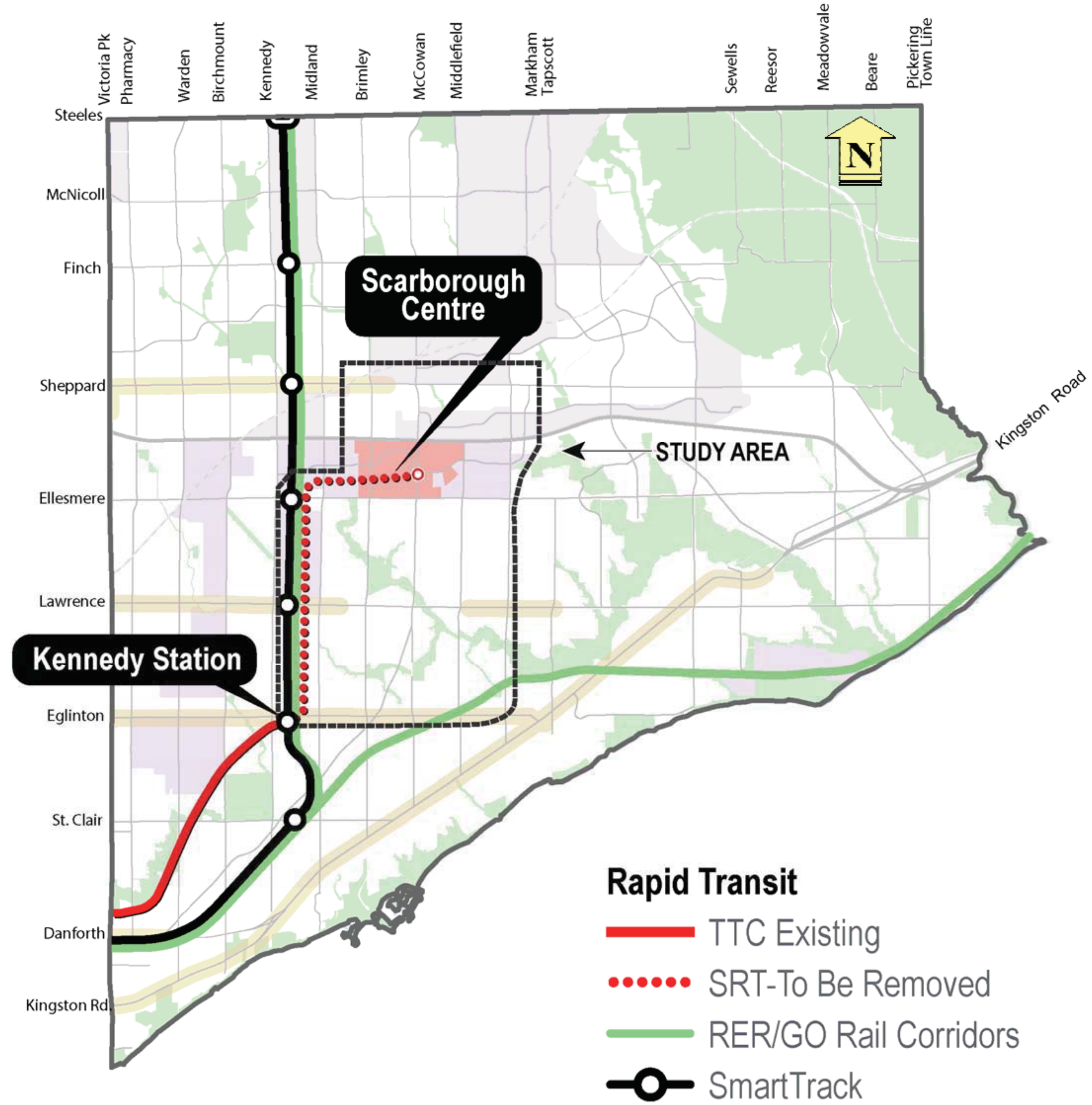
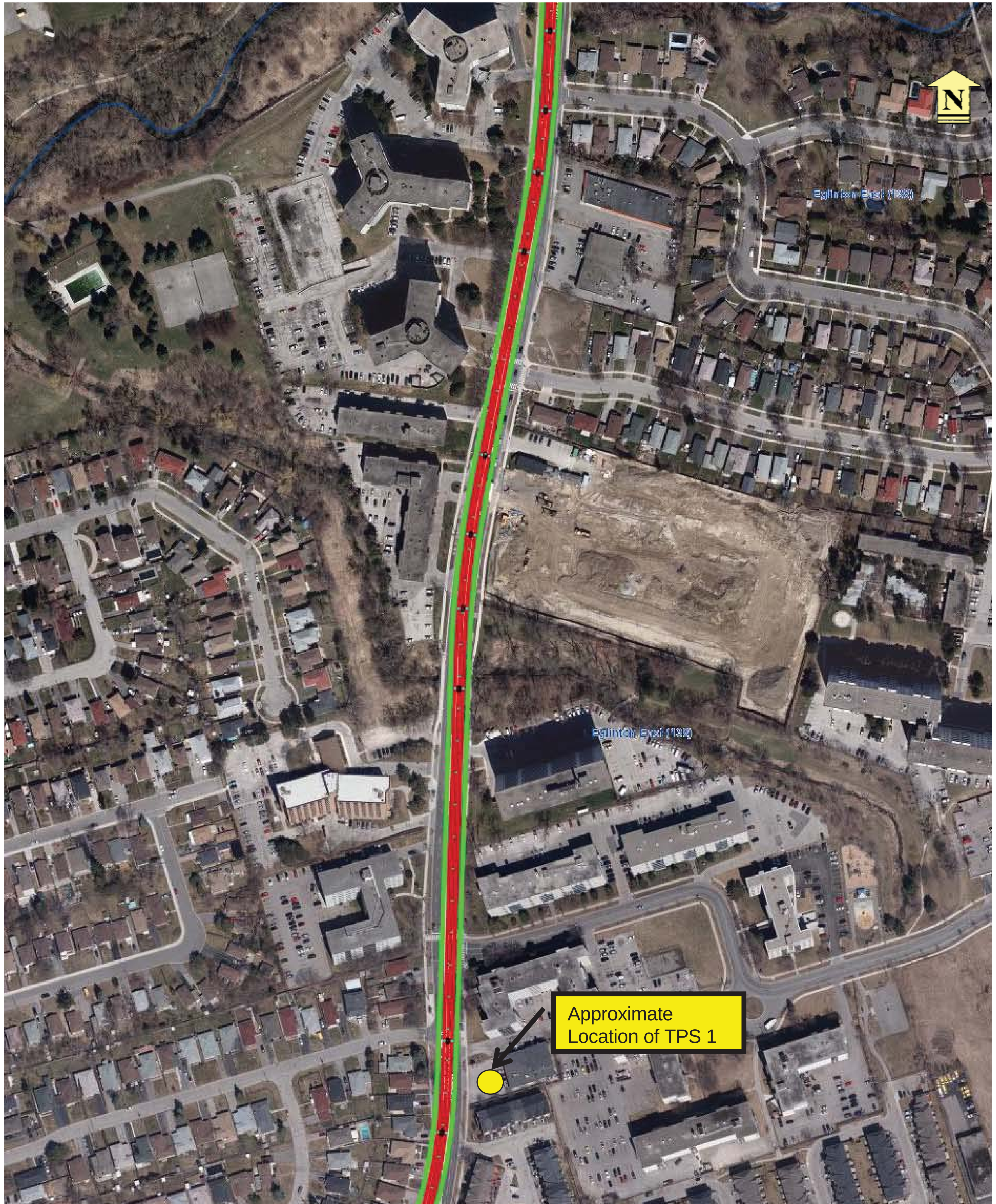
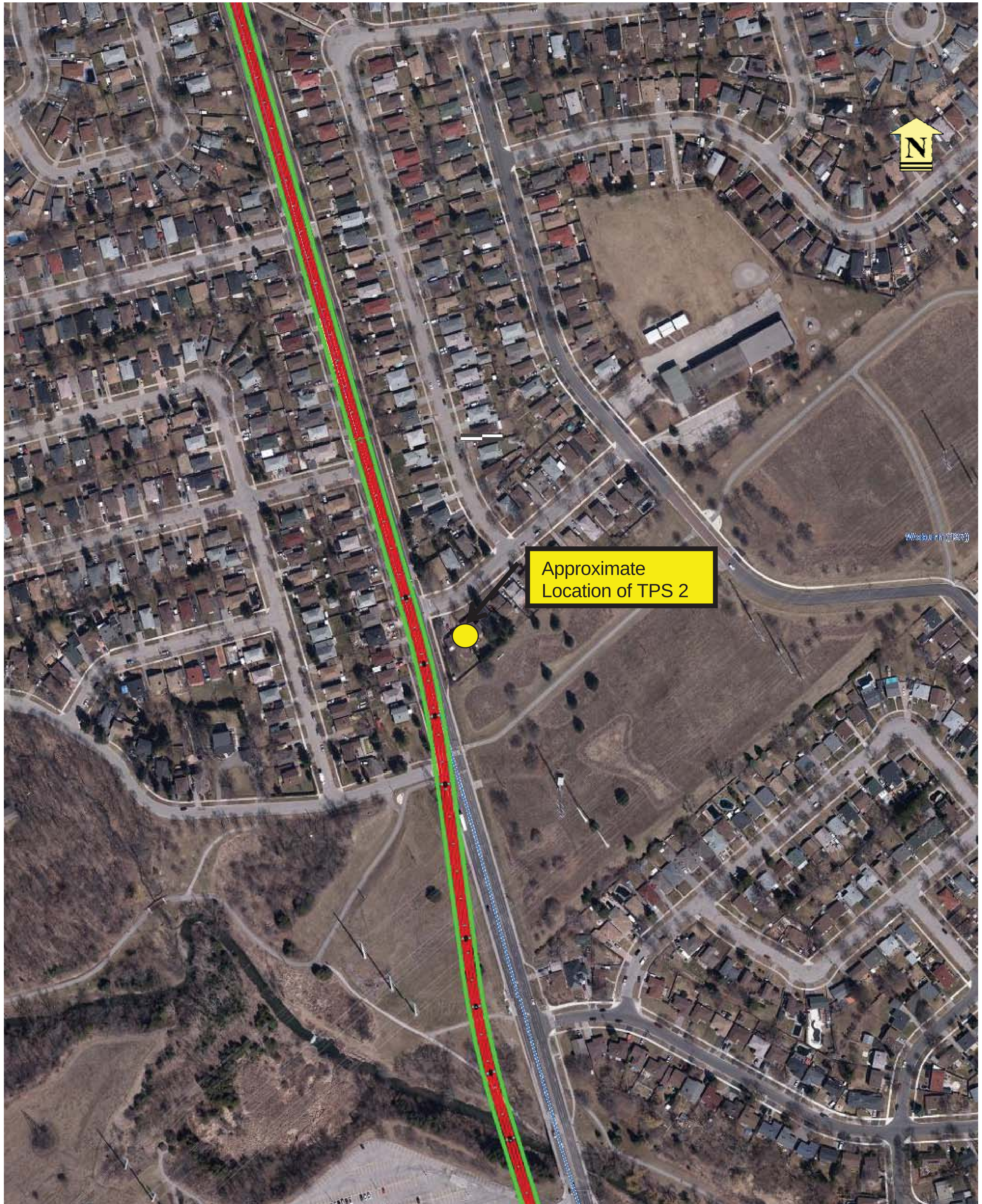


FIGURE 1
STUDY AREA

FIGURE 2.1
SUBWAY ALIGNMENT


N
Approximate
Location of TPS 1


McCowan and Danforth
N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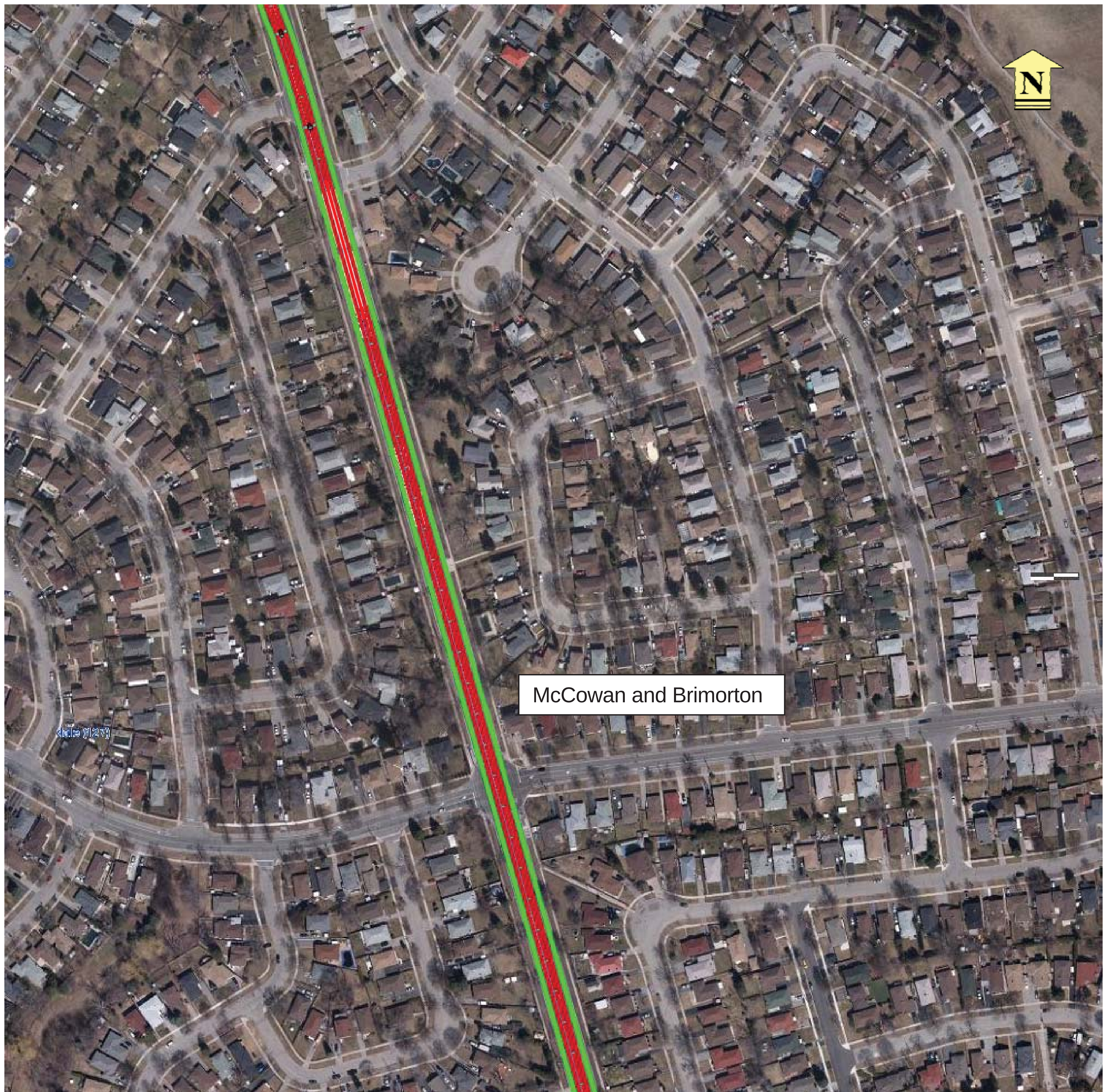
Approximate
Location of TPS 2


N
McCowan and Brimorton


N
Approximate
Location of TPS 3
McCowan and Ellesmere

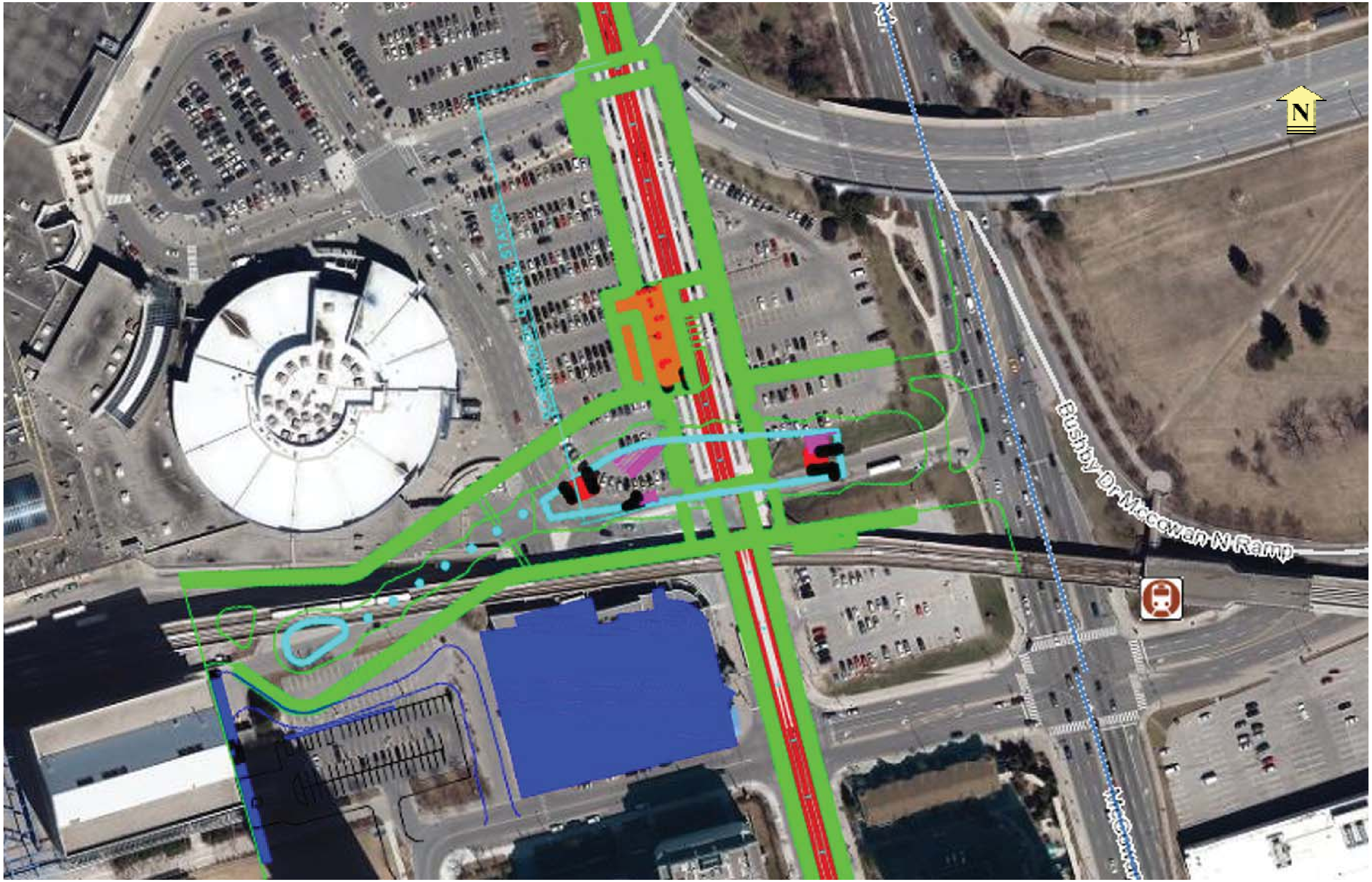


FIGURE 3
PROPOSED SCARBOROUGH TOWN CENTRE STATION

IMPORTANT NOTES RELATED TO THE INFORMATION PRESENTED IN FIGURES 4.1 - 4.5 (SELECTED POINTS OF RECPTION)

The figures to follow are intended to show the exact location of the selected receptors only. The figures are based on alignment drawings, which contain outdated information related to the selected locations for the Traction Power Substations and Emergency Exit Buildings. For this information, reference should be made to the main report by AECOM.

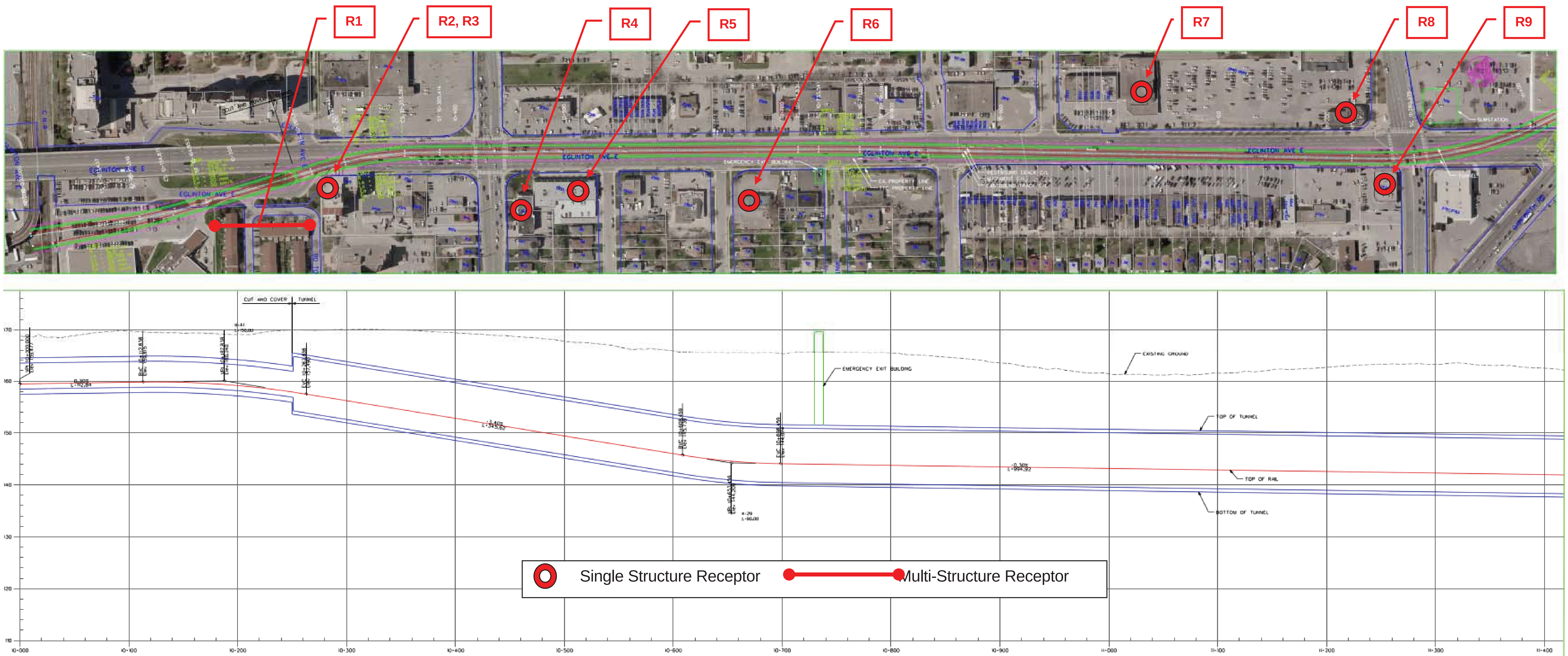


FIGURE 4.1
SELECTED POINTS OF RECEPTION

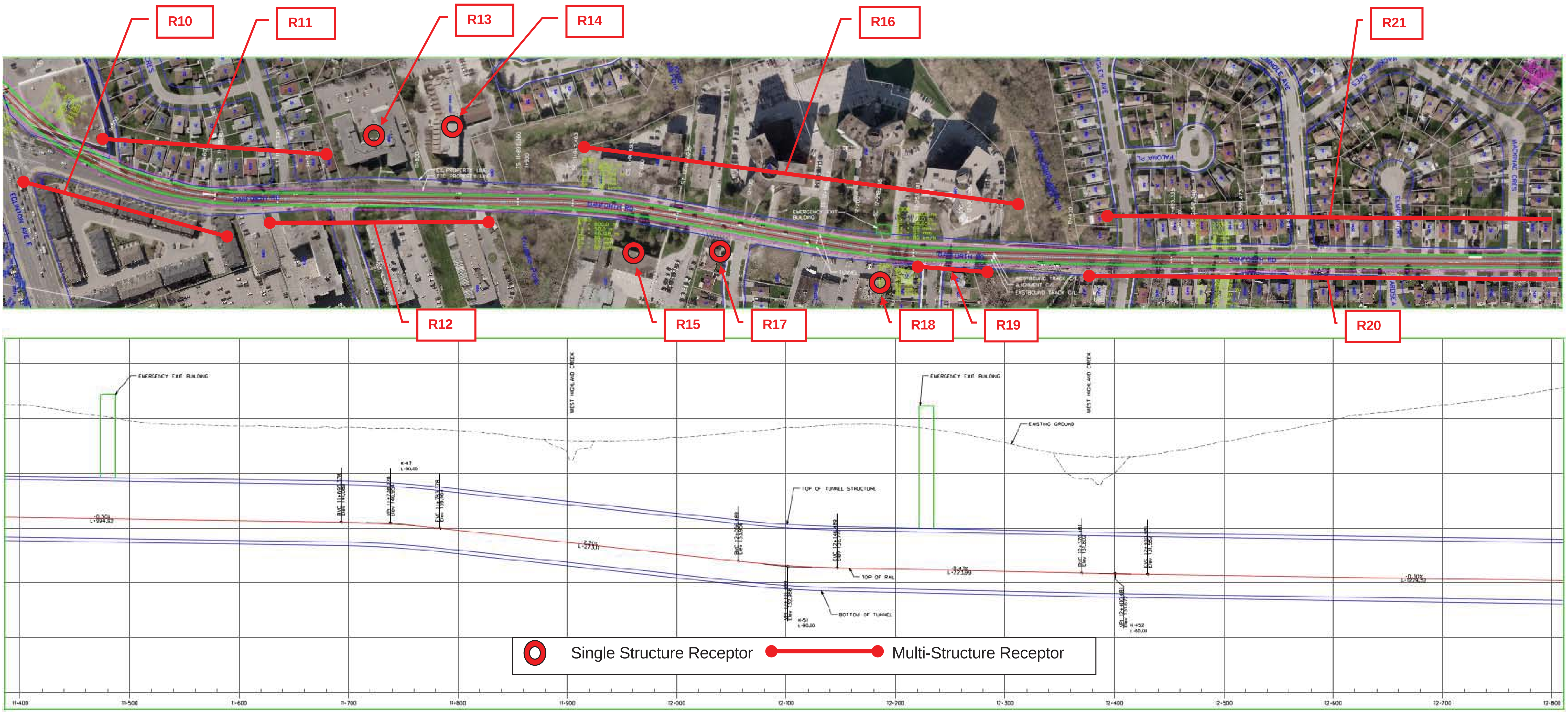


FIGURE 4.2
SELECTED POINTS OF RECEPTION

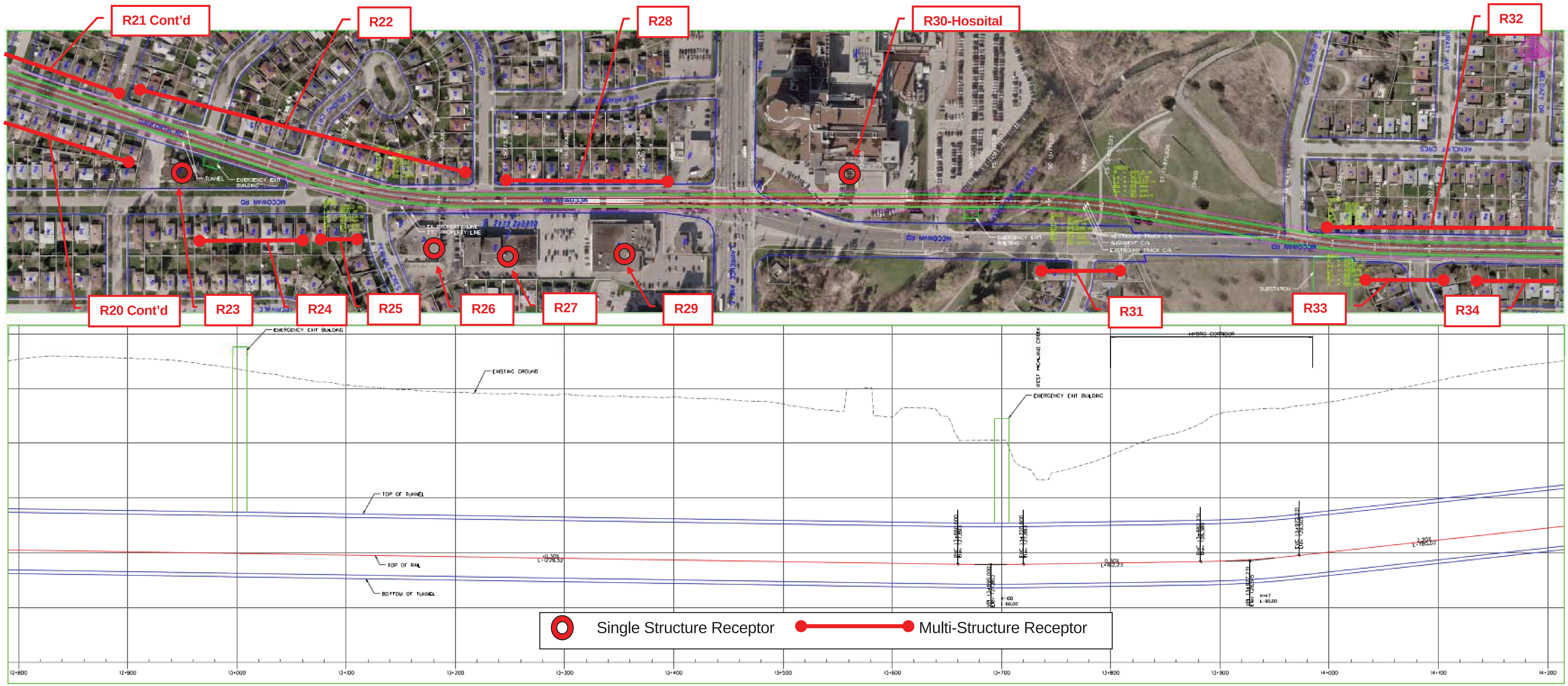


FIGURE 4.3
SELECTED POINTS OF RECEPTION

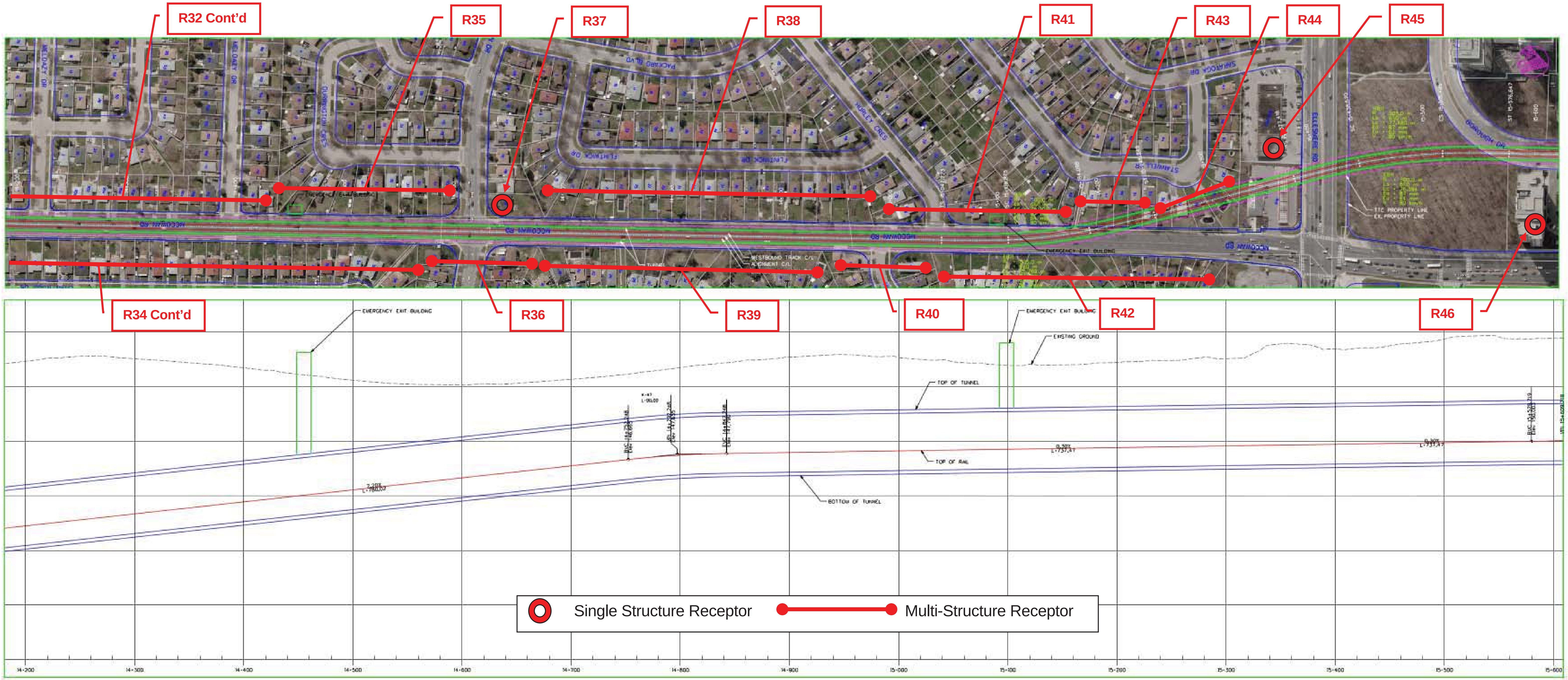


FIGURE 4.4
SELECTED POINTS OF RECEPTION

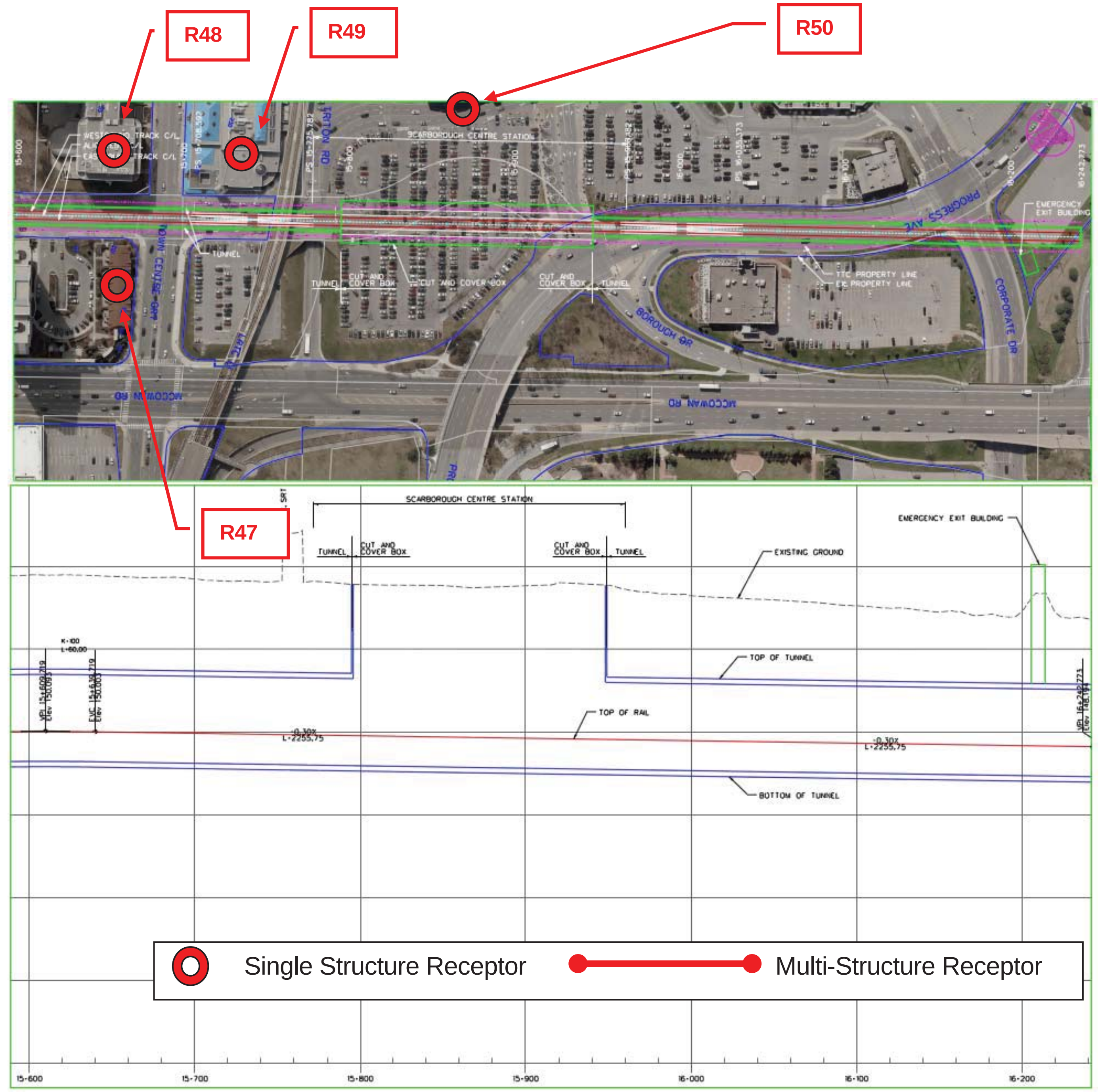


FIGURE 4.5
SELECTED POINTS OF RECEPTION

ATTACHMENT 1

GLOSSARY

GLOSSARY

A weighted decibel; dBA A nationally and internationally standardized frequency weighting applied to the sound level (measured in decibels) spectrum to approximate the sensitivity of the human hearing mechanism as a function of frequency (pitch).

Airborne Sound is sound that reaches the point of interest by propagation through air.

Ambient/ Background Sound Level is the all-encompassing noise associated with a given environment and comprises a composite of sounds from many sources, other than the source of interest, near and far. In the context of this document, the ambient or existing noise level is the noise level which exists at a receptor as a result of existing traffic conditions without the addition of noise generated by the proposed undertaking or the new source of noise.

A-Weighted sound level The "A-weighted sound level" is a *sound pressure level* indicated by a measurement system that includes an *A-weighted* network. The resulting value is in *decibels* and commonly labelled *dBA*.

A-Weighting is a frequency weighting intended to approximate the relative sensitivity of the normal human ear to different frequencies (pitches of sound). The specific variation of sensitivity with frequency to conform to IEC Publication 651.

dBA means the A-weighted sound pressure level.

Decibel is the common measure of sound level or sound pressure level. It is the term to identify 10 times the common logarithm of the ratio of two like quantities proportional to power or energy. The "decibel" is a dimensionless measure of sound level or sound pressure level; see sound pressure level.

Environmental Noise is noise transmitted through the outdoor environment as opposed to noise generated and contained within buildings.

Equivalent Sound Pressure Level denoted Leq is the level of a steady sound having the same time integral of the squared sound pressure, in the measurement interval, as the observed sound.

Indoor sound level is an estimated/calculated sound level in the central part of a room.

L_{eq} – The Energy Equivalent Continuous Sound Level is the constant sound level over the time period in question, that results in the same total sound energy as the actually varying sound. It must be associated with a time period. Leq is a measure of total sound energy dose over a specified time period.

Leq (T): Leq (16 hours), Leq (8 hours), Leq (1 hours) means the A-weighted level of a steady sound carrying the same total energy in the time period T as the observed fluctuating sound. The time period T is given in brackets.

Noise is defined as any unwanted sound.

Noise Sensitive Land Use means a land use that is sensitive to noise, whether inside and/or outside the property and that must be planned and/or designed using appropriate land use compatibility principles. Examples of sensitive land uses:

- residential developments;
- seasonal residential developments;
- hospitals, nursing/retirement homes, schools, day-care centres;
- other land uses that may contain outdoor and/or outdoor areas/spaces where an intruding noise may create an adverse effect.

In general, a noise-sensitive land use could be any type of land use where environmental noise is likely to cause an *adverse effect* or material discomfort whether inside or outside of a building.

Point of Reception means any point on the premises of a person where sound or vibration originating from other than those premises is received. For the purposes of noise impact assessment in the plane of a bedroom window, the point of assessment is typically 4.5 m above ground unless the dwelling is a multi-storey building. The point of reception is commonly used for assessment of *stationary sources* of noise

Sound is a fluctuation in pressure, particle displacement or particle velocity propagated in any medium; or the auditory sensation that may be produced by it.

Sound (Pressure) Level is the logarithmic ratio of the instantaneous energy of a sound to the energy at the threshold of hearing. It is measured in decibels (dB)

Sound Level is the A-weighted sound pressure level in dBA.

Stationary Source of Noise For the purpose of this document, a stationary source of noise is defined as: "Stationary source means all sources of sound/vibration; whether fixed or mobile, that exist/operate on the premises, property or facility, the combined sound/vibration levels of which are emitted beyond the property boundary of the premises, property or facility, unless the source(s) is (are) due to temporary "construction" as defined in the applicable municipal noise "By-Law"."

Time Periods (MOECC predefined time periods) "***Day-time***" is the 16-hour period between 07:00 and 23:00 hours. **"*Evening*"** is the 4-hour period between 19:00 and 23:00 hours. **"*Night-time*"** is the 8-hour period between 23:00 and 07:00 hours.

Vibration is a temporal and spatial oscillation of displacement, velocity or acceleration in a solid medium.

ATTACHMENT 2

SOUND AND VIBRATION LEVEL CRITERIA

MOEE/TTC PROTOCOL FOR NOISE AND VIBRATION ASSESSMENT FOR THE PROPOSED YONGE-SPADINA SUBWAY LOOP

JUNE 16, 1993

TABLE OF CONTENTS

RCEP Profile #1411

PROTOCOL FOR NOISE AND VIBRATION ASSESSMENT

PART A. PURPOSE

The Toronto Transit Commission (TTC) and the Ministry of the Environment and Energy (MOEE) recognize that transit facilities produce noise and vibration which may affect neighbouring properties within urbanized areas. This document identifies the framework within which criteria will be applied for limiting wayside air-borne noise, ground-borne noise and vibration from the TTC's proposed Yonge-Spadina Subway Loop Line (the "Line"). The framework presented in this document is to be applied for planning purposes in order to address the requirements of the Environmental Assessment Act and is to be utilized during implementation of the Line.

The passby sound levels and vibration velocities in this protocol have been developed specifically for the Line and this protocol is not to be applied retroactively to existing TTC transit lines, routes or facilities nor to transit authorities other than TTC. Further, the criteria specified for this project are not precedent setting for future projects.

Prediction and measurement methods are being developed by the TTC. This will be done in consultation with MOEE and the Ministry of Transportation (MTO). Studies pertaining to noise and vibration levels are also being conducted by TTC. Upon completion of these studies, the TTC may revisit the assessment criteria and methods in this protocol to modify them as required in consultation with MOEE and the Ministry of Transportation (MTO).

PART B. GENERAL

During design of the Line, predicted wayside sound levels and vibration velocities are to be compared to criteria given in this protocol. This will permit an impact assessment and help determine the type or extent of mitigation measures to reduce that impact. Sound levels and vibration velocities will be predicted from sound levels and velocities of TTC's existing rail technologies.

The criteria presented in this document are based on good operating conditions and the impact assessment assumes this condition. Good operating conditions exist when well maintained vehicles operate on well maintained continuous welded rail without significant rail corrugation. It is recognised that wheel flats or rail corrugations will inevitably occur and will temporarily increase sound and vibration levels until they are corrected. Levels in this protocol do not reflect these occasional events, nor do they apply to maintenance activities on the Line. TTC recognizes that wheel rail squeal is a potential source of noise which may pose a concern to the community. TTC is investigating and will continue to investigate measures to mitigate wheel rail squeal and will endeavour to mitigate this noise source. TTC endeavours to minimize the noise and vibration impacts associated with its transit operations and is committed to providing good operating conditions to the extent technologically, economically and administratively feasible.

It is recognised that levels of sound and vibration at special trackwork, such as at crossovers and turnouts, are inevitably higher than along tangent track. Also, there is a limit to the degree of mitigation that is feasible at special trackwork areas. This is to be taken into account in predicting sound and vibration levels near these features and in applying the levels in this protocol. Special trackwork, such as at crossovers and turnouts, is encompassed within the framework of this document.

This protocol applies to existing and proposed residential development having municipal approval on the date of this protocol. The protocol also applies to existing and municipally approved proposed nursing homes, group homes, hospitals and other such institutional land uses where people reside. This protocol does not apply to commercial and industrial land uses.

This protocol does not apply closer than 15 m to the centreline of the nearest track. Any such cases shall be assessed on a case by case basis.

Part D of this document deals with air-borne noise from the Line and its construction. Part E deals with ground-borne noise and vibration from the Line.

PART C. DEFINITIONS

The following definitions apply to both parts D and E of this document.

Ancillary Facilities:

Subsidiary locations associated with either the housing of personnel or equipment engaged in TTC activities or associated with mainline revenue operations. Examples of ancillary facilities include, but are not limited to, subway stations, bus terminals, emergency services buildings, fans, fan and vent shafts, substations, mechanical equipment plants, maintenance and storage facilities, and vehicle storage and maintenance facilities.

Passby Time Interval:

The passby time interval of a vehicle or train is given by its total length and its speed. The start of the pass-by is defined as that point in time when the leading wheels pass a reference point. The end of the pass-by is defined as that point in time when the last wheels of the vehicle or train pass the same reference point. The reference point is to be chosen to give the highest level at the point of reception or point of assessment, i.e. usually at the point of closest approach. From a signal processing perspective, the passby time interval will be defined in the prediction and measurement methods being developed.

PART D. AIR-BORNE NOISE

1.0 DEFINITIONS

The following definitions are to be used only within the context of Part D of this document.

Ambient:

The ambient is the sound existing at the point of reception in the absence of all noise from the Line. In this protocol the ambient is taken to be the noise from road traffic and existing industry. The ambient specifically excludes transient noise from aircraft and railways, except for pre-existing TTC rail operations.

Daytime Equivalent Sound Level:

$L_{eq,15h}$ is the daytime equivalent sound level. The definition of equivalent sound level is provided in Reference 2. The applicable time period is from 07:00 to 23:00 hours.

Nighttime Equivalent Sound Level:

$L_{eq,8h}$ is the nighttime equivalent sound level. The applicable time period is from 23:00 to 07:00 hours.

Point of Reception:

Daytime: 07:00 - 23:00 hours

Any outdoor point on residential property, 15 m or more from the nearest track's centreline, where sound originating from the Line is received.

Nighttime: 23:00 - 07:00 hours

The plane of any bedroom window, 15 m or more from the nearest track's centreline, where sound originating from the Line is received. At the planning stage, this is usually assessed at the nearest facade of the premises.

Passby Sound Level, L_{passby} :

Within the context of this document, the passby sound level is defined as the A-weighted equivalent sound level, L_{eq} [Reference 2] over the passby time interval.

2.0 RAIL TRANSIT

In the assessment of noise impact, rail transit is considered to include the movement of trains between stations, the movement and idling of trains inside stations as well as the movement of trains between the mainline and ancillary facilities. Ancillary facilities are not considered part of the rail transit and are assessed as stationary sources. Trains idling in maintenance yards and storage facilitities are part of the stationary source.

The assessment of noise impact resulting from Line is to be performed in terms of the following sound level descriptors:

1) Daytime equivalent sound level, $L_{eq,16h}$,
2) Nighttime equivalent sound level, $L_{eq,8h}$,
3) Passby Sound Level, L_{passby}.

The predicted daytime and nighttime equivalent sound levels include the effects of both passby sound level and frequency of operation and are used to assess the noise impact of the Line. The Passby Sound Level criterion is used to assess the sound levels received during a single train passby. The criteria and methods to be used are discussed in Sections 2.1 and 2.2.

2.1 Criteria

Noise impact shall be predicted and assessed during design of the Line using the following sound level criteria:

DAYTIME EQUIVALENT SOUND LEVEL:

The limit at a point of reception for the predicted daytime equivalent sound levels for rail transit operating alone (excluding contributions from the ambient) is 55 dBA or the ambient $L_{eq,16h}$, whichever is higher.

NIGHTTIME EQUIVALENT SOUND LEVEL:

The limit at a point of reception for the predicted nighttime equivalent sound levels for rail transit operating alone (excluding contributions from the ambient) is 50 dBA or the ambient $L_{eq,8h}$, whichever is higher.

PASSBY SOUND LEVEL:

The limit at a point of reception for predicted L_{passby} for a single train operating alone and excluding contributions from other sources is 80 dBA. This limit is based on vehicles operating on tangent track. It does not apply within 100m of special trackwork and excludes wheel rail squeal.

Mitigating measures will be incorporated in the design of the Line when predictions show that any of the above limits are exceeded by more than 5 dB. All mitigating measures shall ensure that the predicted sound levels are as close to, or lower than, the respective limits as is technologically, economically, and administratively feasible.

2.2 Prediction

In most cases, a reasonable estimate of the ambient sound level can be made using a road traffic noise prediction method such as that described in Reference 9, and the minimum sound levels in Table 106-2 of Reference 6. Prediction of road traffic L_{eq} is preferred to individual measurements in establishing the ambient. Prediction techniques for the L_{eq} from road traffic and the L_{eq} or L_{passby} from transit shall be compatible with one another. Any impact assessment following this protocol shall include a description of the prediction method and the assumptions and sound level data inherent in it. Prediction and measurement methods compatible with MOEE guidelines and procedures are being developed by the TTC at the date of this protocol in consultation with MTO and MOEE.

3.0 ANCILLARY FACILITIES

Predicted noise impacts from ancillary facilities shall be assessed during the design of the Line in accordance with the stationary source guidelines detailed in Reference 5. The predictions used shall be compatible with and at least as accurate as CSA Standard Z107.55.

4.0 BUSES IN MIXED TRAFFIC

Where buses are part of the road traffic there are no additional criteria requirements beyond those presented in the Ministry of Transportation of Ontario Protocol for dealing with noise concerns during the preparation, review and evaluation of Provincial Highways Environmental Assessments (Reference 1). Buses should be considered as medium trucks in the traffic noise prediction models.

5.0 CONSTRUCTION

Noise impacts from the construction of the Line are to be examined. For the purposes of impact assessment and identifying the need for mitigation, the Ministry of the Environment and Energy guidelines for construction presented in Reference 7 are to be referred to.

PART E. GROUND-BORNE VIBRATION

The assessment of ground-borne vibration impact is confined to the vibration that is produced by the operation of the Line and excludes vibration due to maintenance activities.

In recognition of the fact that the actual vibration response of a building is affected by its own structural characteristics, this document deals with the assessment of ground-borne vibration only on the outside premises. Structural characteristics of buildings are beyond the scope of this protocol and beyond the control of the TTC.

It is recognised that ground-borne vibration can produce air-borne noise inside a structure and there is a direct correlation between the two. The TTC can only control ground-borne noise by controlling ground-borne vibration. Accordingly, ground-borne noise will be predicted and assessed in terms of vibration measured at a point of assessment using the limit in Section 2.0, Vibration Assessment.

1.0 DEFINITIONS

The following definitions are to be used only within the context of Part E of this document.

Point of Assessment:

A point of assessment is any outdoor point on residential property, 15 m or more from the nearest track's centreline, where vibration originating from the Line is received.

Vibration Velocity:

Vibration Velocity is the root-mean-square (rms) vibration velocity assessed during a train pass-by. The unit of measure is metres per second (m/s) or millimetres per second (mm/s). For the purposes of this protocol only vertical vibration is assessed. The vertical component of transit vibration is usually higher than the horizontal. Human sensitivity to horizontal vibration at the frequencies of interest is significantly less than the sensitivity to vertical vibration.

2.0 VIBRATION ASSESSMENT

Vibration velocities at points of assessment shall be predicted during design of the Line. If the predicted rms vertical vibration velocity from the Line exceeds 0.1 mm/sec, mitigation methods shall be applied during the detailed design to meet this criterion to the extent technologically, economically, and administratively feasible. Where it is suitable, a double tie system or its equivalent will be the mitigation method of choice. This is a state of the art vibration isolation system developed by TTC and used where vibration isolation is required on new underground lines (see Reference 8).

Any impact assessment following this protocol shall include a description of the prediction method and the assumptions and data inherent in it. Prediction and measurement methods are being developed by the TTC at the date of this protocol in cooperation with MTO and MOEE.

References

1)A Protocol for Dealing With Noise Concerns During the Preparation, Review and Evaluation of Provincial Highways Environmental Assessments, Ministry of Transportation, February 1986.

2)Model Municipal Noise Control By-Law, Final Report, Publication NPC-101 Technical Definitions, Ministry of the Environment, August 1978.

3)Model Municipal Noise Control By-Law, Final Report, Publication NPC-103 Procedures, Ministry of the Environment, August 1978.

4)Model Municipal Noise Control By-Law, Final Report, Publication NPC-104 Sound Level Adjustments, Ministry of the Environment, August 1978.

5)Model Municipal Noise Control By-Law, Final Report, Publication NPC-105 Stationary Sources, Ministry of the Environment, August 1978.

6)Model Municipal Noise Control By-Law, Final Report, Publication NPC-106 Sound Levels of Road Traffic, Ministry of the Environment, August 1978.

7)Noise Control Guideline For Class Environmental Assessment of Undertakings, February 1980, Ministry of the Environment.

8)Toronto Subway System Track Vibration Isolation System (Double Tie) - Technical Report, TTC Engineering Department, June 1982.

9)**STAMSON 4.1**, Ontario Ministry of the Environment Road and Rail Noise Prediction Software

ATTACHMENT 3

ROAD TRAFFIC DATA

City of Toronto - Traffic Safety Unit

Detailed 24-Hour Count Summary Report

MCCOWAN RD S/B N OF TOWN CENTRE CRT

Category: 24 HOUR

Survey Date: April/18/2013

Station: 2916

Start Time: 00:00

Count Period: 0015 Minutes

TIME	COUNT	TIME	COUNT	TIME	COUNT
00:00:00	94	08:00:00	400	16:00:00	335
00:15:00	89	08:15:00	427	16:15:00	308
00:30:00	100	08:30:00	447	16:30:00	309
00:45:00	89	08:45:00	456	16:45:00	349
01:00:00	65	09:00:00	426	17:00:00	324
01:15:00	57	09:15:00	415	17:15:00	396
01:30:00	53	09:30:00	362	17:30:00	342
01:45:00	35	09:45:00	330	17:45:00	352
02:00:00	24	10:00:00	350	18:00:00	362
02:15:00	34	10:15:00	338	18:15:00	337
02:30:00	17	10:30:00	307	18:30:00	304
02:45:00	25	10:45:00	262	18:45:00	319
03:00:00	25	11:00:00	297	19:00:00	284
03:15:00	31	11:15:00	271	19:15:00	291
03:30:00	26	11:30:00	302	19:30:00	299
03:45:00	16	11:45:00	296	19:45:00	229
04:00:00	33	12:00:00	274	20:00:00	247
04:15:00	19	12:15:00	307	20:15:00	230
04:30:00	25	12:30:00	294	20:30:00	246
04:45:00	18	12:45:00	309	20:45:00	218
05:00:00	33	13:00:00	336	21:00:00	225
05:15:00	37	13:15:00	286	21:15:00	229
05:30:00	49	13:30:00	262	21:30:00	217
05:45:00	100	13:45:00	323	21:45:00	200
06:00:00	182	14:00:00	314	22:00:00	218
06:15:00	222	14:15:00	280	22:15:00	188
06:30:00	235	14:30:00	310	22:30:00	197
06:45:00	251	14:45:00	304	22:45:00	177
07:00:00	295	15:00:00	278	23:00:00	169
07:15:00	307	15:15:00	341	23:15:00	145
07:30:00	394	15:30:00	302	23:30:00	153
07:45:00	371	15:45:00	328	23:45:00	115

Comment:

Printed On: 13 Aug, 2015 1:47:24PM

City of Toronto - Traffic Safety Unit

Detailed 24-Hour Count Summary Report

MCCOWAN RD N/B S OF TRITON RD **Category: 24 HOUR**

Survey Date: April/18/2013

Station: 2917

Start Time: 00:00 **Count Period: 0015 Minutes**

TIME	COUNT	TIME	COUNT	TIME	COUNT
00:00:00	107	08:00:00	344	16:00:00	398
00:15:00	82	08:15:00	291	16:15:00	385
00:30:00	74	08:30:00	308	16:30:00	418
00:45:00	85	08:45:00	300	16:45:00	430
01:00:00	65	09:00:00	274	17:00:00	390
01:15:00	48	09:15:00	292	17:15:00	407
01:30:00	49	09:30:00	276	17:30:00	377
01:45:00	31	09:45:00	260	17:45:00	357
02:00:00	26	10:00:00	227	18:00:00	385
02:15:00	30	10:15:00	252	18:15:00	364
02:30:00	13	10:30:00	277	18:30:00	351
02:45:00	26	10:45:00	245	18:45:00	330
03:00:00	14	11:00:00	300	19:00:00	355
03:15:00	19	11:15:00	290	19:15:00	338
03:30:00	30	11:30:00	272	19:30:00	343
03:45:00	20	11:45:00	310	19:45:00	328
04:00:00	25	12:00:00	264	20:00:00	299
04:15:00	16	12:15:00	291	20:15:00	316
04:30:00	20	12:30:00	272	20:30:00	281
04:45:00	34	12:45:00	305	20:45:00	301
05:00:00	28	13:00:00	285	21:00:00	285
05:15:00	42	13:15:00	300	21:15:00	262
05:30:00	40	13:30:00	286	21:30:00	249
05:45:00	119	13:45:00	310	21:45:00	238
06:00:00	141	14:00:00	330	22:00:00	222
06:15:00	171	14:15:00	355	22:15:00	239
06:30:00	239	14:30:00	392	22:30:00	178
06:45:00	220	14:45:00	365	22:45:00	192
07:00:00	292	15:00:00	378	23:00:00	171
07:15:00	344	15:15:00	406	23:15:00	153
07:30:00	320	15:30:00	395	23:30:00	114
07:45:00	300	15:45:00	448	23:45:00	129

Comment:

City of Toronto - Traffic Safety Unit

Turning Movement Count Summary Report

MCCOWAN RD AT TRITON RD (PX 1485)

Survey Date: 2015-Apr-29 (Wednesday)

Survey Type: Routine Hours

Time Period	Vehicle Type	NORTHBOUND Exits	NB Left	NB Thru	NB Right	NB Total	EASTBOUND Exits	EB Left	EB Thru	EB Right	EB Total	SOUTHBOUND Exits	SB Left	SB Thru	SB Right	SB Total	WESTBOUND Exits	WB Left	WB Thru	WB Right	WB Total		Peds	Bike	Other
08:00-09:00	CAR	989	3	987	0	990	0	2	0	1	3	1,323	0	1,322	8	1,330	11	0	0	0	0	N	0	0	0
	TRK	38	0	37	0	37	0	1	0	0	1	43	0	43	3	46	3	0	0	0	0	S	0	0	0
AM PEAK	BUS	88	42	3	0	45	0	85	0	22	107	29	0	7	64	71	106	0	0	0	0	E	0	0	0
																						W	30	0	0
	TOTAL:	**1,115**	**45**	**1,027**	**0**	**1,072**	**0**	**88**	**0**	**23**	**111**	**1,395**	**0**	**1,372**	**75**	**1,447**	**120**	**0**	**0**	**0**	**0**				
16:00-17:00	CAR	1,346	11	1,343	0	1,354	0	3	0	3	6	1,160	0	1,157	13	1,170	24	0	0	0	0	N	0	0	0
	TRK	31	1	31	0	32	0	0	0	0	0	28	0	28	2	30	3	0	0	0	0	S	1	3	0
PM PEAK	BUS	71	42	4	0	46	0	67	0	26	93	27	0	1	58	59	100	0	0	0	0	E	0	0	0
																						W	37	0	0
	TOTAL:	**1,448**	**54**	**1,378**	**0**	**1,432**	**0**	**70**	**0**	**29**	**99**	**1,215**	**0**	**1,186**	**73**	**1,259**	**127**	**0**	**0**	**0**	**0**				
OFF HR AVG	CAR	1,000	16	995	0	1,011	0	5	0	4	9	958	0	954	12	966	28	0	0	0	0	N	0	0	0
	TRK	49	1	48	0	49	0	1	0	0	1	45	0	45	1	46	2	0	0	0	0	S	0	0	0
	BUS	55	38	1	0	39	0	54	0	24	78	26	0	2	40	42	78	0	0	0	0	E	0	0	0
																						W	21	0	0
	TOTAL:	**1,104**	**55**	**1,044**	**0**	**1,099**	**0**	**60**	**0**	**28**	**88**	**1,029**	**0**	**1,001**	**53**	**1,054**	**108**	**0**	**0**	**0**	**0**				
07:30-09:30	CAR	1,931	18	1,927	0	1,945	0	4	0	2	6	2,531	0	2,529	13	2,542	31	0	0	0	0	N	1	0	0
	TRK	77	2	75	0	77	0	2	0	1	3	86	0	85	4	89	6	0	0	0	0	S	1	2	0
2 HR AM	BUS	162	83	6	0	89	0	156	0	47	203	57	0	10	119	129	202	0	0	0	0	E	0	0	0
																						W	70	0	0
	TOTAL:	**2,170**	**103**	**2,008**	**0**	**2,111**	**0**	**162**	**0**	**50**	**212**	**2,674**	**0**	**2,624**	**136**	**2,760**	**239**	**0**	**0**	**0**	**0**				
16:00-18:00	CAR	2,576	29	2,570	0	2,599	0	6	0	9	15	2,371	0	2,362	22	2,384	51	0	0	0	0	N	0	0	0
	TRK	62	1	62	0	63	0	0	0	1	1	47	0	46	2	48	3	0	0	0	0	S	1	3	0
2 HR PM	BUS	140	83	4	0	87	0	136	0	53	189	56	0	3	112	115	195	0	0	0	0	E	0	0	0
																						W	76	0	0
	TOTAL:	**2,778**	**113**	**2,636**	**0**	**2,749**	**0**	**142**	**0**	**63**	**205**	**2,474**	**0**	**2,411**	**136**	**2,547**	**249**	**0**	**0**	**0**	**0**				
07:30-18:00	CAR	8,507	110	8,478	0	8,588	0	29	0	27	56	8,734	0	8,707	81	8,788	191	0	0	0	0	N	1	0	0
	TRK	333	8	327	0	335	0	6	0	2	8	314	0	312	8	320	16	0	0	0	0	S	3	6	0
8 HR SUM	BUS	522	319	14	0	333	0	508	0	194	702	213	0	19	391	410	710	0	0	0	0	E	0	0	0
																						W	229	0	0
	TOTAL:	**9,362**	**437**	**8,819**	**0**	**9,256**	**0**	**543**	**0**	**223**	**766**	**9,261**	**0**	**9,038**	**480**	**9,518**	**917**	**0**	**0**	**0**	**0**				

Total 8 Hour Vehicle Volume: 19,540

Total 8 Hour Bicycle Volume: 6

Total 8 Hour Intersection Volume: 19,546

Comment:

ATTACHMENT 4

PREDICTION OF TRAFFIC AMBIENT NOISE – SCARBOROUGH TOWN CENTRE

SS WILSON ASSOCIATES - TRAFFIC NOISE PREDICTION MODEL

Consulting Engineers, Richmond Hill, Ontario *August 28, 2014*

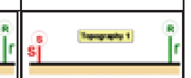
SSE SUBWAY EXTENTION -

AMBIENT DUE TO TRAFFIC - AT TOWNHOUSES, SOUTH WEST CORNER

Source(s) of Road Traffic Noise: **McCowan Rd & Bushby Drive**

Receptor Name: **R1 - 24hr Leq**

SSWA Project Number WA14-040

Record Number	*1*	*2*	*3*	*4*
Include the following Segments in the calculations? (0 or 1)	1 Yes	1 Yes	0 No	0 No
Road Name & Direction	McCowan Rd	Busby Drive	Text	Text
Segment Detail	(Bushby/Town Centre)	Assumed Traffic	Text	Text
Section/Segment Number	S1	S2	S2	S2
MOE Topographic Case (1-11)-See Instructions	1  S and R on flat ground	1  S and R on flat ground		
Traffic Data Input Method	24 hour Data	24 hour Data	24 hour Data	24 hour Data
Alpha (α) Input; Manual or Auto?	Automatic	Automatic		
Notes on your choice of α	As per MOE Procedures	As per MOE Procedures		
Manual Alpha				
Intermediate Surface; Absorptive or Reflective	Reflective	Reflective		
Pavement Type	Asphalt-Concret	Asphalt-Concret	Asphalt-Concret	Asphalt-Concret
Include Effect of Dense Woods?	No	No		
Measured Angle Case Number	1	3	3	3
Angle description	-θ1 Left & +θ2 Right	+θ1 & +θ2 Both on the Right	+θ1 & +θ2 Both on the Right	+θ1 & +θ2 Both on the Right
Angle Theta 1	-90	-90	-90	-90
Angle Theta 2	0	90	90	90
Angle Theta Error Detection Flag				
Subtended Angle (Angle of Exposure), °	90	180	180	180
% increase / year	2.00%	0.00%	0.00%	0.00%
Number of years	10	0	0	0
24 Hour Traffic Data	44196	10000	9999	9999
Medium Truck %	5.00%	2.00%	0.00%	0.00%
Heavy Truck %	5.00%	2.00%	0.00%	0.00%
Daytime Traffic Split	90.00%	90.00%	90.00%	90.00%
Daytime Hours	16	16	16	16
Posted Speed (Km/Hr) [S]	60	50	70	70
Road Gradient (%) [Gradient]	0.00%	0.00%	0.00%	0.00%
Wood Depth (m)	0	0	0	0
Number of Rows of Houses	0	0	0	0
Night time Number of Rows of Houses	0	0	0	0
Percentage of Row Occupied by Houses	80%	80%	80%	80%

SS WILSON ASSOCIATES
Consulting Engineers
Richmond Hill, Ontario
(905)707-5800
info@sswilsonassociates.com

ANALYSIS OF WEEKLY HOURLY TRAFFIC COUNTS BASED ON AADT & CORRESPONDING HOURLY TRAFFIC SOUND LEVELS

Scarborough Station
McCowan Rd NB + SB of Bushby/Town Centre
Our File Number: WA14-040

Date Printed 2015 10 10

Annual Average Daily Traffic, **AADT**, is the total volume of vehicle traffic for a year divided by 365 days.

Predicted Leq for AADT (365 days): 66.0 dBA

DAILY TRAFFIC DATA/COUNTS

Hour End At	MONDAY EB+WB & Date ?	MONDAY % of 24 hr	TUESDAY EB+WB & Date ?	TUESDAY % of 24 hr	WEDNESDAY EB+WB & Date ?	WEDNESDAY % of 24 hr	THURSDAY EB+WB & Date ?	THURSDAY % of 24 hr	FRIDAY EB+WB & Date ?	FRIDAY % of 24 hr	SATURDAY EB+WB & Date ?	SATURDAY % of 24 hr	SUNDAY EB+WB & Date ?	SUNDAY % of 24 hr	Total of all Days	Average of all Days	Average %age	dB Correct'n to Leq24 hr	HOURLY Leq	
1		0.0	-	0.0	-	0.0	769	1.7	-	0.0	-	0.0	-	0.0	769	769	1.7	-3.8	62	NIGHT
2		0.0	-	0.0	-	0.0	403	0.9	-	0.0	-	0.0	-	0.0	403	403	0.9	-6.6	59	NIGHT
3		0.0	-	0.0	-	0.0	207	0.5	-	0.0	-	0.0	-	0.0	207	207	0.5	-9.5	57	NIGHT
4		0.0	-	0.0	-	0.0	191	0.4	-	0.0	-	0.0	-	0.0	191	191	0.4	-9.8	56	NIGHT
5		0.0	-	0.0	-	0.0	209	0.5	-	0.0	-	0.0	-	0.0	209	209	0.5	-9.5	57	NIGHT
6		0.0	-	0.0	-	0.0	443	1.0	-	0.0	-	0.0	-	0.0	443	443	1.0	-6.2	60	NIGHT
7		0.0	-	0.0	-	0.0	1,657	3.7	-	0.0	-	0.0	-	0.0	1,657	1,657	3.7	-0.5	66	NIGHT
8		0.0	-	0.0	-	0.0	2,533	5.7	-	0.0	-	0.0	-	0.0	2,533	2,533	5.7	1.4	67	DAY
9		0.0	-	0.0	-	0.0	2,931	6.6	-	0.0	-	0.0	-	0.0	2,931	2,931	6.6	2.0	68	DAY
10		0.0	-	0.0	-	0.0	2,666	6.0	-	0.0	-	0.0	-	0.0	2,666	2,666	6.0	1.6	68	DAY
11		0.0	-	0.0	-	0.0	2,350	5.3	-	0.0	-	0.0	-	0.0	2,350	2,350	5.3	1.1	67	DAY
12		0.0	-	0.0	-	0.0	2,343	5.3	-	0.0	-	0.0	-	0.0	2,343	2,343	5.3	1.0	67	DAY
13		0.0	-	0.0	-	0.0	2,350	5.3	-	0.0	-	0.0	-	0.0	2,350	2,350	5.3	1.1	67	DAY
14		0.0	-	0.0	-	0.0	2,473	5.6	-	0.0	-	0.0	-	0.0	2,473	2,473	5.6	1.3	67	DAY
15		0.0	-	0.0	-	0.0	2,610	5.9	-	0.0	-	0.0	-	0.0	2,610	2,610	5.9	1.5	68	DAY
16		0.0	-	0.0	-	0.0	2,760	6.2	-	0.0	-	0.0	-	0.0	2,760	2,760	6.2	1.8	68	DAY
17		0.0	-	0.0	-	0.0	2,878	6.5	-	0.0	-	0.0	-	0.0	2,878	2,878	6.5	1.9	68	DAY
18		0.0	-	0.0	-	0.0	2,905	6.6	-	0.0	-	0.0	-	0.0	2,905	2,905	6.6	2.0	68	DAY
19		0.0	-	0.0	-	0.0	2,830	6.4	-	0.0	-	0.0	-	0.0	2,830	2,830	6.4	1.9	68	DAY
20		0.0	-	0.0	-	0.0	2,387	5.4	-	0.0	-	0.0	-	0.0	2,387	2,387	5.4	1.1	67	EVENING
21		0.0	-	0.0	-	0.0	1,984	4.5	-	0.0	-	0.0	-	0.0	1,984	1,984	4.5	0.3	66	EVENING
22		0.0	-	0.0	-	0.0	1,747	4.0	-	0.0	-	0.0	-	0.0	1,747	1,747	4.0	-0.2	66	EVENING
23		0.0	-	0.0	-	0.0	1,456	3.3	-	0.0	-	0.0	-	0.0	1,456	1,456	3.3	-1.0	65	EVENING
24		0.0	-	0.0	-	0.0	1,114	2.5	-	0.0	-	0.0	-	0.0	1,114	1,114	2.5	-2.2	64	NIGHT
	0	0	0	0	0	0	44,196	100	0	0	0	0	0	0	44,196 Theoretical AADT	44,196	100	-29		

RESULTS SUMMARY:

Daily Leq Averages	
Leq 24 Hr	66
Leq Day	68
Leq Eve	66
Leq Night	61

Minimum Hourly Leq	
Lmin Day	67
Lmin Even	65
Lmin Night	56

NOTES:
....
....
....
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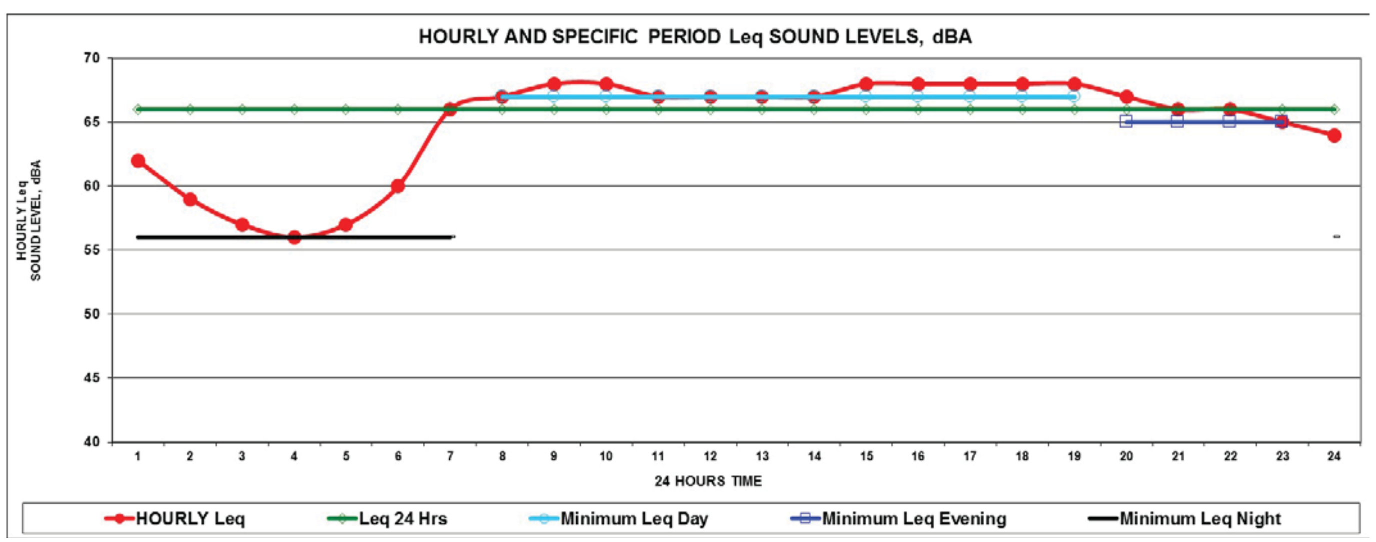
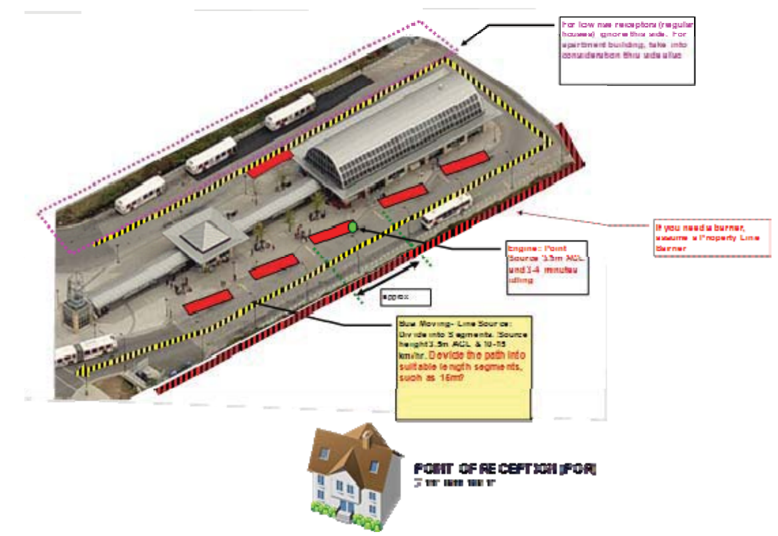


ATTACHMENT 5

SAMPLE BUS TERMINAL SOUND LEVEL PREDICTIONS



Based on N23 Model: 2015-06-06

SS WILSON ASSOCIATES
BUS TERMINAL SOUND LEVEL PREDICTION MODEL

GRAPHIC INSTRUCTIONS

27/07/2017 8:58

File Number : WA14-040

Project Name : Scarborough Centre Station (SSE)

Receptor Name : POR -(Night Time) - 75 Town Centre Court 2nd Storey

Other data

	BUS IDLING DATA										BUS MOVING DATA									
POR Xr Co-Ordinates, m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POR Yr Co-Ordinates, m	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ground Elevation at POR ,m	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
POR Height above ground, m	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
POR Zr Co-Ordinates, m	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5
Consider Source ? (YorN)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Source Code Name	Idling 1	Idling 2	Idling 3	Idling 4	Idling 5	Idling 6	Idling 7	Idling 8	Idling 9	Idling 10	Moving 1	Moving 2	Moving 3	Moving 4	Moving 5	Moving 6	Moving 7	Moving 8	Moving 9	Moving 10
Source Name/Details	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus
Source Xs Co-Ordinates, m	12	-15	-41	-69	5	-5	-23	-41	-59	-77	-95	-77	-59	-41	-23	-5	18	36	54	72
Source Ys Co-Ordinates, m	110	110	110	110	104	135	135	135	135	135	106	106	106	106	106	106	106	106	106	106
Ground Elevation at source, m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Source Height above ground, m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Source Zs Co-Ordinates, m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Point or Line Source (P or L) ?	P	P	P	P	P	P	P	P	P	P	L	L	L	L	L	L	L	L	L	L
Reference Sound Level, dBA	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Reference Dist. for Lp, m	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Source-Receptor Distance,m	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Selected Ds-r ,m	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Frequency	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Geomtrical Spreading	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consider Dist.atten.(Y or N) ?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reference Dist. for Lp, m	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Source-Receptor Distance,m	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Distance Reduction Factor	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Distance Error Flag	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Geometrical Spreading, dB	-18.2	-18.2	-18.6	-19.4	-17.8	-19.7	-19.8	-20.0	-20.4	-20.8	-20.1	-19.5	-18.9	-18.4	-18.1	-17.9	-18.0	-18.3	-18.7	-19.3
ISO Ground Attenuation	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Model (1=none,2=CMHC,3=ISO)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Distance used for calculation	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Source Height above ground, m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
POR Height above ground, m	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Barrier Height Factor(2xbh) (CMHC)																				
Is there a sound Barrier ?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ground Attenuation, dB																				

WA14-040

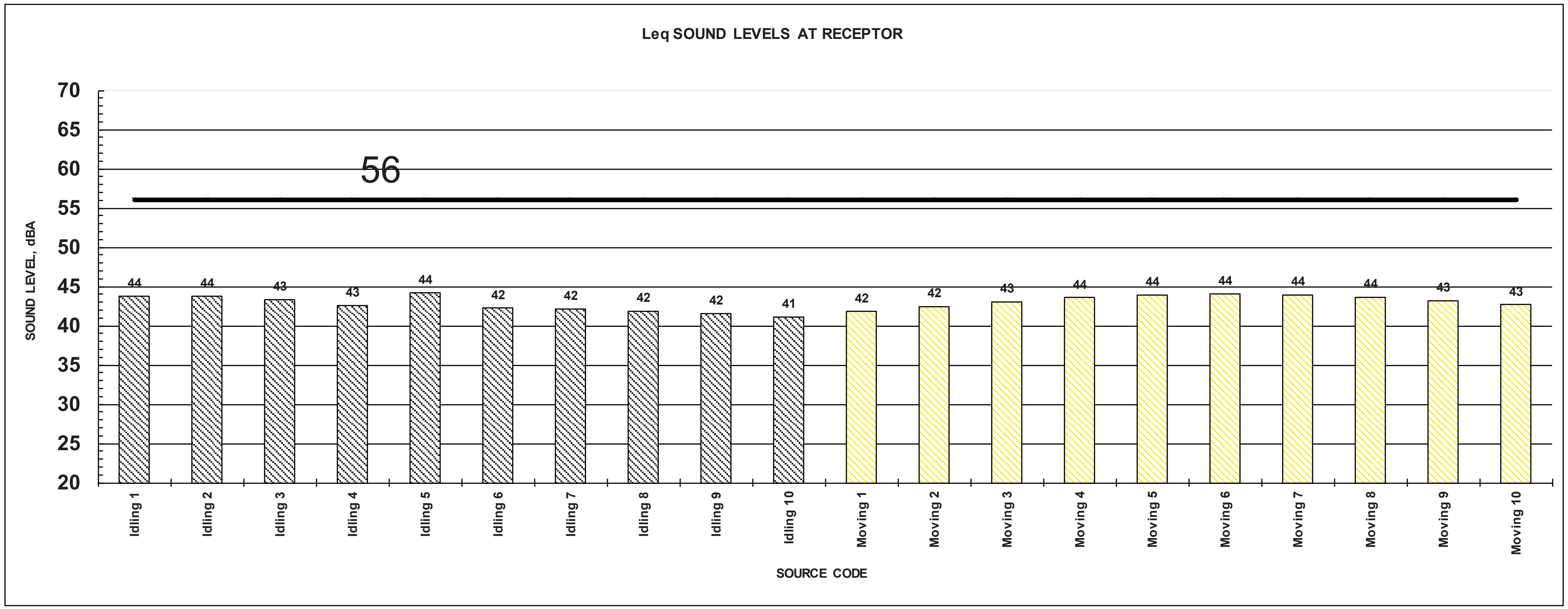
Yes Atmospheric Attenuation	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consider atm.atten.(Y or N) ?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Atmospheric Attenuation, dB	-0.2	-0.2	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3
Barrier Attenuation	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consider Barrier Attenuation (Y or N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ground Elevation at source, m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOURCE-BARRIER DISTANCE(sbd)	7	7	7	7	7	7	7	5	5	5	3	3	3	3	3	3	3	3	3	3
Ground Elevation at Receptor,m	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
RECEIVER-BARRIER DIST.(rbd)	115.3	115.6	121.4	132.9	109.4	137.8	139.5	145.4	151.2	158.9	148.5	138.0	129.0	122.0	117.3	115.2	116.4	120.4	126.8	135.3
BARRIER HEIGHT (bh)																				
BARRIER GND. ELEV.(bge)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BARRIER THICKNESS (bt)																				
Barrier Attenuation, dB																				
Barrier Acoustic Zone	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright
Barrier Top Elevation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Based on N23 Model: 2015-06-06

SS WILSON ASSOCIATES
BUS TERMINAL SOUND LEVEL PREDICTION MODEL

28/04/2016 15:58

File Number : WA14-040
Project Name : Scarborough Centre Station (SSE)
Receptor Name : POR -(Night Time) - 75 Town Centre Court 2nd Storey
Other data



Source Number	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Source Code Name	Idling 1	Idling 2	Idling 3	Idling 4	Idling 5	Idling 6	Idling 7	Idling 8	Idling 9	Idling 10	Moving 1	Moving 2	Moving 3	Moving 4	Moving 5	Moving 6	Moving 7	Moving 8	Moving 9	Moving 10
Source Name/Details	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus
Net Leq @ Receptor,dBA	43.8	43.7	43.3	42.5	44.2	42.2	42.1	41.9	41.6	41.1	41.8	42.5	43.1	43.6	43.9	44.1	44.0	43.7	43.2	42.7

Based on N23 Model: 2015-06-06

SS WILSON ASSOCIATES
BUS TERMINAL SOUND LEVEL PREDICTION MODEL

27/07/2017 9:02

GRAPHIC INSTRUCTIONS

File Number : WA14-040

Project Name : Scarborough Centre Station (SSE)

Receptor Name : POR -(Day time) - 75 Town Centre Court 2nd Storey

Other data

	BUS IDLING DATA										BUS MOVING DATA									
POR Xr Co-Ordinates, m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POR Yr Co-Ordinates, m	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ground Elevation at POR ,m	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
POR Height above ground, m	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
POR Zr Co-Ordinates, m	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5	55.5
Consider Source ? (YorN)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Source Code Name	Idling 1	Idling 2	Idling 3	Idling 4	Idling 5	Idling 6	Idling 7	Idling 8	Idling 9	Idling 10	Moving 1	Moving 2	Moving 3	Moving 4	Moving 5	Moving 6	Moving 7	Moving 8	Moving 9	Moving 10
Source Name/Details	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus
Source Xs Co-Ordinates, m	12	-15	-41	-69	5	-5	-23	-41	-59	-77	-95	-77	-59	-41	-23	-5	18	36	54	72
Source Ys Co-Ordinates, m	110	110	110	110	104	135	135	135	135	135	106	106	106	106	106	106	106	106	106	106
Ground Elevation at source, m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Source Height above ground, m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Source Zs Co-Ordinates, m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Point or Line Source (P or L) ?	P	P	P	P	P	P	P	P	P	P	L	L	L	L	L	L	L	L	L	L
Reference Sound Level, dBA	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Reference Dist. for Lp, m	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Source-Receptor Distance,m	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Selected Ds-r ,m	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Frequency	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Geomtrical Spreading	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consider Dist.atten.(Y or N) ?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reference Dist. for Lp, m	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Source-Receptor Distance,m	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Distance Reduction Factor	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Distance Error Flag	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Geometrical Spreading, dB	**-18.2**	**-18.2**	**-18.6**	**-19.4**	**-17.8**	**-19.7**	**-19.8**	**-20.0**	**-20.4**	**-20.8**	**-20.1**	**-19.5**	**-18.9**	**-18.4**	**-18.1**	**-17.9**	**-18.0**	**-18.3**	**-18.7**	**-19.3**
ISO Ground Attenuation	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Model (1=none,2=CMHC,3=ISO)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Distance used for calculation	122	123	128	140	116	145	146	150	156	164	152	141	132	125	120	118	119	123	130	138
Source Height above ground, m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
POR Height above ground, m	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Barrier Height Factor(2xbh) (CMHC)																				
Is there a sound Barrier ?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ground Attenuation, dB																				

WA14-040

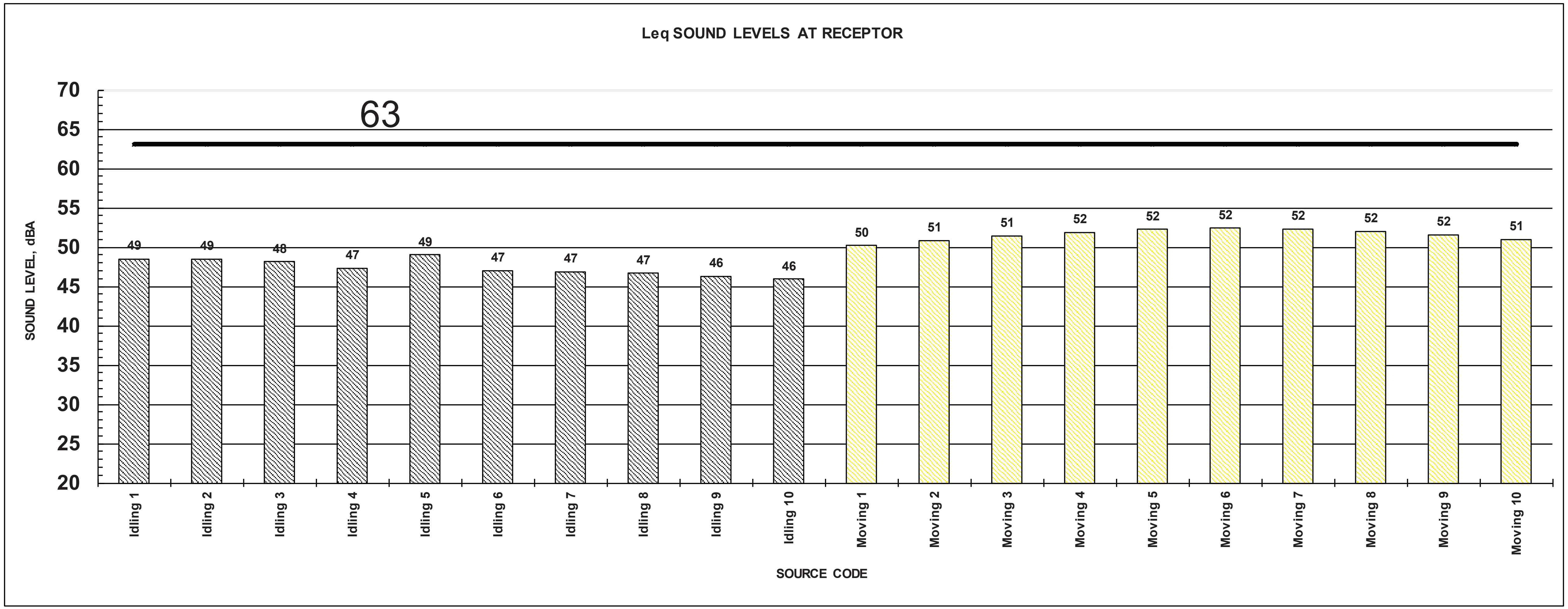
Yes Atmospheric Attenuation	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consider atm.atten.(Y or N) ?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Atmospheric Attenuation, dB	**-0.2**	**-0.2**	**-0.3**	**-0.3**	**-0.2**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.2**	**-0.2**	**-0.2**	**-0.2**	**-0.3**	**-0.3**
Barrier Attenuation	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Consider Barrier Attenuation (Y or N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ground Elevation at source, m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOURCE-BARRIER DISTANCE(sbd)	7	7	7	7	7	7	7	5	5	5	3	3	3	3	3	3	3	3	3	3
Ground Elevation at Receptor,m	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
RECEIVER-BARRIER DIST.(rbd)	115.3	115.6	121.4	132.9	109.4	137.8	139.5	145.4	151.2	158.9	148.5	138.0	129.0	122.0	117.3	115.2	116.4	120.4	126.8	135.3
BARRIER HEIGHT (bh)																				
BARRIER GND. ELEV.(bge)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BARRIER THICKNESS (bt)																				
Barrier Attenuation, dB																				
Barrier Acoustic Zone	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright	bright
Barrier Top Elevation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Based on N23 Model: 2015-06-06

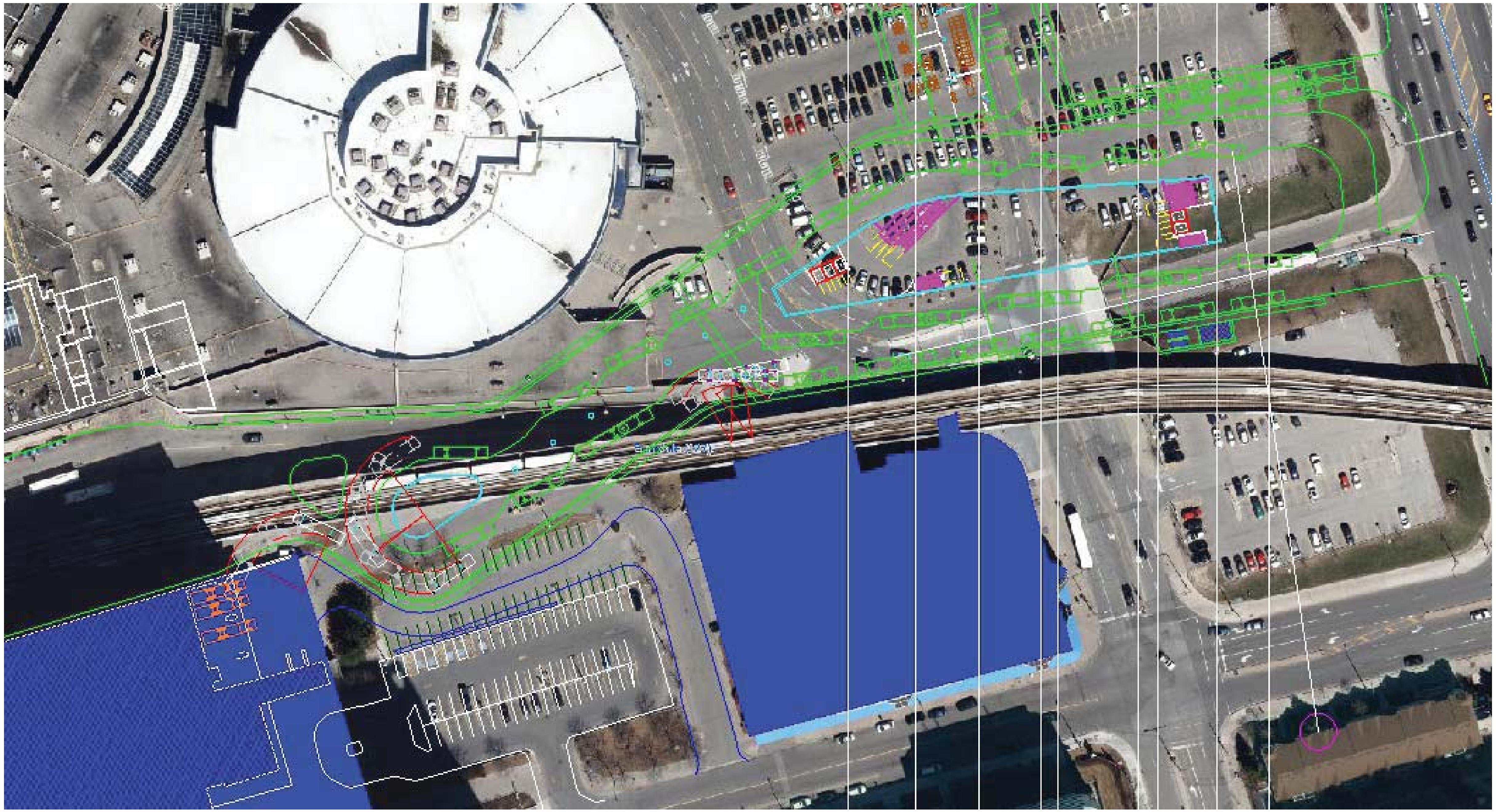
SS WILSON ASSOCIATES
BUS TERMINAL SOUND LEVEL PREDICTION MODEL

28/04/2016 16:01

File Number : WA14-040
Project Name : Scarborough Centre Station (SSE)
Receptor Name : POR -(Day time) - 75 Town Centre Court 2nd Storey
Other data



Source Number	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Source Code Name	Idling 1	Idling 2	Idling 3	Idling 4	Idling 5	Idling 6	Idling 7	Idling 8	Idling 9	Idling 10	Moving 1	Moving 2	Moving 3	Moving 4	Moving 5	Moving 6	Moving 7	Moving 8	Moving 9	Moving 10
Source Name/Details	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus	Bus
Net Leq @ Receptor,dBA	48.5	48.5	48.1	47.3	49.0	47.0	46.9	46.7	46.3	45.9	50.2	50.8	51.4	51.9	52.3	52.4	52.3	52.0	51.6	51.0



Cad Model for Noise Modeling of Proposed STC Bus Terminal

ATTACHMENT 6

ACTUAL MEASUREMENTS OF AMBIENT AND SUBWAY GROUND-BORNE VIBRATION LEVELS

1. OBJECTIVES OF THESE EXPERIMENTAL FIELD MESERMENTS

The primary objectives of this attachment are summarised as follows:

a) To verify the accuracy of the previously developed sound/vibration prediction model as it applies to the current subway line.
b) To demonstrate the potential sound and vibration levels due to train pass bys without any mitigation and compare the same with actual indoor ambient sound and vibration levels inside one of the most critical points of reception.

Therefore, it was not the intent of this fieldwork to be used as a consistent method for prediction at all other receptors.

2. BACKGROUND

As part of the proposed SSE subway project, SS Wilson Associates carried out measurements of ground-borne vibration levels for the following purposes:

1. Confirmation of typical pass-by vibration levels due to subway train movements within two subway lines; the Bloor-Danforth Line and the Sheppard East Line as measured on the ground levels at several locations/areas in Toronto.
2. Actual background/ambient vibration levels inside the Scarborough General Hospital (the Hospital).
3. Measurements of typical ground-borne vibration levels due to the pass-by of surface vehicular road traffic on typical Toronto Streets.

The objectives and details of each measurement session is addressed in the following sections.

3. MEASUREMENT EQUIPMENT

The following instrumentation was used:

- PCB (ICP) accelerometer Scantek Model PV-57A.
- Rion NA-28, Type 1 Sound/Vibration Level and Frequency Real Time Analyzer (RTA).
- NTi-XL2 Type 1 Sound/Vibration Level and Frequency Real Time Analyzer (RTA).
- Bruel & Kjaer Calibration Exciter Type 4294.
- Other ground installation kits

Figure A6.1 shows a typical field instrumentation set-up.

FIGURE A6.1 - TYPICAL MEASUREMENT

For soft ground cases, the accelerometer was rigidly mounted on an aluminum spike which was driven into the undisturbed ground to approximately 6" below the surface. This assembly is used to measure the vertical vibration level component.

For hard ground and finished flooring cases, the accelerometer was rigidly adhered to the ground/surfaces using the special wax recommended by the manufacturer of the equipment.

The Real Time Analyzers were set to read and to store the 1/3 Octave Bands for each pass-by vibration event on a continuous basis with more interest in the analysis corresponding to the "maximum" levels due to the entire event (subway train/vehicle) pass-by. The vibration levels reported are RMS vibration acceleration levels in dB re 10^-5 m/sec.sq (referred to in this document as La in dB, ref. 10^{-5} m/sec.sq) . Adequate and/or continuous sampling measurements were taken depending on the desired measurement results which were then analyzed in our laboratory to present the required pass-by results, frequency analysis, overall measured vibration levels, etc. to suite.

In all cases, a calibration signal was used to calibrate the analyzers as shown in Figure A6.2 using "1g" calibration signal at 160 Hz.

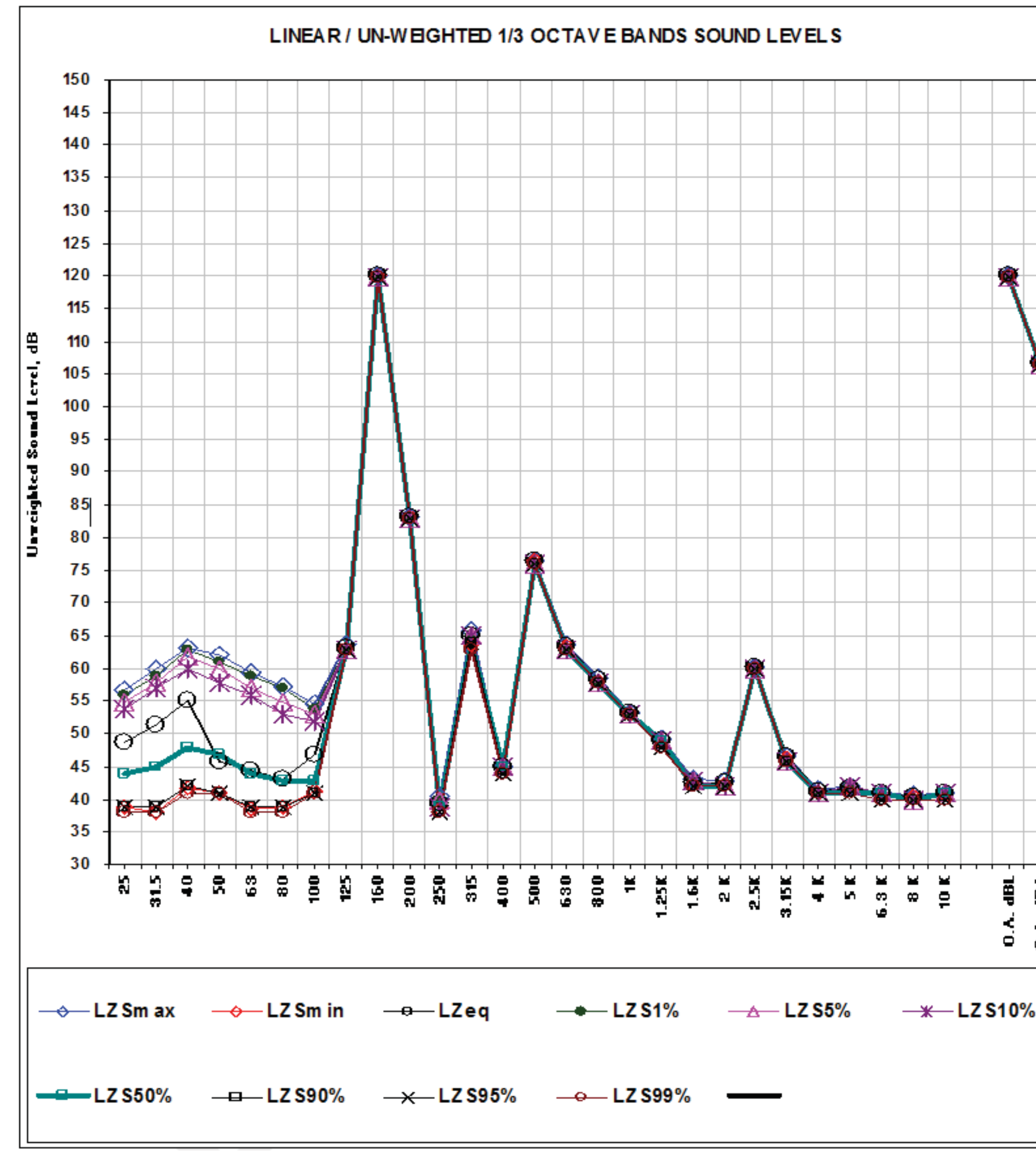


FIGURE A6.2 - TYPICAL 1g VIBRATION CALIBRATION SIGNAL

4. **TYPICAL SUBWAY TRAIN PASS-BY VIBRATION LEVELS DUE TO MOVEMENTS WITHIN THE BLOOR-DANFORTH SUBWAY LINE**

The noted subway line has been constructed based on conventional track fixation methods without consideration for vibration isolation as was the common practice several decades ago.

The objective of this investigation is summarized as follows:

a) To study typical vibration propagation rates with distance from the subway alignment.
b) To compare the measured results with the well established prediction model used by SS Wilson Associates for subway vibration level predictions.
c) To compare the un-mitigated vibration levels with ambient vibration levels measured at some receptor locations

Figure A6.3 illustrates the subject area of this investigation.

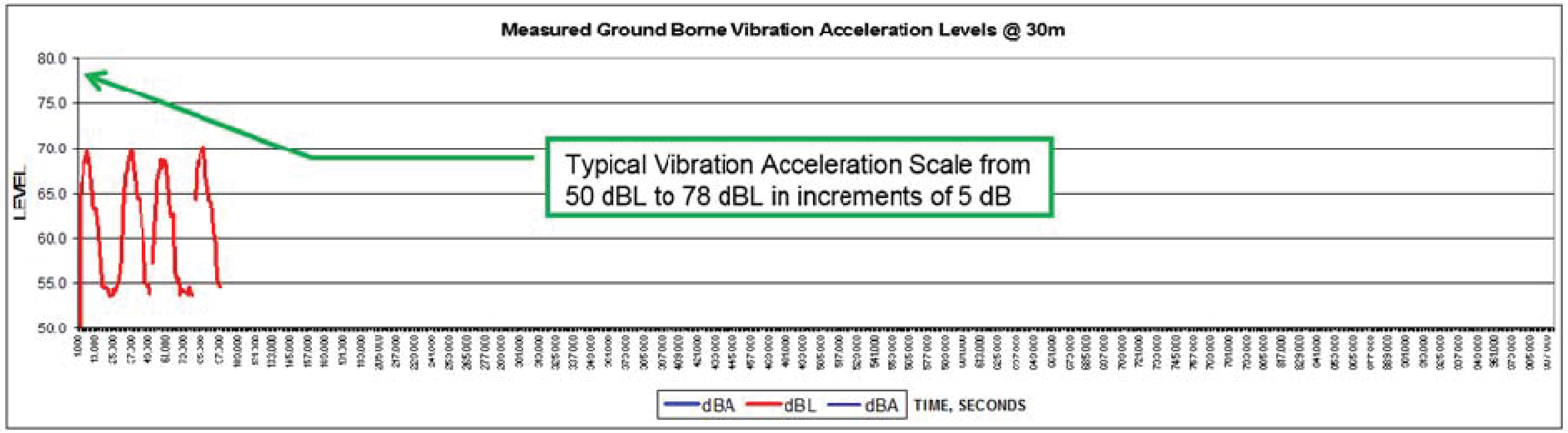
FIGURE A6.3 - THE SUBJECT MEASUREMENT

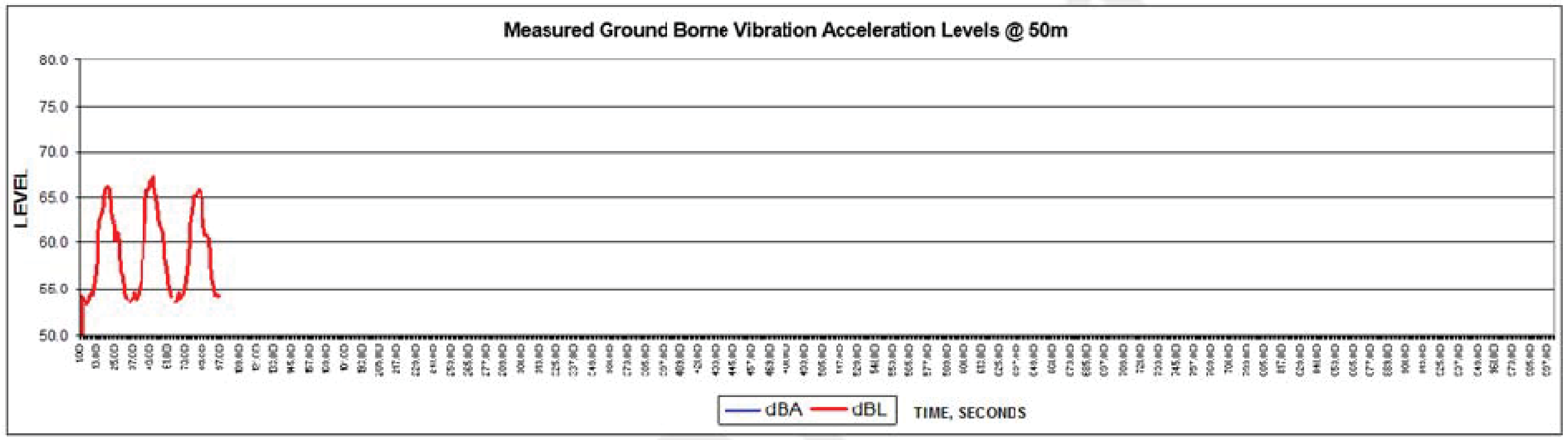
FIGURE A6.4 - THE SUBJECT MEASUREMENT LOCATIONS

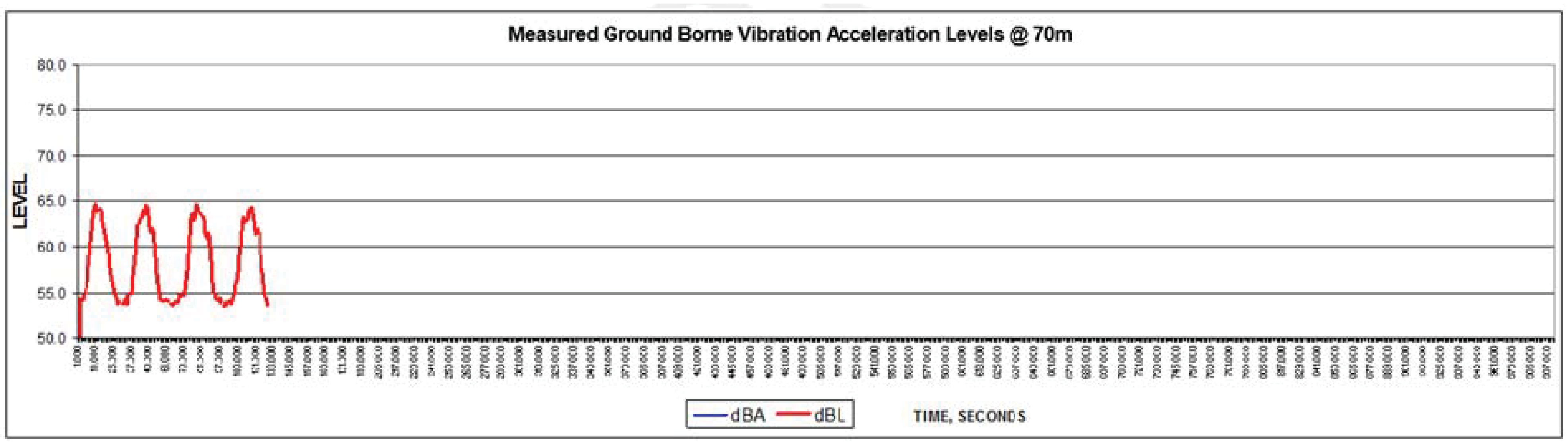
The following Figure A6.5 illustrates the results of the series of ground (park ground) subway pass-by vibration level measurements at the noted lateral distance setbacks from the subway alignments (no vibration isolation):

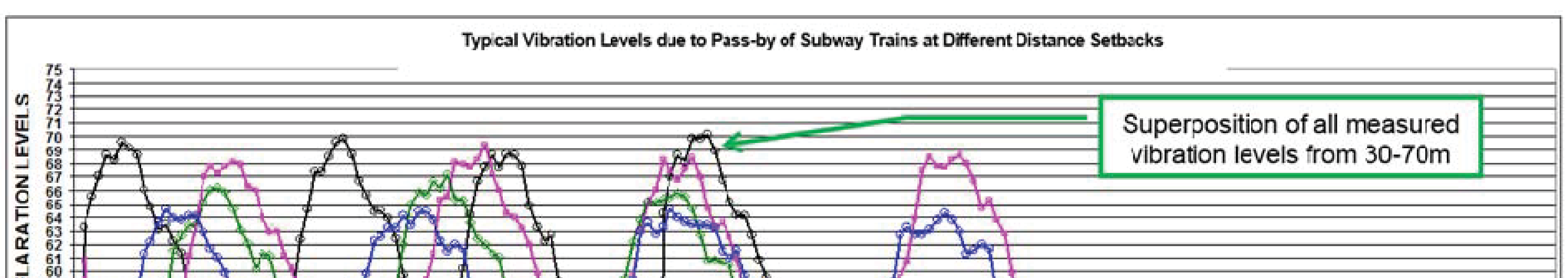
The following is a summary of the results for this case:

- Pass-by @ 30m: La= 70 dB (in Acceleration dB re 10^-5 m/sec.sq.)
- Pass-by @ 40m: La= 68 dB (in Acceleration dB re 10^-5 m/sec.sq.)
- Pass-by @ 50m: La= 66 dB (in Acceleration dB re 10^-5 m/sec.sq.)
- Pass-by @ 70m: La= 64 dB (in Acceleration dB re 10^-5 m/sec.sq.)


Measured Ground Borne Vibration Acceleration Levels @ 30m
LEVEL
80.0
75.0
70.0
65.0
60.0
55.0
50.0
Typical Vibration Acceleration Scale from 50 dBL to 78 dBL in increments of 5 dB
dBA
dBL
dBA
TIME, SECONDS


Measured Ground Borne Vibration Acceleration Levels @ 50m
LEVEL
80.0
75.0
70.0
65.0
60.0
55.0
50.0
dBA
dBL
TIME, SECONDS


Measured Ground Borne Vibration Acceleration Levels @ 70m
LEVEL
80.0
75.0
70.0
65.0
60.0
55.0
50.0
dBA
dBL
TIME, SECONDS


Typical Vibration Levels due to Pass-by of Subway Trains at Different Distance Setbacks
Superposition of all measured vibration levels from 30-70m
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60

5. TYPICAL MEASURED AMBIENT VIBRATION LEVELS INSIDE SCARBOROUGH GENERAL HOSPITAL

One of the identified very sensitive areas in proximity to the proposed subway alignment is the well established Scarborough General Hospital shown in Figure A6.6 where the SSE subway alignment is located further east.

Accordingly, a decision was made to undertake extensive background/ambient ground-borne vibration level measurements inside many vibration-sensitive areas and rooms within the hospital.

FIGURE A6.6 - SCARBOROUGH GENERAL HOSPITAL- TORONTO

It is important to note that in a hospital environment there are numerous internal sources of noise and vibration including rotating machinery/motors, people walking, HVAC system and miscellaneous activities.

Figure A6.7 is a summary of the actually measured ground-borne vibration levels with varying degrees of occupancies and operational levels.

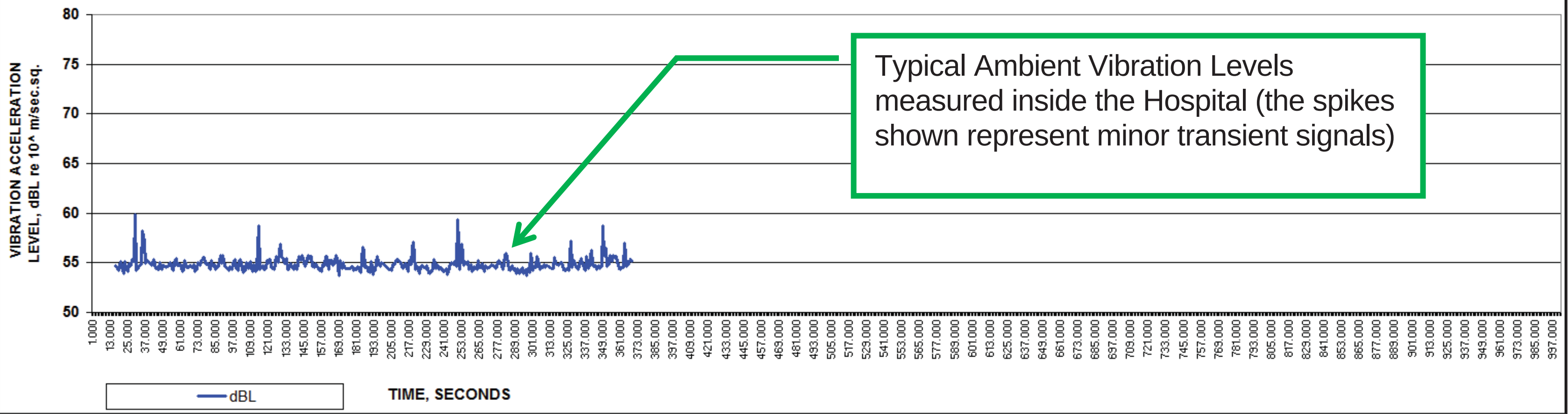
From the extensive measurements, the following is a summary of the measured vibration levels inside the Hospital Building:

- Lowest Measured Levels: La= 53 dB (in Acceleration dB re 10^-5 m/sec.sq.)
- Highest Measured Levels: La= 59 dB (in Acceleration dB re 10^-5 m/sec.sq.)
- Typical Inside Transient Levels: La= up to 62 dB (in Acceleration dB re 10^-5 m/sec.sq.)

FILE NUMBER: WA14-040

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
NTi MEMORY NUMBER: X-Ray Centre- Ground Floor
NTi FILE NAMES: SLM003
Text

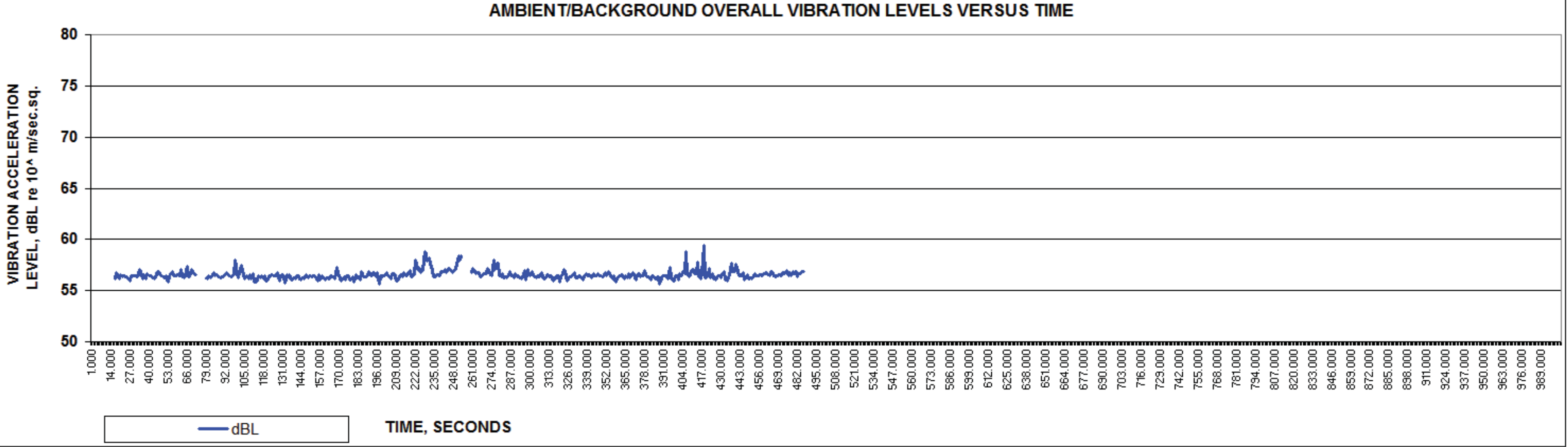
AMBIENT/BACKGROUND OVERALL VIBRATION LEVELS VERSUS TIME



FILE NUMBER: WA14-040

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
NTi MEMORY NUMBER: Nuclear Room, 1st Floor
NTi FILE NAMES: SLM006
Text

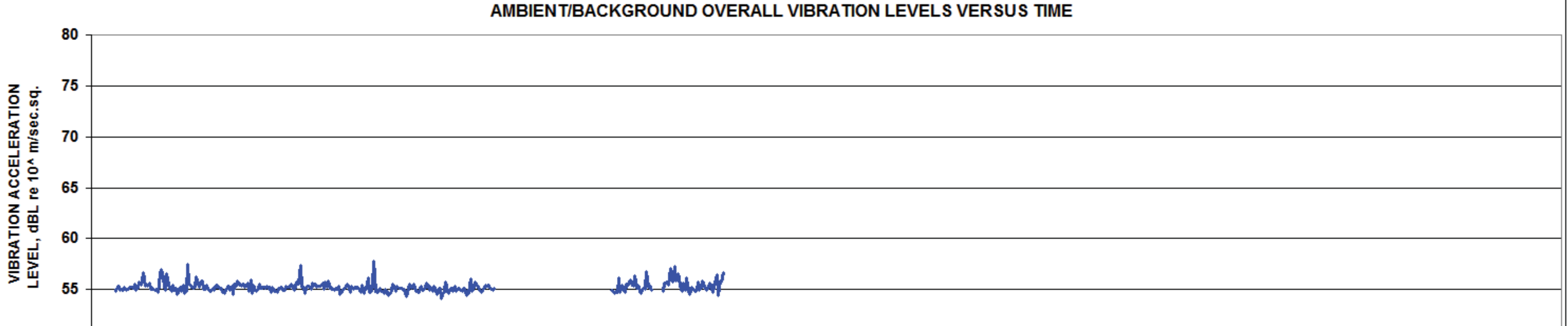
AMBIENT/BACKGROUND OVERALL VIBRATION LEVELS VERSUS TIME



FILE NUMBER: WA14-040

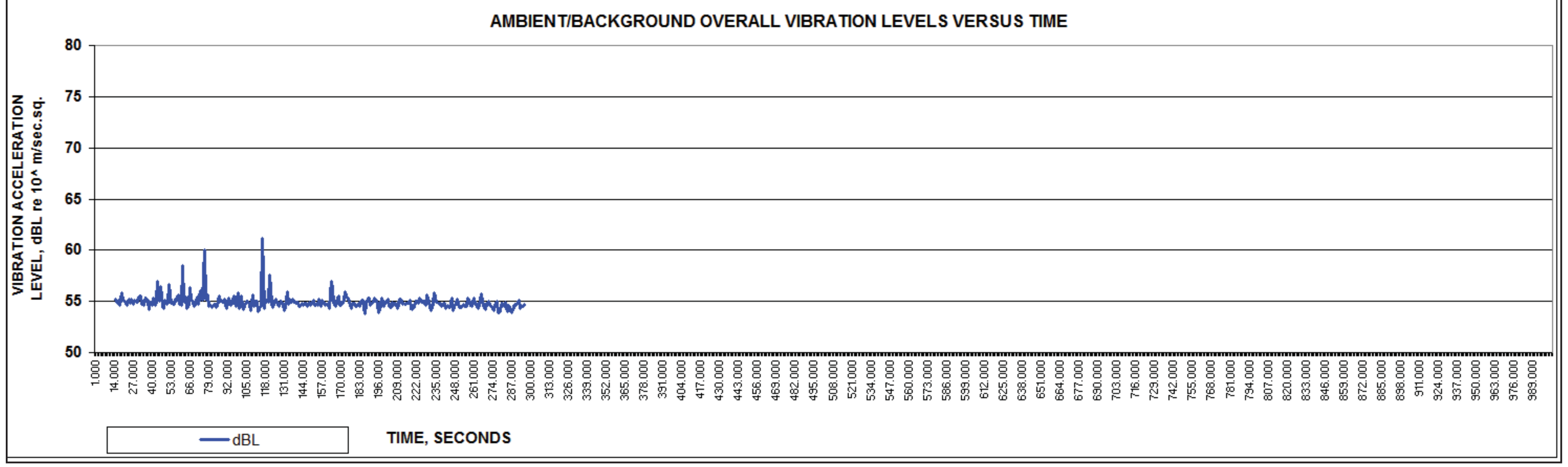
SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
NTi MEMORY NUMBER: ANGIO RM #8
NTi FILE NAMES: SLM007
Text

AMBIENT/BACKGROUND OVERALL VIBRATION LEVELS VERSUS TIME



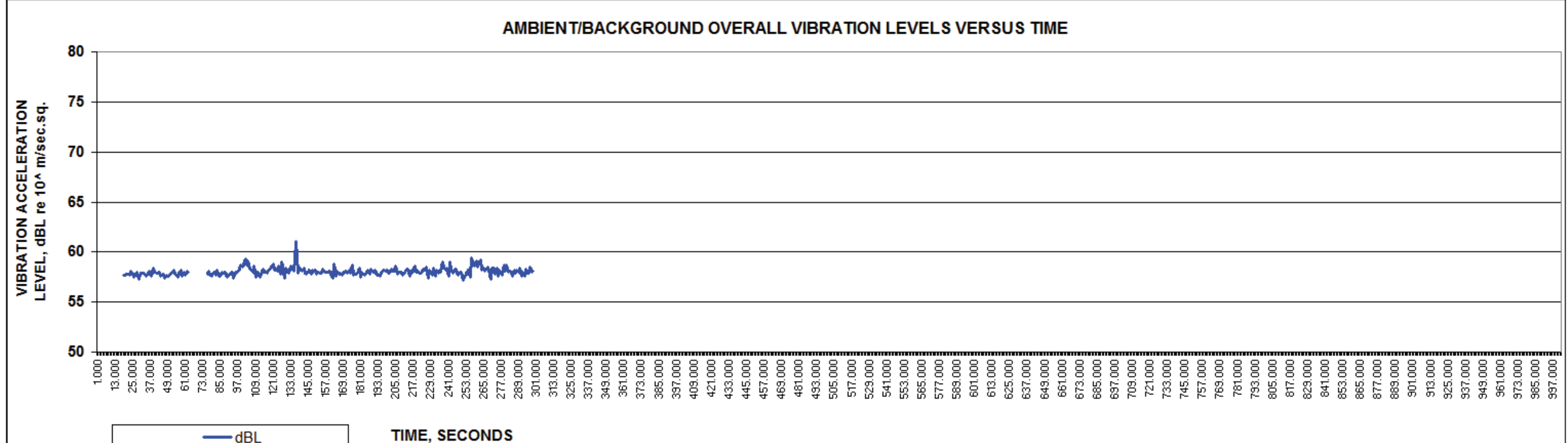
FILE NUMBER: WA14-040

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
NTi MEMORY NUMBER: Sleeping Rm- 5th Floor
NTi FILE NAMES: SLM009
Text



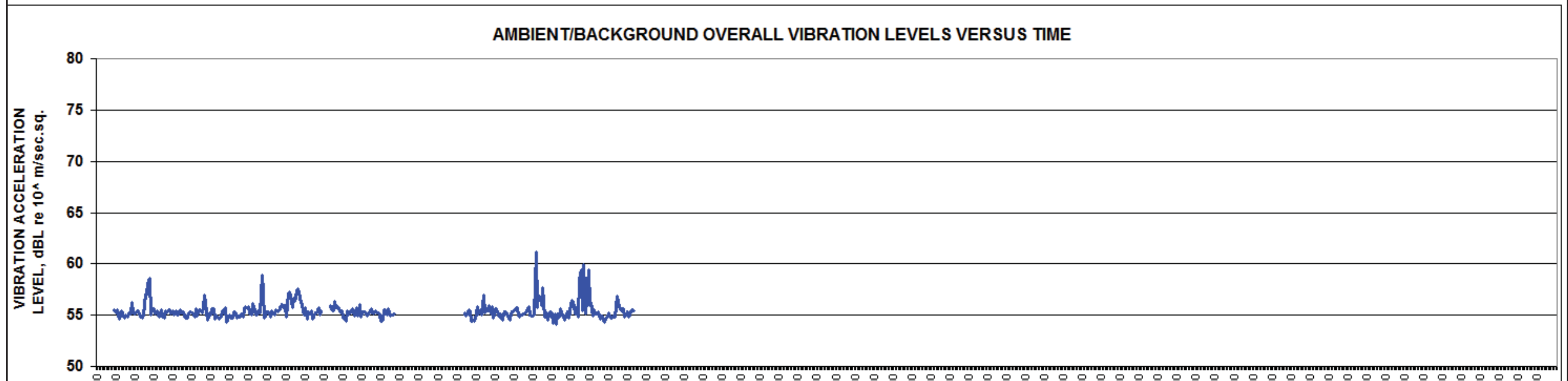
FILE NUMBER: WA14-040

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
NTi MEMORY NUMBER: X-Ray Rm#1-5th Fl
NTi FILE NAMES: SLM011
Text



FILE NUMBER: WA14-040

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
NTi MEMORY NUMBER: IndoscopyRm#2-3rd Fl
NTi FILE NAMES: SLM
Text



7

SS WILSON ASSOCIATES

Consulting Engineers, Richmond Hill

FILE NUMBER: **WA14-040**

AMBIENT DATA ANALYSIS FROM NTi SOUND/VIBRATION ANALYZER

AMBIENT/BACKGROUND VIBRATION LEVELS MEASUREMENTS (in Acceleration dB re 10^-5 m/sec.sq.)

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
OTHER 1 ....
OTHER 2 ....
....

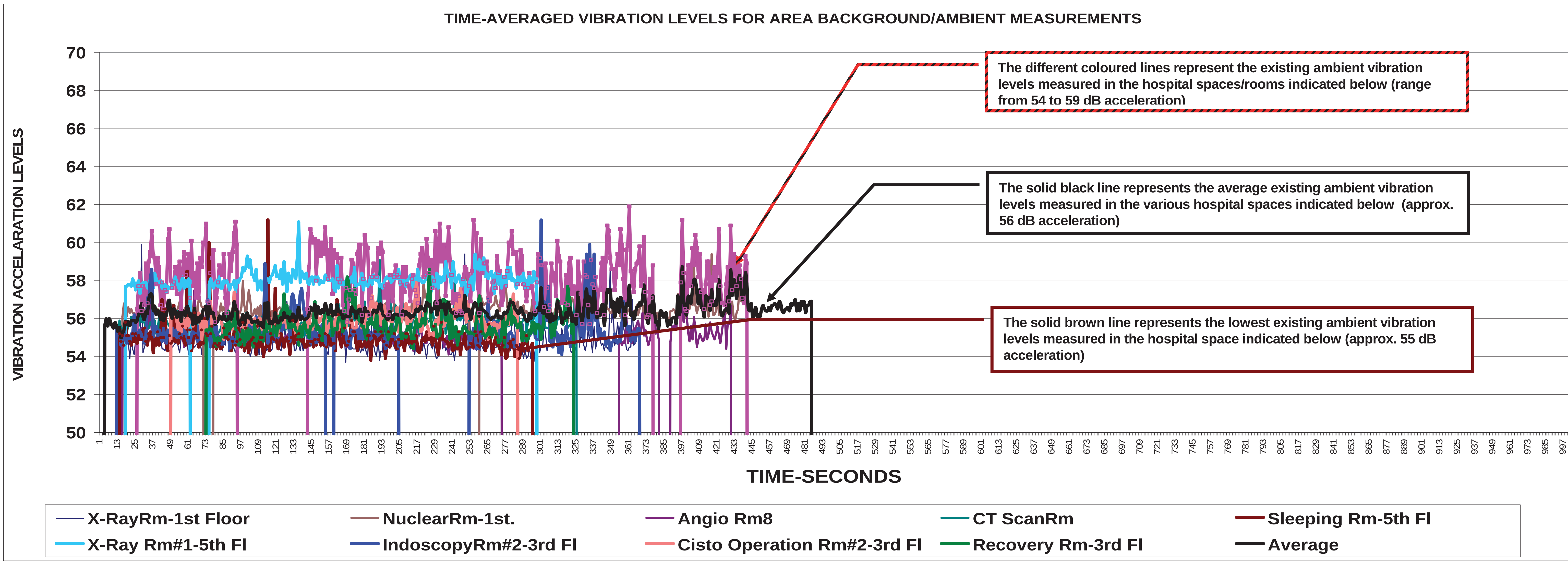


FIGURE A6.9.a : SUMMARY OF MEASURED EXISTING AMBIENT VIBRATION LEVELS INSIDE THE SCRBOROUGH GENERAL HOSPITAL

7

SS WILSON ASSOCIATES

Consulting Engineers, Richmond Hill

FILE NUMBER: **WA14-040**

AMBIENT DATA ANALYSIS FROM NTi SOUND/VIBRATION ANALYZER

AMBIENT/BACKGROUND VIBRATION LEVELS MEASUREMENTS (in Acceleration dB re 10^-5 m/sec.sq.)

SCARBOROUGH GENERAL HOSPITAL
EXISTING AMBIENT MEASUREMENTS
OTHER 1 ....
OTHER 2 ....
....

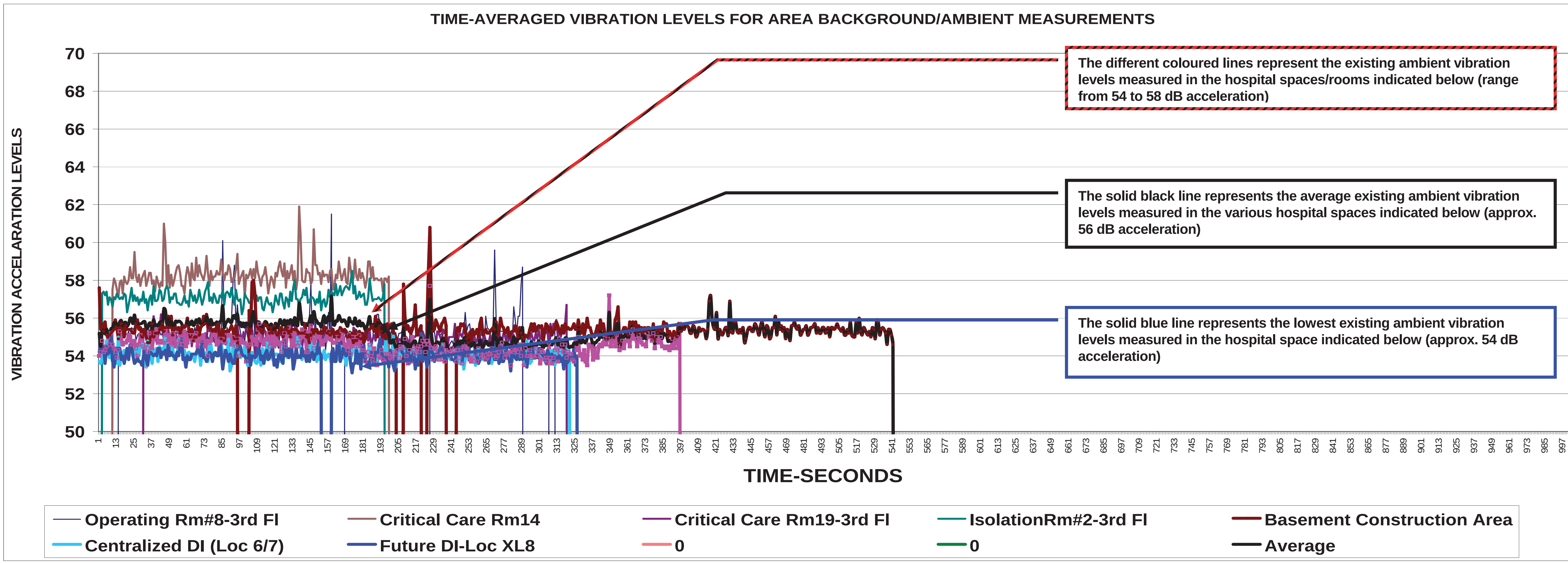


FIGURE A6.9.b : SUMMARY OF MEASURED EXISTING AMBIENT VIBRATION LEVELS INSIDE THE SCRBOROUGH GENERAL HOSPITAL

Comparison Between Typical Subway Pass-Bys and the Ambient Levels Inside the Hospital

On the assumption that the proposed subway alignment would be located at an approximate distance setback of 30m from the closest critical room towards the east end of the hospital building, a comparison is presented in Figures A6.9a,b and A6.10 which demonstrate the existing ambient vibration levels inside the Hospital building with approximate subway pass-by vibration levels as typically measured outside without and with floating slab isolation. The foregoing results do not include the expected transfer function from outside to the inside of the building and the possibility for the subway being located closer than 30m to the Hospital.

The results do, however show the need for further detailed investigation of this potential impact during the detailed design stage of the subway.

Importance of Measuring the Ambient Vibration Levels Inside the Hospital

Unlike all other noise sensitive land uses where the generally accepted criteria specify a maximum vibration level that should not be exceeded inside these uses, the hospital presents a special case in this specific application due to the nature of the specific clinical activities being conducted on the east side of the hospital. These locations are the nearest to the subway alignment.

In order to minimize and preferably to eliminate the vibration impact within this critical wing of the hospital, the most prudent approach is to maintain the status quo as far as their existing vibration acceleration levels are concerned with a maximum increase of 2-3 dB to the existing ambient vibration levels as a result of the subway train movements.

Accordingly, the charts presented herein illustrate the actually measured ground vibration levels inside the hospital due to a variety of existing equipment and operations that should not be materially exceeded (2-3 dB).

SS WILSON ASSOCIATES

Consulting Engineers, Richmond Hill

FILE NUMBER: WA14-040

AMBIENT DATA ANALYSIS FROM NTi SOUND/VIBRATION ANALYZER

AMBIENT/BACKGROUND VIBRATION LEVELS MEASUREMENTS (in Acceleration dB re 10^-5 m/sec.sq.)

SCARBOROUGH GENERAL HOSPITAL

EXISTING AMBIENT MEASUREMENTS VS EXISTING TTC PASS-BY @30m - NO MITIGATION

OTHER 1 ....

OTHER 2 ....

....

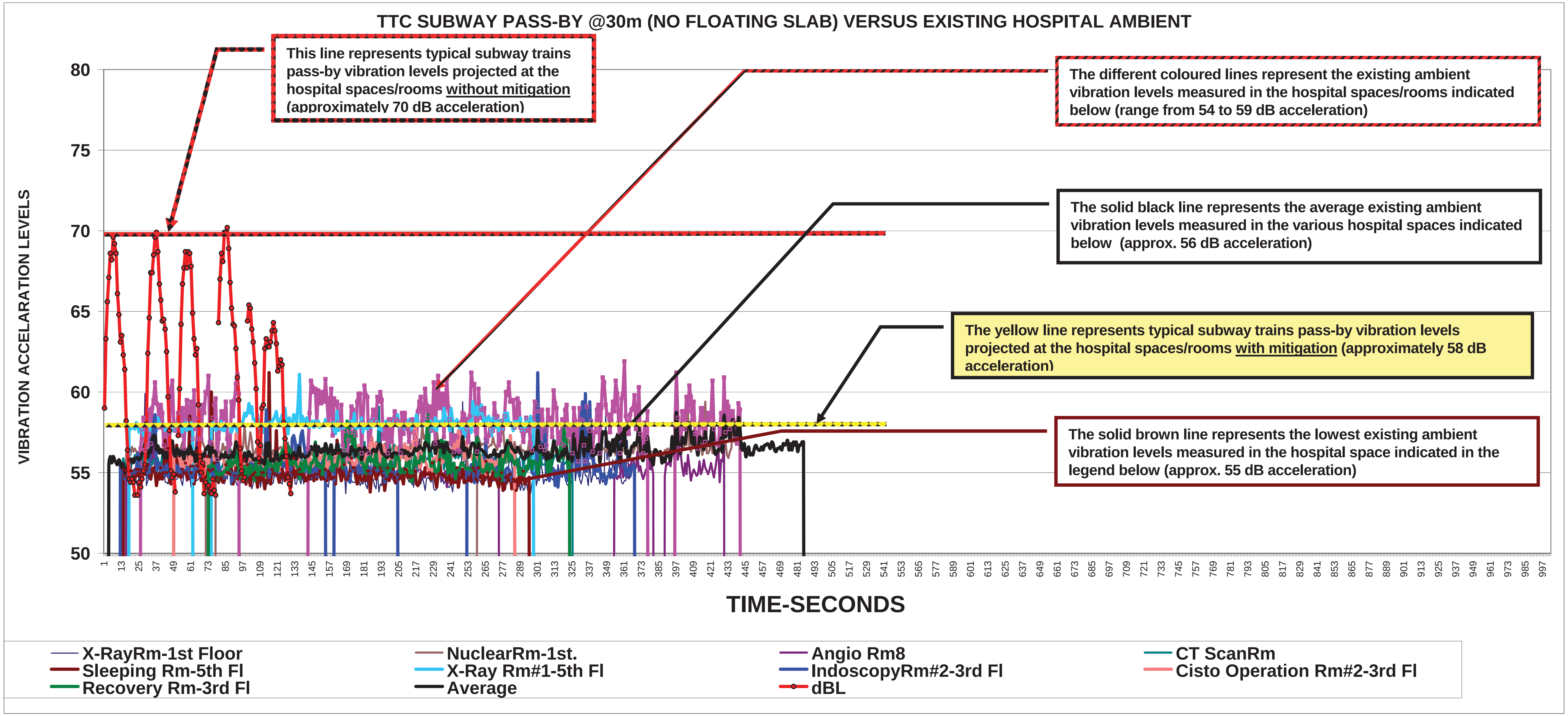


FIGURE A6.10 : COMPARISON BETWEEN MEASURED EXISTING AMBIENT VIBRATION LEVELS INSIDE THE HOSPITAL AND TYPICAL SUBWAY TRAIN VIBRATION LEVELS OUTSIDE OF THE HOSPITAL BUILDING

Concluding Remarks

Based on the above results of ambient vibration levels in the Hospital, it is therefore recommended that due to the critical nature of the hospital functions, the maximum subway pass-by levels should not exceed a vibration acceleration level of 55dB (acceleration re 10^-5 m/sec.sq) and that further detailed investigation of this potential impact be addressed in more details during the detailed design stage of the subway.

6. MEASURED SUBWAY VIBRATION LEVELS ALONG THE SHEPPARD SUBWAY LINE

One of the issues of concern for the SSE project is the fact the proposed alignment is planned directly under a very limited number of residential buildings and other buildings.

In order to gain confidence with the expected low levels of subway pass-by vibration levels in such a situation where the plans for the SSE call for the use of floating slabs for vibration control, new field measurements were undertaken at comparable locations along the Sheppard Subway line for confirmation and confidence purposes.

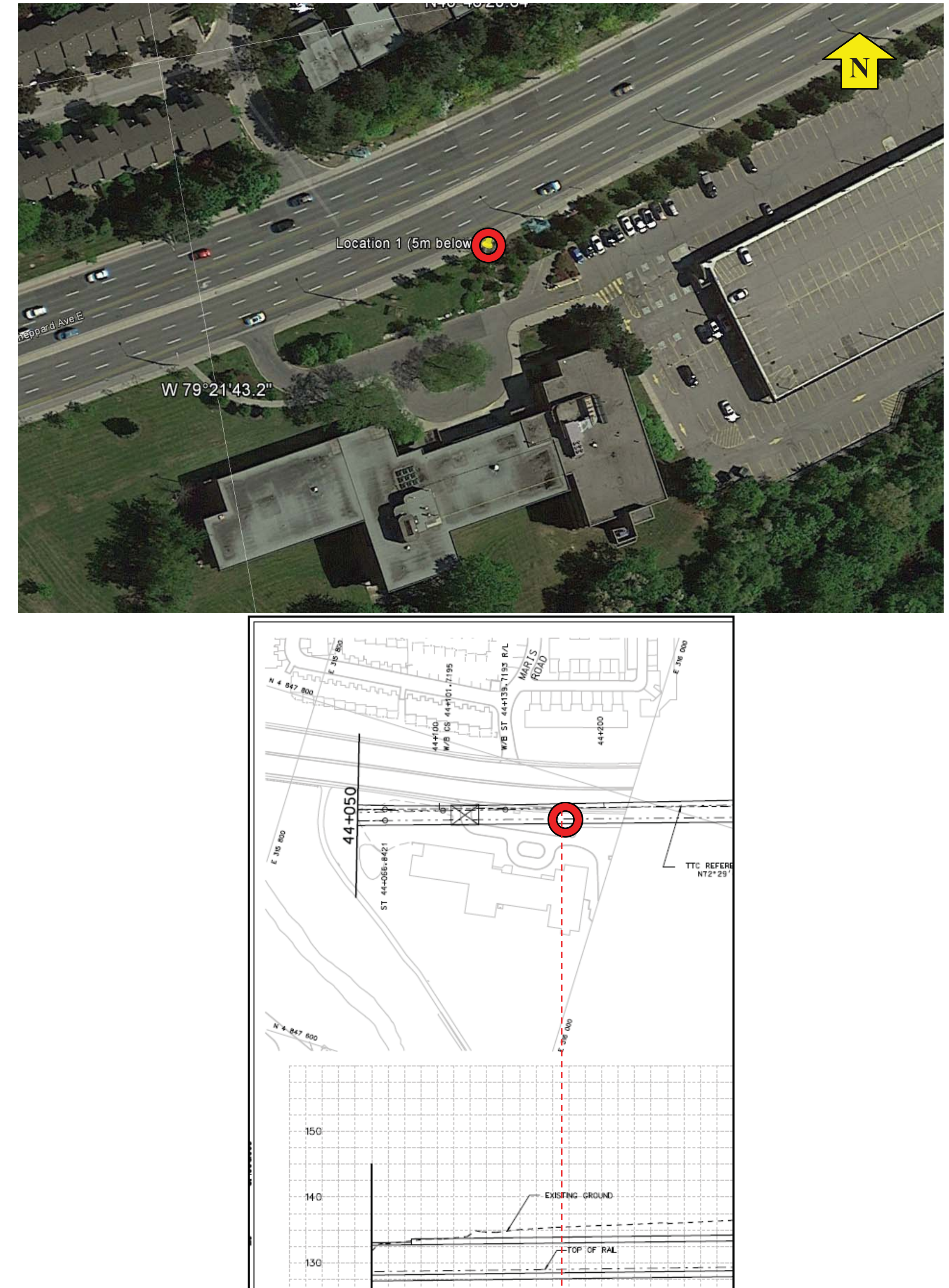


FIGURE A6.11 - SHEPPARD SUBWAY TRAIN VIBRATION LEVEL MEASUREMENT LOCATION 1

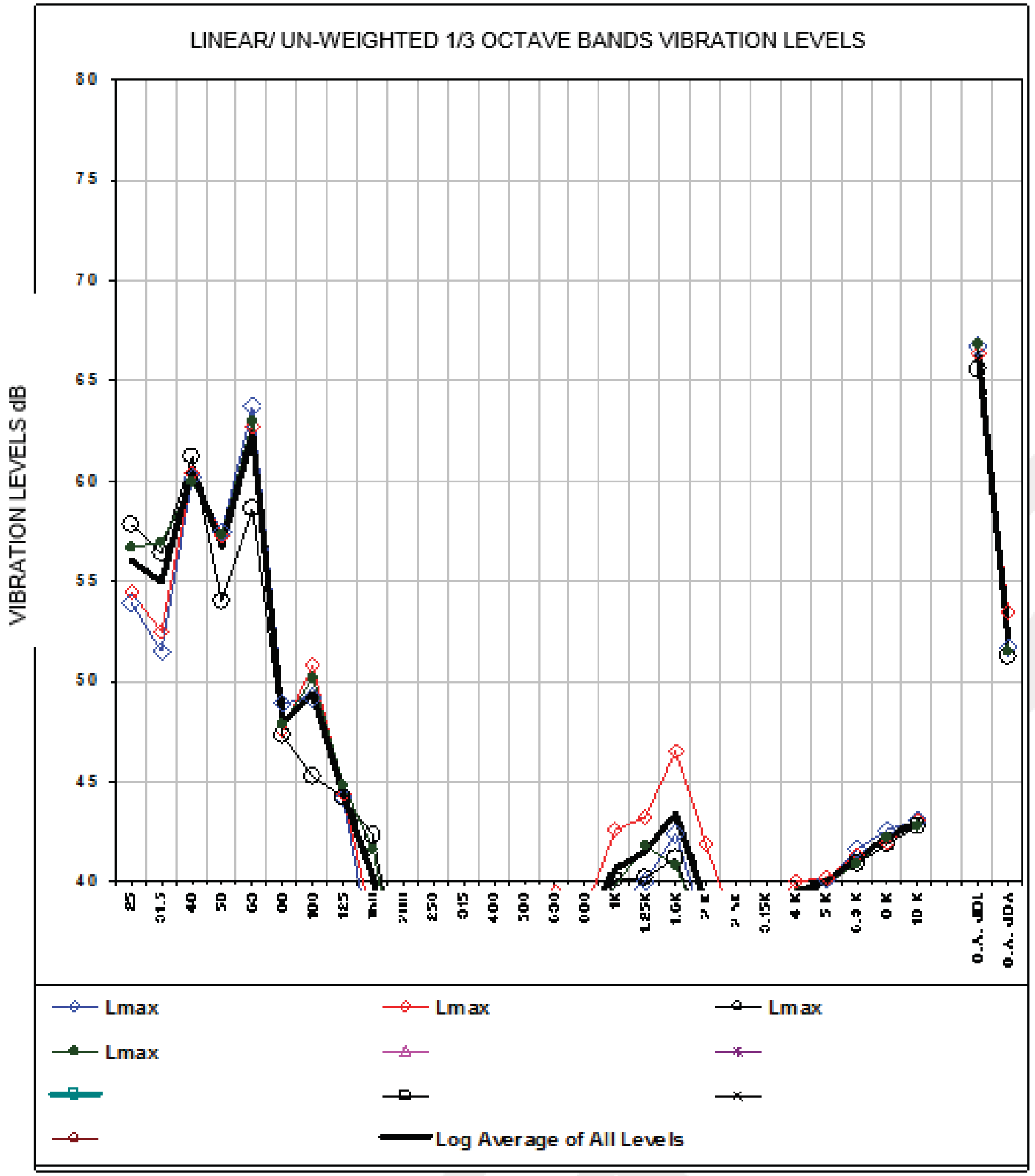


FIGURE A6.12 - RESULTS OF THE TRAIN VIBRATION LEVEL MEASUREMENT VS. VIBRATION FREQUECNY (1/3 OCTAVE BANDS) AT LOCATION 1

Figure A6.11 illustrates measurement location #1 as well as the existing Sheppard Line drawings for the same area and Figure A6.12 illustrates the maximum vibration levels of the subway pass-bys.

Figure A6.13 illustrates measurement location #2 (in close proximity to special tracks-crossings) and the existing Sheppard Line drawings for the same area. Figure A6.14 illustrates the train vibration levels at location #2 for several pass-bys.

From the results at Location 1, it is concluded that the subway pass-by levels immediately below the line will result in vibration acceleration levels of approximately 66 dB (acceleration re 10^-5 m/sec.sq) at such a shallow depth. The levels will increase considerably below La 66dB with deeper subway alignment as evident from Location 2.

At Location 2, it is concluded that the subway pass-by levels immediately below the line will result in vibration acceleration levels of up to approximately 60 dB (acceleration re 10^-5 m/sec.sq) at such depth.

This information was used for demonstration purposes and for verification of the model used in this report. As such locations of various depth and relative position to special track work were selected.

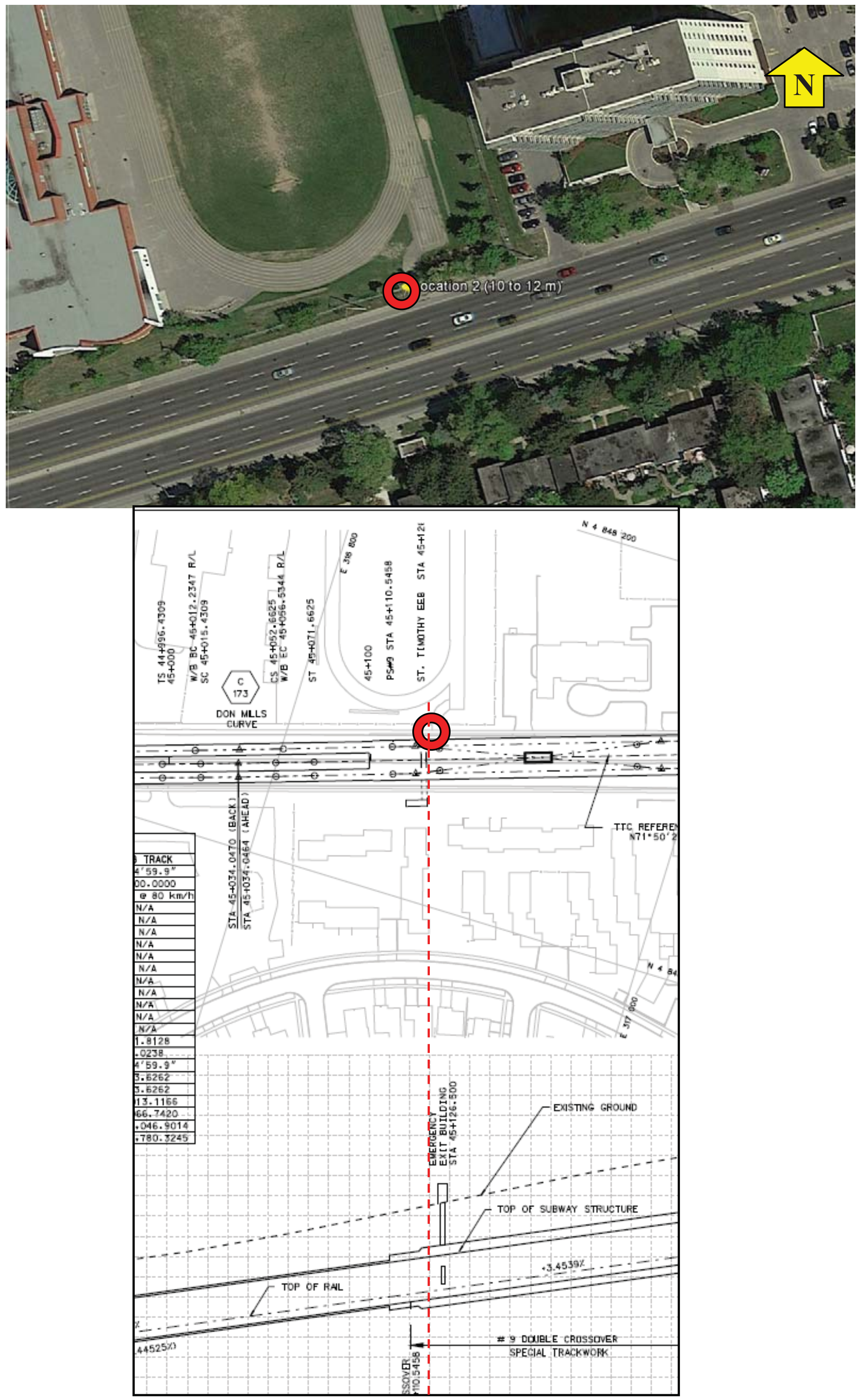


FIGURE A6.13 - SHEPPARD SUBWAY TRAIN VIBRATION LEVEL MEASUREMENT LOCATION 2

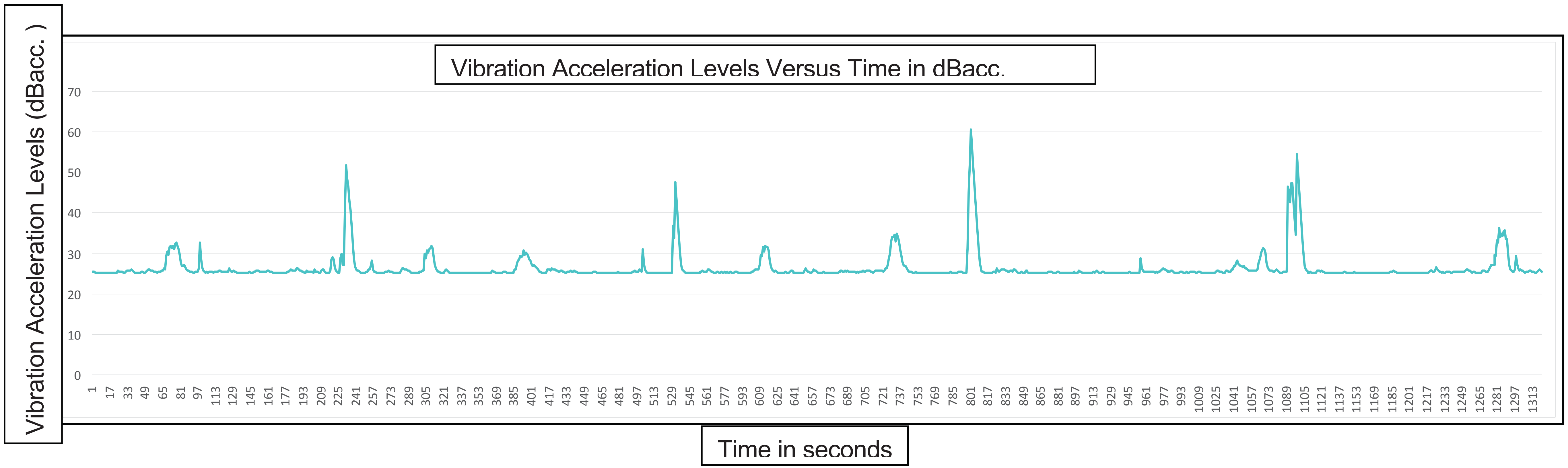


FIGURE A6.14 - RESULTS OF THE TRAIN VIBRATION LEVEL MEASUREMENT VERSUS TIME AT LOCATION 2

ATTACHMENT 7

Noise and Vibration Impact Summary for the Stanwell Drive Area, Transit Project Assessment Process – Scarborough Subway Extension

June 9, 2016

June 9, 2016

AECOM
30 Leek Crescent,
Richmond Hill,
ON L4B 4C2

Re: Noise and Vibration Impact Summary for the Stanwell Drive Area,
Transit Project Assessment Process – Scarborough Subway Extension
SSWA File No. WA14-040

1. Introduction:

The purpose of this memo is to summarize the noise and vibration effects expected from the planned Scarborough Subway Extension on the area of Stanwell Drive. The information contained in this memo is extracted from the Noise and Vibration Impact Study still under preparation by SS Wilson Associates (SSWA) for the subway project.

2. Summary of Assessment Process:

To assess the effects of noise and vibration on various residences and businesses along the subway alignment SSWA identified 50 receptors. A receptor is a group of buildings along the subway alignment that have similar conditions for the following:

- Type of Land use (Residential, Commercial, Industrial, etc.)
- Horizontal Distance to Subway Alignment
- Depth to Subway Alignment
- Distance to Cross-Over Tracks
- Other special factors that may affect the sound and vibration levels

Three receptors have been used to represent the houses on Stanwell Drive. These receptors have been named R41, R43, and R44 in the draft Noise and Vibration Study. R41 includes 41 and 43 Stanwell Drive, R43 includes 45-51 Stanwell Drive, and R44 includes 53-63 Stanwell Drive. Figure A Below provides a visual representation of the subway alignment, and the houses grouped into each receptor name. Figure A also indicates that no subway track ‘cross-overs’ are planned near Stanwell Drive. Figure B shows the vertical alignment of the subway track.

In general, for the analysis process, several conservative assumptions have been made which ensures the noise and vibration predictions are also conservative. This is achieved by taking the worst case condition for each of: horizontal distance to track, depth to track, and distance to a cross-over (if applicable).

In addition, for all of the Stanwell Drive receptors, a conservative adjustment has been applied to the predicted noise and vibration levels to account for the buildings being of light frame construction. This adjustment is in favour of the homeowners as it also imposes more restrictions on the subway design for noise and vibration.

Similarly, the recommended vibration isolation measures to the TTC, namely to use a floating floor slab system, is based on data that is also considered conservative. This is an added safety factor for noise and vibration.

3. Results and Efforts to Protect Local Residents:

The following is a summary of the applicable criteria and the predicted worst case noise and vibration levels due to future train pass-bys at the Stanwell Drive receptors:

- Projected Indoor Sound Level: 22 – 32 dBA
- Recommended Indoor Sound Level Criteria: 35 dBA
- Excess Above Indoor Sound Level Criteria: 0 dBA

- Projected Indoor Vibration Level: 52-62 dB re 10E-6 in/sec
- Ministry of Environment and Other Recommended Vibration Criteria: 72 Lv in dB re 10E-6 in/sec (based on MOE-TTC protocol)
- Excess Above Vibration Level Criteria: 0 dB

The above mentioned levels are based on the inclusion of a floating floor slab to support the subway track. Therefore, the predicted noise and vibration levels are both acceptable for all three receptors. The floating floor slab design significantly reduces the noise and vibration levels in buildings near the alignment. The floating slab design has will be recommended by SSWA for the entire alignment.

4. Summary:

In Summary, the impacts of noise and vibration from the proposed subway on the residents of Stanwell Drive have been considered. The methods used to predict the noise and vibration levels are conservative in several ways and the prediction process has been conducted in the best interest of home and business owners. The predicted vibration levels for the residents of Stanwell Drive are lower than the Ministry of Environment and Climate Change's criteria. The predicted noise levels for the residents are lower than the best practice criteria for indoor noise.

Prepared by:
Hazem Gidamy, M.Eng., P.Eng.,
Principal

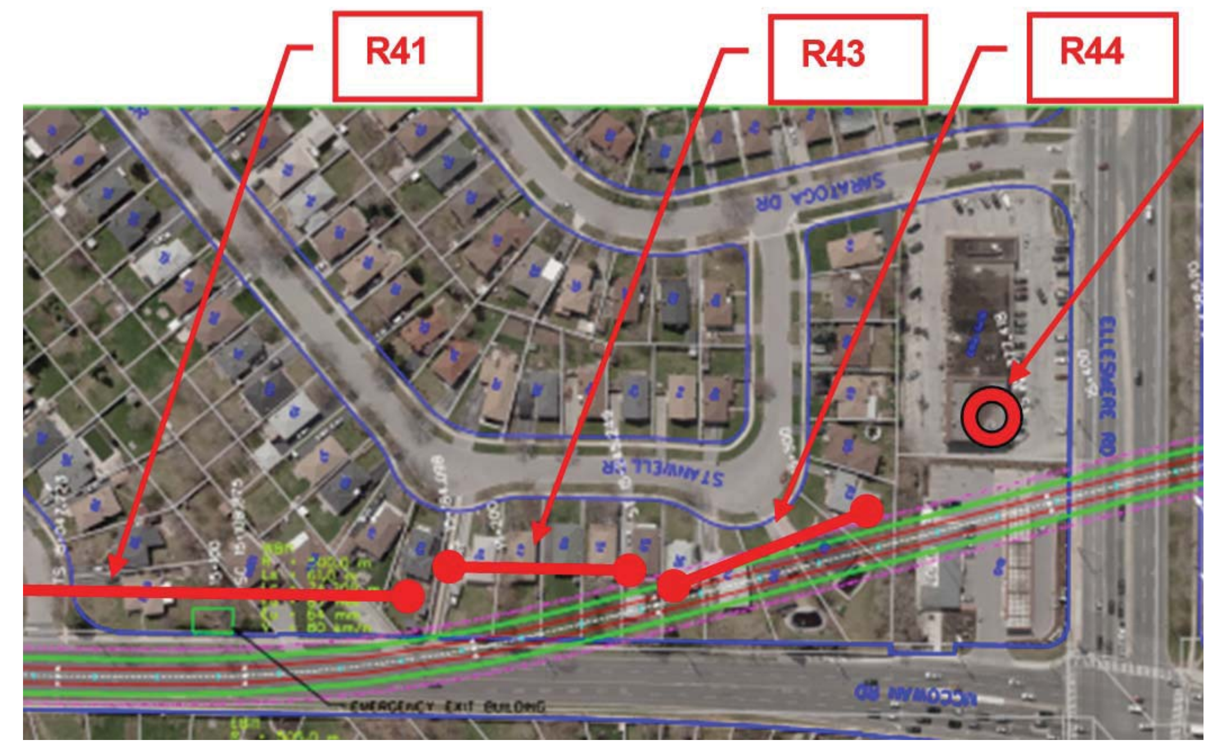


Figure A: Scarborough Subway Receptors and Alignment

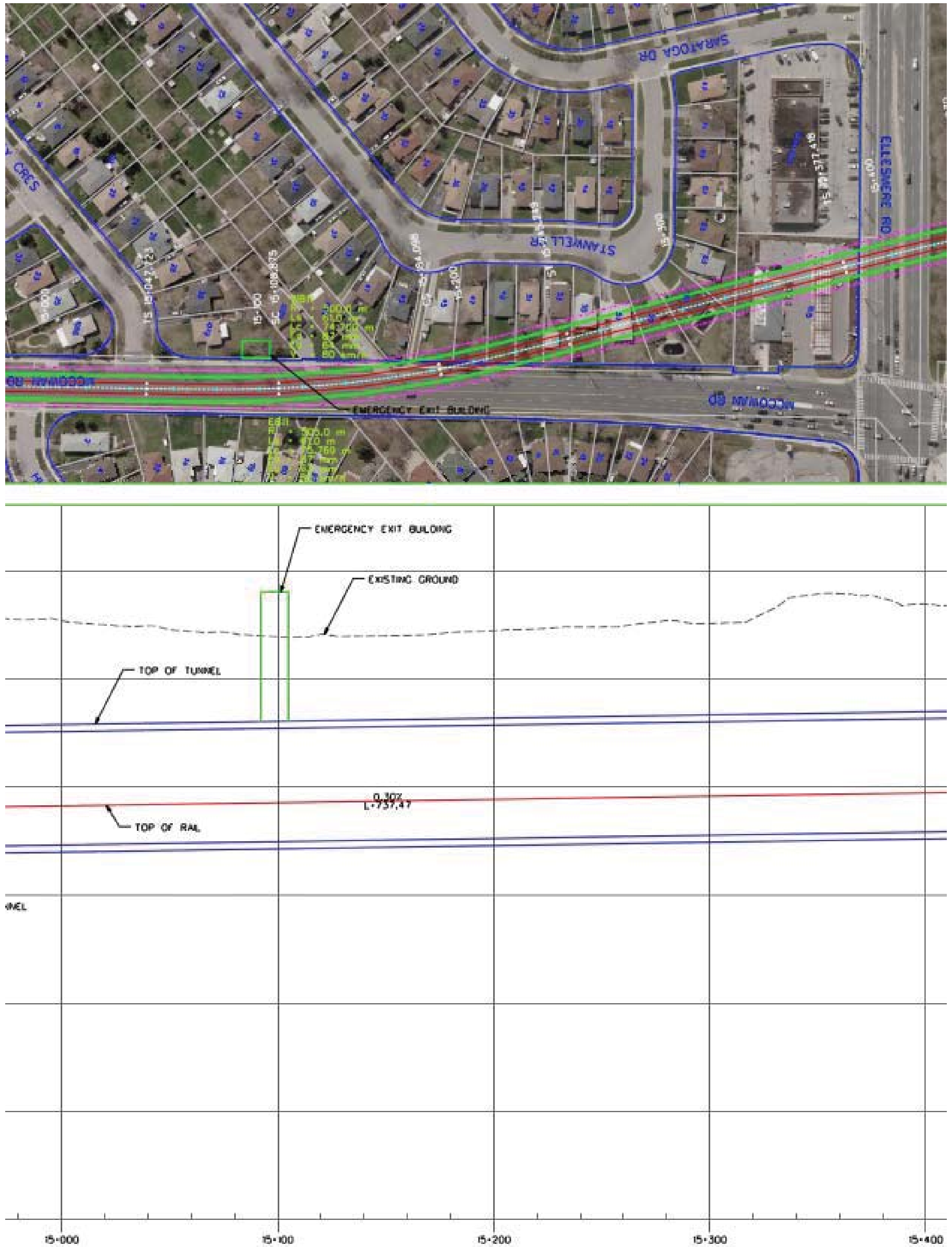


Figure B: Scarborough Subway Alignment and Depth

REFERENCES

1. Community Noise from Rapid Transit Systems, G.P. Wilson, W.I. & A. (no date)
2. MTA New York City Transit Study (no date)
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